Undergraduate Engineering and Built Environment Project Conference 2017

Toowoomba, Australia
18-22 September 2017

Book of Abstracts
Final Year Student Research Project Presentations

Heads of Schools Welcome

A very warm welcome to the University of Southern Queensland, Toowoomba Campus for the 2017 Undergraduate Engineering and Built Environment Project Conference.

The annual Project Conference held on campus in Toowoomba forms the culminating point of your studies in engineering, spatial science and construction. Engineers Australia and other professional bodies have highly praised the Conference for being cross disciplinary and for the quality of your research presentations.

An important dimension of this Project Conference is the interaction that it generates between our graduating students and students who are within the penultimate stage of their studies. The interactions help provide those students with a sense of what will be expected of them in their final year.

The Conference is also an opportunity for you to showcase your skills, knowledge and achievements, and to interact with and learn from your peers. Please make the most of this week – share your knowledge and experiences with your colleagues, network with staff and other students and take the time to reflect on how far you have come in your learning journey and career.

Finally, we would like to acknowledge the efforts of the many academic and professional staff that have been instrumental in making this Project Conference a success. In particular, we would like to thank Associate Professor Alexander Kist, Mr Andreas Helwig and the course team for their outstanding work in organising the project conference and activities. We also recognise the efforts of the project examiners, Mr Chris Snook, Professor Karu Karunasena and Dr Andreas Nataatmadja; and your project supervisors in providing guidance during your project year.

On behalf of all the academic and professional staff, we wish you an enjoyable and rewarding Project Conference.

Professor Kevin McDougall
Head, School of Civil Engineering
and Surveying

Associate Professor Tony Ahfock
Head, School of Mechanical
and Electrical Engineering

Examiner's Welcome

On behalf of the course examiners, we would like to welcome you to the Engineering and Built Environment Conference 2017.

The Project Conference, inaugurated in 1998, is being attended by all penultimate and final year engineering and surveying students. This year there are about 520 students attending this multi-disciplinary conference.

These proceedings include extended abstracts of the verbal presentations that are delivered at the project conference. The work reported at the conference is the research undertaken by students in meeting the requirements of courses *ENG4111/ENG4112 Research Project*. The research is generally pursued over the full final year and will be nearing completion at the time of the conference.

The event also permits penultimate year students, who will undertake their research project in the following year, to experience the technical conference environment, gain appreciation of the standard and breadth of projects that may be pursued, and the presentation standards that will be expected of them.

As for any major event, success requires the effort of many individuals. We would like to thank the Assistant Examiners Professor Armando Apan, Dr Jo Devine, Mr Andreas Helwig, Dr Ray Malpress, Dr Andreas Nataatmadja, Dr Wijitha Senadeera and Associate Professor Paul Wen for their contributions. Academics chairing sessions and critiquing the presentations also play an important role and we thank them for taking time out of their busy schedules to assist with these tasks.

A special thanks to the professional support teams, especially Ms Ashly Peterson and Mr Terry Byrne. Without their help, we would not be able to run this event. Last but not least we would also like to thank all attendees for discussing their work, engaging with their peers and providing valuable feedback during the presentations.

We hope you enjoy this opportunity to share ideas and discuss your work with your peers and faculty staff.

Associate Professor Alexander A. Kist
Examiner ENG3902 & ENG4903
Toowoomba, September 2017

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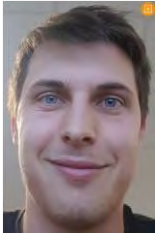|		
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Understanding the relationship between Quality & Cost and to a lesser extent Time with the aim of preventing the occurrence of Quality problems

School of Civil Engineering and Surveying

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Bachelor of Construction (Honours) (Civil)

Supervisors: Dr Vasantha Abeysekera, USQ

Keywords: Construction defects, Quality, Cost.

1. Introduction

The main objective of this project is to 'understand the root causes of quality problems that have a significant impact on time and a significant impact on cost'. The elements of Time, Cost and Quality are all interrelated in a concept known as the Iron Triangle (Figure 1). Whilst there are many reasons for quality problems, this study focusses on defects management particularly with respect to identifying root causes of defects. All of these defects have resulted in both additional money being spent and time being wasted in order for them to be resolved. Given these unsatisfactory circumstances, it is therefore useful to investigate this phenomenon further.

2. Background

Despite significant advancements in technology levels, along with a great deal of hindsight from projects in the past, there are still an alarming amount of defects that occur on a project- by- project basis in the construction industry. The basis of this research topic is to understand why these defects continue to occur so frequently in the construction industry in 2017.

3. Methodology

The first step is to obtain an extensive knowledge and understanding of all of the key concepts related to this topic. These concepts include quality in construction, quality management, defects, root cause and root cause analysis. The next step is to then identify the critical incidents that have led to defects that have had a significant impact on time or cost. The final step is to then apply the established Root Cause Analysis techniques to these critical incidents in order to identify the root causes.

Figure 1: The Iron Triangle (Lock 2007)

4. Key Outcomes

The key outcomes of this project are expected to be the root causes of defects that have a significant impact on either cost or time. These findings will allow to determine whether or not these defects can be prevented in the future.

5. Further Work

The most important stage of this project that needs to be completed is the data collection stage. In order for this to be achieved, the surveys that will be used to undertake this section of the project must be finalised in order to gain an ethics approval from the USQ ethics committee. If this project is deemed to be highly successful, it may lead to further research being undertaken in the future.

6. Conclusions

Due to the fact that this project is still approximately 2 months away from completion, it is difficult to draw any conclusions at this point in time. However, if any of the identified root causes are determined to be preventable, this would suggest that the project has been an overall success.

Acknowledgements

I would like to thank my supervisor Dr Vasantha Abeysekera for his guidance and support throughout this entire process.

References

Lock, D 2007, *Project Management (9e ed.) Gower Publishing*, Ltd.

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1

Renewable Energy Site Selection Tool

Sponsor – Ergon Energy/Energy Queensland

Joshua Adams

BENG - Electrical and Electronic Engineering

Supervisors: Dr. Les Bowtell USQ

Glenn Springall Ergon Energy

Keywords: Renewable Energy, Multi Criteria Decision Making, Electrical Network Grid

1. Introduction

In the last 10 years renewable energy generation has become a very important topic on a global scale. Seventy five percent of power consumed is generated using non-renewable sources and many studies have shown these resources are rapidly depleting (APC 2017). Queensland is no exception to this large industry change and Ergon Energy and clients are looking to implement these technologies where it is most beneficial. Renewable energy comes in many different forms, and each type is suited to a physical location. This project will look at implementing an algorithm which determines possible renewable energy and determines how effective the system may be.

2. Background

The renewable energy site selection algorithm would be an extremely helpful and "efficient tool for both Ergon Energy and clients. This would allow swift decision making on whether a proposed site is feasible, and expected parameters or variables to consider when building a site to meet relevant Australian Standards. Not only would this enhance the economic benefit for all parties, renewable energy sites across the entirety of Queensland would become increasingly popular and cause a shift away from non-renewable sources. The algorithm would require extensive coding knowledge as well as creating an algorithm which is compatible with the ArcGIS program, featuring a user friendly UI.

3. Methodology

After extensive research, it was found there would be many factors which would be used for the final algorithm. The algorithm would include design alternatives for wind turbine plants and solar energy sites. This includes solar irradiance, average wind speed, transportation, proximity to powerlines, geospatial factors such as slope and water paths. The social and ethical impacts were also considered, and this includes protected flora in national parks, state reserves, and aesthetics and noise contributions. These datasets are publicly available from many state wide sources (BOM 2017).

These sections have formed the criteria for the decision process which was to be taken place. An Analytical Hierarchy Process was implemented which also required giving each criteria a calculated weighting. This formed the basis for the algorithm and was to be coded in Python language.

4. Key Outcomes

At this stage of the project different variables and key considerations have been identified for both PV arrays and wind turbines. The hand calculations for the AHP decision process, and have found the relevant weightings for the different factors and worked out the weightings for the design alternatives.

5. Further Work

The future that could be done would be to finish the coding stages and view the output on ArcGIS. It would also be proven to be effective if the final output is verified with known results. These comparisons include the USQ carpark project, and AGL wind turbine sites. This will be undertaken to ensure the validity of the model.

6. Conclusions

In summary, the report has shown the need for a suitable algorithm, and that many factors which would influence the decision of a renewable energy site location. Using several different datasets, the AHP and appropriate criteria weightings a valid output should be achievable. Hopefully, the program will have many key features such as adhering to standards, key design features and rough averages of land value on that area.

Acknowledgements

I'd like to thank Les Bowtell and Glenn Springall for the opportunity to undertake this project.

References

American Physical Society, 2010, *Integrating Renewable Energy on the Grid,* viewed 7/03/17, https://www.aps.org/policy/reports/popa-reports/upload/integratingelec.pdf

National Renewable Energy Laboratory, Bureau of Meteorology, 2017, *Climate Data Online,* viewed 15/03/17, http://www.bom.gov.au/climate/change/datasets/datasets.shtml

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2

The influence of fibre length on the load transfer in sugarcane bagasse fibre/ polymer composites

Sponsor – School of Civil Engineering and Surveying

Dhari S Gh H H Alanezi
Bachelor of Engineering
mechanical

Supervisors: Dr / Assoc Khalid Saleh, USQ

Keywords: Please include three keywords that describe your work.

1. Introduction

Although physical and mechanical properties of various composites of bagasse/ polymers have been studied, very few have been revealed about load transfer mechanism in bagasse fibre/ polymer composites. This study aims to explore the influence of fibre length on the load transfer in bagasse high- density polyethene (HDPE) polymer composite. Sugarcane fibres will be prepared locally. The fibres will be chemically treated with different concentrations of NaOH. The sugarcane fibres/ HDPE reinforced composites will be fabricated, and the tensile behaviour of the composites will be investigated. The findings of the work will be given next semester when the data and results analysed.

2. Background

In recent years, various types of bagasse fibre based composites. Yousif and El-Tayeb (2008) has examined the potential of using sugarcane fibre/ polyester composite as a substitute of conventional synthetic glass fibre. The characteristics of bagasse fibre/cement composites were examined by (Ariffin et al., 2008)for Malaysian sugarcane using electron beam radiation techniques. Lu, Wu, Negulescu, and Chen (2006) studied sugarcane fibre/HDE composites and found that the HDPE resins withlow MFI exhibit high tensile and impact strengths for the composites.

3. Methodology

The sugarcane bagasse fibre sample of various lengths will be mixed with HDPE resins. The weight percentage of the fibre and resin will be recorded. A fixed amount of fibre and resin will be mixed. The mixing process will be done in high temperature (around 1650C) for about 10-15 minutes (Lu et al.2006). After mixing, the blend will be removed from the mixer and cooled down toroom temperature.
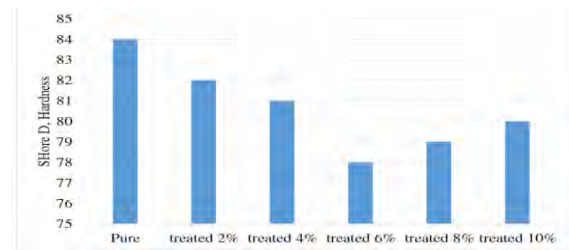
Figure 1 – Sore D hardness value of different materials based on different treatment of fibres.

4. Key Outcomes

Figure 1 shows that the hardness of the composites reduces with the addition of the fibres. The lowest value of the hardness seems to be at the 6% NaOH treated fibres. In the literature, the hardness of similar composites has not been reported. It can be suggested that the reduction in the hardness due to the presence of the fibres which can have some voids in the fibres themselves composites

5. Further Work

For the future work, it is recommended to use the sugarcane in house good since it has less strength compared to other natural fires.

6. Conclusions

It has been found that different chemical treatments significantly influence the load transfer from the polyester resin into the sugarcane fibres. Optimum treatment found within 6% NaOH.

Acknowledgements

Would like to thank my family for their sport in all my study in Australia and especially during my fi al semester. Also, I would like to say thank you for my great supervisor Dr Khalid Saleh who was really helpful and guiding me though the right path to get all the information needed for my project.

References

Yu, Y, Zhang, B, Tang, Z & Qi, G 2015, 'Stress transfer analysis of unidirectional composites with randomly distributed fibers using finite element method', Composites Part B: Engineering, vol. 69, pp.278-285.

Shalwan, A & Yousif, BF 2013, 'In the state of art: mechanical and tribological behaviour of polymeric composites based on natural fibres', Materials & Design, vol. 48, pp.14-24

Mussig, J 2010, Industrial Applications of natural Fibres: Structure, Properties and Technical Applications, Wiley Publications, United Kingdom

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3

Influence of fibre length on mechanical properties of natural and synthetic fibres reinforced epoxy composites

School of Civil Engineering and Surveying

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Mechanical Engineering

Supervisors: Dr Belal Yousif, USQ

Keywords: fibre length, tensile, composites.

1. Introduction

In this project, a comparative investigation will be carried out to study the possibility of using natural fibres practically jute fibres as substitute to synthetic fibres (glass). Epoxy composites will be fabricated incorporate with the jute fibres and glass fibres. Different fibre lengths will be considered (5mm, 10 mm, 15mm, and 20 mm). Tensile characteristics of bother composites will be determined. Fracture behaviour will be examined using

2. Background

There are many parameters influencing the composite design and performance such as fibre length, fibre orientation and fibre form. The general forms of fibres are presented by (Kutz, 2015) as continuous fibres, discontinuous fibres and whiskers, particles and fabrics or mats. Selection of the fibre forms depends on many consideration such as the application, the size of the components and the amount of the mass products, (Mallick, 2007).

I would focus on those works since they are the most related and recent works. Yu et al. (2014) studied carbon nanotubes with different lengths of less than 4 μ m, 2-3 μ m and 8-20 μ m that were used to reinforce carbon/carbon composites. The results concluded that the improvement has strongly influenced by the orientation and length of the fibres. Small length of fibres and very large length of fibres may have defects such as degradation of fibre -matrix interface which can result in annular cracking. This can lead to a very high out-of-plane compressive strength. It is recommended that the fibres should be straight and long and to reinforce the fibre-matrix interface

3. Methodology

Jute fibres were obtained from Bunning warehouse in a mat form, Figure 3.2. The fibres (Figure 1) were

extracted from the mat and separated into different fibre length of 5, 10 and 15 mm. The prepared block was then cut into the tensile dog-bone shape in a dimensions given in figure 3.4. in the experiments, universal tensile machine is used to conduct the tensile testing at a loading rate of 5mm/min. each set of fibre length include 3 samples. The average of the data will be determined and the other properties will be collected. The fracture of the samples will be examined using scanning electron microscopy.
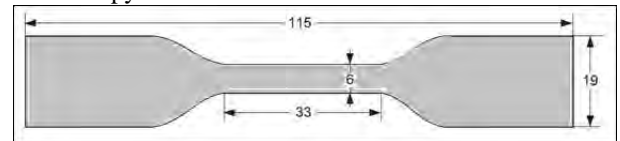
Figure 1 sample preparation of the composites

4. Key Outcomes

The preliminary raw data shows that there is significant influence of the fibre length on the tensile behavior of the composites. That does nto mean the longer the fibre will produce good tensile properties. There is an optimum fibre length in which the load can transfer to the resin during the working conditions.

5. Conclusion and Further Work

Intermediate fibre length is the optimum value for the high tensile proeprties for the composites. Interfatial adhesion of the fibre with the matrix is controlled by the fibre length during the loading conditions. It is recommended to significantly focused on the interface region during the future study for further analysis the results.

References

Mallick, P. K. (2007). *Fiber-reinforced composites: materials, manufacturing, and design*: CRC press.

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4

The use of waste cooking oil Biodiesel at different engine compression ratio

School of Mechanical and Electrical Engineering

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Mechanical Engineering

Figure 1

Supervisors: Dr.Saddam Al-Lwayzy, USQ

Keywords: waste cooking Biodiesel.

1. Introduction

Diesels fuels have high demand in the industrialization world of any country. The search of useful energy and desire to have a clean environment remain always a vital point of interest for any researcher. The fast depleting petroleum reserves have already waved a warning signal all around the world to look for alternative sources to meet the increasing needs of energy. Further, the harmful emissions of fossil fuels also need to be taken care of. An enormous quantity of used cooking oil is being wasted around the world. Disposal of such oil remains again a matter of concern as many pollution related problems.

2. Background

A large magnitude of used cooking oil is wasted all around the regions of the world which causes many environmental problems which disturb the ecological balance. So the best way to avoid the unbalance in the ecological balance is to produce the waste cooking oil methyl esters (WCOME) from the used cooking oil and employ it as an alternative fuel in CI engines (Magín Lapuerta, July-August 2007), (M.A. Kalam, January 2011).

3. Methodology

The WCOME will be tested using the engine test bed at P7,USQ (figure 1) and the results will be compared with diesel fuel. The studied parameters will be: engine power, torque, fuel consumption, thermal efficiency, exhaust gas temperature, in-cylinder pressure, CO, CO2, NOx, and O2 and Are-fuel ratio.
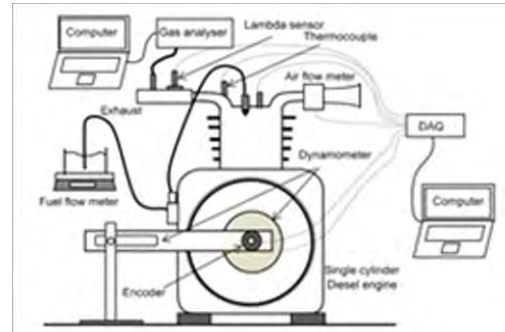
4. Key Outcomes

The key outcome of the is project is run the diesel engine with renewable fuel from WCO and measure the performance and the emissions, it also aims to change the engine compression ratio to increase the power output for the new fuel to overcome the reduction in the power due to the lower heating value of the fuel. At this stage, the literature review and the information related to the effect of compression ratio on the engine performance and emission is collected. Methodology, risk management plan, and save work procedure are developed.

5. Further Work

I will perform the experiments by using the available project resources at USQ and obtain the results, scrutinizing the data and gather the needed information.

6. Conclusions

The results that are expected to obtain are performance and emission characteristics of the engine fueled with waste cooking methyl ester (WCOME).

Acknowledgements

I would like to thank my supervisor for helping me in this project.

References

M.A. Kalam, ,. H. M. M. J. A. L., January 2011. Emission and performance characteristics of an indirect ignition diesel engine fuelled with waste cooking oil. *Energy,* 36(1), p. 397–402.

Magín Lapuerta, ,. O. A. R. G.-C., July-August 2007. Stability of diesel–bioethanol blends for use in diesel engines. Fuel, 86(10-11), pp. 1351-1357.

Mapping and Spatial Analysis of Land Cover Dynamics of Threatened Grassland Ecosystems in the Condamine River Catchment

School of Civil Engineering and Surveying
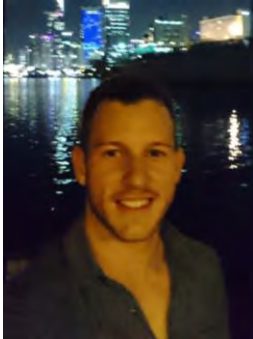
Matthew Alcorn

Bachelor of Spatial Science

Supervisor: Prof Armando Apan, USQ

Keywords: Remote sensing,

1. Introduction

GIS and mapping have played a pivotal role in the monitoring and prevention of environmental degradation, and with the advent of remote sensing further applications in the realm of environmental preservation and monitoring have risen. The use of these technologies is a proven method in the monitoring of large scale land cover analysis and changes, of which has been adapted to the procedure of assessing the current and changing state of the native grasslands in the Condamine River Catchment.

2. Background

The existence of the native grasslands in the Condamine region has been dwindled to less than 1% of its original state, and its remaining distribution is fragmented and sparse. If land use conversion in the Condamine region continues to go unhindered the grasslands will be eradicated completely. Joint analysis using satellite imagery and thematic data will provide quantitative and qualitative data on the land uses most pertinent to the grasslands eradication, with the additional success of this project proving the effectiveness of remote sensing in the classification of grasslands in temperate climates.

3. Methodology

The main aim of the project was to evaluate and define the land use and land cover changes of the Condamine Catchment through the analyses of thematic data and multi-temporal satellite imagery over the select time period. Classification of the satellite imagery was performed and overlain with the thematic data so that quantitative data could be queried. The analysis of this data together allows a correlation between the data and imagery to become apparent, and helps in determining patterns and prime contributors to the reduction of the native grasslands.

Land Uses That Have Contributed The Most to the Clearing of Threatened Grasslands

- ■ Cropping
- ■ Irrigated cropping
- ■ Irrigated cotton
- ■ Grazing native vegetation
- ■ Other

4. Key Outcomes

Unsurprisingly, preliminary land use analyses have found that cropping has accounted for 78% of the reduction of the crops since the early 1900's, with the next land use being grazing. As for land cover, the automated detection and classification of grasslands using remote sensing has yet to meet adequate accuracies. Ultimately, since grasslands share too close of a spectral signature to other common land covers (e.g. crops) land classification is too inaccurate.

5. Further Work

Research will proceed with further attempts to reach a classification that yields an 80% accuracy rating.

6. Conclusions

This project has found the prime land uses contributing to the eradication of the native grasslands, while initial tests show that automated classification of grasslands in satellite imagery appears to need further research.

Acknowledgements

References

Apan, A., Raine, S. R., & Paterson, M. S. (2000). *Image analysis techniques for assessing landscape structural change: a case study of the Lockyer Valley catchment, Queensland*. In Proceedings of the 10th Australasian Remote Sensing and Photogrammetry Conference, 21-25.

Butler, D. W. (2005). *Conservation of Endangered Grasslands in the Brigalow Belt: Are Things Looking up for Bluegrass Downs?* Australasian Plant Conservation: Journal of the Australian Network for Plant Conservation, 14(3), 3.

Mas, J. F. (1999). *Monitoring land-cover changes: a comparison of change detection techniques*. International journal of remote sensing, 20(1), 139-152.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

6

Flexural and compressive characteristics of eco- concrete based on waste ceramic powder

Sponsor – School of Civil Engineering and Surveying

Fahad Aldalmani
Bachelor of Civil Engineering

Supervisors: Dr Khalid Saleh, USQ

Keywords: waste ceramic powder, concrete, strength.

1. Introduction

This project based on the recommendation of previous project conducted at USQ in S2-2016 on the usage of waste ceramic as aggregates in concrete. In that project, it was recommended to use the waste ceramic as powder which is supported by the literate as well. This project is motivated accordingly and focuses on the usage of waste ceramic as powder in concreate. Flexural and compressive properties of the prepared concrete will be investigated. The failure mechanism will be identified.

2. Background

In the light of the above literature, there is an interest in using waste ceramic in different engineering applications. From academic point of views, there is great interest to understand the potential of using waste ceramics in different applications. Majority of the works were focused on the usage of waste ceramics in constructions. Further, the main usage of the waste ceramics can be focused to be in the concrete. The current trend and interest in using waste ceramics in building is to incorporate ceramic powder in concreate rather than as aggregates due to reasons given in the previous section, (Kannan et al. 2017). There are few points can be summarized from the literature which are as follows:

- There is concern with regards of the pollution generated in cement production and attention should be paid to reduce the production of cement or find alternatives
- There is an issue in deposing waste materials. Ceramic is one of them and need to be incorporate in engineering applications and further understanding is required
- The works done on using course aggregate of ceramics in concreate has contradiction and need further confirmation on the effect of the course aggregate of waste ceramics

- Ceramic powder is the potential materials in concrete which can overcome some of the above issues.

3. Methodology

Concrete samples were prepared according to the standard using cylindrical shape. Different content of ceramic powder were used in the concrete samples. Compressive and flexural tests were performed according to the standard.

4. Key Outcomes

At this stage there is some initial data showing the adding of the waste ceramic powder improved the compressive and flexural properties of the concrete. However, this is with the case of 10% adding of waste ceramics. At higher percentage, deterioration in the properties took place. This is in agreements with the published data showing in figure 1.
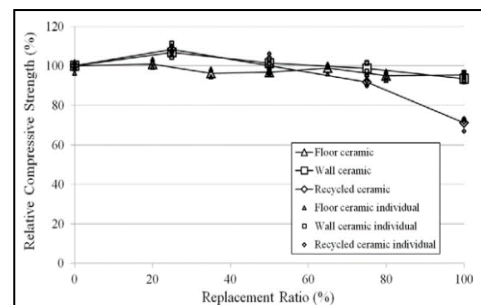
Figure 1 Relative compressive strengths of concretes containing coarse recycled ceramics by Anderson et al. (2016)

5. Conclusion and Further Work

It is high recommended to utilize the usage of the waste powder ceramics in concrete at low percent of content. Further study is required owing to possible incorporate high content of the waste ceramic in concrete.

References

Anderson, DJ, Smith, ST & Au, FTK 2016, 'Mechanical properties of concrete utilising waste ceramic as coarse aggregate', *Construction and Building Materials*, vol. 117, pp. 20-8.

Kannan, DM, Aboubakr, SH, El-Dieb, AS & Reda Taha, MM 2017, 'High performance concrete incorporating ceramic waste powder as large partial replacement of Portland cement', *Construction and Building Materials*, vol. 144, pp. 35-41.

Workability and Compressive Strength of Eco- Friendly Concrete Based on Waste Ceramic Particles

Sponsor - School of Civil Engineering and Surveying

Fahad Alenezi

Bachelor of Engineering (Honours) (Civil Engineering)

Supervisor: Assoc Prof. Belal Yousiff

Keywords: Eco-material, ceramic particles, compressive strength, failure mechanism, workability

1. Introduction

The total amount of natural resources is gradually reducing due to various productions. The construction materials are very expensive and the energy required to produce these materials is extremely unreasonable. For this reason, it is very necessary to search for the alternative materials to minimize the cost and time for the construction. Suitable proportions of waste materials can be used as an alternative of cement to achieve a required strength of concrete.

2. Background

Even few years back, ceramics where only used in pottery. Now a day use of this material is limited to produce roofing tiles, pipe and bricks. A study by Raval, Patel, and Pitroda (2013) shows that cement can be replaced with 10%, 20%, 30%, 40% and 50% ceramic waste in different construction purposes. This study has found that it is possible to increase the concrete strength about 30% and reduce the cost around 13.67% at the same time.

3. Methodology

The total flow or steps of the study is explained using the following flow chart,

MATERIALS SELECTION

SAMPLE PREPARATION: MOULDING AND CURING

SLUMP TEST

COMPRESSIVE STRENGTH

TENSILE TEST
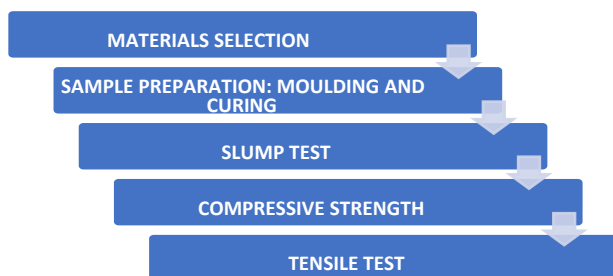
4. Key Outcomes

After the replacement of ceramic waste, the maximum workability of concrete was found to be 15%. After that percentage, the workability was decreased up to 35% and finally it started to rise again.

With the replacement of ceramic about 25%, compressive strength of concrete was found to be 17.3 MPa which is a bit lower than the strength of conventional concrete. On the other hand, by replacing 15% waste ceramic particles, the strength of concrete can be increased up to 23.1 MPa.
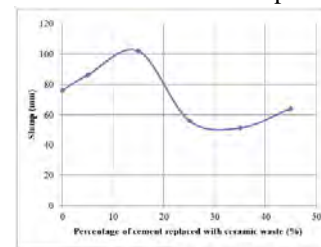
Figure 1- Slump of concrete versus Percentage of cement replaced with ceramic waste.
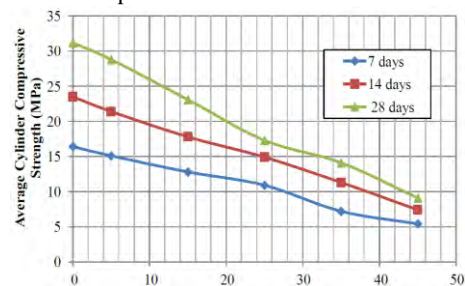
Figure 2- Average Compressive strength versus percentage of ceramic.

5. Further work

In future, I would like to recommend investigating the interaction among the ceramic particles and cement will allow to improve the content of the ceramic powder.

6. Conclusions

The reduced compressive strength is quite acceptable from industrial purposes. It is advised that the low percent of waste ceramics can be efficiently used from both industrial and environmental point of views.

Acknowledgements

I would like to thank the University of Southern Queensland for its support to complete my research project.

References

Dinar, A., & Rapoport, A. (2013). Analyzing Global Environmental Issues: Theoretical and Experimental Applications and Their Policy Implications: Routledge.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

8

Influence of Coir fibre on Adhesive Wear and Frictional behaviour of Epoxy Composites

Sponsor – School of Mechanical and Electrical Engineering

Mubarak Alenezi

Bachelor of Engineering Honours (Mechanical)

Supervisors: Dr Belal Yousif, USQ

Keywords: wear, friction, coir, composites

1. Introduction

In this project, the adhesive wear behaviour of natural fibre reinforced epoxy composites will be studied. The influence of the applied load, sliding distance, sliding velocity and contact conditions dry will be considered in the project. Scanning electron microscopy and roughness profile devices will be used to examine the worn and counterface surfaces. Block on ring technique will be used in the tribological experiments. Wear and frictional behaviour of the composites will be evaluated at different operating parameters. The impact of the interface temperature on the surface modification will be studied.

2. Background

Wear is a process of loss of material or damage due to material displacement (no net change in weight or volume) to one of two solid surfaces in relative motion or both of the solid surfaces in relative motion (Azwa, Yousif, Manalo, & Karunasena, 2013; Yoo & Eiss, 1993). Wear may occur either by mechanical or chemical interaction (Stachowiak & Batchelor, 2013). Oil palm fibre, another natural fibre which is the sugarcane fibre has been investigated. The work proposed the use of sugarcane fibre to replace glass fibre as reinforcement materials and compare their wear properties. Sugarcane fibre and glass fibre were chopped into lengths of 1mm, 5mm and 10mm in randomly distributed and unidirectional mat fibres. The results after testing with a POD machine showed that the wear resistance of sugarcane fibre reinforced polyester increased significantly with increasing load. However, for the glass fibre reinforced polyester, the wear resistance deteriorated drastically. Both works done above proved natural fibres have very high potential to replace synthetic fibres in tribological appearance.

3. Methodology

Coconut fibres were purchased from Bunnings Warehouse at Toowoomba region, Queensland, Australia. It is stated that the coconut is prepared in china. The fibres were extracted and prepared. The fibres are in long length and have some undesired substances attached to it. The diameter of the fibres are about 300 to 400 µm.

4. Key Outcomes

Figure 1 shows the frictional behaviour of different coir composites at different applied load. The addition of the fibres significantly reduces the friction coefficient. The significant of the work will be the usage of lightweight materials for industrial applications.
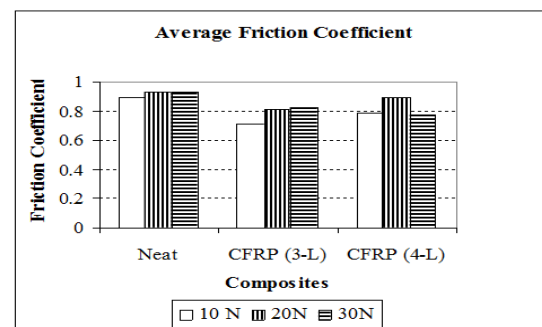
Figure 1 Average friction coefficient for different

5. Further Work

There are many things to be considered in the future work such as different wear modes, different operating parameters and considering the real application in gears and bushes.

6. Conclusions

The main conclusion of the work is that the addition of the coir fibres significantly improve the wear and the frictional behaviour of the composites.

References

Azwa, Z., Yousif, B., Manalo, A., & Karunasena, W. (2013). A review on the degradability of polymeric composites based on natural fibres. Materials & Design, 47, 424-442.

Stachowiak, G., & Batchelor, A. W. (2013). Engineering tribology: Butterworth-Heinemann.

Yoo, J. H., & Eiss, N. S. (1993). Tribological behavior of blends of polyether ether ketone and polyether imide. Wear, 162, 418-425.

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9

WASTE COOKING OIL BIODIESEL FOR DIESEL ENGINE

Sponsor –School of Mechanical and Electrical Engineering

Yousiff Alenezi

Bachelor of mechanical engineering

Supervisors: Dr Saddam hussen Allwayzy, USQ

Keywords: Waste cooking oil (WCO), trans esterification, biodiesel

1.   Introduction

Today, the consumption of fuels shows a significant growth as a result of oil dependency that has been generated in the country, leading to a great amount of pollution emitted towards the atmosphere which in turn results to greenhouse effect and eventually global warming. In order to accomplish this various methodologies were used including fuel preparation and properties and also engine test. There has been a lot of enthusiasm to create biodiesel as an option fuel since it is environmental friendly. For instance, one of the major benefits associated with biofuel is the fact that it can be produced from sustainable assets such as creature fats and vegetable oils (Yochelson, 2016).

2.   Background

Biodiesel has been the major optional diesel fuel for many nations and is normally obtained from creature fats or vegetable oils. There are several advantages of creating biodiesel as an option fuel, due to its environmental advantages. For instance it is environmentally friendly and can be produced from sustainable assets such as vegetable oils and creature fats. Biodiesel is a fuel of vegetable origin that has been used to replace the conventional fuel.

3.   Methodology

In this research project I mainly used quantitative research so as to quantify the research problem by generating numerical data. However, I made use of measurable data so as to formulate facts and also reveal research patterns. In this study I employed a variety of data collection methods such as online research, mobile surveys and interviewing. In this way I was able to gather a lot of information which was significant to the project. For instance, according to Datta and Mandal (2017), they revealed that there is a lot of variation in the CO_2 emission rate at all the brake power used after they studied the CO_2 emission with various blends of biodiesel and two varying treatment of oil as shown in the figure 1 below. Include a heading and a reference to the figure. Please see Figure 1 for an example.
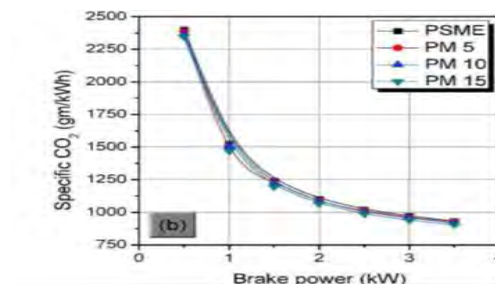
Figure 1 - CO2 emissions with brake power for biodiesel and (a) biodiesel-ethanol, (b) biodiesel- methanol blends, by (Datta & Mandal, 2017)

4.   Key Outcomes

Vegetable oils were used as fluid energizers in burning diesel motors. Biodiesel has been proven to be a good alternative as opposed to the ordinary diesel fuel. This is because there was reduced emissions of carbon dioxide and hence friendly to the environment.

5.   Further Work

There are some issues which I won't be able to address, e.g. assess the situations of various countries all over the world since they have different policies and yet they are sovereign.

References

Datta, A., & Mandal, B. K. (2017). Engine performance, combustion and emission characteristics of a compression ignition engine operating on different biodiesel-alcohol blends. Energy, 125, 470-483. doi:https://doi.org/10.1016/j.energy.2017.02.110

Yochelson, J. (2016). Loving and Leaving Washington: Reflections on Public Service: U of Nebraska Press.

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10

Mechanical and Tribological performance of epoxy composites based on waste ceramic powder

Sponsor – School of Mechanical and Electrical Engineering

Saad Alfadhly

Bachelor of Mechanical engineering

Supervisors: Assoc Prof Belal Yousif, USQ

Keywords: waste ceramics, mechanical, tribological, epoxy composites.

1. Introduction

Eco-materials are becoming the hot topic in recent years due to the impact of synthetic and conventional materials on environments and the cost of resources. On the other hand, there is another equally important issue related to the disposing of waste materials. This project is motivated to address those two issues by developing new epoxy composites based on waste ceramic powder. Tensile behaviour of the newly developed composites with different weight percent of waste ceramic will be investigated. Adhesive wear and frictional performance of the newly developed composites will be studied. The failure mechanisms will be addressed with the aid of the scanning electron microscopy.

2. Background

In the literature, there are many works have been done to use the waste ceramics in civil applications such as concrete as aggregate (Liu, Farzana, Rajarao, & Sahajwalla, 2017) or powder. Interestingly, there are few recent works have been attempted to use the waste ceramic in polymer composites such as (Gohil, Suhail, Rose, Vella, & Nair, 2017). Detailed the importance of using the waste ceramics in polymer composites with some considerations.

3. Methodology

Mould technique is used for the current fabrication process of waste ceramic/epoxy composites. There are two moulds were used. The first one is for the tensile samples, Figure 1 and the second for tribological samples. In the fabrication process, the mixture of epoxy resin and hardener is mixed first and prepared. After that the amount of waste ceramic is added. Electrical mixture is used to uniform the waste ceramic distribution in the composites.

Figure 1 - mechanical sample fabrication

4. Key Outcomes

It is expected different contributions of this work to industries, government policies, environments, and the science of composites, environment, waste management and tribology. The details of the findings will give a clear picture of the outcomes.

5. Further Work

Further study on the adhesion of the ceramic powder with the resin should be the focus of the future study. Also, there are some other resin which can be used and considered in the future works.

6. Conclusions

At this stage, the composites are prepared and the initial results showed that the mechanical (Hardness) properties improved with the addition of the waste ceramics to the epoxy. Tribological results should some deterioration of the properties at high percent of the waste ceramics (above 30%).

Acknowledgements

References

Gohil, S. V., Suhail, S., Rose, J., Vella, T., & Nair, L. S. (2017). Chapter 8 - Polymers and Composites for Orthopedic Applications A2 - Bose, Susmita. In A. Bandyopadhyay (Ed.), Materials for Bone Disorders (pp. 349-403): Academic Press.

Liu, P., Farzana, R., Rajarao, R., & Sahajwalla, V. (2017). Lightweight expanded aggregates from the mixture of waste automotive plastics and clay. Construction and Building Materials, 145, 283-291.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

11

Environmental Fate and Behaviour of Imidacloprid Insecticide, Environmental Impact and Threats to Australian Honey Bees.

Sponsor – School of Civil Engineering and Surveying

Fahad Alhamad

Bachelor of Environmental Engineering (honours)

Supervisors: Dr Ian Craig, USQ

School of civil Engineering and surveying

Keywords: Imidacloprid, Honey Bees and Harmonic Radar Technology

1. Introduction

Insecticides are natural or synthetic chemicals used to control insects by killing them or preventing them from engaging in behaviours deemed undesirable or destructive for plant. Application of insecticides in agriculture industry is intended for insect or pest management; they are important for disease control and providing food and fibre for a growing population. Many insecticides act upon the nervous system of the insect (e.g., Imidacloprid) while others act as growth regulators. This study explores the technical data available on Imidacloprid.

2. Background

Imidacloprid is extensively used in agriculture industry to control sucking insects, termites, some soil insects, and fleas on pets. In 1985, a chemist from Japan created the compound Imidacloprid There are over hundred different pesticide products for sale in Australia that contain Imidacloprid. Existing literature explains how it disrupts the nerve's ability to send a normal signal, and how it stops the nervous system of the insect from functioning properly and results in the death of the vector.

3. Methodology

This chemical mimic nicotine and is found to be effective on invertebrates. It is the recent decline in the population of honeybees which are responsible for food crop pollination cycle that resulted in significant observations, studies, and discussions on

Imidacloprid. It can be attached to the crop seed or applied directly on the foliage of plant. After entering in the soil or to seed, the chemical acts as a systematic insecticide. Application of this chemical on terrestrial plants protect them from insect pest, and does not impact the plants adversely.

4. Key Outcomes

Physical properties suggest that it is a stable compound, which does not like to bond with soil, however, due to high solubility, it can easily be leached in the environment. As a result, it may leach from soil into groundwater under some conditions.

5. Further Work

Imidacloprid is not very toxic to birds and slightly toxic to fish, although this varies by species. Imidacloprid can be toxic to honeybees and other beneficial insects. The role, if any, of Imidacloprid in Colony Collapse Disorder is an ongoing research.

6. Conclusions

Harmonic Radar Technology developed in UK has been used to investigate the effects of insecticides on the flight of the bees. Tests show bees that ingest Imidacloprid, fly in random circles rather than a straight path and becomes disoriented.

Acknowledgements

References

Gervais, J.A.; Luukinen, B.; Buhl, K.; Stone, D. (April 2010). "Imidacloprid Technical Fact Sheet" (PDF). National Pesticide Information Center. Retrieved 12 April 2012.

CDPR, California Department of Pesticide Regulation. 2015. Pesticide Use Reporting. http://ziram.lawr.ucdavis.edu/PURwebGIS.html.

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12

Influence of ageing process on mechanical properties of natural fibre composites

School of Civil Engineering and Surveying

HUSAIN ALI

Mechanical Engineering

Superviser: Dr Belal Yousif, USQ

Keywords: aging, mechanical, natural fibres, composites.

1. Introduction

There are many limitations of using natural fibres in engineering applications such as the fear of component failure due to the lack of understanding, poor fire resistance and poor interaction with other materials. In this project, jute fibres will be used as reinforcements in epoxy composites. The interfacial adhesion of the jute fibres will be improved with the NaOH chemical treatments at 6% concentration as recommended by the literature. Understanding of the impact of the ageing process on the compressive and hardness behaviour of the composites will be investigated. Different volume fractions of fibres will be considered. Scanning electron microscopy will be used to observe the failure surfaces

2. Background

In real application, more of the design components are exposed to different environmental conditions. Most of the research done on the fibre polymer composites have not considered those conditions; however, the tests have been performance under room conditions and dry conditions. This is one of the main reason of the industrial fear of using such materials in various applications, and they are still dependent on metals. In recent work by Rocha, Raijmaekers, Nijssen, van der Meer, and Sluys (2017).

3. Methodology

Jute fibres are used in the current study in a mat form as show in in figure 3.2. The fibres were obtained from Bunnings hardware in Toowoomba, QLD, Australia. In the fabrication process hand-lay-up method is used. A mould of 120 mm x 50 x 5 mm is used for the fabrication. Before starting the fabrication, the cavity of the mould were coated with a layer of wax to prevent the adhesion of the epoxy to the steel mould. A layer of mixture (epoxy and hardener) is poured into the mould with an amount of 150 grams. The next step is placing a layer of jute fibres into the mould. This step is repeated until the cavity is filled. During the laying process, a steel roller is used to get rest of the bubbles, the block of the composite is placed at room temperature for a day to get self-cured. After the self0cured completed, the block of the composites placed in an oven at temperature of 120 oC to be cured.

4. Key Outcomes

It is expected that the aging process will significantly modify the mechanical properties of the composites as previously shown in the literature, Figure 1. At this stage, there is no data for current investigation to be display.
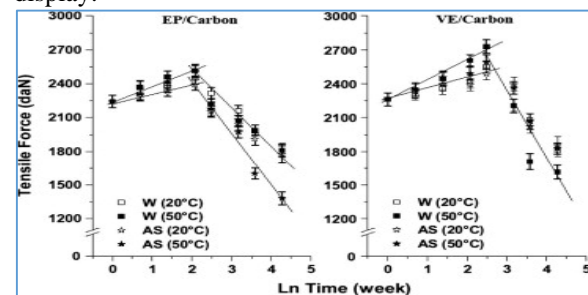
effects of ageing time on the tensile strength of carbon/epoxy composites.

5. Further Work

There are many things to be considered in the future work such as different loading conditions.

6. Conclusion

The main findings of the work at this stage is that there is a clear by the naked eyes that there are some changes on the physical appearance of the composites which have been aged in different process.

Acknowledgements

References

Cysne Barbosa, A. P., P. Fulco, A. P., S.S. Guerra, E., K. Arakaki, F., Tosatto, M., B. Costa, m. c., & D. Melo, J. D. (2017). Accelerated aging effects on carbon fiber/epoxy composites.

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13

Mechanical Behaviors of Grout for Strata Reinforcement

Sponsor – Minova Australia and School of Civil Engineering and Surveying

Hamed Alkandari

Bachelor of Engineering
(Honours) (civil Engineering)

Supervisors: Dr Ali Mirzaghorbanali, USQ

Keywords: Grout, Water to cement ratio, sample size

1. Introduction

Ground reinforcement, which is the injection of foreign materials into the ground, is required when open-cut excavations are made or tunnels are constructed. Moreover, such type of treatment of the ground is also necessary to support the structure being formed and for stability of the adjacent structures. This study investigates mechanical properties of grout based on the accredited standards. The properties that will be investigated in this study include Universal Compressive Strength, Creep and Modulus of Elasticity.

2. Background

Timber was used as a roof support material in the early 1900s which buckled. Over five thousand workdays were lost in working mines that utilized timber and over two thousand fatalities occurred. Timber was replaced by anchored roof bolts which had mechanical anchors that were embedded in the bolt which provided tension that anchored the bolt. The mechanical anchoring technology was replaced by fully grouted roof bolts which develops high stresses in localized areas under small roof movements. Due to this reason, they are stiffer than their precedents. The grout in this type of support acts as a binding medium between the rock and the bolt, improving the load transfer due to higher degree of encapsulation

3. Methodology

The experimental phase consists of casting 15 grout sample, 5 cubic, 5 cylindrical and 5 rectangular. Tests will be performed on samples after curing times of 1, 7, 14, 21 and 28 days. Cubic and cylindrical samples will be tested for Uniaxial Compressive Strength while Bending Tests will be performed on rectangular samples.

4. Key Outcomes

The project focusses on finding the effects of curing time on large and small scale uniaxial compressive strength, on bending strength of grout samples and the effect of water to grout ratio on compressive strength of grout samples. The study conducted by Major et. al. 2017 found that water to grout ratio significantly effects the uniaxial compressive strength of the both samples. Increasing the quantity of water creates gaps among grout particles which become pores after evaporation because of curing which lower strength properties.

5. Further Work

The testing phase of the samples is to begin. This will lend much understanding towards the properties of grout and their dependence on water content and the curing times. This study will be helpful for grout producers and will also enhance rock bolts and cable bolts installation practices in Australian mines.

6. Conclusions

The mechanical properties of Stratabinder HS grout will be studied in this project. The effect of curing time and water ratio will provide a better understanding about load transfer mechanisms of rock bolts and cable bolts.

Acknowledgements

References

Majoor, D., Mirzaghorbanali, A. & Aziz, N. (2017). *Strength properties of grout for strata reinforcement*. Wollongong, University of Wollongong, 204-201.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

14

Laser Scanning, Reflectorless and Post Processed data in the Built Environment

Sponsor – School of Civil Engineering and Surveying

David Allen

Bachelor Spatial Science Technology

Supervisor: Shane Simmons, Senior Lecturer (Surveying)

Keywords: Laser Scan; Built Environment; Reflectorless.

1. Introduction

The continual development of measurement technology used by surveyors leads to questions of accuracy and reliability. Laser scanning, reflectorless measurement and post-processed data are used in many jobs in the built environment. This project tested laser scanning, reflectorless and post-process data points to test their accuracy and precision. The basement of a live construction development was used as the testing site. The accuracies of the technology and its relation to industry standards in the built environment are discussed.

2. Background

The outcomes from any measurement project requires a fit for purpose result. The newly release Leica TS16 and Trimble SX10 total stations were tested in a built environment. This analysis gives consideration to building format plans, lease plans and plans for community titles and how such technology meets standards.

3. Methodology

Baselines were established to create a control network that resulted in quantitative and qualitative results. Least squares adjustments were used to control the main network while triangulation provided accurate position for wall targets. The network of control is shown in Figure 1. This testing method provided a guide for precision and accuracy.

4. Key Outcomes

A key finding that reinforces other past papers is that the greater the angle of incidence of a measurement to the plane of the target object the greater the error.
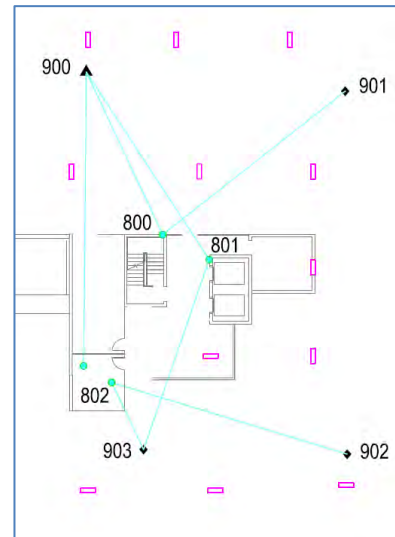
Figure 1 - Control Network

The more time and effort taken to design a control network to limit measurement errors the better the measurement results can be, though the time taken to make these improvements is not necessarily appropriate based on timeframes, budgets and the accuracy required.

5. Further Work

Future work in this dissertation will involve further analysis of the data sets against each other and the control network.

6. Conclusions

The key achievement is the comparison of two newly released total stations and the relationship between such fine accuracy and a fit for purpose product.

References

Lambrou, E & Pantazis, G (2010) *Evaluation of the credibility of reflectorless distance measurement*. Journal of Surveying Engineering, 136(4).

Reda, A & Bedada B, *Accuracy Analysis and Calibration of Total Station based on the Reflectorless Distance Measurement*, Royal Institute of Technology, Sweden.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

15

GSM Based Automated Digital Metering System

School of Mechanical and Electrical Engineering
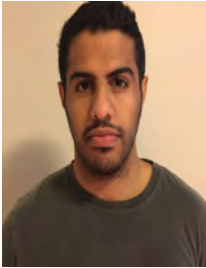
Musaed ALMajdali

Mechatronics

Supervisors: Dr Steven Goh,

Keywords: Analog Metering System (AMS), Digital Metering System (DMS), Energy and Gas Meters, GSM, Harmonics, Power Factor (PF).

1. Introduction

Most of the world metering system is based on AMS. In today's modern world AMS is not able to provide the accurate and effective readings of the consumption of the power and gas utilities due to its inherent processing and computation limitations. In this project all the problems of the AMS are investigated thoroughly, and model of the automated DMS is presented which not only contains the solution of all of the problems of analog metering system but also offers some advance features based on GSM technology.

The proposed design of metering system not only measures all the critical parameters of the power (like correct energy consumption in presence of harmonics in system, True PF etc.) and gas (correct measurement of gas flow under varying environmental conditions etc.) utilities, but also has the built-in option to transmit the utility consumption data to both utility consumer and company database wirelessly using GSM. There are many other significant features of the GSM based automated digital metering system which are discussed in details in the final report of the project.

2. Background

The importance of the project comes from the fact that both the utility consumer wants that, he should only be charged for the utility he consumed and he should not be liable to pay for the utility he did not consume. On the other hand, the utility company also do not want to go in loss by charging less for the more utility consumption. So it is equally important for both utility consumer and company to have the correct metering of utility consumption, which is not possible with analog metering system.

3. Methodology

The methodology to build the model of this project is shown in the following block diagram.
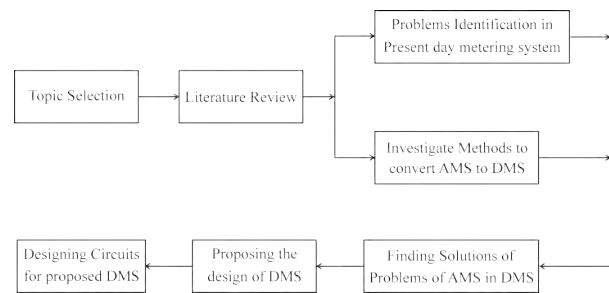
It is clear from the above block diagram that after topic selection and literature review, the problems in AMS are defined. Digital methods are investigated to solve the problems of AMS. Finally the conceptual design of the DMS is proposed, and then all of the building blocks of the conceptual design are converted into electronic circuits. The complete electronic model of the DMS is simulated using Proteous Software and performance and effectiveness of DMS is verified.

4. Key Outcomes

The key outcomes of this project include the following;

1. Integrating power and gas utilities into one single digital meter.

2. DMS is having solution of all AMS problems and much more advance in its functioning

3. Providing the correct readings of utility consumption data under all practical conditions.

4. Wireless transmission of data using GSM

5. Further Work

In this project, the design and model of the DMS is proposed. In future work, the hardware prototype of this model can be built and tested under practical conditions.

6. Conclusions

The performance of DMS is much more superior to the AMS, it offers the solutions of all of the problems of AMS with much more versatile features. In near future, DMS will be used in all smart metering system.

Acknowledgements

References

Darby, S. (2015). Literature review for the Energy Demand Research Project. *Environmental Change Institute*.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

16

The Factors that affect the labour productivity in Kuwait in the residential construction industry

School of Civil Engineering and Surveying

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Bachelor of Engineering (Civil Engineering)

Supervisors: Dr Nateque Mahmood, USQ

Keywords: labour productivity, Kuwait, SPSS

1. Introduction

Despite modern advancements in technology and organizational structure, defining productivity is still challenging. Productivity of each industry is unique in the sense that the inputs are usually different in different industries. The construction industry is multibillion dollar business, with most of it cost being paid to the labour (30% – to 50%). Kuwait**i** construction industry has annual growth of 3.6% and approximately USD 188 bn is being spent in the construction industry**,** which means that the construction industry is highly dependable on labour and the labour is the only productive resource in the construction trade. Hence, this project aim to identify the factors affecting the productivity.

2. Background

The Kuwaiti construction industry in general was investigated before, the previous research focused on one perspective. while in this research multiple stakeholders will participate and the prime focus will be on the residential sector mainly.

3. Methodology

Quantitative approach is adopted for this research and the quantitative data will be collected by using a questionnaire survey. First, the factors affecting labour productivity will be identified. The Litterateur was divided based on the geographical location of the countries as an initial approach to identify the factors that are relevant to Kuwait Next, the questionnaire will be disseminated to contractors, design engineers and project managers. Finally, it will be analysed in SPSS

.

4. Key Outcomes

This in this research the focus is on various stakeholders' aspects to identify the factors affecting the labour productivity in Kuwaiti construction sector. Therefore, identifying the factors affecting the productivity is one of the major outcomes. 6 main categories were created and 37 factors identified.   The questionnaire has been created based on this approach. And then it will be handed to the participants to rank the factors on scale of 5 based on the negative impact

5. Further Work

In order to complete the research survey questionnaire, ethics approval is needed from the University, Then the data analysis process will begin using SPSS software

6. Conclusions

productivity of labour in the construction project is considered to be the t critical part in the industry. The outcome of this project will inform the critical factors that affect the labour productivity in the residential sector in Kuwait in order in decrees the total value of the construction project

Acknowledgements

Who I would like to thank my supervisor for providing the help I needed.by guiding me through this project and help me develop a full understatement of the project.

References

Jarkas, A.M. 2015, "Factors influencing labour productivity in Bahrain's construction industry", *International Journal of Construction Management,* vol. 15, no. 1, pp. 94-108.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

17

Two strokes engine performance using waste cooking oil
Sponsor –School of Mechanical and Electrical Engineering
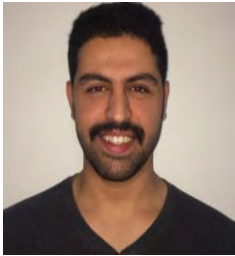
Mohammed Almutairi

Bachelor of Engineering

(mechanical)

Supervisors: Assoc Prof Belal Yousif, USQ

Keywords: two strokes engines, waste cooking oils, performance.

1.   Introduction

The aim of this research is optimise the biodiesel fuel that can be produced from waste cooking oil for two stroke engines and study the performance of two stroke engines work on the proposed fuel from the first stage. Firstly, the waste cooking oil will be characterised and improve its poor properties using chemical additives. Secondly, biodiesel production method from waste cooking oil will reviewed, assessed and optimised to obtain the most appropriate biodiesel fuel. Thirdly, the performance of two stroke engines that run on the optimised fuel will be investigated. The successful completion of this project will create opportunities to highly consider the usage of the proposed biodiesel fuel for two stroke engines

2.   Background

Lubricants are used to reduce the friction between two moving parts and to absorb the frictional heat as well. The lubricant is known a long time ago when the wheels have been invented by 3500 B.C to serve as potter's wheels around in Mesopotamia, (Childress, 2000). Nowadays, lubrication is becoming an essential need for mechanical machines, (Sharma, Adhvaryu, Perez, & Erhan, 2006). Applications of Biolubricants are becoming very vast and dependent on the oil characteristics.

There are few important points have been found in the literature; mainly are

•   Two strokes engines is coming back to the marks, and there is need to improve their effect on environments

•   Waste cooking oil is an issue from disposing point
• Biolubricant is a new area of research owing to replace the syntactic oils. However, findings an alternative non-edible oil with high production is the missing point.

3.   Methodology

Castrol 2T is used as synthetic two strokes engine oil which has been purchased from supercheap store in Toowoomba, QLD, Australia. Waste cooking oil is provided by fish and chips restaurant in Toowoomba, QLD, Australia. The oil was cooked for a week and used at cooking temperature. The oil first filtered with sieve to get rid of the big residual fish or potatoes. The oil then filleted with cloth filter of very low porosity. Before using the filter, the oil was heated up to reduce the viscosity since it was difficult to get it through the filter. Sample of the prepared synthetic oil and waste cooking oil is given in figure 3.1, right and left photo respectively.

Figure 1 electrical generator operated with waste cooking oil and petrol.

4.   Key Outcomes

At this stage, the generator is operated and there is no issue with the electrical provided. Different percent of the addition of the waste cooking oil has no much influence on the generated power. However, there is high emission generated as seen by the naked eyes and would be confirmed with the data.

5. Conclusions & Further Work

The main findings are that the usage of waste cooking in in two stroke engine is possible under the operating condition reported in this work. However, further study on the influence of the waste cooking oil on the life of the engine should be considered.

6. Acknowledgements

References

Childress, D. H. (2000). Technology of the Gods: The Incredible

Sciences of the Ancients: Adventures Unlimited Press.

Sharma, B. K., Adhvaryu, A., Perez, J. M., & Erhan, S. Z. (2006). Biobased grease with improved oxidation performance for industrial application. Journal of agricultural and food chemistry, 54(20), 7594-7599.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

18

Properties of Cement and Geopolymer Mortar Reinforced with Glass Fibre

Sponsor – School of Civil Engineering and Surveying

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Bachelor of Engineering Honours

(Civil)

Supervisor: Dr. Mainul Islam, USQ

Keywords: Geopolymer, Portland cement, glass fibres

1. Introduction

There are a number of environmental and health effects associated with ordinary cement. In order to address these issues, a number of alternatives are under research such as geopolymer cement. Geopolymer cement possesses reduced carbon footprint, and it effectively utilises industrial waste materials such as fly ash and slag. On the down side, it tensile and bending strength is poor due to ceramic-like nature and a number of reinforcements (bars, fibres etc.) have been considered for improving their mechanical properties. In this research study, glass fibres will be added to geopolymer mortar and ordinary cement in different proportions (1.25, 1.5, and 1.75 % by volume). A number of characteristics (physical, microstructure, mechanical) of the resultant cement composites will be studied. In addition, a comparison will be made in the above-mentioned properties of both, geopolymer and ordinary cement based, composites.

2. Background

Cement is one of the most important materials related to construction and infrastructural development. It is extensively used as concrete because it alone doesn't possess good strength and durability, essential for construction purposes. The same issue is prevalent with the geopolymer mortar because of its ceramic-like properties. In order to address these issues, conventional bars or fibres (Glass/carbon fibres) reinforcements are commonly used for both structural and non-structural purposes. Glass fibres are strong, yet light in weight and possess good fracture toughness as well as tensile strength. Alkali resistant glass fibres, a type of glass fibres, are commonly used because of the high alkalinity of the cement mixtures. They are added in different volume percentages ranging from 0.5 to 2%. It has been found that the compressive strength increases with the addition of glass fibres up to a certain extent (Nematollahi, Sanjayan, Chai, & Lu, 2014).

Figure 1 - UTM at USQ

3. Methodology

Different mixtures of geopolymer, cement and glass fibres will be prepared and slump tests will be carried out. Each mixture will then be transferred to its respective mould for allowing it to cure and then the cylinders will be placed in potable water for a number of days. Each cylinder will then undergo testing and the respective data will be collected. Each cylinder sample will also be tested by using SEM for analysis at microlevel. The obtained data will then be analysed, interpreted and discussions will be presented. Figure-1 shows a picture of the universal testing machine (UTM) which will be used for conducting research testing.

4. Key Outcomes

Preliminary studies on the proposed samples have indicated that the addition of glass fibres considerably improves the mechanical properties of both type of composite samples. In addition, as the percentage is increased, there is a gradual improvement in mechanical properties as reported in earlier studies (Vijai, Kumutha, & Vishnuram, 2012), as well.

5. Further Work & Conclusions

An agreement has been found in the research findings of earlier research studies and the results obtained in preliminary studies. A number of different samples (of geopolymer, cement and glass fibre) will be further prepared and tested for understanding effects of glass fibres on their physical & mechanical characteristics.

Acknowledgements

References

Nematollahi, B., Sanjayan, J., Chai, J. X. H., & Lu, T. M. (2014). Properties of fresh and hardened glass fiber reinforced fly ash based geopolymer concrete. Key Engineering Materials, 594(2014), 629-633.

Vijai, K., Kumutha, R., & Vishnuram, B. (2012). Properties of glass fibre reinforced geopolymer concrete composites. Asian journal of civil engineering (Building and housing), 13(4), 511-520.

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19

The influence of Nano-Graphite as lubricant additive on lubricity of canola oil and tribological behaviour of mild steel

Sponsor: School of Mechanical and Electrical engineering

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Bachelor of mechanical engineering

Supervisors: Dr Khalid Saleh, USQ

Keywords: biolubricant, mild steel, graphite tribology.

1. Introduction

The usage of vegetable oil as a lubricant has its own limitations due to their poor viscosity performance despite the recent works to improve the characteristics of potential oils. On the other hand, there are some works have been attempted to use graphite as additives in lubricants which have not been explored in vegetable oil yet. In this project, nano-graphite will be used in vegetable oil and its influence on the oil lubricity will be studied. The wear and frictional behaviour of mild steel will be explored as well. Worn surfaces will be examined using Scanning electron microscopy. Roughness profile of the counterface will be considered as well.

2. Background

Recently, the is significant interest in using additives in lubricant especially carbon-based additive, (Shahnazar, Bagheri et al. 2016). Shahnazar, Bagheri et al. (2016) investigated the performance of mineral oil containing Nano-graphite, Figure 2.10. The results of the work were very remarkable since the addition of the graphite significantly reduce the damages on the surface of the metals despite the poor desperation of the graphite in the oil. Spherical nanoparticles are the main reasons of the wear reduction of the materials under lubricant containing the Nano-graphite. This has been explained in section 2.3 with the aid of figure 2.4. Similar findings have been reported by Lee, Cho et al. (2007) considering different volume content of nanopyramids. Also, the results showed that the high volume fraction of the additives reduces the wear and the frictional behaviour of the interacted metals. This is in contradict to the findings obtained by Zareh-Desari and Davoodi (2016). Zareh- Desari and Davoodi (2016) suggested an aggregation of particles takes place at high volume fraction. This disagreement could be related to the roughness of the surfaces rather than the volume fraction. However, the main issue of using the nano-carbon or graphite is the dispersion in the lubricants.

3. Methodology

Bio lubricants were prepared based on canola oil blinded with different percent of nano-graphite solid lubricant owing to improve the viscosity and lubricity of the oil. The experiments were conducted at USQ using newly developed tribology machine. Different operating parameters and blinds were used. Mild steel were tested against stainless steel.

4. Key Outcomes

There is no confirm findings can be given here. However, based on the previous reported works, the addition of the carbon nanotubes with the 0.5% significantly dropped the friction coefficient of rubbed pair. This may be similar the current results. The initial findings found that the addition of the graphite greatly influence the viscosity of the oil.
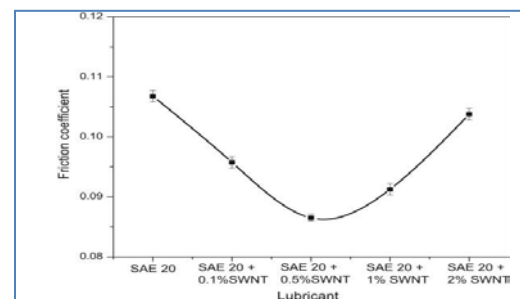
Figure 1 Influence of single-wall carbon nanotubes concertation in SAE 20 Oil on friction coefficient (Cursaru, Andronescu et al. 2012)

5. Conclusions and Further work

There is a high potential of replacing the ordinary oil with canola oil based on low percent of nano-graphite additives. It is recommended further study on different counterface and parts to give better and comprehensive understanding on the influence of graphene on the tribological performance of different materials.

References

Cursaru, D.-L., C. Andronescu, C. Pirvu and R. Ripeanu (2012). "The efficiency of Co-based single-wall carbon nanotubes (SWNTs) as an AW/EP additive for mineral base oils." Wear 290–291: 133-139.

Lee, J., S. Cho, Y. Hwang, C. Lee and S. H. Kim (2007). "Enhancement of lubrication properties of nano-oil by controlling the amount of fullerene nanoparticle additives." Tribology Letters 28(2): 203-208.

Shahnazar, S., S. Bagheri and S. B. Abd Hamid (2016). "Enhancing lubricant properties by nanoparticle additives." International Journal of Hydrogen Energy 41(4): 3153-3170.

Zareh-Desari, B. and B. Davoodi (2016). "Assessing the lubrication performance of vegetable oil-based nano-lubricants for environmentally conscious metal forming processes." Journal of Cleaner Production 135: 1198-1209.

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20

Power quality analysis of USQ Ipswich

Sponsor – e.g. School of Mechanical and Electrical Engineering

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Bachelor of engineering honours, electrical and electronics.

Supervisors: Dr Les Bowtell, USQ

Keywords: Power Quality Analysis of USQ Ipswich

Figure 1 – *General Process for Energy Audit ((Anupama Gupta, 201))*

1. Introduction

This project is aiming to enhance the power Quality I USQ Ipswich campus by applying multiple methods and conducting the existing technologies. This project will indicate the possible solution for enhancing the power quality. Applying energy audit specifically level 2 according to the Australian standard (AS/NZS 3598.2:2014). Ipswich USQ campus is a historical building, so hard to find existing smart digital metering. In this project we will consider the HVAC (heating, ventilation and air conditioning), lightings and computers energy consumption and reviewing the tariff cost. Building management system (BMS) is one of the important application that would help in power quality enhancement.

2. Background

This project is important because it will enhance the power quality by calculating the energy consumption and reviewing the tariff cost. By decreasing the wasted energy usage we will reach the benefit of this project.

3. Methodology

The methodology for carrying out the energy audit consists on below given specific steps. It carries general planning, data measurement plan, data collection, field work, analysis and report. Following methodology can be used for carrying out this energy audit; (StandardTM, 2014). Energy audit involves the steps like planning, problems identification, control of input energy and output ratio to minimize the cost while maximizing the productivity. (K. R. Chowdhury, 1997) The general process for the energy audit has be shown in figure 1.

4. Key Outcomes

We visited the site that we are doing the project and identifies some problems and trying to figure out possible solutions. We asked for all required information in order to apply our methodology according to the information that we will receive.

5. Further Work

If the time permit we will help to install some new metering and find existing technologies to help enhance the power quality by providing data and billing information for the energy consumption in the USQ campus.

6. Conclusions

The power framework can majorly affect HVAC effectiveness and unwavering quality, also on vitality utilization and costs. This project aims to understand how the power quality in the USQ (Ipswich campus) can be enhanced by the application of building management system (BMS).

Acknowledgements

References

Anupama Gupta, P. V. R. P., 2015. A Review on Energy Management and Audit. *nternational Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,* Volume 4.

Standard™, A. Z., 2014. *Australian/New Zealand Standard Energy audits AS/NZS 3598.2:2014,* s.l.: Australian/New Zealand Standard™.

K. R. Chowdhury, M. D. F., 1997. Search: a routing protocol for mobile cognitive radio ad hoc networks. *Computer Communication Journal,* Volume 32.

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21

The adhesive wear behaviour of UHMWPE for knee replacement applications

Sponsor – School of Mechanical and Electrical Engineering

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Engineering

Supervisor: Assoc Prof Belal Yousif,USQ

Keywords: adhesive wear, UHMWPE, wet and dry contacts

1. Introduction

In this project, the adhesive wear behaviour of ultra- high molecular weight polyethylene will be tested under dry and wet contact conditions. The influence of the applied load, sliding distance, sliding velocity and contact conditions (wet/dry) will be considered in the project. Scanning electron microscopy and roughness profile devices will be used to examine the worn and counterface surfaces. Block on ring technique will be used in the tribological experiments. Different solutions in the interface will be considered in the tests. Comparison with the previous published work will be established.

2. Background

Knee and especially the cartilage and meniscus are subjected to tribological and bio-mechanical loading conditions which required good understanding in the design of the artificial knee, (Liu, Jennings, Ingham, & Fisher, 2015).

As mentioned in the previous section, the knee joint is covered with soft layer of articular cartilage with the presence of lubricant (synovial fluid). The loads experienced by the knee joint are significantly excess many times of the body weight during normal daily activities as reported by Stewart (2010). Figure 2.6 shows examples of the deteriorations in the knee since there is bon-bon contact at the edges of the knee. Also, the alignments of the whole body are not correct (Figure

2.6 b). In such situation, the doctor will confirm the need for the replacement is severe pain existed.

several articles in the literature have been studied and there are huge interest in several areas related to the total knee replacement such as design, selection of material,surveying… etc. the most important considerations to be taken seems to be the materials itself emphasising on the soft part of the knee (the polymer). This includes the material type, the stress on the material, tribological behaviour of the material itself. This motivates me to study the mechanical part in the knee especially the polymer part under tribological loading condition. This project UHMWPE is selected to be investigated under a dry and wet contact conditions. Adhesive wear of the selected material will be studied under several operating parameters, sliding speed, applied load and sliding durations. Also a scanning electron microscopy will be adapted to categorise the damages on the samples after each test. In addition, debris from the test will be collected and studied.

3. Methodology

At university of southern Queensland, there is a multi-purpose tribology machine which can be operated under dry and wert contact conditions, Figure 3.1. the tribology machine is made of 1.5 hp motor, block on ring arm, pin on disk arm, load cells to capture the frictional force, and control panel. The machine is integrated with a computer and data acquisition system to directly capture the frictional force with the time. Both configuration is placed in a container to allow both dry and wet contact conditions to be performed. Under the wet contact condition, the container will be filled with water and the sample will be immersed in the water during the operating. The load cell can be operated under the wet contact conditions. The applied load can be increased up to 100 N and the sliding velocitycan reach up to 7 m/s.

Figure 1. tribology machine

4. Key Outcomes

UHMWPE exhibited good wear and frictional performance under the wet contact conditions compared to the dry contact conditions.

5. Conclusion and Further Work

Wet condition introduces low friction coefficient and low material removal. The debris is an essential matter to be considered. Real liquid generated by the knee is recommended for the suture work.

References

Liu, A., Jennings, L. M., Ingham, E., & Fisher, J. (2015). Tribology studies of the natural knee using an animal model in a new whole joint natural knee simulator. Journal of Biomechanics, 48(12), 3004-3011.
doi:http://doi.org/10.1016/j.jbiomech.2015.07. 043

Stewart, T. D. (2010). Tribology of artificial joints. Orthopaedics and Trauma, 24(6), 435-440. doi:http://doi.org/10.1016/j.mporth.2010.08.00 2

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Influence of ageing process on the adhesive wear behaviour of kenaf fibre reinforced epoxy composites

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Supervisors: Dr Belal Yo Yousif, USQ

Keywords: aging, composites, tribological performance

1. Introduction

Nowadays, green products are on the table of government policies, environmental agents, industries and researchers. Biodegradable materials are one of the challengeable areas for the green products. Natural fibres found be an excellent candidate to replace synthetic fibres in polymer composites. However, the limitation of understanding such biodegradable reinforcements under different environmental conditions is becoming an obstacle for the industries. In this study, the kenaf fibre reinforced epoxy composites will be aged in water, engine oil and diesel for three months. The adhesive wear behaviour of the composites will be tested using a block on the ring. The damages on the surfaces will be examined using SEM. The findings will be significant to the industries and the sense of biocomposites

2. Background

Due to the importance of natural fibre/polymer composites and their ways to the industrial products, it is essential to understand the tribological behaviour of such composite under ageing processing. Few works have been found in the literature related to this topic such as (Yousif & Nirmal, 2011), Figures 2.14 and 2.15. In that work, bamboo fibre/epoxy was immersed in different solutions and the wear behaviour o fibre composites were evaluated after three months of ageing. Figure 2.14 indicates that tap water and salt water is the most influential solution in the absorption rate of this composite. Petroleum product such as diesel, petrol and engine oil have less absorption rate compared to the water. The high density of that solution and high viscosity are the reason of the less penetration of that solution in the composites.

Another important parameter to be considered when adhesive wear tests conducted is the applied loads. Each material has it is own PV limits which it the maximum value of speed times the applied loads, (Chand, Dwivedi, & Sharma, 2007). In general, the influence of the applied on the specific wear rate is not that remarkable as can be seen in work done by Shalwan and Yousif (2014) when different epoxy composites were tested against steel under adhesive wear loadings, Figure 2.13.

3. Methodology

Kenaf fibres were obtained from Malaysia through my Supervisor Dr Belal Yousif. The fibres cleaned and washed with water. As recommended by the literature, 4% NaOH treatment of fibre is a must; the washed kenaf fibres were chemically treated with the 4% NaOH. Press machine will be used to fabricate the composites. The fibres will be placed in unidirectional in a container, and the mixture of epoxy and hardener will be poured into the container and then vacuumed press machine will be used to get rid of the air in the composites. The block of the composites was cut into small samples of 20 mm x 10 mm x 10 mm.

Figure 1 Aged samples for three months

4. Key Outcomes

Different aging process has different effect on the wear and frictional behaviour of the composites. Diesel exhibited the lowest wear and frictional values which is due to the lubricity of the liquid and low impact on the composite structure.

5. Conclusion and Further Work

The composite is recommended to be used for bearing application under diesel lubricant conditions. Future work is recommended for three body abrasion since the designed component may be subjected to machining or such loading.

References

Chand, N., Dwivedi, U., & Sharma, M. (2007). Development and tribological behaviour of UHMWPE filled epoxy gradient composites. *Wear, 262*(1), 184-190.

Shalwan, A., & Yousif, B. F. (2014). Influence of date palm fibre and graphite filler on mechanical and wear characteristics of epoxy composites. *Materials & Design, 59*, 264-273. doi:https://doi.org/10.1016/j.matdes.2014.02.066

Yousif, B. F., & Nirmal, U. (2011). Wear and frictional performance of polymeric composites aged in various solutions. *Wear, 272*(1), 97-104. doi:https://doi.org/10.1016/j.wear.2011.07.006

The influence of the fibre orientation on material removal of fibre reinforced polymeric composites due to shear force under sliding conditions

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering Honours (mechanical)

Supervisors: Dr Khalid Saleh, USQ

Keywords: shear loading, fibre orientations, composites

1. Introduction

In this project, hand lay-up technique will be used to fabricate polyester composite based on glass and jute fibre mates. Three different orientations will be considered in the fabrication for both composites. The characteristics of the material removal from the surface of the composite due to sliding condition will be investigated. Different applied loads will be considered to gain different shear force in the interface. Scanning electron microscopy will be used to examine the influence of the shear force on the interaction between the fibre and the resin after sliding at different orientations. The outcome will be significantly contributed to the knowledge of composite science and tribology.

2. Background

According to Shalwan and Yousif (2013), the addition of the natural fibres significantly improved the wear behaviour of the composites since there is a great reduction in the specific wear rate of the composites. However, in term of the frictional behaviour, such composites cannot be used for low friction applications such as bearings, sliding and gears. El-Tayeb (2008) studied the wear and frictional behaviour of sugar cane reinforced polyester and glass fibre polyester composites were tested for friction coefficients and wear rates under dry sliding contact conditions in parallel and anti-parallel orientations. The unidirectional sugarcane polyester showed lowest wear resistance when fibre was oriented parallel to sliding direction. When it was tested in AP-O, wear resistance was as high as that of GRP composite. The coefficient of friction also exhibited this behaviour.

3. Methodology

The fibres were firstly treated to enhance the interfacial adhesion of the fibres with the epoxy matrices. In the treatment, the fibres firstly socked in 6% NaOH solution for 24 hours. The prepared fibres were formed in a mat form displayed. A mould of 20 cm x 20cm x 1.5 cm is used to in the fabrication. The composite were tested using block on ring tribology machine.

4. Key Outcomes

Figure 1 shows the composite when it was tested in normal orientation. The figure clearly shows that the fibres is able to protect the polymer region can carry the load. In other orientations, the complete fibre were exposed to the rubbing area and the damages were very severe.
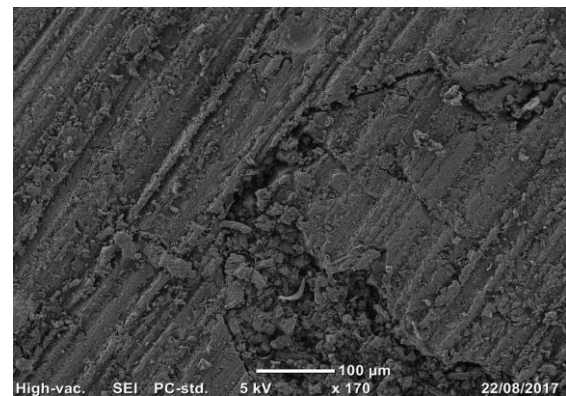
Figure 1 - Sample Diagram

5. Further Work

It is recommended to conduct the tests for other materials using different configuration of fibres.

6. Conclusions

It has been found that 6% NaOH improved shear resistance of the composites. Normal orientation exhibited good wear performance with high friction presented dur to the high resistance to the shear force.

References

El-Tayeb, N 2008, 'A study on the potential of sugarcane fibers/polyester composite for tribological applications', *Wear*, vol. 265, no. 1, pp. 223-35.

Shalwan, A & Yousif, BF 2013, 'In State of Art: Mechanical and tribological behaviour of polymeric composites based on natural fibres', *Materials & Design*, vol. 48, pp. 14-24.

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24

Autonomous Solar Panels Cleaning System

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering Honours (Mechatronics)

Supervisor: Dr Tobias Low, USQ

Keywords: autonomous, solar panels cleaning. Soiling, dust.

1. Introduction

The global requirement of alternate energy resources against the conventional available electrical energy resources is continually increasing (Jawale, Karra & Patil 2016). For these stated reasons the demand for alternative energy sources has become essential, and in this regard solar energy has effectively proved to be the best alternative energy resource because of its easy accessibility and pollution-free nature.

It is clear that the efficiency of the conversion of solar energy into electrical energy is highly affected by the soiling of the solar panels due to environmental conditions. With the accumulation of the dust on the surface of the solar panel, the intensity of the solar light striking with the solar cells reduces which exponentially decrease the electrical output of the solar panel (Tejwani & Solanki, 2010).

This project aims to solve the dusting and soiling problem of the solar panel system by proposing the design of the autonomous cleaning system.

2. Background

With the advancement in the development of renewable energy sources particularly in solar energy system the problem of the solar panel dusting and soiling came into limelight. According to one of the survey conducted by the solar company it is found that on average the output of the solar panel reduces by more than 50% when it is not properly cleaned on regular intervals of time. Many European solar companies are researching, investigating and developing the autonomous systems for proper dusting and cleaning of solar panels (Kumaravel & Jeevandoss 2011). Some of the solar companies have implemented the concept of autonomous solar cleaning system and benefited from the enhanced performance associated with it.

3. Methodology

From literature review the present cleaning methods are identified and examined. Also, advantages and drawbacks are investigated. Using top bottom design approach, to propose the design, model and working of each block of the proposed autonomous cleaning system. Model the enclosure of the autonomous cleaning system device. Look for the existing cleaning brushes models or design and build its 3D model. Design the electronics circuits consisting of motors, batteries and microcontroller to control the motion of the cleaning brushes. Integrate all the physical components (both mechanical and electrical) with 3D printed device autonomous device and test the complete model in real time environment. Write the final report summarizing the details of all of the investigations and finding of the research work.

4. Key Outcomes

This project will add an additional method to clean solar panels in households. The possibility of using unmanned aerial vehicles as a part of the system to transport the cleaning unit form the ground to the top of the solar panel.

5. Further Work

Further studies should be done on stable design for a unit that can balance properly on the solar panel. The unit need to be able to be transported by UAV and landed on a sloped panels.

6. Conclusions

The autonomous solar panels cleaning system will be a system that can clean households' solar panels by using unmanned aerial vehicle.

References

J. B. Jawale, V. K. Karra and B. P. Patil, "Solar panel cleaning bot for enhancement of efficiency — An innovative approach", Devices, Circuits and Systems (ICDCS), 2016 3rd International Conference on, [5 Mar 2016]

R. Tejwani and C.S. Solanki, "360° sun tracking with automated cleaning system for solar PV modules", Photovoltaic Specialists Conference (PVSC), 2010 35th IEEE, [25 Jun 2010]

M. Kumaravel and C. R. Jeevandoss, "Sunlight based I-V characterization of solar PV cells", Instrumentation and Measurement Technology Conference (I2MTC), 2011 IEEE, [12 May 2011]

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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INVESTIGATION OF THE USE OF AN ENVIRONMENTALY- FRIENDLY GEOPOLYMER AS A SUPPLEMENTARY BINDER FOR FOAMED BITUMEN STABILISATION

Sponsor – School of Civil Engineering and Surveying

Piumika Ariyadasa

MENS(Civil)

Supervisor: Dr Andreas Nataatmadja, USQ

Keywords: Foamed Bitumen Stabilisation, additives, polymer

1. Introduction

Significant fatigue performance and rut resistance characteristics have been the motive behind its wide acceptance of foamed bitumen stabilisation as the most promising in situ solution for most Australian road conditions. Foamed bitumen stabilisation in QLD commonly employs C170 Bitumen and a supplementary binder in the form of 1.5% quicklime. Despite its commonly use, there are two serious problems with adding lime; result in an increase of crack potential due to dry out the aggregates to be stabilised excessively and health issues such as causing significant burning to skin and respiratory problems so not very safe.

This project aims to investigate the suitability of a green polymer as the supplementary binder to overcome the shortcomings of lime with foam stabilisation. Considering the inherent properties towards strengthening weak soils, Sodium Silicate solution and fly ash together would be a good combination (a green polymer) worth introducing as a stabilising additive with the added benefit of low risk.

2. Background

In foamed stabilisation, a road recycler is used for pre-milling followed by pulverisation to provide more surface area for supplementary binder (quicklime) to interact (AustStab 2002)). Shape correction is achieved using a grader then lime is spread using spreader trucks and the rate depends on available ground conditions. Then foamed bitumen is sprayed on to the recycled pavement material straight after ensuring that the adequate lime content is fully slaked. Here the problem comes as to the supplementary additive: lime should not be in the material for long prior mixing with foam bitumen as to high potential of change in soil composition due to reaction of lime with clay fines.

Accordingly, working window allowed between mixing lime and compaction is 2 hrs which often hard to achieve. However, in spite of numerus experimental investigations have been conducted, find a better replacement for lime is as yet to be found.

By knowing polymer is good as a primary stabilising binder, this research aims to investigate on Sodium silicate + fly ash as a supplementary binder which has never been studied before. This research is expected to bring foam stabilising technique more economically feasible by utilising fly ash, a waste product of Coal Power available in large quantities desperately in need of utilisation.

3. Methodology

The experimental study for the mix design will be as follows;

1. Characterisation tests for the host soil

2. Specimens will be foamed blending recycled aggregates separately with lime and geopolymer at varying proportions and compacted ready for 28 days UCS test under standard curing conditions. Results will be analysed for optimum polymer/lime content and working time will be checked by comparing specimen dry densities.

3. Marshall Stability test and various others tests will be performed on foamed specimens produced using WLB 10 S foamed bitumen machine mixing same recycled aggregates with optimum lime/polymer content. Results will be analysed for best mix, Density, Volumetric properties. and overall expected field performance hence suitability of this green geopolymer against lime in foamed stabilisation method will be evaluated.

4. Results

Considering the results obtained, overall expected field performance will be evaluated hence suitability of this green geopolymer against lime in foamed stabilisation method will be confirmed.

References

1. Austroads 2011a, Review of Foamed Bitumen Stabilisation Mix Design Methods', Report AP-T178-11 Austroads Publications Online, cited 03 August17,<https://www.onlinepublications.austroads.com.au/items/AP-T178-11

2. Ramanujam, J & Jones,J 2000, 'Characterisation of Foamed Bitumen Stabilisation', Road System & Engineering Technology Forum,cited 18 May 17, < http://www.auststab.com.au/pdf/tp27.pdf>

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

26

Performance Rating of Residential Builders

School of Civil Engineering and Surveying

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Bachelor of Construction (Honours)

(Management Major)

Supervisors: Dr Vasantha Abeysekera, USQ

Keywords: performance, rating system, residential, quality.

1. Introduction
Quality has always been an important factor in construction, alongside time and cost. In the low-density residential sector, it's difficult for consumers to choose contractors based on anything but cost due to inaccessibility to resources. Most commonly, consumers would choose contractors based on cost, word of mouth and testimonials from past customers. This method doesn't give the full picture and can be bias, hence the need for a form of performance assessment that is publicly accessible.

2. Background
Multiple other building sectors already have some form of pre-qualification process, but the low-density residential construction sector does not. This is likely due to the large costs of each project and the fact that cost is being paid by one entity. To ensure the costs the general public spends is not wasted on poor quality homes and are not taken advantage of, a method to assist consumers in choosing the builder with providing the greatest value to them is needed.

3. Methodology
Investigate the current Queensland Building Construction Commission (QBCC) framework and assess its' adequacy and current problematic areas that can be addressed. From the issues identified, create possible performance rating systems tailored specifically for Queensland to assess builders with the inclusion of a resulting reward and punitive approach for well or poor performing contractors respectively.

To assess the feasibility, suitability and acceptability of the performance rating system, feedback is needed from the people who would be most affected by its' implementation. This is done by conducting a verbal survey consisting of the general public, builders, building certifiers and the QBCC.

4. Key Outcomes
From investigating the QBCC framework, recent problematic trends have been identified such as the rise of the costs of non-completion claims.

Investigations into existing performance rating systems of other sectors, governments and countries have demonstrated a number of possible criterions which Queensland builders could be assessed against as well as the similarities, demonstrating areas that are considered significant across numerous locations.

From the above, development of various possible performance rating systems is conceptualised. Incentives and punitive approaches are also believed to assist the system for the desired outcomes.

5. Further Work
More people still need to be surveyed to produce a more accurate analysis of its' feasibility, along with refining the chosen performance rating system including incentivised and punitive consequences.

6. Conclusions
Performance ratings systems are prevalent in other building sectors but there is also a possibility for them in the private housing sector whilst still maintaining their benefits for both consumers and builders.

Acknowledgements
I would like to thank my supervisor, Vasantha Abeysekera for our weekly discussions in offering guidance when difficulties arose and pushing myself to continually work towards the goal at hand. I'd also like to extend my thanks to all participants who were kind enough to offer a moment of their time in answering the survey questions, making up the data presented in this study.

Power Quality Analysis of USQ Toowoomba

School of Mechanical and Electrical Engineering

Salman Ashkanani

Electrical and Electronics (Honours)

Supervisors: Dr Les Bowtell, USQ

Keywords: Energy Audit, Harmonics, LED.

1. Introduction

As part of previous energy audit recommendation USQ made an upgrades in Z building by replacing LED lights (Light Emitting diode) panels. As this project include energy audit looking at the importance of few things that required for this project is necessary. for example, looking at the negative effects such as high or low frequencies. In order to complete the work in good way. It is required to collect the data from USQ campus all the sufficient information needed to this project to improve the power quality by analysing the data that received from the digital metering and other electrical equipment that can provide the data collection.

2. Background

This project aims to improve the power quality which will benefit the facility with many advantages. With energy audit, the result of this is to provide a better power quality with more efficient and less cost.

3. Methodology

Harmonics distortion is one of the main issues that it requires to deal with while analysing the power quality. For example, harmonics (3 x 60 Hz) and so forth. Harmonics distortion if the waveform occurs simply when the fundamental 2nd, 3rd and other harmonics are interfering. Showing in figure above, noticing a clear flat waveform with a peak of 382.6. In order to get this flat waveform, V fundamental has to be 399 volts and the V3 is 5 volts with the respect of the angle of -30 degrees also V5 is 12 volts and the angle is 180, now changing the measure of V3 and V5 a little will not consider as a
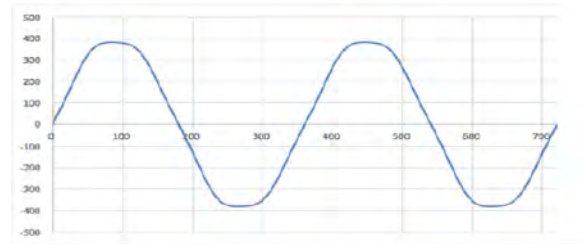
Figure 1 – Harmonic distortion

large effect of the waveform so it is still remaining a flat waveform.

4. Key Outcomes

The main key in this project is to enhance the power quality now in order to measure this, sample of the replaced Fluorescent lamps and new LED panels are provided which will be conducting test some of these materials.

5. Further Work

Seasonality modelling will be importance as well as the assessment of HVAC storage. Other aspects such as alternative heating sources for example, Biomass.

6. Conclusions

Improving power quality by following major steps of energy audit strategies.

Acknowledgements

References

A. A. Moustafa, A. M. M. a. M. A. E.-G., 2000. Separation of customer and supply harmonics in electrical power distribution systems. Orlando, FL,, IEEE International Conference on Harmonics and Quality of Power(ICHQP00).

Dige, 2010. Nonlinear Loads on the Electric Power System Causing Problems for Local Utilities. [Online]. Available at: http://www.brighthubengineering.com/power-generation-distribution/89979-nonlinearloads-on-electric-power-systems-cause-problems-for-local-utilities/[Accessed 2017].

Effectiveness of Bitumen Emulsions as a Stabilisation Agent in Recycled Sealed Rural Roads

School of Civil Engineering and Surveying

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Bachelor of Civil Engineering (Honours)

Supervisors:Dr Soma Somasundaraswaran, USQ

Keywords: Bitumen Emulsion Stabilisation

1. Introduction

Pavement stabilisation has been an advancing technology in Australia for many years. With the need for greener technology, uncertainty of future quarry products and the need for more resilient and financially viable pavement is becoming increasingly important.

This dissertation intends to discover the suitability of bitumen emulsion as a stabilisation agent in a rural sealed road, by incorporating varying amounts of emulsion into specimens and testing the material strength properties.

2. Background

Pavement failures are becoming more common, with availability of funds and the increase in traffic adversely affecting the road network. In situ stabilisation provides a reduction in travel time and material cartage, lowering energy usage and protecting future gravel supplies. Bitumen emulsion can also be applied cold, which is advantageous over comparable products like foamed bitumen.

3. Methodology

Material testing will be conducted to assess the suitability of the application of emulsion stabilisation. Samples have been taken from the Gap Road Construction Project in Pittsworth, using a Wirtgen stabilisation rig as seen in figure one. Control material will be tested for comparative properties including Atterbergs and particle size distribution. Stabilised samples will be tested for indirect tensile modulus.

4. Key Outcomes

This investigation intends to determine if bitumen emulsion stabilisation is effective on recycled pavements from a rural sealed road. This will be achieved by comparing the results acquired in testing, with international design manuals, and between historical testing results of other forms of stabilisation in the Toowoomba Region.

Predications of the outcomes include a reduction in moisture sensitivity (Horak et.al. 1984) and better strength characteristics over untreated material (bondetti et al 2004) along with a comparable modulus to foamed bitumen stabilised materials.

Figure 1: Wirtgen Stabiliser on Gap Road

5. Further Work

Moving forward from this investigation, it would be ideal to test various materials in more districts of the Toowoomba Regional Council. With such a vast area, different gravel products are used throughout each region, and the effectiveness of emulsion stabilisation depends on individual gravel properties.

6. Conclusion

Predicted conclusions are that bitumen emulsion stabilised materials will have a modulus comparable to foamed bitumen, and will exhibit a variety of benefits over unstabilised pavement materials due to the inherit reduction in moisture sensitivity.

Acknowledgements

References

Bondietti M., Murphy, D. Jenkins, K., & Burger, R. (2004). Research on the Stabilisation of Two Different Materials Using Bitumen Emulsion and Cement: Proceedings of the 8th Conference on Asphalt.

Horak, E., Myburgh, PA., & Rose, DA., (1984). Rehabilitation of a cement treated base pavement (Volume 1): Proceedings of the 4th Conference on Asphalt Pavements for Southern Africa, Cape Town, South Africa, , pp 316-326

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Accuracy Comparison between GPS Surveying & UAV Surveying on Seawall Monitoring

Faculty of Health, Engineering and Sciences

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Bachelor of Spatial Science (Honours) Major Surveying

Supervisors: Dr Xiaoye Liu, USQ Mr Julian

Armstrong, North Group Consulting

Keywords: DJI Phantom 4, UAS, GPS, Seawall.

1. Introduction

Monitoring seawalls is necessary to ensure there is no movement, shift or sag of the seawall. These monitoring surveys are necessary and can take up considerable amount of time to complete. This research project was performed to understand what is completed during a monitoring survey, and what method, between Corse Network GPS Survey and UAS Photogrammetry is not only quicker at performing this task but also which is more accurate.

2. Background

Seawalls can consist of many different materials; in some cases cars were even used. With incorrect materials used, and without proper monitoring, seawalls and their integrity could quickly be compromised and cause loss of land or even lives.

This project was important to establish a more effective means of monitoring these seawalls, whilst also improving in the technologies available. The use of UAS technology could potentially improve the area of seawall monitoring.

This project will help to provide further support in the existing knowledge within the UAS technologies in the field of surveying.

3. Methodology

In order to gather enough information, it was necessary to conduct 3 Drone flights over the project area of Tallebudgera Creek Training wall. I order to complete the flights it was necessary to research the requirements and criteria of seawall monitoring and UAS Flight.

A flight path and a GPS survey method was created to use as a comparative method between the flights and conventional surveying. Litchi, an on-board flight app was installed to the Ipad (drone controller) to create the nominated flight paths. This was an integral part of the project. It allowed the pilot the ability to give the nominated flight height, speed, and camera angle and flight path.

All three flights and surveys will be used to create 3D point clouds/CAD Files using Magnet Office and Trimble Agisoft Photoscan and compared and analyse. This data will be used to establish the quickest and most accurate survey method for seawall monitoring.

Figure 1 – DJI Phantom 4

4. Key Outcomes

- Drone surveying with a DJI Phantom 4 is an effective and accurate way of monitoring seawalls.
- Litchi, the flight program used, was an effective tool and was an essential part of the project, allowing autonomous use of the Drone.
- The overall clarity of the photos from the DJI photogrammetric purposes was superb. Clear and precise imagery.
- Trimble Agisoft Photoscan was a simple and effective means of data reduction, allowing an easy interface for all levels of users.

5. Further Work

The comparison data still needs to be compiled and checked against one another to have a better understanding of the accuracies achieved and the results between the two methods of the chosen project area.

6. Conclusions

The DJI Phantom 4, with in house camera can be used as a UAS System and can provide accurate methods of capturing data. This coupled with Litchi, was an impressive piece of technology allowing accurate and fully autonomous use of the drone. If needing a cheaper and quick alternative to GPS Surveying, Drone photogrammetry may be able to provide the accuracies you require.

References

DJI Official. (2017). Phantom 4 - DJI's smartest flying camera ever.. [online] Available at: https://www.dji.com/phantom-4

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Performance of a 2 Plus 1 Treatment on a Rural Highway in Australia

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Majoring in Civil Engineering

Supervisor: Mr Trevor Drysdale, USQ

Keywords: Rural Highway, 2 Plus 1 Treatment, Traffic Performance

1. Introduction

Two-lane highways in rural Australia perform an important task of conveying traffic across long distances. Some sections of rural two-lane highway are under ever increasing strain due to increasing traffic demand. Not all two-lane highways can be upgraded to a four lane carriageway due to cost.

2. Background

The conventional way of optimising a two-lane highway in Australia is ensuring that there is a desirable amount of overtaking opportunities on the section of road. However, on some sections of road the traffic exceeds the capacity of the road but doesn't warrant the implementation of duplication.

The 2 plus 1 (2+1) treatment can be used on the busier sections of road that contain large percentages of heavy or slow vehicles. This treatment is essentially providing continual overtaking lanes in both directions maintaining a consistent opportunity for drivers to pass slower vehicles as shown in Figure 1.

The use of a 2+1 treatment has generally been used in Europe to improve safety, but little research reported the traffic performance improvements or disadvantages.

3. Methodology

A literature review was performed including the compilation of existing literature on 2+1 treatments to provide insight into how the treatment was implemented differently in each case. A concept design & strategy on a typical section of road was created. Analysis in HCS2010, which is endorsed by the Transportation Research Board (2010a), was then

Figure 1 - Typical 2+1 Treatments (Derr, 2003)

performed to find the existing segment of road performance and then the 2+1 treatment was analysed to find the improvement in performance over the section of road.

4. Key Outcomes

From research it was obvious that no case study had implemented the 2+1 treatment the same. No guideline for this treatment has been detailed. The 2+1 treatment is an effective alternative to duplication.

5. Further Work

Further experimentation of application in an Australian road environment is required to create a practical guideline to assist with the implementation of the treatment in the industry.

6. Conclusions

The 2+1 treatment can be implemented on rural two-lane highways in Queensland that are struggling to maintain satisfactory performance. The treatment improves traffic performance and the level of service of near capacity two-lane highways.

Acknowledgements

References

Derr, B. R. (2003). Application of European 2+1 Roadway Designs. *National Cooperative Highway Research Program*

RESEARCH RESULTS DIGEST(275).

Transportation Research Board. (2010a). *Highway Capacity Manual Volume 1*. Washington, DC: National Academy of Sciences.

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Human Powered Lift for Improved Safety when Working at Heights

School of Mechanical and Electrical Engineering

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(Honours)(Mechanical)

Supervisors: Dr Ray Malpress, USQ

Keywords: human powered lift, working at heights, safety

1. Introduction

Human power has been used to power motion for hundreds of years. Walking, pushing, peddling and winding are all mechanisms used to power vehicles or machinery without the need for an external power source. This concept has been extended to power other vehicles such as planes, helicopters & boats. Human powered vehicles are not only a cheap and environmentally friendly option, they are also a great health and fitness option for the user. This project looks at the possibility of using human powered movement as a method improved safety when working at heights.

2. Background

Currently, methods for working at heights include ladders and Elevated Work Platforms (EWP). Where an EWP is not appropriate due to height, cost or level of hazard, a ladder is generally used. Ladders are highly hazardous and are responsible for many deaths in Australia each year. This hazards are due to the unstable nature of a ladder, its tendency to tip or slip and the precise way in which it must be used to be safe. This project will explore options for an improved EWP or ladder which is powered by human movement.

3. Methodology

A literature review has been completed to understand current methods of working at heights, hazards and with working at heights, design requirements and limitations, the ergonomics of human power and attitudes towards safety and their effects on incident rates. This information was used to create a set of design requirements. Design ideas were developed and

Figure 1 - Vertical Walking - Manually Powered Lift

assessed for suitability. The final design will be tested and a prototype developed if feasible.

4. Key Outcomes

The design methodology was successfully applied and a design has been developed. The intention of the design is to replace the ladder for use in some construction settings.

5. Further Work

Testing of the design using FEA analysis will commence shortly to validate that the design criteria have been met. A prototype should be developed and trialled in a real world setting.

6. Conclusions

There are very few designs for human powered vehicles for movement in the vertical direction. Working at heights is one area that can benefit from this technology, however there are potentially many more.

Acknowledgements

I would like to thank my supervisor Dr Ray Malpress for his quick and thorough feedback throughout, as well as his guidance and patience. The idea for the project came from a conversation with Shaun Johnstone who suggested I consider vertical motion, thank you Shaun.

References

Vertical Walking - Manually powered Elevator uses 10% as much Energy as climbing Stairs 2016, YouTube, YouTube. Directed by Lab, RF.

Australia, SW 2013, Work-Related Injuries and Fatalities Involving a Fall from Heights Australia, TDA Section,   viewed 25th March 2017, <http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/812/Falls-from-Height.pdf>.

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Detection of High Impedance Earth Faults Utilising Metering Assets

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Power Engineering)

Supervisor: Dr Andrew Hewitt, USQ

1. Introduction

Presently, when a high impedance earth fault occurs that is not isolated by protection systems, Energex is reliant on members of the public to report the event. The aim of this research project is to investigate the use of distribution transformer metering assets for the detection of BFEFs.

2. Background

A high impedance earth fault typically occurs when an overhead conductor breaks and falls, making contact with the surface of the ground. The fault current that flows may be fed directly from the source feeder, or back-fed via the primary windings of the downstream distribution transformers, as depicted in Figure 1. In the latter case, the fault current will be influenced by the load side impedance.

3. Methodology

Data has been collected from metering assets located on the secondary terminals of 11kV/415V distribution transformers, and correlated with known BFEFs within the Energex 11kV network. Theoretical analysis of BFEFs has been performed to assist in the identification and verification of the fault characteristics exhibited by the historical metering data.

4. Key Outcomes

Theoretical analysis and fault data shall be used to develop a fault analysis methodology that can identify BFEFs within the Energex 11kV Network. The proposed fault detection scheme will be designed to operate after the existing protection systems have operated to ensure that the 11kV network protection
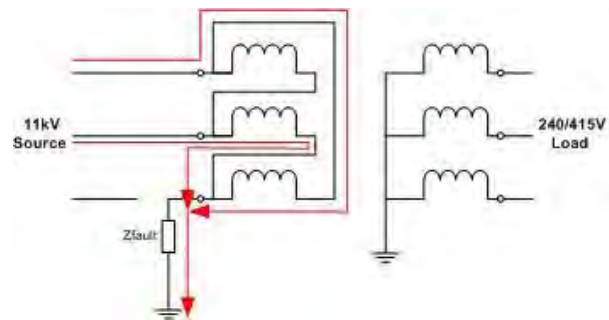
Figure 1 – A Single Wire Down Back-Fed Earth Fault

grading is not compromised, whilst also ensuring that any BFEF is disconnected quickly and reliably.

5. Further Work

Further analysis of historical and theoretical fault data is being undertaken to develop a fault detection algorithm, and to ascertain if the proposed system will operate correctly based on historical metering data.

6. Conclusions

Historical data and theoretical analysis indicates that the magnitude and angle of the secondary phase voltage, current and sequence components may be used to indicate and differentiate between the presence of a BFEF and an open circuit 11kV line or fuse.

Acknowledgements

References

Benner, C. & Russell B. (1997). Practical high impedance fault detection on distribution feeders in *IEEE Transactions on Industry Applications, 33(3).* doi:10.1109/28.585852

Li, L., & Redfern, M. (2001). A review of techniques to detect downed conductors in overhead distribution systems in Developments in *Power System Protection, Seventh International Conference Publication No.479 (IEE),* 169-172. doi:10.1049/cp:20010127

Abusdal, G.M., Heydt, G.T., & Ripegutu, A. (2015). Utilization of advanced metering infrastructure in back- fed ground fault detection, IEEE. doi:10.1109/PESGM.2015.7285819

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Accounting for climate variability in the design of rain-fed water supply systems in Papua New Guinea communities

Faculty of Health, Engineering and Science

Nana Bill

Environmental Engineering

Supervisor: Justine Ballie, USQ

Keywords: Climate, Rainfall, Water Supply

Introduction

WHO (2016) states that Papua New Guinea is one of the least countries in the world to access portable safe drinking water. The socio-economic factors that contribute to the well-being of PNG are closely linked to the natural environment. Therefore the climate is a major player towards availability and sustainability of resources to sustain societies.

1. Background

Climate change and ENSO driven weather extremes that triggered drought, flood, cyclone, frost and landslide have devastating impacts on food and water availability across PNG. According to World Bank (2011), 18% of total population live in urban areas while 82% reside in rural areas and depend heavily on subsistence agriculture coupled with fishing and hunting. The water availability is extreme affected by climate drivers including ENSO and MJO. Therefore the main aim of my research project is to explore climate variability and develop a climate resilient sustainable design for rain-fed water supply system, as a means to support rural communities during food and water shortage. Water resources management is a core subject area in Environmental Engineering. Therefore this project gives me the opportunity to apply the knowledge and skills gained and expand on my research ability.

2. Methodology

The methodology employed is mainly quantitative research based on climate and rainfall data, which is associated with a water balance model, regression analysis, cumulative probability analysis and basic statistical analyses.

3. Key Outcomes

The western Pacific warm pool is influenced by the El Nino Southern Oscillation and Madden Julian Oscillation and these climatic phenomena extremely affects the rainfall in PNG (ABOM 2011). This is due to the latitudinal location and the country's physiography. Linking the two phenomena and using statistical analysis to establish a relationship with PNG rainfall for different regions has allowed for the development of decision rules under different climatic conditions. This has been incorporated into a water balance model for the water supply systems. Using the model, key driving factors for design and operation are identified and used to develop a climate resilient and sustainable rain-fed water design including appropriate operational guidelines for different locations within PNG as a support system during drought.
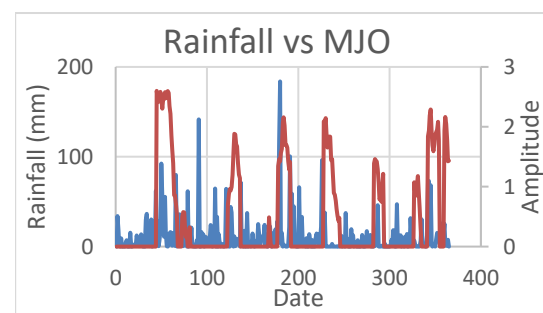
Figure 1 – Rainfall & MJO relationship

4. Further Work

There has been some difficulty to access historical PNG rainfall data from PNGWS. Therefore if time and resources permits a design and operational guidelines for a water supply system to cope with future climate conditions can be completed.

5. Conclusions

A water supply system must be climate resilient in order to be economical and sustainable. Links between climate drivers and rainfall can be used to predict upcoming dry periods and appropriate management strategies can be adopted to offset the impact of climate variability on rain-fed water supply systems in PNG.

Acknowledgements

References

World Bank (2011). *Vulnerability, Risk Reduction and Adaptation to Climate Change Papua New Guinea.*
Australian Bureau of Meteorology and CSIRO, (2011). *Climate Change in the Pacific: Scientific Assessment and New Research. Volume 1: Regional Overview. Volume 2: Country Reports.*
World Health Organisation (2016). *World Health Statistic 2016 Data Visualisation Dashboard.*

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34

Using Stereo Images from an Imaging Total Station to Autonomously Produce 3D Real World Co-ordinates

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours) majoring Surveying

Supervisor: Dr Glenn Campbell, USQ

Keywords: Imaging Total Station, Analytical Photogrammetry, Programming

1. Introduction

The common survey instrument a 'Total Station' has seen in recent years the integration of a digital camera. The software linked to this instrument does not allow coordinated points to be formed from just taking images, it needs additional measured points with the images. It is however possible to use other photogrammetry software packages, although this does not easily provide the required outcome and is significantly expensive, therefore the general surveyor would not justify these costs. This opens the gap to create a tailored program to achieve 3D coordinates from just the images taken. This can be achieved through using the images taken with the instrument and its attached metadata, and applying analytical photogrammetry processes.

2. Background

This project is significantly beneficial as it works towards maximising the use of the spatially known position of the camera in the instrument. It introduces a cost effective and efficient process to undertake a survey. Creating the possibility for surveyors to complete a task substantially safer and quicker.

3. Methodology

To identify if the coordinates created through the two photos were accurate, it was important to one, test the points through several scenarios. These included, objects at different depths in the stereo image pair, and scattered objects throughout the overlap of the images. I.e. high, low, left and right. Two, have a survey accurate model of the objects chosen for comparison. Due to the large quantity of mathematics involved in generating a
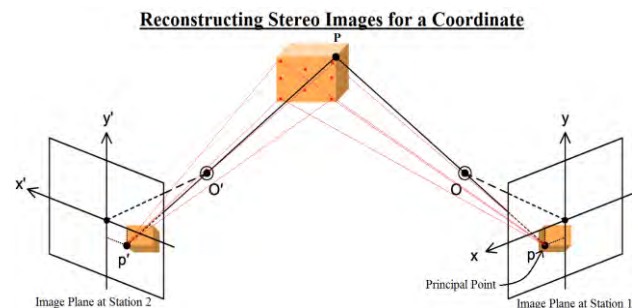
Figure 1: Projection from Principal Point to Object (Dai & Lu 2012, p.888)

single point using the stereo images, it was critical to develop a code to automate the process and make it achievable to test the large population size.

4. Key Outcomes

The key outcome for this project is to provide a program where you click on the same object on two photos taken by the Imaging Total Station, and allow the program to generate 3D real world coordinates of that object in a .CSV or similar format.

5. Further Work

Final analysis of data is yet to be finalised. However, at this stage areas to increase the accuracy of the generated coordinates will be beneficial, through looking at the quality of the camera and the camera focal length. Another area to look at entails improving the code to generate line work and digital terrain models to increase the functionality of the program.

6. Conclusions

The project aims to achieve optimising the use of the camera in the Imaging Total Station, by producing a tailored code to work in sync with the instrument to minimise field time and maximise efficiency to complete surveys, particularly of buildings at a low cost.

Acknowledgements

I would like to thank my supervisor Glenn Campbell. The advice and ideas he gave me throughout the project were first class. I would also like to thank the University of Southern Queensland for allowing me to use an S7 Imaging Total Station to complete my testing and suitable software to write my code.

References

Dai, F. & Lu, M. (2012), Three-dimensional modeling of site elements by analytically processing image data contained in site photos. *Journal of construction engineering and management*, *139*(7), 881-894.

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Investigating the Cause of Requests for Information (RFIs) in Civil Construction

School of Civil Engineering and Surveying

Jared Black

BENH

Supervisor: Mr Paul Tilley, USQ

Keywords: RFI, Construction, Civil

1. Introduction

Requests for Information (RFIs) are an important means for contractors to formally request additional information during construction projects.

This research project focuses on the causes of RFIs in civil construction projects, as well as the consequences of these RFIs.

2. Background

Despite advances in technology, it is widely accepted that the improvement in performance of the construction industry is not in line with that of other industries. There is a growing body of research that implicates poor performance from all project stakeholders as the primary cause of dissatisfactory project outcomes

From designer's perspective, this research indicates not only that performance is not improving, but that the quality of project documentation has been declining for the past 30 years.

One means of assessing project documentation quality is by assessing the RFIs that are received from the contractor during construction.

3. Methodology

The methodology for this project is based on industry case studies. The case study data was collected from projects managed by Black & More, an engineering and project management consultancy based in Cairns, Queensland.

4. Key Outcomes

It is expected that this research will help to compare existing research which typically focuses on building construction project documentation, with civil construction project documentation.

Preliminary results indicate that due to a reduced level of complexity, civil construction projects receive less RFIs relating to missing, incorrect and conflicting information when compared with building projects. The
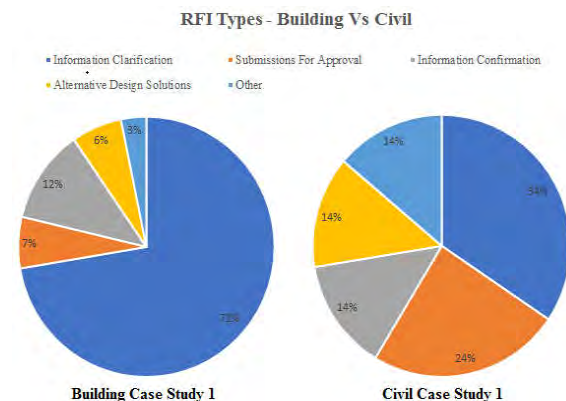
Figure 1 – Comparison of Building Project RFI types and Civil Construction RFI types for two case study projects.

number of other RFIs was comparable with the building project case studies (Refer to Figure 1 above).

5. Further Work

Undertaking further research that focuses on large budget civil construction projects may help to better connect the existing research on complicated building projects with the remote civil construction work which is the forms the basis of this research.

6. Conclusions

It is anticipated that the final conclusions of my research will be that RFIs in civil construction projects have similar causes to RFIs in building construction projects, and that the consequences of these RFIs are comparable.

Acknowledgements

The work undertaken to date would not have been possible without the continuing assistance of Mr Paul Tilley, who has provided input and advice on this topic since September 2016. Paul's extensive research and similar reports on construction have formed the background to this research.

Without access to industry data from Black & More, it would not have been possible to undertake research of this nature.

References

Hughes, N. Wells, M. Nutter, C. L. & Zack, J. G. (2013) *Impact and Control of RFIs on Construction Projects*, Navigant Construction Forum.

Tilley, P. A. (1997) *Causes, Effects and Indicators of Design and Documentation Deficiency,* Proceedings of the First International Conference on Construction Industry Development: Building the Future Together, Singapore, Vol. 2, pp. 388-395 (9-11 December, 1997)

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

36

Fatal crashes at T-junctions in New South Wales

School of Civil Engineering and Surveying
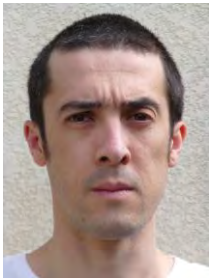
Tyson Blades

Bachelor of Engineering
(Honours) (Civil)

Supervisor: Dr Soma Somasundaraswaran,
USQ

Keywords: T-junctions, Fatal crashes, Vulnerable road users (VRUs)

1. Introduction

T-junctions are generally accepted as being the safe form of basic road intersection, however there have been more fatal crashes at this basic intersection type than any other within NSW over the past decade. The project aims to identify factors contributing to these crashes using crash data, and discuss findings against current design standards, design practices and existing research.

2. Background

Intersections are locations of the more complex driving tasks, being prone to increased crash occurrences and crash severity, and the most crashes in urban areas.

Limited literature exists examining specific attributes of fatal crashes at T-junctions over the area of a significant road network, with relevant studies typically being focused on a single, or a few road safety issues.

There is an opportunity to improve the understanding of why high numbers of fatal crashes are occurring at T-junctions, regardless of the perceived advantages they have over the other types of basic road intersection.

3. Methodology

A network screening process has been used to identify the sites where fatal crashes at T-junctions occurred in the NSW road network over a five-year study period (2011-2015).

A validation process confirmed that the identified sites met suitability criteria for the project requirements, and a nominal safety evaluation was undertaken to assess critical geometric components of the validated sites.

Results of the data analysis have been prepared using the key groupings: type of intersection control; speed environment and; network environment (urban or rural).
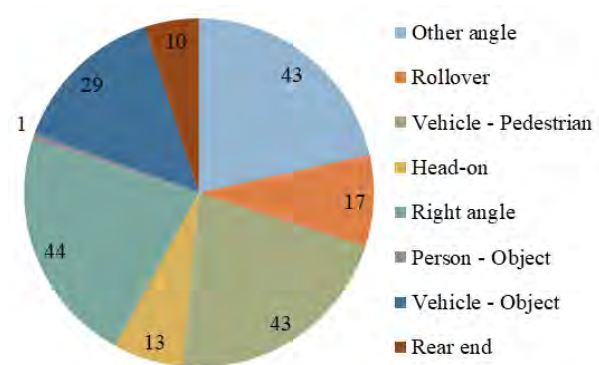
Figure 1 – Number of fatal crashes at NSW T-junctions by first impact type (2011-2015)

4. Key Outcomes

T-junction crashes resulting in a fatality were 'one-off' events, with one fatal crash at each location. Despite there being no repeat crash sites, there are factors that may increase the risk of these crashes occurring. Most crashes involved VRUs (older road users, motorcyclists, pedestrians and cyclists). Their layout also makes them prone to side impacts, there being a high number of 'right angle' crashes as shown in Figure 1.

5. Further Work

The results of the data analysis are to be discussed in relation to current design standards and guidelines, in the context of Safe Systems principles, considering impending vehicle and road safety technology.

6. Conclusions

Despite the favourable geometric conditions provided by T-junctions, they may be prone to severe impact crashes involving VRUs. Their status of being recognised as generally safe may warrant review.

Acknowledgements

References

Austroads. (2010). Guide to Road Design Part 4A: Unsignalised and Signalised Intersections *2nd edn, AGRD04/10*. Sydney: Austroads Limited.

Cornelissen, M., Salmon, P. M., Stanton, N. A., & McClure, R. (2015). Assessing the 'system' in safe systems-based road designs: Using cognitive work analysis to evaluate intersection designs. *Accident Analysis and Prevention, 74*, 324-338. doi:10.1016/j.aap.2013.10.002

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

37

Rehabilitation of Timber Bridge Piles with Splitting Failure Mechanism

Sponsor – School of Civil Engineering and Surveying
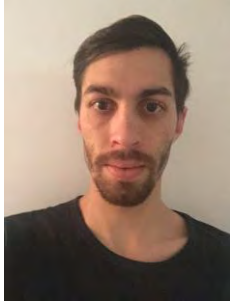
Rahmin BORZOU

Bachelor of Engineering

(Honours) (Civil)

Supervisors: Dr Weena Lokuge, USQ

Mr Tony White, Quakewrap

Keywords: Rehabilitation, timber, defect, bridge

1. Introduction

This research project seeks to investigate the failure mechanisms of deteriorated timber piles. Splitting is the number one cause of failure in timber piles due to thermal expansion.

Quakewrap is a current rehabilitation product that claims an increase in strength of the defected pile using grout, resin and Fibre Reinforced Polymer (FRP) wrapping. This project will take adopt this technique for testing. 16 samples will undergo compression testing to validate this claim of increase in strength.

2. Background

Currently tens of thousand of bridges around Australia still use timber piles as the main form of support (Scott 2001). Most of these bridges can be seen in rural areas proving hard for maintenance access and constructing of new age bridges.

3. Methodology

This project requires a substantial amount of laboratory work and testing.

This project can be broken up into two stages: stage 1 involves literature research into the types of defects that can be seen through inspection guidelines and reports (Main Roads 2014).

Stage 2 is analysing the load capacity of a defected pile (splitting) at three depths with no rehabilitation versus that of a defected pile at three depths incorporating grout, resin and FRP wrapping. These samples will then be tested using a SANS compression testing machine.

Figure 1 – Rehabilitation using Grout, Resin and FRP wrapping

4. Key Outcomes

The major outcomes that this research project hopes to fulfil are:

1. Test the performance of Quakewrap product on timber piles.

2. Development of a document which could be used by the industry to validate and improving on current technology.

5. Further Work

Numerical results obtained from the testing data will be analysed and compared in the coming weeks. Addressing other aspects of defects in timber piles and how they can be managed through technology improvements is the future.

6. Conclusions

This timber pile rehabilitation technique proves to be very effective in improving strength in defected piles. Wrapping defected piles is an easy efficient way of gaining back axial strength that was previously lost.

Acknowledgements

I would like to thank my supervisor Dr Weena Lokuge who has guided me through this research project. Plus, Tony White from Quakewrap who has helped with sample preparation.

References

MainRoads (2014), Detailed Visual Bridge Inspection Guidelines for Timber Bridges, Main roads, Perth, Australia.

Scott, I., Wheeler, K. (2001 Application of fibre reinforced polymer composites in bridge construction, New South Wales, Australia.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

38

In situ testing of hot water system sacrificial anodes

School of Mechanical & Electrical Engineering

Norman Bowkett

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(Honours) (Electrical &
Electronic)

Supervisors: Dr John Leis, USQ

Keywords: Ultra-sonic, piezoelectric transducer, sacrificial anodes.

Figure 1 – Sacrificial Anode Example

1. Introduction

The aim of this project is to investigate whether it is possible to determine the state of a sacrificial anode using an ultrasonic probe signal. The condition of the anode is determined by a multitude of factors including water quality, and cannot be predicted reliably. Current practice is to replace all anodes periodically, which is time consuming and expensive, and results in serviceable anodes being replaced.   Moreover, not replacing anodes when they are no longer protecting the tank invariably results in significant damage to the tank itself, resulting in the need for replacement.

Ultrasonic probe signals are employed to determine whether measurement of reflected pulse amplitude, or change in resonant frequency, provides sufficient information to determine the state of the anode, and hence its serviceability.

2. Background

It had been identified that there was no simple way to determine if the sacrificial anode requires replacing. The process involves potentially dangerous task of isolating the hot water system, hydraulically and electrically, before removing the anode to determine if a replacement is required.

If such a non-destructive test proves both feasible and reliable, then substantial savings may accrue in terms of reduction of anode replacement time, as well as removing the need to periodically replace anodes which are deemed to be satisfactory

3. Methodology

The two proposed measurement methods are time-domain reflectometry and variation of resonance. In the former, timing and amplitude of the reflected waves are analysed, whereas in the latter changes in resonant frequencies of the anodes will be examined.

For these tests to be achieved a suitable driving circuit for the piezoelectric transducers was designed. This is coupled with programming of a microcontroller to drive the circuit and sample the signals for post processing in MATLAB.

4. Key Outcomes

The final design for the driver circuit has been completed and tested.   Numerous refinements were made to the basic design over several iterations to gain a clean signal from the piezoelectric transducer

The microcontroller chosen is a Nucleo-F446RE development board, with the 180MHz process it would ensure that the ADC is able to sample up to 80kHz with accuracy.

5. Further Work

Next the testing on the anodes themselves will take place. Once this information has been gathered then the signal processing will take place to determine if the state of the anode can be correlated with the sampled signals.

6. Conclusions

The conclusions reached in this research is the way in which a piezoelectric transducer needs to be driven for a clean signal to be transmitted.

Acknowledgements

References

Krautkramer, J. & Krautkramer, H. (1977), *Ultrasonic Testing of Materials*, Springer.

Manbachi, A. & Cobbold, R. S. C. (2011), '*Development and application of piezoelectric materials for ultrasound generation and detection*', Ultrasound 19(4), 187–196.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

Estimation of Peak Design Discharges within the Mackay Region

Sponsor – Mackay Regional Council / AECOM Australia Pty Ltd

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Supervisors: Dr Ian Brodie, USQ
Dr Md Jahangir Alam, USQ
Mrs Melanie Collett, AECOM

Keywords: Peak Design Discharge, Rainfall, Runoff, Routing, Rational Method, RFFE, FFA, FLIKE, WBNM, TUFLOW

1. Introduction

The design of flood mitigation measures makes up a significant sector of the civil engineering industry, as well as the assessment of flood risk imposed on existing landscape by new development. Understanding of quantum of floods is critical in design and there are currently a number of different approaches to estimating the peak design discharge for catchments and streams.

2. Background

There is a variety of methods for the calculation of design discharge. Historically, the Probabilistic Rational Method was most popular within the industry, and where stream gauge data was present, at site Flood Frequency Analysis (FFA) methods (refer Figure 1) were commonly used. However, the recent revision of the Australian Rainfall and Runoff (ARR) guidelines has introduced the new Regional Flood Frequency Estimation (RFFE) Model, which relies heavily on historical gauge data, and has been proven to significantly over or under estimate in data poor catchments (refer Figure 1). This investigation will provide the industry with a greater understanding of what calculation methods are more suited to catchments in the Mackay region based on their characteristics and data available.

3. Methodology

Historical flood data for the Mackay Region was sourced and used to determine peak design discharges through a number of methods. These methods included at site Flood Frequency Analysis (FFA) calculations, as well as catchment delineation to undertake the Probabilistic Rational Method and Regional Flood Frequency Analysis (RFFE) Model. Computer simulations of historical data was also undertaken using FLIKE software and a runoff routing (WBNM) and hydrodynamic (TUFLOW) model was constructed
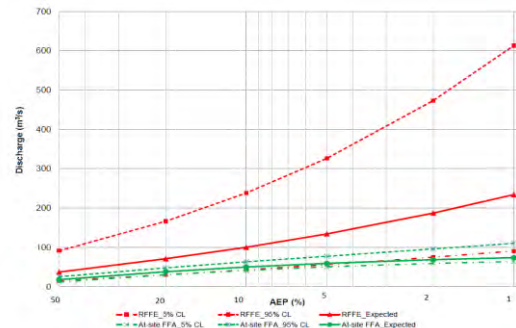
Figure 1 - RFFE Model 2015 vs. at-site FFA flood estimates (for the Morass Creek at Uplands, VIC) (Rahman et al, 2015)

and calibrated to historical events for simulation and comparison of different hydrological inputs.

4. Key Outcomes

The results of the modelling undertaken as part of the project provides a comparison between the current and incoming peak flow estimation methods as outlined in the 2016 revision of the Australian Rainfall and Runoff (ARR) Guidelines.

5. Further Work

Further investigations into the relationship between loss values and the estimation of peak design discharges should be undertaken to support this study's findings. This would help provide a basis for selection of both initial and continuing rainfall loss values for use in design discharge calculations and modelling for the Mackay Region.

6. Conclusions

The investigation confirmed that there can be large variances (some up to ±50%) in results between peak design discharge calculation methods for the same area. Each method is dependent upon the suitability of the data available and also the catchment characteristics input into the calculation. The study has provided reasoning into the selection of method for the calculation based on the mentioned variables.

Acknowledgements

I would like to thank AECOM for providing the tools and software required to undertake this project, in particular Mrs Melanie Collett for her guidance, Dr Ian Brodie and Dr Md Jahangir Alam for their continued assistance as project supervisors and finally, Mackay Regional Council for suppling the historical flood data

References

Rahman, A, Haddad, K, Kuczera, G & Weinmann, E 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Book 3 - Chapter 3: Regional Flood Methods, Commonwealth of Australia, Canberra, ACT.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

40

Identification of Infiltration within Albury Sewerage Infrastructure

Sponsor – AlburyCity Council

James Buckle

Bachelor of Engineering (Honours) (Civil Engineering)

Supervisors: Dr Jahangir Alam, USQ

Mr Greg Whorlow, AlburyCity Council

Keywords: Infiltration, Sewerage, Infrastructure

1. Introduction

Sewer Inflow and Infiltration (I/I) is a well-known and well-documented issue that plagues many sewer infrastructure networks where the ingress of ground water and storm water enters the sewerage network.

The aim of this dissertation was to determine the most effective method of identifying I/I within AlburyCity's sewerage network.

2. Background

AlburyCity has had long-term issues with I/I with flows doubling in the sewerage treatment works during some rain events, which indicates a large scale I/I problem. This leads to higher operational and capital costs along with large peak wet weather flows, which pose a health risk to the community (Hutchinson, 2016).

I/I source detection is difficult because typically the infrastructure is buried, comes from many different smaller sources and requires specialised technology (WSAA, 2013). This was overcome by utilising different source detection measures.

3. Methodology

Two sewerage catchments were analysed using different source detection measures including:

- Smoke Testing
- Electronic Scanning
- CCTV Inspection
- Visual Inspections

The source detection methods were then compared for identifying I/I based on cost, suitability and effectiveness.
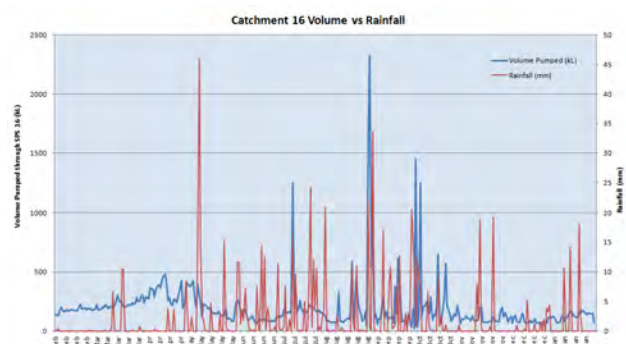
Figure 1: Rainfall vs Pump Station Flows

4. Key Outcomes

Smoke Testing, Electronic Scanning and Visual Inspection of the sewerage catchments have been completed with the results pending.

From the tests performed it has been determined that I/I source detection is a difficult problem to tackle because most I/I occurs in small amounts from hundreds of sources across a catchment.

5. Further Work

Further work to be undertaken includes an in depth analysis of the results from the testing and determining the most effective method that AlburyCity will use into the future to identify I/I sources.

6. Conclusions

I/I source detection is a complex problem to overcome which requires a lot of time, effort and resources. Despite these barriers it is worth performing the source detection works to combat I/I due to the ongoing risk and financial strain it places on the community.

Acknowledgements

References

Hutchinson, R 2016, 'Sewer Infiltration - Analysis, Impacts & Mitigation for a Growing City', University of Southern Queensland.

WSAA 2013, 'Manangement of Wastewater System Infiltration and Inflow Good Practice Guideline: The "How To" ', vol. 2

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USQ Pool Vehicle Fleet

Sponsor- School of Mechanical and Electrical Engineering

Mohammad Butaish

Bachelor of Electrical & Electronics

Supervisor: Andrew Wandel, USQ

Keywords: Electrical Fleet, economics, environment analysis

1. Introduction

Vehicle fleet service is an important service used by USQ in its different campuses and its proper management and fleet induction are also important aspects to get true financial, economic and environmental benefits. Transport sector is a major contributor to the global climate change due to high CO_2 emissions. This projects aims to analyse vehicle data provided by the University Of Southern Queensland to get clear image of their future needs especially electric vehicles and to study the possibility of reducing the cost of new fleet and even the operating cost along with reduction of CO_2 emissions. This would be achieved by investigating different car technologies available in the market especially Nissan and Tesla electric cars are available in the market with competitive price and travelling distance.

2. Background

Global warming and constantly increasing fuel supplies are great challenges for the future generations. Renewable energy resources and storage media to save the energy are explored to meet these future challenges. The efficiency of the storage media like batteries is a continuously improving in the field throughout the world to get more economic benefits.

3. Methodology

Selection of vehicles require deep data analysis of liquid fuel cars previously used in the different campuses and on the base of this analysis new pool of vehicles would be inducted in the university fleet for the transportation. The analysis includes the frequent distance covered by the cars during different trips because electric cars are limited in mileage and their prices in market also increase with increasing mileage. The GHG emission analysis of new cars is another aspect for the selection of cars.

The Figure 1 is showing the probability of the trip distance covered by cars used in one of the USQ campuses. The same analysis would be done on all the cars used in different campuses to analyze the actual requirement of the university. Two main computer applications are used to accomplish this analysis, Matlab and Excel.

4. KeyOutcomes

Most of the cars used in the USQ are used in the short distance trips and few cars are used for medium and long-distance trips. Electric cars are mostly suitable for short distance trips of up to 345 Km. Parking time data analysis reveals that enough time is available for the cars to be fully charged in the campus because fast chargers can charge the car in 30 minutes. The electric cars for medium and long-distance trips could be selected for better fuel economy.
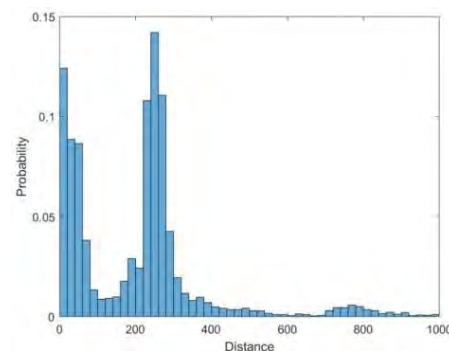
Figure 1. Distance Travelled by Toowoomba Campus cars

5. FurtherWork

The complete analysis of short, long distance trips and the charging time would be compared with the future requirements of USQ fleet for selection of new vehicles, rather electrical and conventional or the certain ratio of selecting electrical and conventional vehicles in complete fleet would be based upon the data analysis would be provided in the form of concrete quantitative figures.

6. Conclusion

The economic and environmental improvements could be made by careful selection of vehicles for the personal and mass use of vehicles at the organization level. Scarcity of resource is the global issue and energy resources are depleting throughout the world and it is the need of the time to explore and utilize new energy resource without compromising working efficiencies.

References

Bureau of Infrastructure, D (2009). Greenhouse gas emissions from Australian transport. www.bitre.gov.au, viewed 17 April 2017, ttps://bitre.gov.au/publications/2009/files/wp_073.pdf

ENG4903Professional Practice2, University of Southern Queensland, Toowoomba, Australia

Management of Unsealed Roads within the Narrabri Shire Council Local Government Area

Sponsor -School of Civil Engineering and Surveying and Narrabri Shire Council

Michael Cain

BENH – Bachelor of Engineering (Honours)(Civil)

Supervisors: Dr David Thorpe, USQ
Mr Anthony Smetanin, Narrabri Shire Council

Keywords: Unsealed Roads, Asset Management

1. Introduction

The purpose of this project is to develop the framework for an efficient maintenance program that will be applied to Narrabri Shire Council's unsealed road network.

The framework aims at producing a set of classes that each road can be placed into. These classes describe the level of service, road usage and the maintenance needs that need to be applied to satisfy them, as well as satisfying the safety and expectations of the public.

2. Background

Safety is a big concern when it comes to rural roads, especially unsealed roads. These types of roads are often overlooked and aren't seen to be a main concern as traffic volumes can be low as well as the funding that is available to maintain them. Maintenance and resources are usually limited so it is important that the right procedure is implemented to efficiency manage these roads.

Narrabri Shire Council is responsible for maintaining approximately 1684km of unsealed roads, so it is important that this is done effectively.

3. Methodology

The methodology that was applied to this project consisted of six main steps. The first step was to outline all the roads under consideration and separate these lengths into suitable sections. Data was then obtained, measured and assessed. This data included all road characteristics, financial records, past maintenance records and maps. The next step was to assess what practices were acceptable and what could be applied in this situation. After maintenance practices were known past records were used to establish a draft set of classes, matching the suitability and relevance. Applying these to the NSC unsealed road network and making recommendations. Figure 1 shows a typical unsealed road within NSC that had been assessed and classed.

Figure 1 – Unsealed Pavement Example

4. Key Outcomes

The key outcome of this project is the development of the framework for an efficient maintenance program that will be applied to Narrabri Shire Council's unsealed road network.

By studying current methods and how effective they can be when managed in the right environment, a number of benefits will be achieved. Safety benefits, financial benefits and benefits of creating a strong customer satisfaction.

5. Further Work

Further work on this project is to apply this framework to all of the Narrabri Shire Council unsealed road network and monitor it over a period of time. This needs to be done to ensure accuracy in findings and iron out inefficiencies.

6. Conclusions

In conclusion, by adopting the method produced, a number of efficiencies will result. These efficiencies will mean that NSC can provide a greater service to the community and in turn a safer unsealed road network.

Acknowledgements

References

ARRB 2009, Unsealed Roads Manual Guidelines to good practice, ARRB Group, Victoria

Austroads, 2009 b, Guide to Road Design. Part 3: Geometric Design, Austroads Inc., Sydney

Austroads, 2009 a, Guide to Pavement Technology, Part 6: Unsealed Pavements, Austroads Inc., Sydney

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Modelling alternate approaches for calculating friction head loss in water distribution pipelines

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Supervisors: Mrs Justine Baillie, USQ

Keywords: Hydraulics, Modelling, Frictional head-loss.

1. Introduction

The accurate estimation of frictional head loss is essential when designing water distribution pipelines to ensure system capacities and delivery pressures are determined with sufficient accuracy. A range of approaches is available to calculate frictional head losses including the Darcy-Weisbach, Hazen-Williams and Manning's equation. The use of the physically based Darcy-Weisbach equation is generally regarded as the most accurate approach. However, this does not deter many practising engineers using or prescribing the empirical Hazen William equation due to its history and ease of use. Modelling software gives the user the ability to run multiple trials when designing distribution networks. However, the software also gives the user the ability to use many of the now obsolete equations why?

Background

The purpose of this paper is to highlight a common oversight during the design of Water Distribution Networks. The introduction and increased use of computer-based modelling should have seen the end of using inappropriate frictional head loss equations, however software designers are still giving the end user the ability to use the wrong equation causing miscalculations.

2. Methodology

To explore the effect of differing Frictional Head-Loss equations a real-world example of a distribution network was designed using EPANET 2.0. This software gives the user the ability to construct large water distribution networks that can then be altered to run comparative experiments. There is a range of variables that affect frictional head loss equations, such as, diameter, pipe roughness, pipe age, operating temperature, fluid, velocity and discharge. It is widely known that changing variables will affect the outcome, the primary purpose of this experiment is to verify and quantify an error that can be applied to each equation. From this exploration, formal recommendations can be made.

3. Key Outcomes

The experimentation has produced expected results; The Darcy Weisbach equation has proven to be the best suited and most stable throughout the different flow categories within the distribution networks. The surprising result is that the Hazen-Williams equation performs better than expected due to the restriction on the diameters used outside of the networks main trunk pipes.

4. Further Work

Further work is needed on the error quantification and model development. The pipe sizes used in Water Reticulation Networks causes the Hazen Williams equation to operate better than expected. However, it is clear that the Darcy Weisbach is the best performer.

5. Conclusions

The Hazen Williams equation even when using advanced modelling software should still be limited to its acceptable range. The limited usefulness of the equation is already well-documented however government agencies and authorities are still prescribing and at times demanding it's used. This practice is in need of change and further investigation.

Acknowledgements

References

Chadwick, A., Morfett, J. and Borthwick, M. (2013). Hydraulics in Civil and Environmental Engineering. 5th ed. Boca Raton: CRC Press, pp.78-79.

Christensen, B., Locher, F. and Swamee, P. (2000). Limitations and Proper Use of the Hazen-Williams Equation. Journal of Hydraulic Engineering, 126(2), pp.167-170.

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Helicopter Vibration Monitoring During Patient Transport

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours)

Supervisors: Assoc/Prof John Leis, USQ

Dr John Grant-Thomson, Neocot

Keywords: Vibration, Helicopter Patient Transport, Microcontroller

1. Introduction

Transporting patients via helicopter is intended to provide medical care that is urgently required to ultimately benefit the patient. If the patient is injured by the vibration from the helicopter transport the purpose of the journey is voided. The aims of this project are to test the vibration in helicopters used for neonatal transport and to investigate ways of reducing vibration through analysis and exploitation of any vibration patterns present.

2. Background

Neonates are newborn children that are less than 4 weeks old. Sometimes it is necessary to transport neonates for medical treatment. Where distances are great the neonate may require transport via helicopter. Previous studies into the area of vibration during patient transport (Karlsson et al 2012) suggest that the levels of vibration during neonatal transport in ambulances and planes exceed the recommended level for adults.

3. Methodology

A literature review was conducted into previous work in this field which provided the expected levels of vibration in a helicopter. Due to the specific nature of the problem and the high cost of commercially available measurement systems it was determined that a system to measure and record vibration levels would need to be designed and built. The system was bench tested throughout the design process using a rough test setup to test the accuracy. There were many challenges during the design process that had to be overcome to result in a final design that would provide an accurate and reliable reading of vibration.
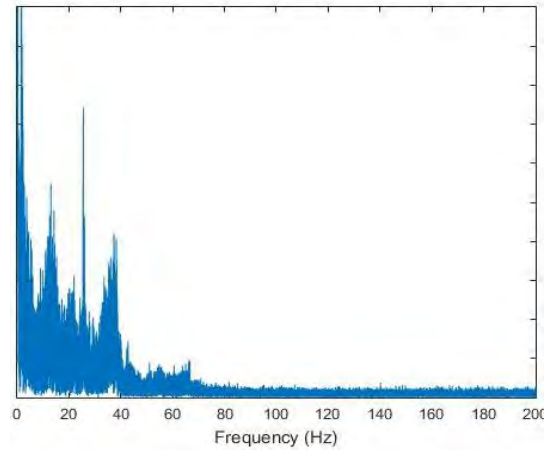
Figure 1 - Example of frequency data of a short car trip

4. Key Outcomes

The key outcomes of this project are to provide insights into vibration during neonatal transport. Thus far a cost effective system of measuring said vibration has been designed and preliminarily tested with an example of an output in Figure 1, with calibration and potentially final testing expected to provide data.

5. Further Work

The remaining tasks are to perform final calibration and testing of the device; to analyse the data collected and to investigate ways of reducing the vibrations present.

6. Conclusions

Accurate data on the amplitude and frequencies of vibration present in helicopters used for neonatal transport will provide opportunities for more accurate information on the effects those vibrations have on neonates as well as potential means of vibration reduction or cancellation. It is expected that the hardware, software and results of this project will be incorporated into an active vibration-control system in future work.

Acknowledgements

References

Karlsson, B., Lindkvist, M., Lindkvist, M., Karlsson, M., Lundstrom, R., Hakansson, S., Wiklund, U. & Berg, J. (2012), 'Sound and Vibration – Effects on Infants' Heart Rate Variability during Neonatal Transport', ACTA Paediatrica (101), 148–154.

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45

A Feasibility study "Can Australia's current and short term infrastructure support the global trend towards Electrical Vehicles".

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Douglas Card

Bachelor of Engineering

(Honours)(Mechanical)

Supervisors: Dr Ray Malpress, USQ

Keywords: Electrical Vehicles, Carbon Emissions, Tesla Model 3

1. Introduction

The recent closures of Ford and Toyota manufacturing plants within Australia, has left Holden the only plant currently producing vehicles within Australia. However with a projected closure date set for October of 2017 it will see the end of an era and Tesla will usher in a new beginning. A time where all vehicles will be imported and Australian drivers will be left with no option but to follow global trends which have already shown to be Electrical or Electrical Hybrid vehicles. The aim is to drastically reduce the carbon footprint on the earth when compared to their Internal Combustion Engine counterparts.

2. Background

Only 14.5% of Australia's energy is supplied by renewable sources leaving the remainder to come from outdated technology such as low efficient coal fired power stations. While Australia has had hybrid vehicles for several years with the fifty thousandth Toyota Prius sold in 2014 none of these vehicles come with a plug in option leading to no demand on the current infrastructure or increase in coal fired power production. With the cornerstone of electrical vehicles recently hitting the market, Australia is about to see the introduction of the Tesla Model 3 which can only be charged at charging stations or plugging into the power grid at home.

3. Methodology

A literature review was conducted to gain a full understanding of how electrical vehicles work, such as vehicle range and efficiency. Also the life cycle of several different types of propulsion were analysed to determine the vehicle with the largest carbon footprint

Figure 1 – Tesla Model 3

with Australia's current energy production methods. Also energy production throughout the day and week were analysed using MATLAB for times that would best suit the charging of plug in electrical vehicles.

4. Key Outcomes

The methodology was successfully applied and the cars compared over a full life cycle to find the vehicle with the smallest carbon footprint based on Australia's current infrastructure.

5. Further Work

Numerical analysis of coal fired power stations and base loads of energy production to show the number of Electrical Vehicles that can be imported before major infrastructure upgrades need to be implemented.

6. Conclusions

Australia has no choice but to follow trends and has to act now to reach its goal of a sustainable green future.

References

Abs.gov.au. (2017). 9309.0 - Motor Vehicle Census, Australia, 31 Jan 2016. [online] Available at: http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0 [Accessed 22 May 2017].

Energy Matters. (2017). Live Australian Electricity Generation Statistics - Energy Matters. [online] Available at: http://www.energymatters.com.au/energy-efficiency/australian-electricity-statistics/ [Accessed 10 Jun. 2017].

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46

Modelling of a Portable Air Conditioner

School of Mechanical and Electrical Engineering

Logan Carrie

Bachelor of Engineering (Honours) – Majoring in Mechanical Engineering

Supervisor: Dr Ahmad Sharifian-Barforoush, USQ

Keywords: Fluid modelling, Transient flow, Portable air conditioner.

1. Introduction

As air conditioners become more important in modern life, the need to the devices are operating effectively has also increases. Therefore, methods such as Computational Fluid Modelling are used to examine the performances of air conditioning units within buildings and other spaces. This modelling method can also be applied within the device itself, where the refrigerant fluid used to heat or cool a space is simulated. Through simulating these devices, relationships between performance and ambient temperature can be made, which can help to improve the design of these devices in the future.

2. Background

This project aims to understand the behaviour of portable air conditioning systems under changed temperature conditions. Previous studies have been conducted both experimentally and numerically on the performance of air conditioning units, but this project aims to review and validate some of the results found within these papers. To do this, the computational fluid dynamics analysis method was chosen to gain better understanding of the behaviour of the fluid within the system and display the results in an intuitive manner.

3. Methodology

Extensive research was conducted on the operation of these air conditioners, what factors affect performance, and what methods of modelling produce the most accurate results. After reviewing the works of others as well as researching different methods of modelling, a final method for modelling the transient flow within the air conditioner unit was decided upon and implemented to attain the results presented within the project.

4. Key Outcomes

Some of the key outcomes of this project include the validation of experimental results from other experimental studies on the performance of portable air conditioners as well as the validation of this transient fluid flow modelling. By implementing the extensive research methodology along with the fluid modelling approach, the results attained helped to give better understanding of the effects of changing temperature on air conditioner performance. These findings could then be used to optimize or improve the design of different air conditioning units, or assist in further studies around this topic.

5. Further Work

Further work to be conducted on this topic includes the additional simulation of the other components of the portable air conditioner as a system. These additional simulations would simulate the interactions between each of the components of the unit and show the relationships between them.

6. Conclusions

The key conclusions of this project include the validation of results of other research papers as well as presenting a clear relationship between ambient temperature and evaporator performance.

Acknowledgements

References

Siang, JT 2015, 'Impacts of room temperature on the performance of a portable propane air conditioner', Computational Engineering Science Research Centre (CESRC), p. 19.

Rotchana Prapainop, KOS 2012, '<Effects of refrigerant properties on refrigerant performance comparison - a review.pdf>', International Journal of Engineering Research and

Brignoli, R, Brown, JS, Skye, H & Domanski, PA 2017, 'Refrigerant Performance Evaluation Including Effects of Transport Properties and Optimized Heat Exchangers', International Journal of Refrigeration.

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47

A Cost Benefit Analysis of Vertical Measurement Tools for Differential Levelling

Sponsor – School of Civil Engineering and Surveying

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Bach of Spatial Science (Hons)

Major - Surveying

Supervisor: Dr Dev Raj Paudyal, USQ

Keywords: Cost Benefit Analysis, Geometrical Height, Digital Leveling.

1. Introduction

The potential for achieving accurate results from a digital level, when conducting a level traverse, cannot be denied. And having the ability to automatically upload the results of the traverse to a software program, such as Trimble Business Centre, for misclose adjustment and inclusion into a wider network adjustment, is theoretically of huge benefit to a surveyor establishing control on an extensive worksite.

The main question is however, what level of accuracy is required? Or in other words how does the accuracy achieved by using the digital level for this task effect the results of the network adjustment?

2. Background

Despite its inherent accuracy when compared to traditional differential levelling, a digital level is a significant expense for a surveying enterprise to make. Can the additional outlay be justified in terms of time saved or accuracy increased? Are there alternatives available, within the current toolset of the average surveyor that are capable of providing adequate information without the extra cost to the business?

3. Methodology

In order to conduct this assessment, a course was set within an area that would be suitable for a GNSS control network. The three instruments used for the comparison were a Trimble DiNi level, a Nikon AS-2C automatic level and a Trimble S6 Total Station with Level Me installed in the hand controller.

Each of the three instruments were used to find the height variation from a known point to four unknowns. Upon completion of each traverse the data collected was
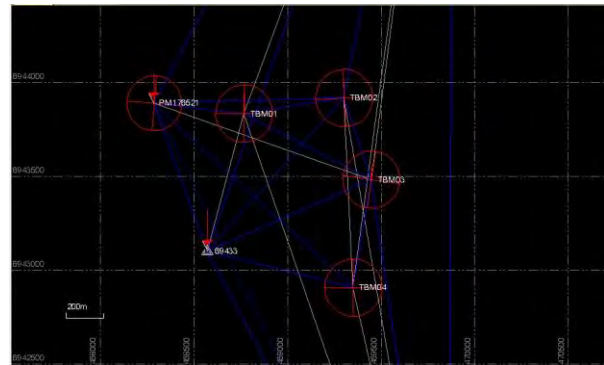
Figure 1 – Initial error ellipses for unknown control points

uploaded into Trimble Business Centre, to be adjusted and combined with Static GNSS data for a series of comparative analyses. The final step in the process is to conduct the cost/benefit analysis of each system.

4. Key Outcomes

Simple comparative analysis of the results from the trial of each individual systems shows little difference between the time taken to complete each traverse, nor for the actual results achieved. The key factor that was identified immediately, was the amount of time it takes to upload the results of each traverse.

5. Further Work

Significant time was devoted to the study of deflection of the vertical and its effect upon the results, however conclusive proof of the need to allow for it is yet to be determined.

6. Conclusions

Initial results suggest that the cost of purchasing a digital level may not be able to be justified by a subsequent improvement in results. It appears instead, that a software upgrade for the total station is a much more effective alternative in both time and money.

Acknowledgements

I would like to thank Dr Paudyal for his guidance in the completion of this project.

References

Snell, M. (2011). *Cost-benefit analysis a practical guide* (2nd ed.): London, Thomas Telford Ltd.

Torge, W. (2012). *Geodesy* (4th ed.). Berlin: de Gruyter.

Featherstone, W. E., & Rüeger, J. M. (2000). The Importance of Using Deviations of the Vertical for the Reduction of Survey Data to a Geocentric Datum. *Australian Surveyor,* 45(2), 46-61.

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48

Critical Factors Affecting Construction Productivity in Maputo, Mozambique

Faculty of Health, Engineering & Science

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Supervisor: Dr Nateque Mahmood, USQ

1. Introduction

Construction is the world's largest and most challenging industry. A construction project involves starting with nothing but an idea and creating a permanent and lasting facility that meets aesthetic, quality, safety, and functional requirements. It involves creating an organization of many types of people who probably have not worked together and who immediately expect that organization to function smoothly.

Improvement of construction productivity has been a major challenge in the construction industry. Increased attention from construction researchers promoting different enhancement actions, since analysing factors affecting labour productivity is an instrumental part in this process.

2. Background

Productivity research in the construction industry has been ongoing since the early 1960s. Research results include measurement development, management and control process, factor exploration, and prediction that have enriched the body of knowledge. However, the research still concluded that productivity is difficult to measure and control.

3. Methodology

The research were conducted in the following steps, this involves desktop research, historical literature review, questionnaires, one on one interview, site investigation, case study, data analysis, results, conclusion and finally some recommendation.

4. Key Outcomes

The following were the critical factors affecting construction productivity, i.e. waiting for information from consultant/client, shortage of construction materials, changes in design drawings during construction, unrealistic contract duration imposed by client, main contractor and sub - contractor payments, unrealistic client initial requirement,
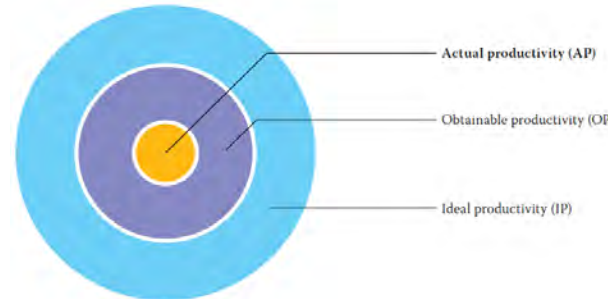
Figure 1 - Actual productivity (Kim et al 2011)

incomplete documentation, miscommunication between respective parties, mistakes in construction and defective works, long waiting time for approval, and lack of responsibilities

5. Further Work

A study similar to the present research is needed for transportation projects to find factors that affect the productivity of highway construction, which will help departments of transportation to minimize unnecessary cost escalations and project-schedule delays.

6. Conclusions

The factors found above which contributes towards the project failure which needs to be controlled considerably in order to achieve successful project completion as planned.

The project team involved in construction project need to ensure their effective contributions towards the project are in place throughout the overall project, so that the above factors and cause of delays are omitted of minimised.

Acknowledgements

References

1. Fah C.C, Martin S, Goran R. and Adrian B. (2012), An Analysis Of Construction Productivity In Malaysia. Construction Management and Economics, 30:12, pp.1055-1069.
2. Sherif M. H, Remon F. A, Enas S. M, Madeha M. A, and Eman K. A. (2014), Critical Factors Affecting Construction Labor Productivity in Egypt. American Journal of Civil Engineering. Vol. 2, No. 2, pp. 35-40.

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Integration of a Light Rail Transit with Autonomous (driverless) Vehicles

Sponsor – e.g. School of Civil Engineering and Surveying

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Bachelor of Engineering Honours (Civil).

Supervisors: Dr Soma Somasundaraswaran, (USQ)

Keywords: *Autonomous Vehicles, Transport Integration, Light Rail Transit.*

1. Introduction

This project was inspired by the idea of 'optimisation', encouraging the integration of emerging and the existing forms of transportation i.e. considering the Autonomous driverless vehicles. The main aim of the investigation was to assess the feasibility of integrating the Autonomous Vehicles and a Light Rail Transit and operating the two modes as complementary to each other.

2. Methodology

The research project analysed local transport usage data sourced from local transportation agencies. The project modelled and simulated the proposed integration concept and compared it to the current transport performance. In addition, it also compared the performance of the different modes of transportation as direct competitors, to assess the implications in the current transport system.

3. Key Outcomes

The research project identified the impacts to the usual journey times and delays comparing the separate and integrated usage of the mode of transport. This also helps assess the congestion related impact as well.

Another key finding was the impact scale due to different levels of penetration of the AVs into the network. This helped determine the pros and cons of the AV-LRT integration idea. The research also determined queue length information which can be used to assess the level of congestion and foreseeable congestion costs in the network.
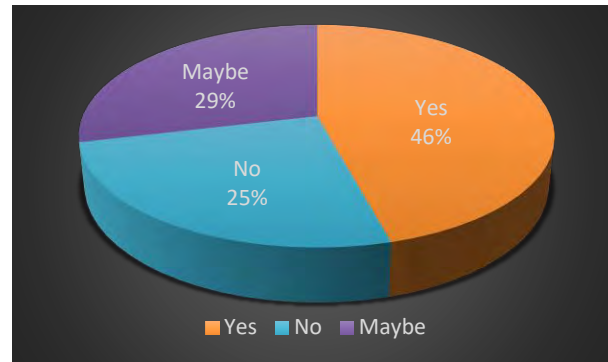
Figure 1 – General public perspective on AV usage.

4. Further Work

There is further work to be carried out i.e. how this idea can be implemented into the current transport systems.

This may involve detailed costs analysis of the integration identifying any operational or usage impacts to the operators and patrons, respectively. A state wide transport network analysis will need to be carried out taking into account the disruptions as a result of the integration so as to identify the large scale implications to the transportation attributes e.g. journey times, delay, level of services, occupancy levels, etc.

5. Conclusions

In conclusion, the research project has verified that the integration is possible. However, the idea will require certain measures to be in place to ensure optimal benefits to the broader community of both public and private users.

Acknowledgements

I'd like to thank Soma, my supervisor for the guidance during the research project. I'd also like to the thank Jerome Catbagan and Lindsay Jacobsen, my colleagues, who advised me during the modelling and simulation phase of the project. Lastly, I'd like to thank the rest of my family and friends.

References

Henderson, C. (2013). Submission – Canberra Light Rail Integration Study. Conservation council, 1-7.

Atkins, (2016). Summary Report – Impact of connected and autonomous vehicles on traffic flow. Atkins Ltd, 1-58.

Stephen, J. (2000). Integrated traffic policies. ICE Proceedings, vol. 138, no 6, 39-43.

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To seal or not to seal in Kingborough?

Sponsor – School of Civil Engineering and Surveying
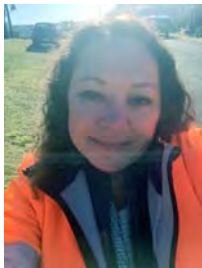
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Bachelor of Engineering (Honours) (Civil)

Supervisor: Associate Professor David Thorpe, USQ

Keywords: Unsealed roads, Local Government Policies, Cost-Benefit analysis

1. Introduction

The municipality of Kingborough is located in southern Tasmania. It is predominantly rural in nature with 49% (265 kilometres) of the road network being unsealed. Having one of the highest population growth rates in Tasmania over the past 30 years the ratepayers of Kingborough are increasingly asking Council to upgrade unsealed roads to a sealed road standard citing improved road safety and reduction in dust as the most common reasons for their requests.

2. Background

Kingborough Council does not have a strategy or policy for assessing the merits and long term costs of upgrading unsealed roads to a sealed road standard. Kingborough requires a procedural document which sets forth guidelines and a measurement system appropriate for its climate, topography, geology, ecology, road design standards and limited financial resources to allow staff to appropriately analyse the viability of community requests for sealing unsealed roads.

3. Methodology

Six key roads were selected for having either considered high traffic volumes (>200), steep topography, increased residential density or high crash history. Assessments were conducted on each road including traffic counts, geometric analysis and crash analysis based on a preferred scoring system. A cost-benefit analysis was undertaken to compare current annual maintenance requirements with the economic benefits of upgrading the unsealed roads to a sealed standard.

4. Key Outcomes

A key outcome of this project was to research other Local Government policies and procedures with respect to

Costs of Maintenance			Cost/km
Rural Sealed	Rehabilitation	Removal and Replacement	$406,500
		Scarify and Overlay	$260,100
	Resurfacing	Single coat spray seal	$34,800
	Other maintenance		$2,399
Unsealed	Maintenance	Replacement of culverts	$37,100
		Regrading	$1,010
		Re-sheeting	$29,379
		Other maintenance	$1,750

Table 1 - Road Maintenance Costs (Tasmanian Grants Commission 2012)

upgrading unsealed roads to allow an engineering assessment to be completed. Another key outcome was to complete a cost-benefit analysis to compare the long term costs of maintaining an unsealed road with the long term costs of upgrading and maintaining a sealed road. The results of the project will assist Council in the development of a strategy and policy in the future.

5. Further Work

Further research to quantify sediment loss on unsealed roads in Kingborough to assess the environmental impact road gravel is having on water quality in its waterways will assist in the development of a road sealing strategy.

6. Conclusions

It is an expected outcome that a scoring system will be developed that will allow Kingborough to assess an unsealed road for its suitability for upgrading to a sealed road standard. It is also expected that this project will demonstrate the difference in costs between maintaining an unsealed road to upgrading and maintaining a sealed road.

Acknowledgements

References

ARRB Transport Research Ltd. (2000). *Unsealed Roads Manual Guidelines to Good Practice* (August 2000 ed.). (G. Guimmarra, Ed.) Vermont South: ARRB Transport Research Ltd.

Tasmania Grants Commission. (2012). *Review of Road Maintenance Costs.* Retrieved October 12, 2016, from https://www.treasury.tas.gov.au/domino/dtf/dtf.nsf/v-publications/publications

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The effects of debonding wax emulsion on tie bar pull out strength in concrete pavements

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Bachelor of Engineering

(Civil Engineering)

Supervisors: Dr Allan Manalo, USQ

Keywords: Debonding, tie bar, concrete

1. Introduction

Tie bars in rigid concrete pavements are used to hold the faces of two slabs of concrete together. While tie bars may provide minimal load transfer, this is not what they are designed to do and should not be included in any calculations other then lateral forces. Tie bars are typically used in longitudinal joints that include saw cuts, edge joints, shoulders and kerb add-ons.

The tie bars used in New South Wales for the Pacific Highway are currently 1.0 m long and 12mm diameter. Bar spacing is a result of bar diameter and total cross sectional width of the concrete pavement

2. Background

During discussions with the contractor, many arguments were put forward relating to the process involved with covering the tie bars with protection sleeves has the potential to cause more harm than good. A comparison between inserted tie bars and tie bars that are paved over with the paving machine would therefore show that the inserted tie bars would have a reduced pull out strength. This is the main motivation in conducting this project.

3. Methodology

A range of different application rates were tested that included no wax emulsion applied, infield application rates of 0.4L/m2 and double dipped resulting in the tie bar being completed covered.

A range of tie bar lengths was also included at 150mm, 300mm and 500mm of insertion length.

Insertion length of tie bar (mm)	Number of tie bars tested		
	No wax emulsion applied	0.4L/m2 emulsion application	Double dipped completely covered
500	5	5	5
300	5	5	5
150	5	5	5

Table 1 – Tie bar testing combinations
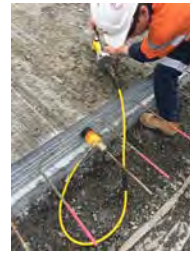
Figure 1 – Testing process

4. Key Outcomes

Confirm if the application of debonding wax emulsion on tie bars effects the tie bar pull out strength.

These tie bars were subjected to an initial load of 48kN, which is inline with RMS testing requirement of 85% of the yield strength of the bar.

Insertion length of tie bar (mm)	No wax emulsion applied	0.4L/m2 emulsion application	Double dipped completely covered
500	pass	pass	pass
300	pass	pass	pass
150	pass	pass	fail

Table 2 – Tie bar testing results at 70-80kN

5. Further Work

This project has not considered any repetitive forces such as expansion and contraction of the concrete on a daily basis and while these force are not enough to break the tie bar they may be sufficient to slowly deteriorate the bond of the tie bar covered in wax emulsion and the surrounding concrete.

6. Conclusions

That the spraying of wax emulsion on paved in-situ tie bars will not have any effect on the pull out strength for the current 1 metre long tie bar used in NSW.

References

Ghali, A & Gayed, RB 2012, 'Bundling of headed bars in concrete', Canadian Journal of Civil Engineering, vol. 39, no. 7, pp. 849-53, Scopus

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On-farm management practices on soil erosion and nutrient pollution control, and an impact assessment on water quality

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Supervisor: Dr Md Jahangir Alam

Keywords: nutrient pollution, farming, water quality

1. Introduction

The impacts of land use on the environment is becoming increasingly important to New Zealanders, and is reflected in government policies focussed around the environment and water quality. This project aims to investigate on-farm management practices on the environment as well as identify potential opportunities and/or barriers for adopting new practices.

2. Background

The Tokomairiro River catchment has had ongoing water quality issues, being a result of farming in the area. Previous studies have been undertaken, and there are continued efforts to reduce nutrient pollution into the river, however water quality modelling has not been undertaken for the catchment. The research looks therefore aims to model the impacts of the land use in the catchment and the effectiveness of management practices on the existing and likely future scenarios.

3. Methodology

To achieve the outcomes of the project, three main processes were completed. A literature review was undertaken to identify management practices; investigate potential effects of climate and land use changes; and highlight socio-economic factors influencing decisions around management practices.

Secondly a questionnaire was developed to identify existing management practices used in the catchment and socio-economic factors associated with the selection and use of management practices.

Finally, modelling was undertaken using the New Zealand-based modelling system Catchment Land Use for Environmental Sustainability (CLUES) (*Semadeni-Davies, A., Elliott, S. & Shankar, U., 2016*). An existing scenario was set up followed by various scenarios to investigate changes in climate and land use.
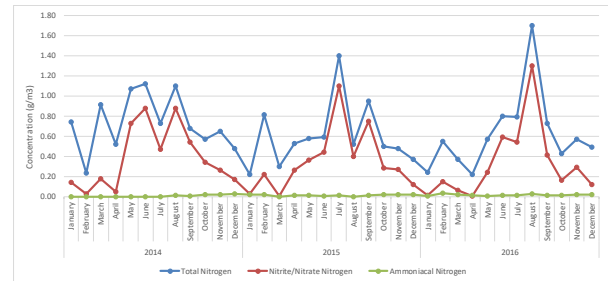
Figure 1 – Nitrogen Concentration Trend 2014-2016

4. Key Outcomes

Key management practices have been identified and applied to the modelling scenarios. Historical water quality data has been analysed (see Figure 1), and the questionnaire is currently underway. Several gaps and limitations from this data have been identified and require addressing.

5. Further Work

Further work involves compiling and analysing the questionnaire responses for conclusions and development of an algorithm.

Modelling of different scenarios and developing conclusions from results is ongoing.

6. Conclusions

Further modelling is required before definite conclusions can be drawn, however it is anticipated that increased nutrient pollution export will result from both the climate change scenario and the land use change scenario.

The research provides a basis for further modelling of nutrient pollution in the catchment, particularly using CLUES with further development and calibration.

Acknowledgements

References

Semadeni-Davies, A., Elliott, S. & Shankar, U. (2016). *CLUES - Catchment Land Use for Environmental Sustainability User Manual*. Retrieved 1 July 2017, ftp://ftp.niwa.co.nz/clues/CLUES%2010%203%20Manual,%205th%20edition,%20June%202016.pdf

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Sustainability of Microgrids for Island Communities

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering

(Electrical & Electronic)

Supervisors: Mr Andreas Helwig, USQ

Keywords: microgrid, sustainable, solar PV, HOMER

1. Introduction

A stable energy supply improves the quality of life of a community. While the mainland has access to the main utility grid, island communities struggle to access a sustainable electricity supply. A solution is to create a microgird system where energy is generated and controlled locally for a community. This project involves the design and optimization of a microgrid system for Fraser Island, Queensland, and to provide modelling that shows microgrids can produce a sustainable energy system while being an economical viable option.

2. Background

While there has been large amount literature in microgrid technologies, there has been no study done on Fraser Island's microgrid potential. Most of the residential buildings are supplied by solar PV with diesel generation and lack sustainable power for all hours of the day. Larger commercial buildings run on diesel generation alone. Adding more renewable generation and battery storage could increase its energy sustainability and reliability while reducing its dependence on diesel fuel and potentially reduce costs.

3. Methodology

An energy audit was done on three communities on the Fraser Island to determine energy usage. Synthetic load curves were created by using maximum demand calculations as there was no kWh metering is available. The microgrid design consists of solar PV, diesel generation and battery storage. HOMER software was used to provide modelling of various combinations and sizing of microgrid components to find optimal designs that can provide both 24 hour sustainability and are economically viable. Optimal systems are determined
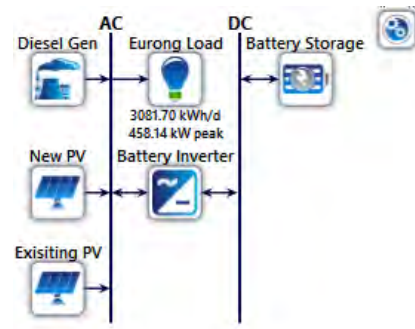
Figure 1 –HOMER microgrid schematic for modelling and optimization of Eurong, Fraser Island

by the cost of energy (in cents / kWh) and total cost of the system over the systems lifespan.

4. Key Outcomes

Energy storage systems are pivotal for sustainable isolated microgrids as they can store excess energy generated, supply stored energy and provide voltage stability. Queensland high solar radiation exposure and decreasing solar PV system costs makes it attractive option for microgrid integration.

5. Further Work

Future research includes looking into microgrid sustainability by maintaining stable voltages of microgrid components and sustainable DC microgrids.

6. Conclusions

Results are inconclusive but initial modelling has shown that microgrids consisting all of solar PV, diesel generation and batteries are the most optimal systems for supplying Fraser Island loads. Microgirds with solar PV and batteries alone are sustainable, but are not economically viable.

Acknowledgements

References

Hartono, B.S., Budiyanto, Y & Setiabudy, R. 2013, 'Review of Microgrid Technology', '*2013 International Conference on QiR*', 25-28 June, pp. 127-132

Lambert, T., Gilman, P. & Lilienthal, P., 2006, '*Micropower System Modelling with HOMER, Integration of Alternative Sources of Energy"*, pp 379-415, John Wiley & Sons Inc., Hoboken, New Jersey

A comparison of mobile phone 3D images and total station data for spatial interpretation of structures

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Supervisor: Dr Albert Chong, USQ

Keywords: Photogrammetry, Electronic Distance Measurement, 3D model.

1. Introduction

Electronic distance measuring (EDM) devices, whether the common total station or laser scanners, are industry standard instruments used to obtain point data of structures or environments.

Photogrammetry, a process of obtaining measurements from photographs has long been used primarily in large scale aerial surveys using high end cameras. The digital era has seen great advancements in this field whereby software packages allow for complete automation of 3D modelling through point generation from digital imagery. Also, digital cameras are becoming so compact they now come standard in mobile phones.

3D Point data from either technology is then used to generate plans and models and allows for spatial analysis and calculations to be performed. It is the purpose of this dissertation to compare the two methods.

2. Background

EDM devices are both highly accurate and expensive, requiring specialty expertise in their application and post processing procedures. A camera equipped mobile phone on the other hand, is almost certainly a possession of most people. To what extent can they be used in surveying and could they potentially replace EDM devices for particular applications?

3. Methodology

Three case studies chosen to simulate places and objects commonly surveyed were captured using both a total station and a mobile phone camera. The data was then used to generate 3D models from which an analysis was performed to determine differences in the object interpretation from the two data sets.

Figure 1 – 3D model using mobile phone imagery

4. Key Outcomes

Two of the case studies have proven that mobile phone 3D imagery can be used to collect and interpret spatial data for particular applications. However, the third case proves that various environmental factors can be detrimental to the end product. The use of 3D models produced using mobile phones is dependent on required accuracies.

5. Further Work

A cost analysis is to be performed to give an indication as to the savings to be had with the photogrammetry technique. Beyond this project, further study into similar applications with drones and laser scanners would expand on this topic.

6. Conclusions

Performing surveys using mobile phone imagery is highly efficient however dependent on such things as accuracy required and environmental factors. As technology ever advances, so do methodologies to perform surveying tasks.

Acknowledgements

References

Yilmaz, H, Yakar, M, Gulec, S & Dulgerler, O (2007). Importance of digital close-range photogrammetry in documentation of cultural heritage, *Journal of Cultural Heritage*, vol. 8, no. 4, pp. 428 – 433.

Jalloh, Y, Ahmad, A, Mat Amin, Z & Sasaki, K 2017, 'Conventional Total Station Versus Digital Photogrammetry in Land Development Applications', *Journal of Environmental and Analytical Toxicology*, vol. 7, no. 1, pp. 1-5.

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Early Detection and Prevention of Catastrophic Failures in Industrial Engines

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Supervisors: Dr Ray Malpress, USQ

Keywords: Engine, Failure, Detection.

1. Introduction

Nowadays there is the trend to operate some industrial machinery such as generator sets, gas pumps, and emergency equipment remotely.   It is sometimes impossible to directly interfere with the operation of the equipment in case of unexpected malfunctions. The aim of this project was to design and test an inexpensive system that would detect an event of the crankshaft bearings failure and provide a quick response.

2. Background

The most expensive parts of large industrial engines are cylinder blocks and crankshafts. In some cases, the cost of the new cylinder block may exceed $100,000AUD.   Premature crankshaft bearing failure may aggravate to catastrophic damage to the cylinder block and render the whole engine unsalvageable. The project has developed a system that provides an on-line monitoring of a few critical engine parameters and applies a simple logic test in a control system to detect the fault conditions.

3. Methodology

Recent studies had proven that monitoring the wear debris in the lubrication oil combined with vibration analysis provide comprehensive information on the current state of the machine (Peng et al. 2005). As such the test prototype detects the wear particles in the oil applying the pressure rise method and vibration analysis as the secondary source for the decision-making algorithm.

Figure 1 : Test engine with the prototype system installed

4. Key Outcomes

The system consists of a microcontroller that reads a vibration signal from an accelerometer and the oil pressure at the filtering element. It sends acquired data to MATLAB for processing. If MATLAB algorithm detects an abnormal vibration signatures or high pressure at the filter, it sends a warning signal to the microcontroller which decides to stop the engine.

5. Further Work

The next stage of the project is to initiate the fault condition in real engine to test the system's ability to detect the abnormal wear particles generated by failing crankshaft bearing as well as determine abnormal vibration signatures.

6. Conclusions

So far, the system detects the presence of the wear particles being manually introduced into the oil. It takes about ten seconds for the system to capture the debris and transfer them to the inline filtering element. Also, the vibration signal acquisition and processing system provides the Fast Fourier Decomposition of the signal and calculates statistics such as RMS and crest factor.   The abovementioned parameters allow distinguishing a fault conditions such as misfire.

Acknowledgements

References

Peng, Z, Kessissoglou, NJ & Cox, M 2005, 'A study of the effect of contaminant particles in lubricants using wear debris and vibration condition monitoring techniques', Wear, vol. 258, no. 11-12, pp. 1651-62.

A comparative study of using an Unmanned Aerial Vehicle (UAV) in surveying projects

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Supervisors: Ms Zahra Gharineiat, USQ

Mr Scott Kimm LS, OnePlan Development Group.

Keywords: UAV, DJI Mavic Pro, Total Station, Drone.

1. Introduction

With the ever-increasing use of technology in surveying, the survey industry needs to move with the times. UAVs have become a new tool for the surveyor for aerial mapping and therefore UAV's have opened a new field to use as a research project.

Land surveying uses specialised equipment which will give a location of something or a relative place of an object or land. The need for technology so that the surveyor can accurately measure just about anything from the land, ocean floor or even the sky. Land surveyors have an integral part in land development.

2. Background

There is a range of new modern technologies a surveyor can utilise in today's field of surveying, these new technologies are such things like GNSS, digital levels, Laser scanners, reflector less measurements and digital cameras to capture measurements. These new technologies can produce digital models that once a total station was the only one that could have achieved these models and plans, although these new pieces of equipment have never fully replaced the total station for surveying. The reason for not adopting the new technologies in surveying is of the already great accuracy and precision of the modern day total station and GNSS units.

Figure 1 – DJI Mavic Pro (DJI, 2017)

The field experiment and research that is a part of this dissertation will compare conventional survey techniques vs a UAV photogrammetry over different survey tasks, the experiment will provide a comparison of the two different types of techniques to measure the land.

3. Methodology

A subject site was chosen that provided a sufficient site for the comparison between the two survey methods. The subject site was measured and captured by the DJI Mavic Pro, Total Station and GNSS. The difference in vertical and horizontal positions of different measured points from both methods were compared and analysed.

4. Key Outcomes

The outcome of this dissertation is to find if the use of the DJI Mavic Pro can be used for aerial surveying and meet the required accuracy and precision for a feature and contour survey.

5. Further Work

A future goal would be to further address the location and how many GCPs to use will impact on the accuracy of the UAV data compared to conventional surveying methods

6. Conclusions

As the results have not yet been finalized a conclusion is difficult to articulate however the key outcome of this project is to compare the accuracy and time taken to capture the required data from a UAV is beneficial to be a piece of equipment for a typical land surveyor.

References

DJI Mavic Pro 2017, image of DJI Mavic Pro, viewed 20 March, <http://www.dji.com/mavic >

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

Scramjet Engine Fluidic Thrust Balancing to Achieve Side Loading

Sponsor – School of Mechanical and Electrical Engineering

Student Name

Bachelor of Engineering

(Mechanical)

Bachelor of Business

(Leadership & Management)

Supervisors: Professor David Buttsworth, USQ

Keywords: Scramjet Engine, Nozzle Thrust Balancing, Hypersonic Thrust Vectoring

1. Introduction

Hypersonic flight technology is a developing technology that holds a lot of benefits in the aerospace field. Achievements of reaching hypersonic speeds in aircraft have been an accomplishment since the hypersonic flight of the X-15 manned airplane on the 12th of April 1961 Anderson (2006).

Thrust vectoring is created by having a fluid flow along the x-axis, which changes direction with the application of a secondary stream applied in the y-axis direction. The focus of this research is then to study the effects of thrust vectoring under hypersonic conditions, with the aim of using a y-axis fluid stream that can achieve a percentage of the axial loading.

2. Background

The experimental research in thrust vectoring will be an addition to the current scramjet design by investigating the interaction and effects of a secondary fluid flow, as shown in Figure 1. This research is important for developing performance capabilities of the scramjet engine such as manoeuvrability, control, drag reduction, and thrust vector control systems Sellam et.al. (2015).

3. Methodology

After extensive research, the findings and calculations can then be analysed to determine the possible flow characteristics and conditions that need to be accounted for. The calculations will then be modelled from Figure 1, which determines the expected side loading caused at the separation line based on the factors of, primary nozzle flow, secondary nozzle flow, diameter of the
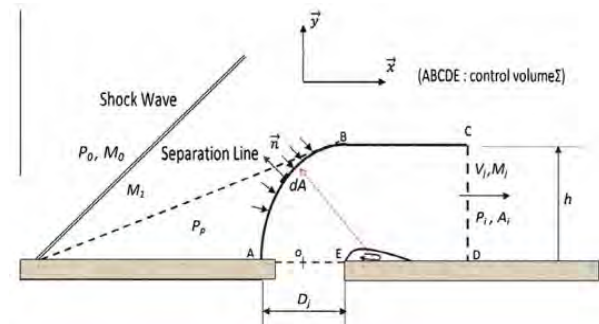
Figure 1 – Transverse Injection into hypersonic flow (Source: Sellam et.al 2015)

secondary nozzle and the associated pressures of the secondary nozzle. From this a component can be designed as a solid model, manufactured, and then tested at the USQ Hypersonic Wind Tunnel (TUSQ).

4. Key Outcomes

The current outcomes of this project have been that there is a level of side loading found in the range of 20% of the axial loading from the Mach 6 nozzle. In order to gain this, the use of the Mach 2 nozzle will be required, and the diameter of the secondary inlet will be equal to the exit diameter of the Mach 2 nozzle.

5. Further Work

The further work of this project is to have a component manufactured for testing, were it will be tested under hypersonic conditions at the TUSQ. Data obtained from this test, can be compared against the modelled data, to give a conclusion on the effects of side loading, while also providing a larger range of data along the x-y, y-z and x-z axes.

6. Conclusions

This project has found that there is conclusive evidence that thrust vectoring can be achieved at hypersonic speeds in the scramjet engine nozzle. From this analysis there has been conclusive evidence that physical experimentation may provide further supporting results to this project.

References

Sellam, M, Zmijanovic, V, Leger, L, Chpoun, A (2015). *Assessment of gas thermodynamics characteristics on fluidic thrust vectoring performance: Analytica, experimental and numerical study,* International Journal of Heat and Fluid Flow, 53, 156-166,

Anderson, JD. (2006). *Hypersonic and high-temperature gas dynamics* (2nd ed). American, Reston, Virginia, Institute of Aeronautics and Astronautics

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

58

Test Harness Development to analyse the performance of an algorithmic based High Voltage Fault Detection, Isolation and Restoration application

Sponsor – Energex Pty Ltd

Jack Delaforce
Bachelor of Engineering (Honours) Power

Supervisors: Dr Andrew Hewitt, USQ
                 Mr Mitchell Bradley, Energex
                 Ms Emma Rogers, Energex

Keywords: High Voltage; Fault Detection Isolation and Restoration; Test Harness Development

1. Introduction

Energex is a South-East Queensland electricity distribution company supplying power to domestic and commercial consumers.   Energex is considering implementation of automated software applications such as fault detection, isolation and restoration (FDIR) on its 11kV distribution network. FDIR could minimise supply interruption times, and ideally reduce the burden on human controllers, particularly accidental re-energising of faulted sections on the network,. While the FDIR application could enhance Energex high voltage network operations, thorough testing and validation is required before implementation.

2. Background

No Australian electricity distribution utilities have implemented an in-service, algorithmic-based FDIR application. This project will enhance knowledge through: development of an FDIR application and associated test device specific to a network; the processes for testing an algorithmic FDIR on a network; and the benefits and challenges of implementing an FDIR application.

3. Methodology

Historical 11kV lockout data was extracted and analysed to identify both usual and unique scenarios. A test network was then designed within the GE PowerOn Fusion Development world to facilitate simulated test scenarios of the FDIR to verify logic. Replication of the test scenarios included creation of scripts which were run via an RTU simulator.

4. Key Outcomes

The key outcomes of this work include the development of the test network, associated fault scripts, and testing/analysis of the FDIR application. The project is now ready for testing stage 1 of the application, supported by technical documentation.
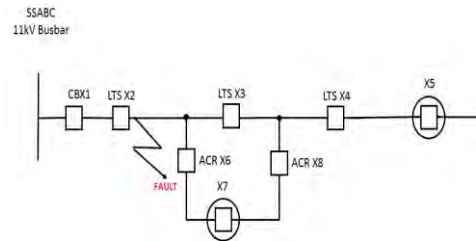
Figure 1 – Typical FDIR fault application scenario

5. Further Work

The next stage is copying over to, and acceptance testing in, the Production environment. The application's engineering documentation is awaiting finalisation, according to company policy. There is further scope in the application's next version to include 11kV feeder circuit breaker fail conditions, mesh networks and the replacement of Substation SACS driven ACO schemes.

6. Conclusions

This project enabled the development of the logic for governing this application and a suitable test network. Creation of the test scripts has permitted validation of the application and ensured its accurate testing after each upgrade of PowerOn Fusion. The test scripts are also the building blocks for testing further versions of the FDIR application.

Acknowledgements

References

Cox, P. 2008. Self-Healing Networks Performance Improvement By Automated Switching Algorithm, *CIRED Seminar 2008: SmartGrids For Distribution.* 24-28 June 2008, Frankfurt, Germany, pp 1-4

Ghorbani, J, Choudhary, MR and Feliachi, A. 2012. Real-time multi-agent system modelling for fault detection in power distribution systems. *North American Power Symposium (NAPS)* 1-6

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

59

Investigation on the management and maintenance of engineering assets of the biomedical industry

School of Mechanical and Electrical Engineering

Ashtika Devi

Bachelor of Engineering
(Honours) (Mechanical)

Supervisors: Asc. Prof David Thorpe, USQ

Keywords: asset management, framework, biomedical engineering

1. Introduction

The biomedical engineering industry is growing at a rapid rate in Australia therefore it is vital that there are consistent frameworks implemented to ensure the success of the industry [1]. The main focus of this project is to assess the current asset management practices in the biomedical field with a view to provide recommendations for a standardised framework.

2. Background

Biomedical engineering is defined as a discipline that improves human health through the integration of engineering and biomedical sciences as well as clinical practices. Australia was ranked fifth in the world in regard to biotechnology innovation and raised AUD$3.4 billion in revenue during 2015-2016, where the figures are forecasted to reach AUD$8.7 billion by 2021. [1]

3. Methodology

The original methodology implemented was to obtain data from an engineering company (unnamed) unfortunately, the data collection was not approved. Due to time restraints, the alternative method was to conduct a survey to determine potential issues identified by the participants. The use of this data and the literature review would then be used to develop a standardised asset management framework for the industry.

4. Key Outcomes

The research will highlight the gap in asset management frameworks for the biomedical industry. It is hoped that the development of the standardised framework will show that company work structures can be implemented
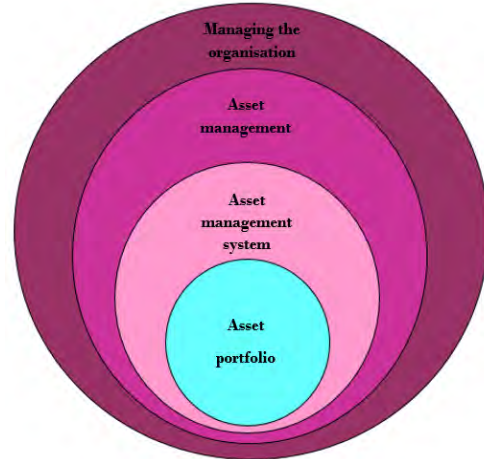
Figure 1 - Relationships between assets, its management and the company [2]

within the framework as well as other factors like risk management systems.

5. Further Work

Present survey to several biomedical companies to gather data on their perspective of asset management. A framework will be proposed as a part of the thesis. If time permits, a costs analysis may be conducted.

6. Conclusions

At this stage of my thesis, I have found that the implementation of an asset management framework for the biomedical industry is not standardised. It was also found that there is not enough support for the industry when compared to the information and support available for assets such as roads.

Acknowledgements

I would like to thank my supervisor, David Thorpe, for all the guidance as well as Samantha Davis for her help with my ethics approval.

A special thank you to my family, especially my husband, for the never-ending support they have given me.

References

[1] *2014 Annual Report 2015* (2015). Retrieved from https://www.health.qld.gov.au/__data/assets/pdf_fil e/0028/164863/mn-2014-15-ar-full.pdf Biggs, J. B., & Tang, C. (2011). *Teaching for Quality Learning at University* (4th ed.): Open University Press.

[2] AS ISO 55001:2014 Asset management - Management systems - Requirements. (2014). Standards Australia.

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The introduction of a Rural Enhanced Auxiliary Left-turn Treatment (EAUL) at geometrically constrained locations in N.S.W'

Sponsor – Roads and Maritime Services

Michael Drake

Bachelor of Engineering (Honours) Majoring in Civil Engineering

Supervisors: Dr Jo Devine, USQ

Mr Peter Ellis, RMS

Keywords: Blind spot, rural intersection, Austroads.

1. Introduction
Some rural intersection arrangements incorporating a left-turn treatment can result in a blind spot. The consequence of this is the potential for an incident resulting in death or serious injury. The aim of the project is to introduce and investigate the effectiveness of an intersection arrangement that eliminates the existing blind spot experienced by the road user.

2. Background
Based on research and observation, there is an apparent blind spot at intersections which occur due to a combination of factors including the obstruction of a smaller vehicle behind a larger turning vehicle in combination with the curve radius, curve direction and longitudinal grade. A consequence of this blind spot is the potential for incidents which result in death or serious injury. These incidents are occurring on intersection arrangements used in current design guidelines and therefore a solution is required which can be incorporated in to existing intersection arrangements, as well as current guidelines used by road authorities for new construction.

3. Methodology
To investigate the proposed intersection configuration, analysis of crash data at test locations where the design had been applied was undertaken to verify the effectiveness of the design implementation. The identification of an existing black spot in need of the proposed treatment was completed through crash data analysis, identifying where there is a high occurrence of the targeted crash type (T-bone crashes). The undertaking of a site inspection and Road Safety Audit also confirmed the blind spot issue was present.
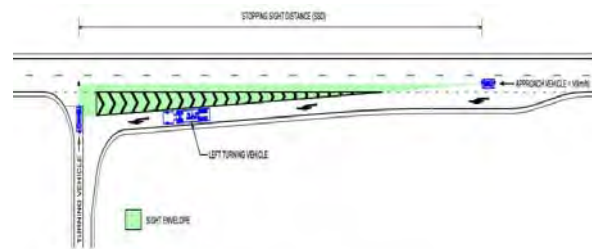
Figure 1 – Rural Enhanced Auxiliary Left-turn Treatment

A technical analysis was conducted which compared the technical aspects of the investigated treatment with current industry guideline treatments. From this, a set of figures and guidelines was produced using the format adopted by Austroads Guide to Road Design and with the aid of computer-aided design and drafting software.

4. Key Outcomes
The four key outcomes from the project were; the confirmation of the blind spot experienced by the road user on intersection treatments found in current design guidelines, verification of the design's effectiveness in mitigating the targeted crash type, the identification of an existing black spot that would benefit from the investigated arrangement, and the production of a set of guidelines and figures based on findings for use by road authorities.

5. Further Work
Further trials of the intersection arrangement may be undertaken at black spot locations to further investigate the effectiveness of the treatment over time and in different application situations.

6. Conclusions
The conclusions drawn from investigations show the proposed arrangement is mitigating the targeted crash type and is indeed effective in eliminating the existing blind spot experienced by the road user. This has resulted in the necessary push to introduce the arrangement in to the Roads and Maritime Services design supplement for Austroads used by the road authority.

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Development and Performance Assessment of an Animal Monitoring System

Sponsor – School of Mechanical and Electrical Engineering

Simon Dutton

Bachelor of Engineering (Mechatronics)

Supervisors: Associate Professor Thomas Banhazi, USQ

Dr Tobias Low, USQ

Keywords: Animal monitoring, remote sensors, industry based.

1. Introduction

The demand for free range pork has never been higher in Western Australia however hot Australian summers afflict significant heat stress on lactating Sows. Pork Innovation WA is pulling its resources into researching the effectiveness of farrow cooling during summer. My project is to look into the feasibility of evaporative cooling but my main focus is on developing the remote monitoring system that the animal scientist can utilize for data collecting during the trial observational study period.

2. Background

It's well known that heat stressed sows spend more time in the wallows resulting in reduced suckling, increased piglet dehydration and an increased risk of piglet overlays. A few cooling methods have been explored overseas with some promising results. Now is the time to investigate a dedicated cooler for Australian conditions however this would not be possible without a robust remote monitoring system to collect data relevant to the animal scientist.

3. Methodology

The animal scientist wants to observe behaviour that can be related back to the coolers. This meant a detailed investigation and specification of sensors, associated computer hardware and software was needed. Significant consideration to the conditions was also required. The final system was being observed for accuracy, reliability and robustness. This process which followed prototype development involved remote access

Figure 1 – Sow farrow

observation, cross corroboration and a number of field trips.

4. Key Outcomes

Initial results were good and the server is operational. Much of the difficulties come down to the environmental factors such as dust, ammonia, insects, rain and the pigs themselves. Through the exploration of some technologies and techniques it's hoped that accurate reliable tracking of Sows can be achieved.

5. Further Work

Further work will involve rectifying any shortfalls before the proposed summer trial. The trial period will require close observation, maintenance and performance documenting.

6. Conclusions

If the any part of the monitoring proves beneficial or conversely, proves ineffective then I have achieved a goal. Ultimately however, if all goes to plan the entire system will provide enough data to conclusively prove or disprove the coolers effectiveness.

References

Barbari M, Bianchi M, Guerri FS, (2007), *Preliminary analysis of different cooling systems of sows in farrowing room*

Kashiha M., (2013), *Automatic identification of marked pigs in a pen image pattern recognition*

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Decision Support System for Managing Complex Construction Projects

Sponsor –School of Civil Engineering and Surveying

Zainab Ebrahim

Bachelor of Engineering (Honours)
(Civil Engineering)

Supervisor: Dr. Nateque Mahmoud

Keywords: resource workflow system, project management, automation, project system

1. Introduction

Project management industry has grown with new challenges emerging continually in hundreds of different ways. Currently, the focus is to provide resource management software that deal with inherent problems that project managers face. To investigate the impact of project complexity on Project success in terms of cost and time over runs, quality and even health and safety in the construction industry. As an implementable project the study seeks to develop a system that offers solutions to project management problems so as to combine the aspect of dynamisms in project, analyse the impact of project complexity to produce concrete and productive outcomes for project complexity management.

2. Background

As there is a growth in project complexities, there continue to be paucity of information regarding complexity and project success. It remains that there is a need for a broad view as well as critical analysis of the underlying implications of projects complexities. Recent developments in project complexities show that researches need to shift attention to find management system that deal with project complexities.

3. Methodology

The research adopted qualitative and quantitative methodologies. Quantitatively, the research stresses on measurements of data and statistical analysis of data collected through survey and manipulation of pre-existing statistical data through computational approach.
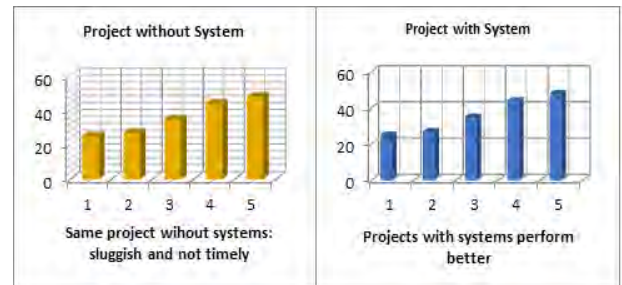
Figure 1- Project with and without system

The research took emails and questionnaires as qualitative approaches of data collection so as to investigate non-numeric data concerning phenomenological points of project complexity and project management system.

4. Key outcomes

The research establishes that complex projects can be managed successfully using existing frameworks and best practices such as Practice Standard for Project Estimating and Primavera. In addressing the issue of project complexity, there need for a change in the level of complexity at different instances of the lifecycle of the project.

5. Further Work

Management of different phases of project development process

6. Conclusions

Due to demand of complex projects, project managers need to embrace project management systems to grapple with the challenge of cost and delayed projects.

Acknowledgements

My appreciation goes to my lecturer and supervisor for their efforts to see the work succeed.

References

Gurjar, N 2017, Basic Mantras of Project Management, In A Forward Looking Approach to Project Management (pp. 83-100), Springer Singapore.

Latent Heat Storage in Solar Water Heating Systems

School of Mechanical and Electrical Engineering
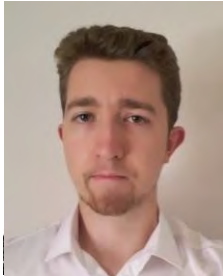
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(Honours) (Mechanical)

Supervisors: Dr Andrew Wandel, USQ

Keywords: Phase-change, solar, heating.

1. Introduction

Substantial quantities of thermal energy can be stored as latent heat in a phase-change material (PCM) that undergoes phase transformation at a temperature that is useful for a given application (Goswami et. al, 2000). This project investigates if a latent heat storage medium can be applied to domestic solar water heating systems (SWHS) to improve thermal output characteristics.

2. Background

Water heating products accounts for 23% of all energy consumed by the average household (Kalogirou, 2009), and storing thermal energy using an insulated tank ensures hot water can be supplied during off-peak periods. Phase-change materials such as paraffinwax offer stable temperatures, low volume and high storage capacities (Duffie et. al, 2013).

3. Methodology

The theoretical PCM upgrade design was based on spherical paraffinwax capsules that would be suspended in the roof-mounted tank itself. A sectional tank design isolates incoming hot water and promotes faster heat transfer rates. Programming in Python was selected as the ideal method of quantifying the performance of SHWS upgrades, as it is cost-free to use and does not require physical prerequisite materials. The simulations used timestep-based equations to plot temperature trends, as shown in Figure 1. Data validation was provided by a physical solar radiation and ambient temperature data collection experiment.

4. Key Outcomes

Simulations indicated that, as expected, the latent heat properties of paraffinwax helped to 'stabilise' the outlet temperature by reducing the daily peaks and troughs. While this did not increase overall energy throughput, the mixing device ensured that the output temperature
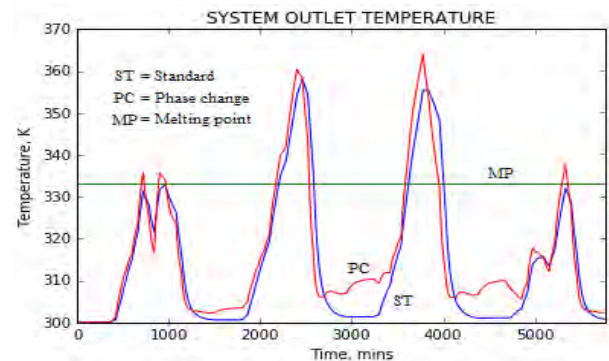
Figure 1 – Graphed SWHS simulation output

was floored to a maximum of 60°C. This meant that the PCM upgrade retains the same on-peak behaviour whilst improving off-peak temperatures, often by up to 5°C. The sectional tank design change was observed to offer improvements, particularly higher peak temperatures in winter conditions and a higher success rate of providing an outlet temperature of 60°C.

5. Further Work

A general costing analysis will be conducted to provide the information required by engineers to make informed business decisions when investigating phase-change materials in future solar developments.

6. Conclusions

This research project has demonstrated that system energy control can improve performance by some degree, without altering the net energy throughput. Programming also provides a great deal of analysis potential at a very low cost.

Acknowledgements

I would like to thank Dr Andrew Wandel for his technical input throughout this research project, and my family for providing a supportive and quiet work environment.

References

Duffie, J. A., & Beckman, W. A. (2013). *Solar engineering of thermal* processes (Fourth ed.). Chichester: Wiley.

Goswami, D. Y., Kreider, J. F., & Kreith, F. (2000). *Principles of solar engineering* (2nd ed.). Philadelphia, PA: Taylor & Francis.

Kalogirou, S. (2009). *Solar energy engineering: Processes and systems.* US: Academic Press.

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Low-Cost Slip Angle Sensor for Use in Analysing Vehicle Handling Characteristics

Sponsor – School of Mechanical and Electrical Engineering

Travis Evans

Bachelor of Engineering (Mechanical)

Supervisors: Mr Chris Snook, USQ

Keywords: Vehicle Dynamics, Slip Angle, Handling.

1. Introduction

Tyres are essential to a motor vehicle as they are the direct link to the road. Their performance is crucial to ensuring a well-balanced and safe motor vehicle. A key measurement used to analyse a vehicles performance is the tyre slip angle. This is the angle between the direction of the wheel rim and the actual tyre trajectory, it is a function of the elastic properties of the rubber tyre. Analysing individual tyre slip is a complex and expensive exercise. Common industry practice is to measure the vehicle side slip (similar to tyre slip but accounts for the whole vehicle's trajectory), which is then translated into front and rear tyre slip. Once obtained, the tyre slip angle can be used to calculate many important vehicle dynamic handling metrics.

2. Background

State of the art vehicle side slip sensors are based around either optical or Global Positioning Satellite (GPS) technology and cost tens of thousands of dollars. The aim of this project is to develop a low-cost slip sensor, sub $2k, with comparable accuracy and repeatability to that of the commercial units. This will allow slip angle measurement to become accessible to a broader range of people and, in turn, extend the knowledge base of vehicle dynamics.

3. Methodology

A review of current theories, technologies and existing equipment was completed to gain a better understanding of vehicle dynamics and highlight a gap in the knowledge. A conceptual design was then modelled in Creo Parametric 3.0 using an iterative process combining key design parameters with 'off-the-shelf' components before commissioning of manufacture. An Arduino microcontroller was programmed and used to collect and process data from a potentiometer and a 3-axis accelerometer/3-axis gyroscope.
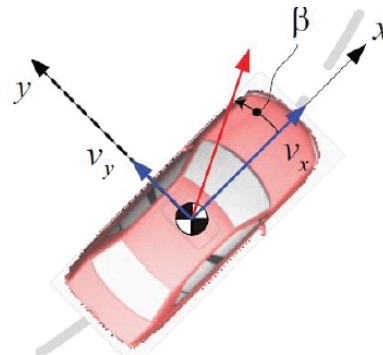
Figure 1 – Vehicle Sideslip, β.

4. Key Outcomes

A prototype unit was designed and manufactured that allows on-vehicle data collection. The unit price came in well below the specified target. It was then tested in static and dynamic environments. The data was collected and post processed to output a front and rear slip angle.

5. Further Work

Further 'on-vehicle' dynamic testing will need to be undertaken to confirm the static and dynamic results achieved. To validate the theory the data needs to be compared to that of a commercial slip sensor.

6. Conclusions

This project shows that it is possible to measure slip angle via a manual trailing arm arrangement for far less than the cost of a commercial unit.

Acknowledgements

References

Gillespie, T, 1992, *Fundamentals of Vehicle Dynamics,* SAE International.

Milliken, W & Milliken, D, 1995, *Race Car Vehicle Dynamics,* SAE International.

Smith, C, 1978. *Tune to Win: The art and science of race car development and tuning*, Aero Publishers Inc.

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Effectiveness of Variable Speed Control Devices in Queensland

Sponsor – School of Civil Engineering and Surveying

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Supervisors: Dr Soma Somasundaraswaran, USQ

Keywords: VSL, Variable speed limits, Queensland traffic management.

1. Introduction

Queensland's population growth has been steep over the last 4 decades. This growth has contributed to urban sprawl allowing the population to be located outside the city centre in low-density housing estates. While much of the population work in the city centre they need to commute daily to their place of work. With thousands of vehicles on main roads at the same time comes congestion due to the roads being at capacity. This congestion occurs at key points termed bottlenecks. This project investigates the effectiveness that Variable Speed Limits has on the traffic safety.

2. Background

Congestion occurs at key points such as off ramps, onramps and other locations that cause the traffic to merge or slow such as lane terminations and diversions. VSL is designed to minimise the speed difference between the vehicles gradually allowing traffic to pass through the bottleneck as a homogeneous body. Slower speeds make it easier for traffic to enter and exit the highway aiming to reduce crashes.

3. Methodology

The main aspect of the project was to collect data and compare the geometric properties of existing VSL sites against the design guidelines. The data was collected manually utilizing the public available tool called Google Earth. Traffic data was then analysed for both Pre and post implementation to determine the impact that VSL has on traffic. Please see Figure 1 for an example of VSL signs on either side of the carriagway.

Figure 1 - VSL signs - Bruce Hwy & Deception Bay Rd Interchange Source: Google Earth 2017

4. Key Outcomes

Results so far have identified that the locations of VSL signs have been adequately placed with respect to the lane edge and merge lane gores. Visually inspecting the site terrain and taking measurements using Google Earth have attained results.

5. Further Work

Key tasks to be completed are traffic data analysis. Further study in 5 years should be performed given that VSL is still a relatively new part of Queensland's traffic landscape. The effects of ramp metering would also be a valuable topic to research.

6. Conclusions

So far it can be seen that road designers adequately follow the design guidelines. It is expected that, with the use of up-to-date traffic data and industry used traffic modelling software, that Variable Speed Limits have a positive effect on traffic flow and safety.

Acknowledgements

References

DTMR (2016). *ITS Placement Guideline*, Transport and Mains Road, Brisbane, Queensland.

Australia Government. (2016). *National Road Safety Strategy*, Brisbane , Queensland

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66

The use of Nearmap imagery in two dimensional topographic surveying applications

Sponsor – Bennett and Bennett Pty. Ltd.
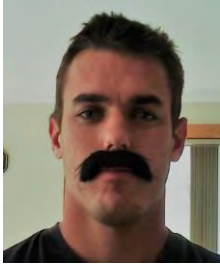
Julian Flynn

Bachelor of Spatial Science (Honours) Survey Major

Supervisor: Dr Dev Raj Paudyal, USQ

Keywords: Photogrammetry, Surveying, Accuracy

1. Introduction

With the increasing accessibility and manipulation with basic surveying software, aerial imagery of various formats are able to be employed in a variety of applications. These applications are sometimes not tested by the end user rather the products available are often used with the assumption that the providers claims of accuracy are correct. Nearmaps imagery is fast becoming a very useful tool in the surveying industry and its uses can be pushed beyond an acceptable limit.

2. Background

Nearmaps posts various claims of accuracy of their imagery in various uses however it may not have been tested publicly. The accuracy claims are either accepted to be true by the end user or the user is required to make assumptions or checks to ensure that the imagery is fit for their purpose. This study is important to the work regularly undertaken in my organisation as the imagery is regularly used to extract geographic information of features visible in the terrain. These features are then often integrated with more accurate survey information. This study tests the appropriateness of this practice.

3. Methodology

The method employed included carrying out a survey in a plane coordinate system with the addition of static GNSS survey in order to place the survey on a true GDA scale in order to check the raw position of the Nearmap imagery downloaded. A survey of a series of features readily identifiable from aerial imagery is then located. The data is then compared to the locations of the same features digitised from a Nearmap image and additionally the locations digitised from a purpose flown aerial orthophoto. The differences are then calculated and compared.
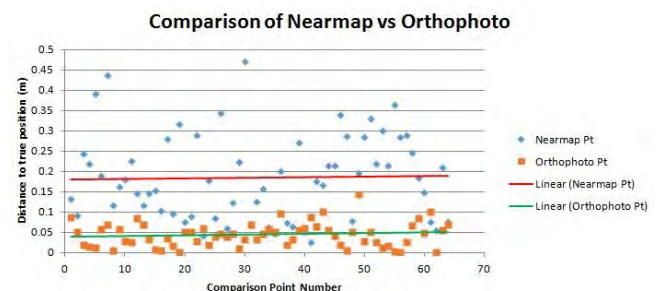
Figure 1 - Orthophoto Comparison Results

4. Key Outcomes

One of the interesting outcomes in this study was that the accuracy stated by Nearmaps was generally achieved however there were localised sections of the imagery which had larger errors compared to other areas of the imagery. The test case proved the accuracy of the purpose flown imagery as a by-product of this study.

5. Further Work

Future project works include assessment of the impending three dimensional mesh products to be released by Nearmap. Other future work may include in depth analysis of elevated objects captured in the Nearmap imagery.

6. Conclusions

The use of Nearmap imagery for data extraction is appropriate however it is important to make redundant checks on the data being extracted as there are localised errors larger than what is advertised by Nearmap.

Acknowledgements

Bennett and Bennet have been instrumental in this study as they donated the use of their equipment, software and subscription resources. A special mention to my peer Marcus Hager who spent the time talking through ideas to help formulate a suitable methodology.

References

Nearmap (n.d.) Retrieved August 7, 2017, from http://www.nearmap.com

Linder, W. (2003). *Digital Photogrammetry Theory and Application*. Germany: Springer

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

67

Resilience of Infrastructure Development and Management

School of Civil Engineering and Surveying

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Bachelor of Civil Engineering (Honors)

Supervisors: Dr David Thorpe, USQ

Keywords: Transport, Resilience & Engineering.

1. Introduction

This dissertation will analyse the current processes used in the construction and repair of major road networks. The project will focus on these critical methods with the expectation of improving overall resilience and road safety.

2. Background

This project seeks to analyse the current standards used in developing major road networks in Australia. The project aims to analyse various networks, exploring the processes used in the design, construction and repair phases to improve overall road resilience. With over 810 000 kilometres of road lengths covering the Australian Continent (Austroads, 1989), annual repairs to these extensive networks currently cost the government 400 million dollars (NSW Government, 2005). Improvements to the construction and repair of these major networks will directly influence financial aspects of the transport industry.

3. Methodology

In order to achieve this, a literature review on relevant publications had to be undertaken. A key focus of the literature review was identifying current road design, construction and repair strategies. The effects of road damage, the impact of flooding on roads and the associated damages, subgrade and pavement selection and identifying other influencing factors, such as traffic volume and management, were key focus points of the review. The dissertation then selected several major networks that had recent exposure to flooding damage and analysed the cost of repairs.

4. Key Outcomes

The project analysed the techniques used in each of these networks with the purpose of identifying the most resilient and financially superior construction process. A comparison table was constructed evaluating the performance of each network during the flood period using key indicators such as overall strength, damage, cost and time to construct and repair.

5. Further Work

Further work in this field may be required; such as determining the effects of roadside vegetation and embankments on the resilience of road networks exposed to heavy flooding. Additional work may be undertaken by importing the findings of this report into traffic simulation software.

6. Conclusions

The completion of the dissertation will result in a constructed comparison table detailing the performances of several key networks within Australia. Connections between the completed table and the processes used in the construction and repair are formed; resulting in determined relationships between materials, construction processes and increased resilience.

Acknowledgements

This project and its works could not be accomplished without the assistance and overview of Dr. David Thorpe from the University of Southern Queensland, Springfield Campus.

References

Austroads, 1989, Rural Road Design: Guide to the Geometric Design of Rural Roads.

NSW Government, 2005. "Appendix M: Flood Damage" *Floodplain Development Manual.* Pp M1-M9

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Lifecycle Costs and Maintenance of Gross Pollutant Traps for Rural Local Government Areas

Sponsor – School of Civil Engineering and Surveying

Benjamin Gibbons

Bachelor of Engineering (Civil)

Supervisors: Dr Nateque Mahmood, USQ

Keywords: Lifecycle Costing, Asset Management, Water Quality.

1. Introduction

A key component of effective asset management is the development of a Lifecycle Costing Model for every asset. The costing model is broken into elements that represent a part or stage of the management costs such as design and construction, maintenance, renewal and decommissioning costs. Accurate costing models allow asset managers to develop yearly financial budgets for maintenance and develop asset strategies for whole of life management.

2. Background

Developing effective lifecycle costs for complex stormwater infrastructure such as Gross pollutant Traps, can be difficult for asset managers. The number of variables that contribute to the maintenance and inspection requirements of these devices can result in inaccurate lifecycle costs models. For rural Local Governments that don't have access to long term maintenance experience there needs to be an effective tool to develop realistic maintenance costs to be used in Lifecycle Costing models.

3. Methodology

This research project involves a desktop study into pollutant sources, type and mobility within urban catchments. The project also includes several case study sites looking at individual gross pollutant traps and the maintenance and pollutant loads resulting from their catchments. These case studies will be used to determine the most common captured pollutants and the maintenance required to keep the traps operating efficiently. Figure 1 shows an example of residential/commercial land use pollutants.

4. Key Outcomes

This research project looks at the variables associated with pollutant loading on water quality treatment trains and aims to develop a simple non- proprietary modeling tool to provide Councils with accurate site specific maintenance cost estimates for individual devices. The modeling tool allows inputs of catchment parameters such as land use, impervious area and source controls. The model calculates an estimate for yearly maintenance costs associated with a particular device.

Figure 1 – Urban Residential and Commercial pollutants
Source: Author 2017

5. Further Work

Further work is required to finalise the layout and function of the modelling tool and finish collection and analysis of data for the case study sites. The number of case study sites had to be reduced due to some of the gross pollutant traps earlier targeted for inclusion still being off line.

6. Conclusions

The types of pollutants can vary between urban catchments depending on the land use within the catchment. Specific catchment parameters can result in different maintenance requirements for similar devices. These variations need to be considered when assigning asset management and maintenance budgets.

Acknowledgements

References

Brodie, IM, 2007, Investigation of stormwater particles generated from common urban surfaces, University of Southern Queensland.

Galloway, MJ, Laffan, SW, Smith, PG, 2006, Urban stormwater pollutants: A survey of three Sydney sub catchments, Water, Vol 33, issue 3, p67-70.

Lloyd, SD, 2004, Exploring the opportunities and barriers to sustainable Stormwater practices in residential catchments, Monash University.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Multi-stations, Trimble SX10 laser scanning applications, capabilities, and relevant accuracies

Sponsor – Harrison Grierson

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Bachelor of Spatial Science Majoring in Surveying

Supervisors: Dr Zhenyu Zhang

Keywords: Scanning, Surveying, Trimble

1. Introduction

This dissertation is based around the testing of a new piece of equipment that has been put on the market from leading global positioning company Trimble.

Laser scanning is relatively new to the surveying world and this instrument combines conventional methods used in traditional surveying equipment and laser scanning into one unit.

Being that this gear is brand new there is limited information about its capabilities and accuracies, hence this research aimed at providing an in-depth analysis into the SX10, put to the test in some real world scenarios that the day to day surveyor would come across and comparing it to tried and tested conventional methods to see how it fairs.

2. Background

Surveying practices are forever changing as the advancement of technology is continually improving the ways we can spatially capture data and complete day to day survey tasks. The SX10 is one of those pieces of equipment that is pushing the envelope a bit further. There have been dedicated scanning instruments in the industry for a while but they are a heavily specialized piece of gear that requires knowledge of dealing with and post processing of these often very large point cloud data sets. The SX10 however provides scanning capabilities combined with the already proven robotic surveying platform that open up the options of data capture techniques that you require for each task. The processing streams have also been developed (and continually develop) to work with TBC (Trimble Business Centre). This software allows simple processing techniques to be employed to process the point cloud data to produce full client deliverables with relative ease.

3. Methodology

The methodology being used for this research project was using conventional surveying methods to complete survey tasks as a base and then comparing them to the results from the SX10 scanned data. By comparing the results between surveyed TIN surfaces, it was possible to determine how the data compared between different survey applications and surfaces. Testing this equipment in real world scenarios allowed for further understanding of its capabilities and some client deliverable products that it could provide.

4. Key Outcomes

The accuracies of this equipment in both topographical and volume areas were proven during the testing phase, proving the advantage especially for volumetric surveys as it provided an extremely detailed model of the area giving a lot more accurate representation which in turn provides a better volume result. This process also provided an understanding of the extra client deliverables available when using this instrument.

5. Further Work

Further testing could be completed to test the accuracy of Trimble Vision. As the SX10 doesn't have a conventional telescope it relies on the Trimble vision to survey points such as reflector less shots on roof peaks and eaves etc.

6. Conclusions

This project demonstrated that the accuracies were very good between many survey aspects however it proved that accuracies differed large amounts when dealing with certain surfaces. Overall it proved to be a very proficient survey tool streamlining workflows and providing clients with great deliverable products.

Acknowledgements

References

E. Lachat, T. Landes, P. Grussenmeyer, (2017), 'First experiences with the Trimble SX10 Scanning total station for building facade survey' <https://www.intarch-photogramm-remote-sens-spatial-infsci.net/XLII-2-W3/405/2017/isprs-archives-XLII-2W3-405-2017.pdf>

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EFFLUENT WATER REUSE FOR TOWNSVILLE

Sponsor –School of Civil Engineering and Surveying

Joel Blake Govan

Bachelor of Engineering (Hons)

Supervisor: Mrs Justine Baillie, USQ

Water Lecturer, USQ

Keywords: Effluent, Water, Reuse

1. Introduction

The Townsville region is currently (2017) experiencing a drought period where by the regions water supply is reduced to reliance on the Burdekin river water supply through the Burdekin Haughton Water Supply Scheme (BHWSS). The BHWSS requires pumping to move the water and is currently a cost of $27,000 a day to the rate payers. The town of Townsville itself is presently on level 3 restrictions and has been on water restrictions for the last 2 years. Water supply security is an issue for Townsville and the dry tropics with low rainfall, arid climate and high-water demand. A water security issue of this kinds warrants alternative solutions to be investigated. One such solution is effluent water reuse, that this research project investigates specifically for Townsville.

2. Background

Regional water supply security has previously been investigated by Townsville City Council (TCC). The proposed solution was to duplicate the BHWSS pipeline and double the supply capacity to Townsville from 130ML/day to 260ML/day. Th investigation also flagged Effluent water reuse as a possible future consideration for the region and the point at which this project picks up and develops.

3. Methodology

A Water Balance Model (WBM) was developed for the Ross River Dam (RRD), the major water storage for the region. The model was validated by comparing historical dam level data with modelled data. Once the model was validated various scenarios of effluent water supply timing were run to test for bulk storage changes.

4. Key Outcomes

The key outcomes this project address is:

1. The viability of Effluent water reuse for Townsville from a supply and cost point of view. Looking at both potable and non-potable reuse schemes.

2. The water demand comparison to other regional centres.

3. Timing triggers for effluent water and BHWSS.
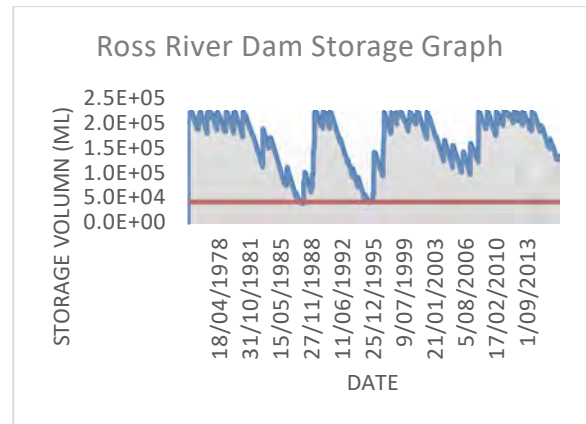
Figure 1 – Ross River Dam Storage Graph

5. Further Work

The project identified a large volume of effluent water that was largely unusable without for neither Potable or Non-potable reuse without the implementation of Reverse osmosis (RO). This was due to the low-lying nature of Townsville and the high infiltration Inflow of salt water. Further study and investigation of this may result in larger volumes of effluent being available for reuse.

6. Conclusions

Conclusions drawn from the work suggest that whilst effluent water reuse does have a positive effect on the supply the volumes being considered are too small to have any large implications. Localised benefits exist, however on a whole the BHWSS is far more effective at supporting Townsville water supply demand.

Acknowledgements

References

Townsville.qld.gov.au. (2017). *Water, Waste & Environment - Townsville City Council*. [online] Available at: https://www.townsville.qld.gov.au/water-waste-and-environment [Accessed 21 Aug. 2017].

Townsville City Council (2012). Integrated Water Supply Strategy. Townsville: Townsville City Council.

Department of Energy and Water Supply (2014). Regional Water Supply Assessment Townsville. Queensland: Department of Energy and Water Supply.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Static and Dynamic Seal Friction in High Performance Hydraulic Systems

Sponsor – Russell Mineral Equipment
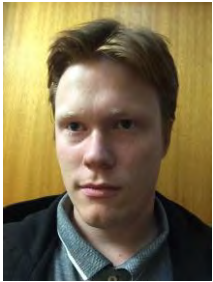
David Gresham
Bachelor of engineering (Hon)

Supervisors:

Mr Chris Snook, USQ

Mr Andrew Tuxford, Russell Mineral Equipment

Keywords: Hydraulic Seal Friction.

1. Introduction

The aim in this Project was to develop a robust experimental platform to replicate the conditions imposed upon the hydraulic seals within the Russell Mineral Equipment (RME) THUNDERBOLT Recoilless Hydraulic Hammer. The primary objective of the investigation is to provide information regarding the amount of energy lost due to frictional forces induced by the hydraulic seals.

2. Background

Within the THUNDERBOLT Hammer, there is suspected loss of energy. The focus of this project is to identify potential energy loss due to the friction between the seals sealing the hydraulic rod and the hydraulic rod. There are many methods of testing hydraulic seals, many rigs developed to assess the capabilities of individual seals or observing tribological phenomena within the system. Papatheodorou, T is an example of critical research in the field among other sources combined with the relevant ISO and AS standards form a representation of the industry standard for hydraulic testing. However, most documented experimentation investigated key characteristics of the seals or assessed the system under relatively low speed operation. The focus of this project is a high-speed application and focusing on the friction and associated phenomena rather than evaluating the seals performance.

3. Methodology

To effectively replicate the THUNDERBOLT Hammer system any developed test rig needs to operate at high speeds. The THUNDERBOLT Hammer utilises its extreme piston speeds, it could not be matched by conventional means. However as can be seen within Figure 1, extrapolated from Papatheodorou, T. 2005, friction is expected to plateau off to a constant value after approximately 1.5 m/min. This enables testing at a lower speed than is present in the hammer while allowing the data to remain valid, despite not being able to be recorded at the speeds actually present in the hammer, provided no alternative tribological phenomena occur at these higher speeds.
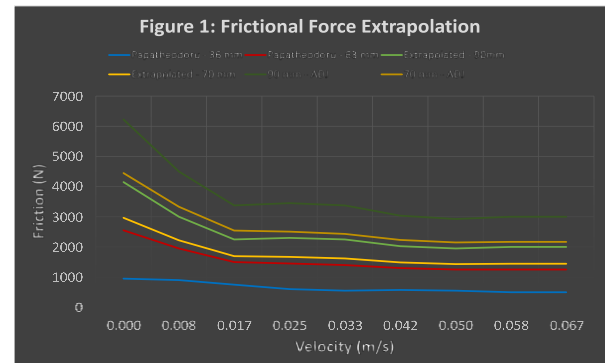
Figure 1 – Friction Force Extrapolated from Papatheodorou, T.

4. Key Outcomes

The test rig, supporting structure, drive system and monitoring sensors have all been designed and simulated. The conclusion of the design process has produced a robust test rig system, driven by an external hydraulic cylinder, that can measure the friction induced by the seals within a contained rig. The designed system achieves this by operating in four (4) different configurations. These different configurations allow the system to approximate the operating environment of each set of seals within the hammer. The simulated operating speeds reach between 2 and 3m/s. The number of components that are required for full system testing and the cost involved in its purchase it has been decided that only the 750 model components will be initially purchased to prove the performance of the test rig.

5. Further Work

Future work at this point in the project include assembling the elements ordered and conducting testing procedures.

6. Conclusions

Thus far the project has developed a robust hydraulic test rig and produced the technical drawings for system.

Acknowledgements

References

Papatheodorou, T. (2004). Influence of hard chrome plated rod surface treatments on sealing behaviour of hydraulic rod seals. Proceedings of the 13th International Sealing Conference, pp. 5-10.

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How have changes in common law understanding of native title affected the practice of cadastral surveyors?

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Bachelor of Spatial Science (Honours) (Surveying)

Supervisors:

Dr Glenn Campbell, USQ

Keywords: Native title, cadastral surveyor, extinguishment, decision tree

Figure 1: Chatbot question example

1. Introduction

The purpose of this research project was to assist cadastral surveyors and industry professionals to understand the existence and limits of native title rights and interests over land. This involved the creation of a simple tool to access collated information and enable people without experience in law or native title specifically to navigate the complexities surrounding native title and determine the likely existence of native title.

2. Background

Cadastral Surveyors are required to have an understanding of laws governing property title, including any rights and restrictions such as native title.

However, there is currently no simple means to assess the requirements of native title with regards to land rights, restrictions and extinguishment. The aim of this project was to provide a simple solution to this issue by developing a decision tree that collates relevant data into a chatbot tool.

3. Methodology

In order to bring together a list of conditions that are required to determine the likely existence of native title, the project required the analysis and documentation of a number of major and significant common law decisions and legislative transformation.

The analysis included an in depth description of the case, and commentary on the relevance of these decisions based on previous cases and relevant laws.

4. Key Outcomes

Following the completion of the case analysis, the data was summarised and collated to create the decision tree. To present the decision tree data in an accessible format, a chatbot program called Chatfuel was used. A chatbot is a modern tool that allows users to interact with content via a Facebook chat interface. The chatbot platform was chosen to present the decision tree information in a simple question and answer format to aid navigation.

5. Further Work

There is an avenue to expand the scope of the cases reviewed and to add content to the decision tree after analysis of the remaining, and any future cases.

Further, the chatbot was chosen because of its accessibility as a free and user-friendly platform for design purposes, the delivery of the decision tree is not necessarily limited to the use of the chatbot platform, and a more bespoke program could be designed or utilised to present the data.

6. Conclusions

The relevant cases and legislation were identified, a number analysed, summarised, and commentary provided, with the results then used to create a decision tree, that is now accessible through a simple and easy to use chatbot program.

7. Acknowledgements

I would like to thank my family for their ongoing support, along with Dr Glenn Campbell, for his feedback and extensive knowledge in the area of native title.

8. References

Strelein, L. (2009). *Comprised Jurisprudence: native title cases since Mabo* (2nd ed): Aboriginal Studies Press, Canberra, ACT.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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STATCOM Technology and Their Application in Power Networks

School of Mechanical and Electrical Engineering

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Supervisors: Dr Andrew Hewitt, USQ

Keywords: reactive power compensation, STATCOM, numerical modelling.

1. Introduction

The STATCOM is a power electronic device that has classically be used within the electrical network to provide reactive power support (operation in two quadrants). In more recent times the scope of STATCOM operation has changed, being multi-purpose and allowing operation in all four quadrants.

The vast operating purpose of the STATCOM is seen from renewable connections where desired operation is in one quadrant (active power injection), to the classical case - two quadrant operation (voltage support and NPS correction). When energy storage is coupled to the DC bus, operation in all four quadrants is achievable and these units (GUSS units) can be seen in the existing network connected to long resistive lines.

Understanding of STATCOM design principles is important in order to recognise the differences in operational capabilities for STATCOMs designed for differing operation purposes.

2. Background

This project seeks to consolidate the knowledgebase around STATCOM design and purpose, subsequently extending upon previous research into the numerical modelling of the three phase STATCOM to analyse the requirements of the DC bus and how they differ depending on STATCOM function.

3. Methodology

A review of the existing design requirements and uses of STATCOM technology has been undertaken

A theoretical analysis of STATCOM operation has been undertaken and used to develop a numerical
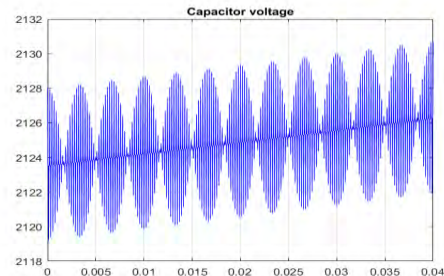
Figure 1 – STATCOM Capacitor Voltage increasing

MATLAB model that represents STATCOM operation when connected to a balanced system. This model will be adapted to allow analysis of the STATCOM behaviour when connected to an unbalanced system.

4. Key Outcomes

This study highlights that the different STATCOM purpose within a power system drive different DC bus design and unbalance present in the grid introduces additional complexities not found in balanced systems.

The outcomes of this study are not relevant for STATCOMs used for renewable energy connection, where the DC bus is stabilised by the renewables.

5. Further Work

The extension of the model to include an analysis of the DC bus when there is negative phase sequence voltages present in the grid.

6. Conclusions

The preliminary outcomes of the numerical model development indicate that the driver of DC bus design should be a product of the STATCOM function in the network as well as the amount of network unbalance.

Acknowledgements

References

Vedam, R. S. & Sarma, M. S., 2009. *POWER QUALITY VAR Compensation in Power Systems*. Boca Raton, FL: CRC Press.

Acha, E, Agelidis, V.G, Anaya-Lara, O. Miller, T.J.E 2002, *Power Electronic Control in Electrical Systems*, Newnes, Woburn

Mohan, N., Undeland, T. M., & Robbins, W. P. (1989). *Power electronics: Converters, applications, and design*. New York: Wiley.

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AN ACCURACY STUDY ON UAV PHOTOGRAMMETRY

Sponsor - Bennett and Bennett Pty. Ltd.

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Major Surveying

Supervisors: Dr Xiaoye Liu, USQ

Marko Tuominen

Keywords: UAS, Photogrammetry, Capability
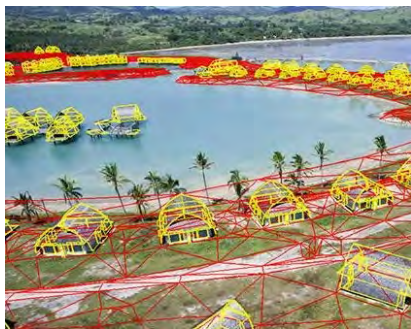
Figure 1: Marriott Resort Survey, FIJI (Bennett + Bennett 2017)

1. Introduction

The science of photogrammetry has long been a recognised tool in the spatial science industry. For a long time, large or complex areas have been surveyed by aerial photogrammetry. Over the recent years with the introduction of small, cheap, unmanned aerial systems (UAS), it is fair to ask, can we achieve the same or better spatial data with these systems? The DJI Phantom D4 Drone was chosen for this study.

2. Background

Photogrammetry is the science of extracting data from photographs to reconstruct a 3d measurable model. The science of photogrammetry has been around since 1851 and has evolved into a tool spatial scientists can use to accurately map large or complex areas today. Due to the recent explosion of popularity of small UAS for video or photography, it should be now possible to achieve the same or better accuracy with these systems to that of a traditional aerial survey because of rapid advances in these systems over recent years.

3. Methodology

The UAS was flown over a previous flight zone done by aerial survey at North Byron Beach Resort. The UAS captured a small portion of this survey. Using sophisticated software packages the two datasets were compared against highly accurate conventional survey methods (adjusted traverse, level run and detail survey). A point vs point and tin vs tin comparison were used to highlight the differences found.

4. Key Outcomes

- UAS can fly much closer to the ground making the pixel size smaller (smallest measurable unit) and is helpful in modelling complex structures.

- A flight altitude of 60m would have undertaken the same survey as the aerial one within two battery lives, making it a more economically viable option for future surveys

- Photos contained sound quality and clarity, being good enough for underlays in plan preparation.

5. Further Work

The use of different photo formats to improve clarity would help in the processing stage.

Testing whether centres rather than edges of objects and where there is large contrast to their surroundings, to see if photos could be more accurately processed.

6. Conclusions

The UAS system was found to be a viable option for future work as the accuracy of data was found to be as good as the previous aerial survey.

References

Bennett + Bennett 2017, *Marriot Resort* Fiji, viewed 10/08/17<http://bennettandbennett.com.au/portfolio-view/marriott-resort/>

The Center for Photogrammetric training, *HISTORY OF PHOTOGRAMMETRY*, viewed 10/07/17<https://spatial.curtin.edu.au/local/docs/HistoryOfPhotogrammetry.pdf>.

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Impedance Spectroscopy Meter for Batteries

Sponsor –School of Mechanical and Electrical Engineering

Kevin Hampson

Bachelor of Engineering (Honours)

 - Power Engineering

Supervisors: Assoc Prof Tony Ahfock, USQ

Keywords: Impedance Spectroscopy, Batteries, Nickel Iron.

1. Introduction

The internal impedance of a battery constitutes a loss that is able to be used to assess the condition of the battery. With the increasing distribution of battery systems into the domestic grid connected market a cheap and portable method of testing the battery to determine the state of health is needed. This project aims to develop a meter that can be used to test the condition of the battery. The Meter is to be tested using Nickel Iron batteries as there is currently no data available for this battery type.

2. Background

Electrochemical impedance spectroscopy (EIS) is a technique that applies a varying frequency signal to the battery and can be used to separate the areas of internal impedance into different regions within the battery. The ability to separate the condition of the electrolyte from the solid to electrolyte boundary enables economic replacement decisions to be made based on the state of health of the separated parts of the battery. The current instruments that are able to perform this type of testing are neither cheap nor portable thus driving the need to develop a meter that addresses these issues. The analysis of the state of health requires data to be available to enable comparison of healthy and aged batteries. The lack of available data on NiFE batteries is to be addressed by testing the meter on this battery type.

3. Methodology

The signal spectrum is created by interrupting the batteries current through a resistor at varying frequencies. An Arduino Due has been selected to interrupt the load current and log the resultant voltage and current waveforms. The results of the logged
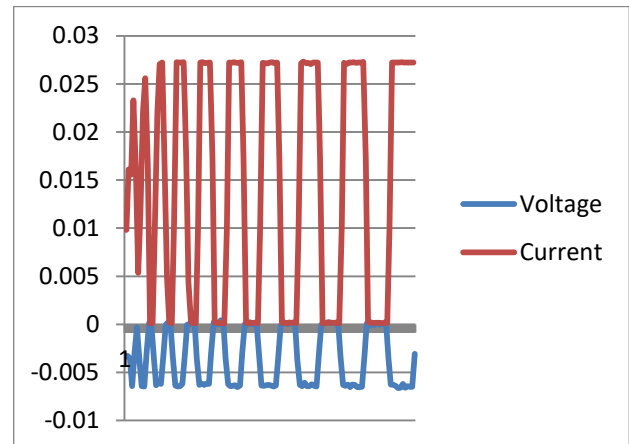
Figure 1 – Current and Voltage waveforms

waveforms can be seen in Figure 1. The current waveform is actual values of current whereas the voltage waveform represents change in voltage from nominal value of zero volts under no load conditions.

4. Key Outcomes

This project has led to the design and manufacture of a circuit that will measure and log the mV changes to current and voltage across a generated square wave frequency spectrum.

5. Further Work

Work is progressing on the model that will display the data in a bode plot which is the primary method of analysing EIS data. Work to take the meter from prototype form to meter into an intrinsically safe case and with a specifically designed PCB is needed to see this meter become commercial viable.

6. Conclusions

This project has demonstrated that a low cost hand held meter based on EIS for the determination of battery state of health is possible and, if pursued, will fill a void in the current market capabilities.

References

Barsoukov, E, (ed) and Macdonald, J R (ed) 2005, *Impedance Spectroscopy*, 2nd edn, John Wiley & Sons, Incorporated, 2005.

Jossen, A 2006, 'Fundamentals of battery dynamics', *Journal of Power Sources,* Volume 154, Issue 2, pp. 530-538,

Sadri, M, & Shoulaie, A 2010, *A practical approach to measure battery's internal impedance*, 2010 1st Power Electronic & Drive Systems & Technologies Conference (PEDSTC)*,* Tehran, Iran, pp. 418-422.

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Developing a Building Cadet Manual

Sponsor –Paynter Dixon Queensland & School of Civil Engineering and Surveying

Jarred Hancock

Bachelor of Construction (Majoring in Construction Management) (Minor in Building

Supervisors: Mr Paul Tilley, USQ

Lecturer (Construction)

Keywords: Development, Cadetships & Construction.

1. Introduction

In the construction industry there is a need for young entrants into the industry to be developed to a high standard that is equivalent to what currently exists. Developing A Building Cadet Manual is the perfect way to ensure that all the requirements that are needed to be developed are tracked and completed promptly.

Through currently completing my Cadetship for a large commercial builder known as Paynter Dixon Queensland, it has become apparent that the development of a Building Cadet within the industry can prove and important resource. Various construction companies have their own processes on how they develop cadets however at Paynter Dixon there was not a specific Cadet Manual which had been issued formally to each Cadet. This research project is aimed at developing a Building Cadet Manual to be implemented within Paynter Dixon.

2. Background

This project will become increasingly important in the construction industry as the level of competency in the industries workers will continue to grow if the correct training and development processes are put into place. The current state of the industry is that there are various systems which are being deployed to those who are in training however there is not a specific manual that is issued to all Building Cadets that is distributed industry wide. This research will help to identify the gaps in current training processes and take into consideration the Building Cadets themselves.

3. Methodology

A large sample of the industries view of Building Cadets will be researched along with the roles that they can step into upon completion of the Cadetship. A base manual (template) will be developed through the assistance and guidance of a Project Manager at Paynter Dixon whom I have spent my time as a Building Cadet learning from. Once this base manual has been developed, a detailed and relatable survey will be created to issue to students who are currently completing their cadetship with a builder. The feedback from this survey will be then be analysed and incorporated into The Building Cadet Manual final development. The Manual will then be tested by myself and Paynter Dixon employees, signing off on sections which have been completed and those which haven't. Once there has been an agreed level of quality, it will be distributed throughout Paynter Dixon to all Cadets.

4. Key Outcomes

So far there has been a thorough development in the base Building Cadet Manual with the survey being completed and ready for distributed through various avenues. Through the development of the base manual it has become apparent the amount of knowledge that is gained through a number of years of learning from a senior employee in the industry.

5. Further Work

The remaining processes involve incorporating the survey's results into the Final Development of the Cadet Manual, completing the manual sign off and approvals with supervisors and then finally distribute to all Cadets within the office. There are currently no aspects which won't be able to be achieved thanks to the constant support from the managers at Paynter Dixon.

6. Conclusions

In conclusion it has been found that through gaining the thoughts and understanding of Building Cadets as well as professional advice from senior employees has lead to a sound development of a Building Cadet Manual.

Acknowledgements

References

Master Builders QLD 2016, *Contract Administration* viewed 180517,

Stojcevski, GLA 2012, *CADET- Centre for Advanced Design in Engineering Training*

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Performance of High Strength Crumb Rubberised Concrete

School of Civil Engineering and Surveying

Tyson Haniotis

Bachelor of Engineering
(Honours) (Civil)

Supervisors: Prof Yan Zhuge, UniSA

Dr Buddhi Wahalathantri, USQ

Keywords: High Strength Crumb Rubber Concrete, HSCRC, CRC, sustainability, water treatment, sodium hydroxide treatment, slab design

1. Introduction

Crumb Rubber Concrete (CRC) is an attempt at promoting sustainability in the built environment through recycling and resource management. CRC is considered an 'environmentally-friendly' alternative to conventional concrete by partially substituting sand with fine rubber stripped from used tyres. However, the material has failed to make significant headway in the industry due to one key flaw; reduced compressive strength.

The aim of this research is to analyse enhanced CRC, also known as High Strength Crumb Rubber Concrete (HSCRC). HSCRC is established through treatment of the rubber particles to increase compressive strength. Furthermore, the study compares the potential of various rubberised concrete designs with different advantages to determine HSCRC's viability in residential slab design.

2. Background

Sand is the most used non-renewable natural resource in the world, with the single greatest demand for the product being concrete mixtures used in the construction industry. Due to; the high usage, resistance to bio-degrading, and 75% void area of tyres, it too is considered a global issue. But by simultaneously addressing these two matters, HSCRC has the potential to deliver greater social, environmental, and economic advantages in the construction industry. Despite the potential of rubberised concrete discovered 25 years ago however, the strongest HSCRC design was formed within the last 3 years and therefore lacks depth and supporting evidence for statistical certainty.

3. Methodology

In order to employ the research aims, the following three stages were addressed:

Stage 1: Measure various material properties to design and test trial mixtures in accordance with Australian Standards.

Stage 2: Develop and test conventional and various 20% rubber supplemented concrete slab designs for compressive and flexural strength.

Stage 3: Repeat Stage 2 using 30% rubber supplemented concrete designs and analyse the results.

4. Key Outcomes

To date the data suggests water treated HSCRC designs are the strongest, however a significant loss has been noted in comparison to conventional concrete.

5. Further Work

At this time, Stage 3 of the methodology is yet to be completed, however future work suggestion will be provided by the conclusion of the research project.

6. Conclusions

With the completion of Stage 3, an analysis on the data will provide greater depth and understanding of both 20% and 30% crumb rubberised concrete. In particular, the conclusion of the study will provide previously unattained data on the viability of HSCRC to meet a standard 25 MPa residential slab design.

Acknowledgements

References

Yousff, O., ElGawady, M. A., Mills, J. E., & Xing, M. (2014). An experimental investigation of crumb rubber concrete confined by fibre reinforced polymer tubes. *Construction and Building Materials*, 53, 522-532. doi:10.1016/S095006181301163

Eldin, N. N., & Senouci, A. B. (1993). Rubber-tire particles as concrete aggregate. *Journal of Materials in Civil Engineering*, 5(4), 478-496. Retrieved from http://doi.org/10.1061/(ASCE)0899-1561(1993)5:4(478)

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Assessing the impacts of Multi-Combination Vehicle on Motorways

Sponsor – School of Civil Engineering and Surveying

Jesse Harris

Bachelor of Engineering (Honours) (Civil)

Supervisors: Mr Chris Snook, USQ

Keywords: Heavy Vehicles, Road Design, Transport Engineering.

1. Introduction

Trucks carry three-quarters of Australia's domestic freight, the National Transport Commission predict that our nation's freight task will increase by 26 per cent between 2016 and 2026 (NTC 2017). Innovative vehicle combinations are constantly being introduced in an effort to develop new efficient combinations to reduce overall freight costs. The number and type of Multi-combination Vehicles (MCVs) requesting access to Australian roads is increasing and as a result placing pressure on transport regulators to expand the networks available to them.

2. Background

Many key freight routes are known to be inefficient and long overdue for upgrade. The inefficiencies drive up the cost of goods to the consumer and have undesirable impacts on the environment such as CO_2 emissions. These costs will continue to grow into the future. Australia needs to develop a means to improve freight transportation without undue social costs. A possible solution may be permitting additional types of MCVs on our motorways. This report will analyse the viability of this proposal by analysing the operation characteristics of MCV and assessing their impact on our motorways.

3. Methodology

A quantitative methodology is adopted to investigate the operational characteristics of MCVs. Motorway standards will be reviewed and a case study on a
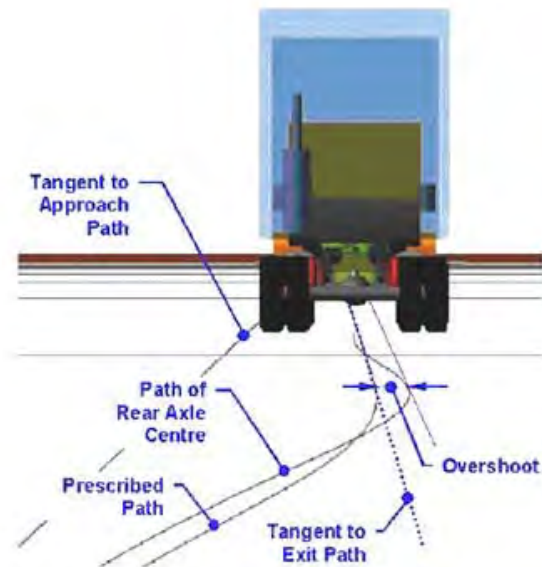
Figure 1 – High speed transient offtracking

section of road will allow an assessment to be undertaken on the suitability of MCVs on Motorways.

4. Key Outcomes

Based on a significant literature review and analysis on a case study section of motorway, this project will highlight issues and risks associated with introducing MCVs to Motorways.

5. Further Work

Further research could include:

- Driver education and behaviour around heavy vehicles

- Autonomous heavy vehicles

- Accuracy of values in standards

6. Conclusions

At this stage it is too early to draw conclusions.

Acknowledgements

References

Haldane, M. J., & Bunker, J. M. (2002). Assessing the impacts of multi-combination vehicles on traffic operations and safety.

Tziotis, M., Milling, D., & Bucko, A. (2015). *Road design for heavy vehicles* (No. AP-T293/15).

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Viability of Aerial Baiting for Wild Dogs in South West Queensland

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours)

Supervisors: Prof Armando Apan, USQ

Dr Lee Robert Allen, Department of Agriculture and Fisheries

Keywords: Dingoes, aerial baiting, south west Queensland

1. Introduction

Dingoes, dingo-dog hybrids and wild dogs have caused a substantial economic impact within the sheep and cattle industry within Australia. That being said, numerous population control management strategies have been implemented within these key agricultural industries. However, to understand whether these management strategies would be suitable across inhabited areas, a site suitability analysis utilising GIS should be undertaken. In this project, a site suitability analysis was undertaken on a targeted area near Charleville in south western Queensland, to determine whether aerial baiting would be a viable option to be utilised as a management strategy.

2. Background

This project is important, as stock losses for both sheep and cattle equate to $66.30 million annually, with an added $18 million in research and other management costs. As there are numerous management strategies utilised in current practices today, determining the right one to implement over the elected area is dependent on a variety of multiple factors. As such, a GIS based approach enables system-based-multi-factor-analysis to occur, to outline the highly suitable areas within the study area.

3. Methodology

The methodology employed to conduct the analysis included outlining a specific study area; collect numerous dingo locations and land attribute factors (slope, aspect, land use, land cover, proximity to road networks and distance from drainage features and other

watering points); and to conduct a site suitability analysis in ArcGIS utilising the "weighted linear combination" technique and output a site suitability map.

4. Key Outcomes

The main outcome of this project is to conduct a site suitability analysis over the selected study area to determine whether aerial baiting is a viable. At this stage, this type of analysis has not been utilised to its full potential within feral animal management, and this project aims to produce suitability digital maps of aerial baiting for dingoes, as well as descriptions or attributes with those areas.

5. Further Work

The recommendations for this dissertation have only been made over the chosen area. Determining the suitability of other sites and the viability of other management strategies would have to be analysed further.

6. Conclusions

The suitability map for aerial baiting of dingoes are expected to be useful in the effective management of feral animals. The GIS analysis techniques generated from this project study can be utilised effectively in understanding how feral animal management programs can be better planned and designed to mitigate the impact of dingoes in Australia.

Acknowledgements

References

Fleming, P., Corbett, L., & Thomon, P. (2001). *Managing the Impacts of Dingoes and other Wild Dogs.* Bureau of Rural Science.

Lamb, D., Saafeld, W., McGregor, M., Edwards, G., Zeng, B., & Vaaron-Morel, P. (2010). A GIS-based decision-making Structure for Managing the Impacts of Feral Camels in Australia. *The Rangeland Journal*, 129-143.

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Investigation into ICSM's guideline for conventional traverse surveys

Sponsor – Faculty of Health, Engineering and Sciences

Rhys Haskard

Bachelor of Spatial Science (Honours) (BSPH)

Supervisors: Mr Shane Simmons, USQ

Keywords: Sets of angles, Traversing, Total station

1. Introduction

ICSM's (Intergovernmental Committee on Surveying and Mapping) guideline for conventional traverse surveys illustrates traverse surveying procedures to endorse the implementation of consistent traverse survey methods to allow a high level of accuracy and reliability in Australia's survey control network.

The aim of this research project is to investigate ICSM's guideline for conventional traverse surveys and observe any areas that it could be improved or better defined.

2. Background

The research conducted within this research project confirmed many of the suggestions set out in the guideline. However it was found that two areas needed further investigation and testing. These two areas are the pointing error and the sets of angles to be measured. The pointing error is how well accurately a surveyor can sight a target the guideline describes this error with a standard offset without taking distance into consideration. The guideline also states that five sets of angles should be measured to achieve the highest accuracy traverse.

3. Methodology

Both areas were tested extensively with over 1200 angular measurements being taken over three nominated distances. These measurements were then statistically analysed to quantify the pointing error and identify the most efficient and accurate number of sets of angles to be read. Figure 1 details the results of reading sets of angles and the effect on accuracy at 20 metres.
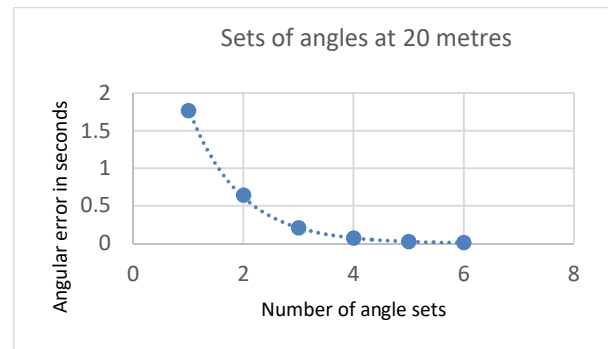
Figure 1. Effect of reading sets of angles at 20 metres

4. Key Outcomes

The results of this testing were employed to create a new guideline with these two areas being updated. It includes a spreadsheet that applies the recommendations in the guideline and allows a surveyor to quickly analyse the accuracy of their traverse and the traverse stations.

5. Further Work

The focus of the project is the horizontal aspects of traversing further work could include the vertical component of traversing.

6. Conclusions

The pointing accuracy is better described via an angular offset relative with distance. The results of sets of angles are still under analysis at this stage.

References

ICSM, (2014). Guideline for Conventional Traverse Surveys, Special Publication 1. Intergovernmental Committee on Surveying and Mapping.
http://www.icsm.gov.au/publications/sp1/Guideline-for-Conventional-Traverse-Surveys.pdf

TSSS, (2006). Total Station Survey System (TSSS) Survey Specifications. California Department of Transportation.
http://www.dot.ca.gov/hq/row/landsurveys/SurveysManual/07_Surveys.pdf

Lambrou & Nikolitsas, (2015). A New Method to Check the Angle Precision of Total Stations. Evangelia Lambrou and Konstantinos Nikolitsas.

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Cricketing Head Injury Analysis and Conceptual Prevention Design

School of Mechanical and Electrical Engineering

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Bachelor of Science (Biology)

Supervisor: Chris Snook, USQ

Keywords: Head injury, protective equipment, sport, cricket.

1. Introduction

Cricket is a popular past time enjoyed by thousands around the world. It's widely considered a non-contact sport and is often the preferred sport parents chose to register their children in. However, in recent times several high-profile injuries have resulted in players and parents questioning the widely considered safety in the sport. Injuries sustained whilst wearing approved helmets has attracted government action to review international helmet standards.

2. Background

Until 2013, two international standards covering cricket helmet design existed covering the testing and design - AS/NZS 4499:1997 and BS 7928:1998. In 2012, the British Standards Institute conducted a review of BS 7928:1998 and in 2013, published BS 7928:2013. Despite all this focus around new testing, players are still sustaining injuries through ball to head contact.

The 2013/14/15 seasons saw three separate incidents of head impact that resulted in two players retiring from cricket, and one, Philip Hughes, tragically pass away.

3. Methodology

An examination of ball velocities experienced during the game of cricket was undertaken. The key velocities recorded included full pitch deliveries, half pitch deliveries and post contact with the bat with both slow and fast bowling. The data was analysed and revealed ball velocities recorded higher than the newly adopted British standards 60 mph. These values set the benchmark for injury mitigation techniques and equipment design.

Material suitability was researched and applied through suitability matrices. A preliminary design will be
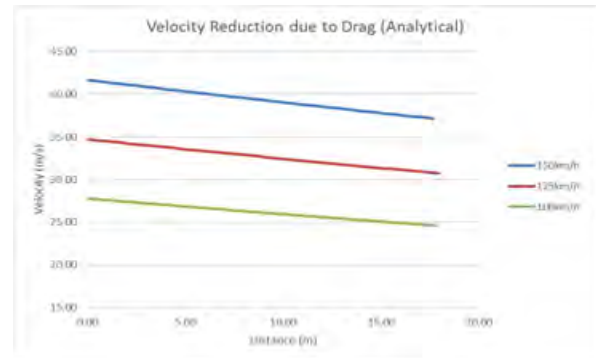
Figure 1 – Velocity Reduction to due drag (analytical)

developed through 3d modelling and analysed against the input parameters developed during the experimental and analytical components of the project.

4. Key Outcomes

To date, research documents, coroners reports and general action in response to the death of Phillip Hughes, have failed to deliver the development of a product or implemented policy to directly mitigate the injury sustained. This project attempts to rectify this. In addition, the evidence supplied by the experiment and analysis indicate the testing speeds specified in the adopted British Standard fall short of in game forces.

5. Further Work

Whilst several designs have been postulated, the final design and material selection is yet to be defined and simulated for conformity in a 3d finite element analysis.

6. Conclusions

It is expected that the project will deliver a preliminary design for a protective product intended to mitigate the injury sustained by Philip Hughes in 2014. In addition, the project provides evidence the British Standard falls short of in game forces and requirements of protective equipment.

Acknowledgements

References

Cricket Australia 2016, *Well Played 2016 Guidelines*, Cricket Australia.

Standards Australia 1997, *Protective Headgear for Cricket Part 1: Helmets*, AS/NZS 4499:1997, Standards Australia, Sydney.

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Underground Dust Control

Sponsor- School of Mechanical and Electrical Engineering

Sam Hawkins

Bachelor of Mechanical Engineering Honours

Supervisor: Professor David Buttsworth, USQ

Keywords: Coal dust, wetting agent, underground mining.

1. Introduction

With the extraction of coal increasing the long term health risks increase with it in the form of black lung disease. This health occurrence is caused by extremely fine coal dust particles entering the respiratory system of miners working in enclosed spaces such as the underground environment. To combat this problem, the mining industry is looking into chemical applications that have the ability to suppress the dust where ordinary water does not.

2. Background

This dissertation investigates the best solutions for controlling underground coal dust using wetting agents and tests the most efficient application rates. By better understanding the existing control methods and their effective ranges, the industry may better combat this risk without the need for expensive mechanical devices.

3. Methodology

This project was conducted by investigation and experimentation. Once existing control methods were found during initial literature review, a potential improvement was identified and an experimental process was developed. This experiment would find analysis a specific wetting agent to find an optimal dosage rate to better control respirable dust. From these results, a design could be implemented to better suit the application.
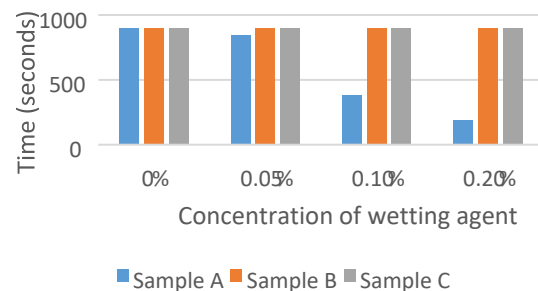
Figure 1: Researched results of the other wetting agents.

4. Key Outcomes

From this dissertation, it was hoped that a better understanding of the control of respirable coal dust for underground mining could be found. This would be achieved through experimental optimisation of GRT wetting agent. An optimized design for a Sandvik MB650 would be made to incorporate the test findings.

5. Further Work

Testing is still required to achieve the desired results which will allow for better conclusions to be made. This testing will take place within the next few weeks. The final design must also be completed and sketches made.

6. Conclusion

From this report, it has been concluded thus far that the most effective and efficient method for controlling respirable coal dust is via wetting agents. The final alterations incorporated a chemical bypass system that allowed for the agent to be distributed effectively without blockages.

7. References

Organiscak, J.A 2015, *Examination of water spray airborne coal dust capture with three wetting agents*, 1st Edition, National Institute for Occupational Safety and Health (NIOSH), Pittsburgh, PA.

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Efficacy and Utility of Visual Simulation in STEM Learning

School of Mechanical and Electrical Engineering

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Bachelors of Engineering (Honours) (Electrical); Bachelor of Business (Management and Leadership)

Supervisors: Dr Andrew Maxwell, USQ

Keywords: VR/AR, Visual Simulations

1. Introduction

Education, and the successful learning outcomes of students is something that is prized by educators and student alike. With the advancements that are being made within Virtual and Augmented Reality (VR/AR) technologies, the applications of these on teaching are to be investigated; this project seeks to develop a further understanding on this area in the tertiary education sector.

2. Background

This project is the combination of three main identified areas and the gap exposed by the interactions between them. These areas are; Visual Information, Immersion theory, and VR/AR technologies. Current educational methods still rely upon traditional analogue technologies, such as paper, ink, and print, to transfer ideas and knowledge of highly complex theories. This project is considering, why does this remain the case, and what are the steps involved in bringing modern visualisation technologies into a classroom to impact students in a positive manner.

3. Methodology

This project seeks to be both a theoretical analysis as well as incorporate a set of empirical techniques. The project therefore is a combination of both qualitative research, with elements relying upon quantitative methods. The literature surrounding the three main areas of the project (Figure 1) exposes a gap within the current literature of a lack application of Visual simulation with current technologies. This project investigates a readily available physics engine on which the development of a 3-D visualisation educational environment can be successfully implemented. Furthermore, how it can scale to present upon 2D surfaces, typically available to students. This is done to assess the viability of the findings and conclusions obtained through the literature.
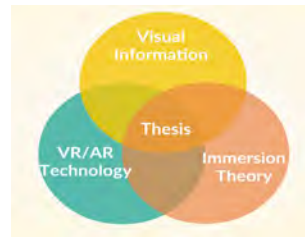
Figure 1 – Gap within Literature

4. Key Outcomes

The research-undertaken throughout this project has determined that the use of serious gaming technologies such as VR/AR can be implemented within a learning environment to achieve a beneficial result for the students. This project has also concluded the necessary steps and requirements that an educator needs to have in order for this simulation, how ever immersive, to result in a high educational learning outcome for their students.

5. Further Work

Given additional time a focus on educational learning and immersion theory would allow for a more extensive matrix, and further refinement of the existing conclusions of the report. Furthermore, the technology of serious-games could be applied in a real situation to test to benefit the learning outcomes of students, to further reinforce the findings of this project.

6. Conclusions

The area of visual simulation is quite vast, and beyond the scope that a 12-month project could achieve. However, this project has assessed a single focus area, and its results indicate that the use of specific and easily available technologies used previously for entertainment can, if applied correctly benefit the learning outcomes of students.

Acknowledgements

References

Jayaram, S. (2001). Assessment of VR technology and its applications to engineering Problems., Journal of comput. Inf. Sci, Eng, 1(1), 72-83.

Linowes, J., 2014. *Unity Virtual treality Projects.* 1st Edition ed. Birmingham: Packt Publishing.

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Human Comfort, CFD Modelling to Provide Energy Efficient Air-Conditioning in a Modern Office
Sponsor - School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Mechanical Engineering)

Supervisor: Dr Andrew Wandel, USQ

Keywords: Thermal Comfort, HVAC, Office Air Conditioning

1.   Introduction

Air-conditioning accounts for 70% of the power consumed for a building in a shell or base building state. For a typical working office, the energy consumption is still as high as 40% of the total usage. This research projects aims to challenge the typical office design philosophy which has changed very little since the first system was installed in 1902. This research project consists of finding alternative design solutions for providing human comfort to an office worker. Utilising CFD modelling of different air delivery locations as well as higher temperature and lower humidity air to create a comparable environment but requiring less energy to create the comparable comfort levels.

2.   Background

There is a global trend towards reducing the carbon footprint by investing in renewable and energy efficient technologies and products. It is also important to challenge conventional design by moving towards a task based air delivery rather than a typical ceiling diffuser which cools the entire room.

Multiple studies have explored and created formulas attempting to portray the uniqueness of human comfort within the same environment. Ultimately, the aim for comfort levels is 90% of people should be satisfied within any given environment whilst 10% of people may still find the environment uncomfortable. This is an important factor to account for during modelling and calculating comfort levels.

3.   Methodology

There are four main variables being modelled for this project, the temperature, the humidity of, the diffuser location and the velocity of the air out of the diffuser. These variables were all modelled using Computational Fluid Dynamic modelling (CFD) using the Ansys
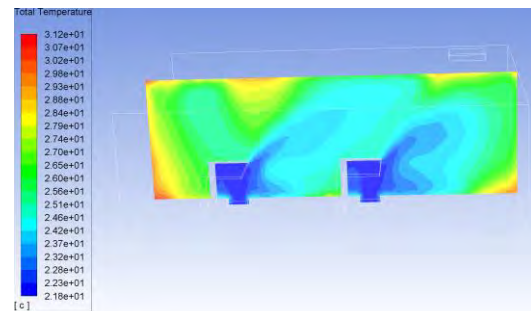
Figure 1 – Temperature Model

program, an output of the temperature mapping can be seen in Figure 1.

4.   Key Outcomes

This project aims to provide recommended ranges in which human comfort will be satisfied with reduced cooling requirements. This would be achieved by supplying air that's approx. 21°C rather than the typical 17-18°C air along with a lower relative humidity. Additionally, using a task based diffuser system results in less fan power and thus reduced energy consumption.

5.   Further Work

While the majority of the modelling is complete, results and finding are still being compiled. Continuation of the project work would be to test the results in a real-world environment and correlate the CFD results with direct human input to assess comfort levels. This would require modification or setup of a typical open office space and a sample pool of a minimum of 15 people.

6.   Conclusions

The project aims to demonstrate human comfort can be achieved with lower energy consumption. This is attained through providing task based air with higher temperatures and lower humidity compared to traditional set points.

References

Humphreys, M. (2005). Quantifying occupant comfort: are combined indices of the indoor environment practicable? *Building Research & Information, 33*(4), 317-325.

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Engineering & Naturally Occurring Asbestos

Sponsor – Orange City Council

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Bachelor of Engineering (Hons)

Civil Major

Supervisors: Dr Ian Craig, USQ

Ms Juliet Duffy, EnviroScience

Keywords: Naturally, Asbestos, Management

1. Introduction

Orange, a regional city located approximately 250km inland from Sydney is founded upon geological strata in which Naturally Occurring Asbestos (NOA) is present. Council, being the direct regulatory authority has developed policy with regards to the management of NOA. There is often a disconnect between policy and field implementation, this research project seeks to evaluate the effectiveness of asbestos management policy within construction projects and the field of engineering.

2. Background

The objective of this research project is to provide informed recommendations, through practical case study analysis for the safe and cost-effective management of NOA within the construction industry, and more specifically Local Government. Analysis of the case studies are to provide key learnings, which will allow conclusions to be drawn with regard to the "best practice" management of NOA within a local government setting

3. Methodology

Case studies were created using engineering projects in which were undertaken by Orange City Council, under the asbestos management policy. Site diaries and a series of accompanying air monitoring results were used to determine the effectiveness of different engineering controls. The airborne fibre levels were also a way of qualitatively assessing the implementation of the asbestos management policy and subsequent plan.

4. Key Outcomes

The current engineering controls were found to be effective in reducing the number of air-borne asbestos fibres. Increased fibre counts were a recurring factor,

Figure 1 – Sample of Naturally Occurring Asbestos (Ostrowski, 2016)

which have been attributed the ongoing management of construction sites which span several months. For the controls to be effective, there needs to be continual evaluation and monitoring. Asbestos management costs were also found to be a significant factor within both projects. The additional costs, both direct and in-direct summed to approximately 15%. These findings were a result of analysing both case studies.

5. Further Work

Current environmental protection legislation requires NOA to be encapsulated on-site. This is considered an appropriate permanent measure, further investigation into how asbestos deteriorates over time and how sediment can move within soil is required.

6. Conclusions

Naturally Occurring Asbestos can be managed within engineering, but is often overlooked due to its unpredictability and microscopic form.

Acknowledgements

I would like to thank Juliet Duffy from EnviroScience for providing me with key information and ideas along the journey.

References

NOHSC (2005) *Code of practice for the management and control of asbestos in workplaces: NOHSC:2018(2005). Canberra National Occupational Health and Safety Committee, Australian Government* Publishing Service.

Hendrickx, M. (2008*). Naturally occurring asbestos in eastern Australia: a review of geological occurrence, disturbance and mesothelioma risk. Environmental Geology*, 57(4), pp.909-926.

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Development of a Low Cost Modular IEC61850 Simulation System Using Touchscreen Raspberry Pi

School of Mechanical and Electrical Engineering

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Bachelor of Engineering Honours (Power)

Supervisor: Mrs Catherine Hills, USQ

Keywords: IEC61850, Substation, Simulation, Raspberry Pi

1. Introduction

Modern electrical substations require communications networks to operate safely and efficiently. Substation Protection relays utilise communications networks to interact with other relays and systems within the substation. IEC61850 is a communications standard which has been developed to allow interoperable, high speed substation communications between the relays and other substation equipment.

2. Background

Still relatively new, the penetration of IEC61850 compliant systems is varied throughout the industry. Increasing implementation as the technology develops will require the training of staff to commission and maintain these systems. An easily accessible, low cost simulator will allow staff to interact and be trained with a simulated system prior to working on a live in-service system.

3. Methodology

This project builds on the prior work of Michael Zillgith, who has developed an open source C programming library which allows access to an IEC61850 compliant stack. The library features include Generic Object Oriented Substation Event (GOOSE) message subscription/publishing and Sampled Measured Values (SMV).

The simulator has been implemented on a Raspberry Pi 3 (Model B) with a touchscreen interface programmed using QT Creator, a C/C++ Integrated Development Environment.

4. Key Outcomes

The completed Intelligent Electronic Device (IED) simulators can simulate the GOOSE messaging subscription/publishing type of communications. This messaging is the basis of the IEC61850 system, allowing

Figure 1 – Circuit Breaker IED Simulator

high speed interaction between IEDs. The application of a touchscreen for human interaction increases the usability of the system for technicians and engineers.

5. Further Work

The speed of the Raspberry Pi processor impedes the application of SMV, as the packet rate is lower than required. Faster hardware needs to be sourced to allow compliant SMV simulation.

6. Conclusions

The completed simulator allows technicians and engineers to interact with a IEC61850 compliant system using low cost hardware/software. Integrating protection relays into the simulation network allows training, testing and development to take place prior to implementation on-site during construction.

References

ZILLGITH, M. (2017). *libIEC61850 / lib60870-5 / open source libraries for IEC 61850 and IEC 60870-5-104*. [online] Libiec61850.com. Available at: http://libiec61850.com/libiec61850/ [Accessed 7 Aug. 2017].

MACKIEWICZ, R. E. Overview of IEC 61850 and Benefits. 2005/2006 IEEE/PES Transmission and Distribution Conference and Exhibition, 21-24 May 2006 2006. 376-383.

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Increase the fatigue life of an electric shovel dipper handle

Sponsor – School of Mechanical Engineering and Surveying

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Bachelor of Mechanical Engineering (Honours)

Supervisors: Mr Chris Snook, USQ

Mr Ryan Fry, CMP Engineers

Keywords: Dipper handle, mining, design

1. Introduction

The primary purpose of this project was to investigate the current P&H 4100 electric shovel dipper handle in order to develop and redesign a dipper handle to increased fatigue life and prevent catastrophic failure.

2. Background

The main research problem of this study is how to increase the fatigue life of the P&H 4100 dipper handle. The primary purpose of this project is to investigate the failure modes of a P&H 4100 shovel dipper handle with the aim to increase the fatigue life of the dipper handle. In order to extend this fatigue life, the two most prominent failures of the shovel dipper will be investigated and analysed to improve the mechanism. The two most prominent failures are:

• Cracking in the internal diaphragms in the dipper handle legs, and

• Adhesive wear on the wear face of the dipper handle where it makes contact with the boom.

This design analysis of the current dipper handle model will address the gap in the literature in this particular area.

3. Methodology

After a thorough review of the current literature, the three phases of the methodology will be discussed. Phase one includes the quantitative and qualitative data collection; phase two the testing phase and phase three the design phase.

In order to increase the fatigue life of a dipper handle, an investigation and analyses of the current dipper handle design must be performed. Current literature indicated that fatigue failure is a common mode of
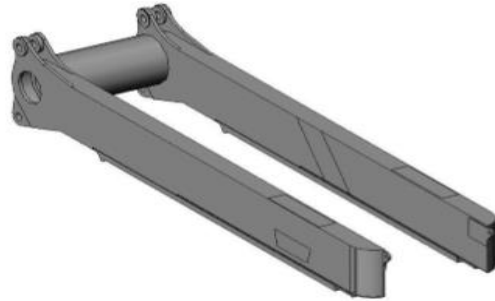
Figure 1 – 3D model of dipper handles

failure in the dipper handles, hence there is a need for a better design in the industry to extend the fatigue life.

4. Key Outcomes

Finite element analysis on the initial design featured in figure 1 has determined that the internal diaphragms in the handle causes initiation sites for fatigue cracking. The handles were remodelled increasing the thickness of the diaphragms or alternatively removing the internal diaphragms, eliminating the detrimental transverse welds. Further analysis were ran on the improved designs in order to compare the various models. Analysis are still underway however an increase in the fatigue life of the dipper handles have been observed from the FEA results obtained by removing the internal diaphragms.

5. Further Work

Future work required in material use such as Bisplate 80 and Hardox HiTuf to determine the effects on the handle design. Operator influence on dynamic loading.

6. Conclusions

The findings of this project has been very favourable and based on the project findings, work will be continued far beyond the scope of this project.

Acknowledgements

References

Chitty, G, Carpinteri, T, Cassidy, G, Rucinski, T, Randall, S & Cortes, O 2008, 'Life extension and reliability improvement of large electric mining shovels', Maintenance Technoligy Institute Department of Mechanical Engineering, Monash University Australia, Report No. MTI/DT/235/K

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Testing Real Time Kinematic Using Multi-Global Navigation Satellite Systems

School of Civil Engineering and Surveying

Scott Johnson

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Supervisors: Miss Jessica Smith, USQ

Figure 1 – RTK Rover station setup and a sample of RTK data collected (inset).

Keywords: GNSS, Single-station RTK, Partnerships.

1. Introduction

GPS has successfully entrenched itself within every day applications and products. The success of and social reliance upon GPS has instigated several nations to develop their own systems, e.g. European Union's Galileo. This provides independence and has the potential to enhance the existing satellite systems (Siejka, 2015). This, combined with the modernisation of the established GPS and Russian owned GLONASS, means the focus is on interoperability and compatibility, and a combined Global Navigation Satellite System (GNSS) will be more complete and diverse (Odolinski, Teunissen & Odijk, 2015a).

2. Background

Real Time Kinetic (RTK) methodologies are widely adopted by high precision users however, environmental constraints and system availability adversely affect its performance (Siejka, 2015). Predominantly it has been reliant upon GPS, however with the introduction of multiple Navigation Satellite Systems (NSS) it is possible that various combinations of NSS partnerships provide an alternative. Understanding the precision and accuracy performance of available partnerships is necessary and can assist to understand if there is any advantage generated from the new systems for users.

3. Methodology

Empirical data using single-base station RTK and post-processed methods have been measured over two 14+ hr sessions, 2 days apart in an open environment. Seven Trimble R10 GNSS receivers were established logging differing NSS partnerships. Techniques to eliminate biases and utilise similar satellite constellations were adopted, such as establishing stations closely (Figure 1). The analysis includes single epoch measurements and data averaged over 1 minute windows with post-processed data providing a 'point of truth' to facilitate accuracy analysis.

4. Key Outcomes

Due to compatibility and interoperability, a number of combinations have been sampled to evaluate their performance. Preliminary results suggest certain combinations perform better than others.

5. Further Work

Given that data acquisition and processing has recently been completed the project is progressing toward analysis and conclusion stages.

6. Conclusions

Although yet to be fully examined, preliminary results suggest some partnerships provide better results than others.

Acknowledgements

References

Odolinski, R, Teunissen, PJG & Odijk, D 2015, 'Combined BDS, Galileo, QZSS and GPS single-frequency RTK', *GPS Solutions*, vol. 19, no. 1, pp. 151-63.

Siejka, Z. (2015). Multi-GNSS as a combination of GPS, GLONASS and BeiDou measurements carried out in real time. *Artificial Satellites, 50*(4), 217-229. doi:10.1515/arsa-2015-0017

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Conceptual Design of a Total Wrist Arthroplasty

Field Orthopaedics

Paul Johnstone

Bachelor of Engineering (Honours) Major Mechanical Engineering

Supervisors: Dr/Assoc Steven Goh, USQ

Dr Chris Jeffery

Design Wrist Arthroplasty
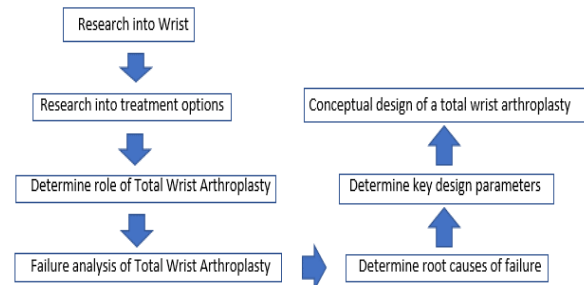
1. Introduction

This research dissertation developed a design of a total wrist arthroplasty which reduced the high complication rates present in other models.

2. Background

Early models of total wrist arthroplasty had complication rates reaching as high as 43% (Lin et al, 2017). This high complication rate is due to several causes which include fracture of implant, pain in wrist, tendon imbalance, component loosening, ulnar drift, soft tissue imbalance, recurrent synovitis, infection, malposition, subluxed component and dislocation. These complications remain a significant problem in the design that needs to be addressed.

3. Methodology

First, review of the literature on the wrist and treatment options available for arthritic wrists. Following this failure analysis methodology was conducted where the previous designs were critically evaluated to determine the root causes of failure and possible corrective actions (Berk, N.D). Finally, research into the key design parameters that was then applied to the conceptual design of a total wrist arthroplasty.

.

4. Key Outcomes

The initial research into the wrist and surgical techniques developed an understanding of the wrist and the role the total wrist arthroplasty plays in the treatment

Figure 1 – Dissertation methodology

of arthritic wrist. The failure analysis determined the root causes of failure for previous total wrist arthroplasty designs. The failure analysis also determined key design parameters which are applied to the initial conceptual design of a total wrist arthroplasty

5. Further Work

This dissertation determined an initial conceptual design of a total wrist arthroplasty. The conceptual design will require further research on the material selection of the components, design of coating to promote cementless fixation and finite element analysis modelling/ component testing.

6. Conclusions

The main limitation for wrist arthroplasty is the high complication rates compared to total wrist fusion. This is primarily the result of root causes of failure which include stress shielding, osteolysis and poor fixation. Control of design parameters that include correct material selection, correct porous fixation design and design components to minimise stress shielding can mitigate these complications. The information gathered on the design parameters were applied to a design of a total wrist arthroplasty that can reduce the failure rate experienced in current designs

Acknowledgements

References

Lin EA & Paksima, (2017), 'Total Wrist Arthroplasty', Bulletin of the Hospital for Joint Disease, 75, 9 -14

Berk JH, N.D, Systems Failure Analysis: A Fault Tree-Driven, Disciplined Failure Analysis Approach, J.H. Berk and Associates, Upland, California, United States,

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Asset Management Modelling

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Bachelor of Civil Engineering (Honours)

Supervisors: Assoc. Prof. David Thorpe

1. Introduction

The project which has been chosen to endeavours to explore how certain pavement modelling systems models the deterioration rate of certain classes of road. Multiple models have been investigated which are quite predominate in the states of NSW and Victoria. Pavement management systems (PMS) which have been closely examined include Assetics and SMEC and Moloney . SMEC and Assetics have been closely examined to see how well each system models a particular class of road. However because each PMS belongs to a different council the way in which each council defines a road in very unique. Each pavement modelling system does measure deterioration in terms of pavement condition index (PCI) as time goes by.

2. Background

Modelling a road deteriorating is very much prediction modelling so that informative decisions can be made when combatting against road defects and other hazards that a deteriorating road may possess. The projects promotes continuous improvement in the field of asset maintenance and gives insight into what a typical pavement modelling system output should look like. Most public authorities need to monitor a road deteriorating but often resort to only one single pavement modelling system. Without resorting to any other pavement management system one cannot tell how reliable their output is when assessing and analysing road deterioration. The research investigations aims to provide a range in which a road deterioration model output can fall into .

3. Methodology

Using historical data available through local councils. PCI values and the year which these values were
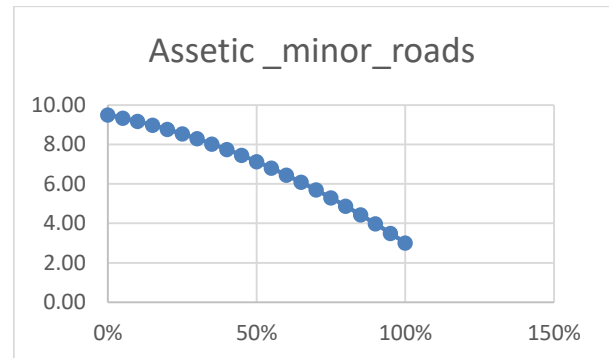
Figure 1 - Sample Diagram

captured will be analysed . Analysis of the data will include weighted average over segments of road . . For class of road arterial, regional , local access , minor and collector trends will be developed for each road type . A comparison between each model trend developed will be between both models created

4. Key Outcomes

Key outcomes that have been achieved includes a understanding of how roads deteriorate and how modelling their deterioration can be achieved. Gaining an understanding how different PMS systems have been modelled and designed to have different algorithms built into them.

5. Further Work

Further work refining the model developed in terms of greater statistical analysis . And finding reasons why the model behaves the way it does .

6. Conclusions

From what the results have shown there is some correlation between model being produced and each road class.

Acknowledgements

Acknowledgement to the assets maintenance teams at Central Coast council and my supervisor David Thorpe.

References

Li. Z ,2005 , *A probabilistic and adaptive approach to modelling performance of pavement Infrastructure* , PHD thesis , The University of Texas.

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Commissioning and Testing of Power System Protection Relays

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Electrical and Electronic)

Supervisor: Dr Andrew Hewitt, USQ

Keywords: Protection Relays, Commissioning and Testing, Programable IEDs.

Introduction

Protection relays have long been used to protect electrical equipment and networks. During the last 30 years, the design of protection relays has changed significantly with conventional electromagnetic relays being replaced by numeric relays, alternatively known as IEDs (intelligent electronic devices). Modern IEDs are software based and offer a large number of programmable functions within a single relay. To ensure a protection systems meets the safety, reliability and security requirements demanded in modern power system, the protection relay must be adequately tested and proven. This thesis investigates the need for sound engineering requirements and approaches when testing and commissioning these IEDS.

Background

When field testing power system protection relays for commissioning purposes, the question of what level of testing is required to confidently place plant into service is highly debatable. As practicing professional engineers, we are often faced with the competing restraints of cost, time and quality when making decisions for the design, procurement, testing and commissioning processes. This project investigates the need for engineering decision making to find intelligent and justifiable decisions for the commissioning and testing of modern IEDs.

## Methodology

A review of Australian Acts, regulations and standards has been undertaken to identify regulatory requirements for testing and commissioning of power system protection. In the light of this information, a rigorous and defendable engineering approach for testing of protection relays has been developed. In order to review and assess the proposed outcomes, information on current industry practices has been collected and reviewed. A critical analysis of these practices has then
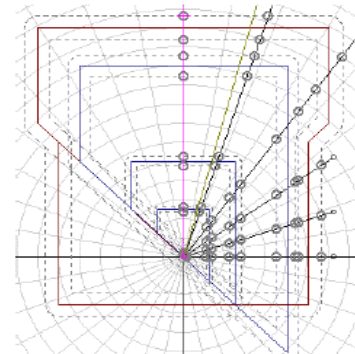
Figure 1 – Quad Distance Characteristic testing

been undertaken to assess the advantages and disadvantages of current practices.

Key Outcomes

The outcome of this investigation is provision sound engineering guidelines around field testing requirements to confidently and safely commission power system protection.

Further Work

Further work includes checking the validity of proposed solutions by confirming their suitability with industry professionals.

Conclusions

Effective testing of protection relays (IEDs) can improve the overall performance of power system protection at a reduced cost. It not only provides reliable and secure protection systems but also enhance the safety of equipment and people during system fault conditions.

Acknowledgements

I would like to thank Dr Andrew Hewitt for providing assistance and support to carry out this project. I also want to thank Mr Paul Hohenhaus for providing information about common industry practices and to faculty of electrical engineering-USQ for providing valuable knowledge to undertake this project.

References

Bastigkeit, B., Schossig, T., & Steinhauser, F. (2009). *Efficient Testing of Modern Protection IEDs.* PAC World.

Price, P., Myers, N., & DeHaan, J. (2011). *Operation, maintenance and field testing procedures for protective relays and associated circuits.* U.S Department of the Interior . Denver, Colorado: Hydro Powr Technical Services Group.

Redesign of Brisbane City Council's Type 3 Asphalt and Development of Mix Specific Flexural Master Curves

School of Civil Engineering and Surveying
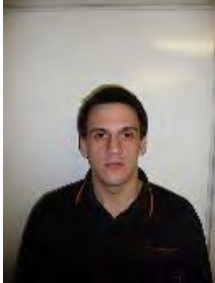
Andrew Kidd

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Andreas Nataatmadja, USQ

Dr Greg Stephenson, BCC

Keywords: Asphalt surfacing design, mix characterisation.

1. Introduction

Brisbane City Council is the largest local council in Australia, and is responsible for the operation and maintenance of a sealed road network spanning over 5700 km. Approximately 26% of this network consists of heavily trafficked industrial, sub-arterial and arterial roads, which are surfaced with BCCs Type 3 asphalt.

Recent concerns with premature failure due to permeability resulting from low in situ air voids, along with instances of segregation and ravelling, have prompted an investigation and redesign of the Type 3 mix. It is apparent that any improvement to the existing design can result in significant cost savings for BCC and ratepayers.

2. Background

While the effects of varying combined aggregate gradations on asphalt performance are generally well understood, there has been little work on assessing the effect of gradation shapes on mix characterisation in the form of flexural modulus master curves for comparable bitumen properties. Similarly, BCCs extensive use of multigrade bitumen has warranted further research into its potential benefits. This project therefore aims to compare gradation properties with mix performance and characterisation testing to produce an improved mix design.

3. Methodology

RAMCODEs gradation analysis, developed by Sanchez-Leal (2007), was investigated and applied to all design gradations as a quantitative approach in comparing gradation shapes and gravel to sand ratios (G/S) with relevant test properties. Five mix designs
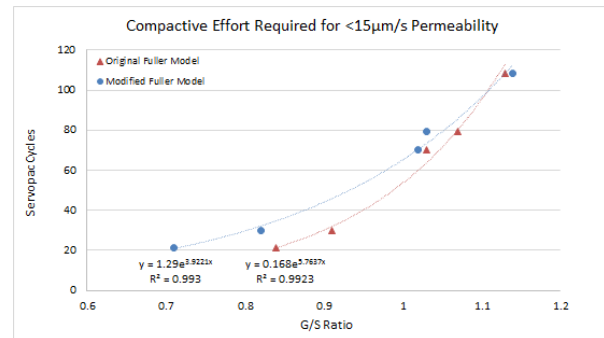
Figure 1 – G/S Ratio as a Predictor for Compactive Effort Required for Achieving Impermeable Mix

including the current Type 3 were examined for their performance in regards to workability, permeability and rut resistance. A durability test was also examined to compare the effects of gradation with short and long term ageing on mix stability and resilient modulus values.

4. Key Outcomes

The RAMCODEs parameters were found to correlate well with the tested performance of the trial mix designs, and may be able to predict performance of other proposed BCC dense grade mixes in the future.

5. Further Work

Development of mix specific modulus master curves has yet to be completed. Additionally, this data may be used to compare pavement designs for conditions typically encountered on the BCC road network. Additional stiffness and fatigue testing with multigrade bitumen would also be highly beneficial.

6. Conclusions

This project will propose an alternative mix design with improved or, at least, comparable performance to the existing Type 3 design. Additionally, mix specific master curves can be used by BCC for improved pavement design.

Acknowledgements

References

Sanchez-Leal, F, 2007, "Gradation Chart for Asphalt Mixes: Development", Journal of Materials in Civil Engineering, vol. 19, February, pp 185-197.

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Monitoring of Mine Rehabilitation Using Satellite Imagery

School of Surveying

Mitchell Kingston

Bachelor of Spatial Science

Survey Major

Supervisors: Prof. Armando Apan

University of Southern Queensland

Keywords: Satellite Imagery, GIS monitoring.

1. Introduction

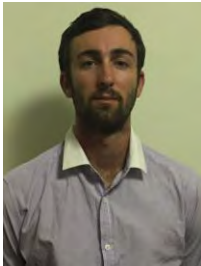Mining has been a significant industry in Australia since the discovery gold in the 19th century, to the iron ore and nickel flourishes of the 1960's and more recently the growth of the coal industry and other fuelling minerals. The benefits from mining in Australia are great, including a high rate of economic growth, record low levels of unemployment and increasing incomes for Australians (Industry.gov.au, 2017). However, the scar which the extraction of these materials has left on our native vegetation can and has been drastic.

2. Background

The aim of this study was to determine the vegetation rehabilitation progress of a mine site in inland central Queensland which has been extended through several stages of development. The extent and destruction of Goonyella Riverside Mine's vegetation to date is compared to the extent and destruction of the vegetation while the mine is in full operation and before mining had commenced.

3. Methodology

This research project used satellite imagery and GIS techniques to identify the success of vegetation rehabilitation in the subject area. Three images were collected including a mixture of LandSat and Sentinel 2 imagery. The main software used to analyse the images was ArcGIS which determined the amount of vegetation in the subject area. This was then analysed and compared over the time periods to determine the progress of the mine rehabilitation.

Figure 1 Moranbah Mine Band 4 Comparisons 1991-2011-2016

4. Key Outcomes

The key outcomes of this project are to use GIS techniques to determine the effectiveness of using satellite imagery as a rehabilitation monitoring system in mine sites. It is expected that they will be of great use for monitoring mine site rehabilitation.

5. Further Work

An extension of this project would be to utilise more modern imaging and different techniques to analyse mine rehabilitation. This would include finding analysing water content and health of vegetation, not just density.

6. Conclusions

This project concludes that mine site rehabilitation can be monitored accurately using satellite imagery.

Acknowledgements

References

Drake, J., Greene, R., Macdonald, B., Field, J. and Pearson, G. (n.d.). A review of landscape rehabilitation frameworks in ecosystem engineering formineclosure. PHD. Australian National University.

Five Applications of Satellite Imagery. (2015). [Blog] GIS Lounge. Available at: https://www.gislounge.com/five-applications-of-satellite-data/ [Accessed 6 Aug. 2017].

Greenpeace International. (2016). About coal mining impacts. [online] Available at: http://www.greenpeace.org/international/en/campaigns/climate-change/coal/Mining-impacts/ [Accessed 5 Aug. 2017].

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Renewable Energy: UAV monitoring of dirt affecting solar panel efficiency

School of Mechanical and Electrical Engineering
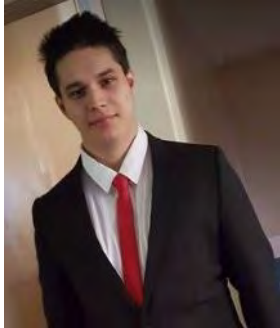
David Kinney

Bachelor of Electrical Engineering

Supervisors: Mr Andreas Helwig

Dr Narottam Das

Keywords: UAV, Solar, IR

1. Introduction

The production of electricity is of the most importance for the engineering world as all current and modern technology either relies on electricity to run or was made using electricity at one point or another. The most common means of mass electricity production comes from coal fired power stations which supply 40% of the world's electricity demand. The supply however is limited and at the current level of consumption it is expected to last another 110 years. Therefore, alternate energy sources must be improved if we are to continue our current way of life. Solar energy is one such alternate source that is on the rise as you can see from the array at the carpark here at USQ. Electrons in PV cells flow and create current when incoming light photons contact the cell and displace the electron into a higher conduction band. From this knowledge, it can be gathered that potential solar output depends on the number of incident photons and therefore surface contaminants that block incoming light reduce the solar panels efficiency.

1. Background

This project is important for a few reasons. The criteria for a project to be considered important are: environment and sustainability, financial gain and health and safety. This project's main aim is to increase efficiency and therefore reduce waste of money and improve environmental sustainability.

The contribution to engineering is that this project has the chance to improve renewable energy by developing a technical solution to aid the maintenance of solar panels and help keep them at maximum output.

2. Methodology

The proposed methodology to follow is to set up solar panels in the sun during the day and measure their maximum output then simulate surface dust deposits by spraying a dirt and water mixture on the surface and measuring the relationship between known amounts of surface contaminant and solar energy output. The second stage is to take place during the steps previously mentioned and it is to take photos using IR camera so that they can be analysed and see if the surface contaminants can be observed and is it possible to know how much energy/money is being lost by visual inspection via IR camera.

3. Key Outcomes

The key outcomes of this project were proving that simulated surface contaminant did reduce the output of the solar panel and that when there was enough dirt it was visible to the FLIR camera in a measurable amount.

4. Further Work

Due to very high risk of damage to persons and or environment as well as ever changing legal issues with drone flying, the UAV section will not be attempted in this project and can be amounted to further work for more qualified/licenced drone pilots.

5. Conclusions

The main conclusion to draw from this project is that renewable energy and reliability engineering in regards to sustainability is an important topic in the current technological age and more emphasis should be put on sustainability and energy research.

Acknowledgements

References

Memming, R., 1931 2015, *Semiconductor electrochemistry*, Second edn, Wiley-VCH, Weinheim, Germany.

Mertens, K., 1963 & Roth, G. 2014, *Photovoltaics: fundamentals, technology and practice,* Wiley, Chichester, England.

M. A. Jaradat, 2015, "A fully portable robot system for cleaning solar panels," 2015 *10th International Symposium on Mechatronics and its Applications (ISMA)*, Sharjah, pp. 1-6.

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Development of Low CO2 Durable Concrete Using Geopolymer and Related Chemically-Activated Cements

School of Civil Engineering and Surveying

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Supervisors: Dr, Zuhua Zhang, USQ

Keywords: Geopolymer cement; green concrete;

Geopolymer

1. Introduction

Over the past 50 years, scientists have been warning about the potential disaster to the planet as a result of the current population growth, and the resulting construction demand for housing and utilities, (Cembureau, 2015). This world population growth has resulted in an increased demand for Portland Concrete. High population, developing countries like China and India this demand has increased by 300% in recent years. Due to the high energy demands in the production of Portland cement it is responsible for large quantities of CO2 being released into the atmosphere. This increase in demand has necessitated the need to find an alternating material for Portland concrete that is friendlier to the environment if we wish to slow Global warming.

2. Background

Winter (2017) explained that concrete in some form has been utilised in construction for more than 2000 years, with Portland cement (patented 200 years ago,), moreover has become the go to product in construction. Van-Deventer (2012) stated that concrete manufacturer is responsible for at least 5% of the world's yearly C02 emissions. The high-energy nature of Portland cement production makes finding a low CO2 emission replacement for Portland cement crucial for the health of the world. In 1977 Davidovits introduced Geopolymers which promises to be an exciting alternative material in construction. One branch of this field is Geopolymer cement that utilises Alkali activated materials with a binder agent to make a concrete like material. Currently industry research into this emerging field is considering different mix designs to determine the strengths and parameters of differing mix designs.

3. Methodology

This project looked at using Fly-Ash, (a waste product of coal power generation) and Blast Furnace Slag, (a waste product of steel manufacturing) in differing ratios as the Alkali material, in conjunction with a binder agent, (Sodium Hydroxide and Sodium Silicate) to create a concrete like mix. These mixes were cast into 100*200mm concrete cylinder moulds and allowed to cure for 7 days before being tested for compressive strength.

4. Key Outcomes

It is hoped that this project will provide a deeper understanding of the effects of differing alkali materials ratios in combination with the binder agent will have on the properties of the Geopolymer cement. Eventually in providing a data set that will allow for the accurate prediction of future mix design and the results they can expect.

5. Further Work

The next step in future studies in this field would be to look at the deferring mixed designs and extent the cure time to determine the effects of longer cure times will have on the final properties

6. Conclusions

Currently no conclusions have been reached as a result of the testing that has been done.

Acknowledgements

References

"Key Facts & Figures". *Cembureau.eu*. N.p., 2017. Web. 24 May 2017.

Van Deventer, Jannie S.J., John L. Provis, and Peter Duxson. "Technical And Commercial Progress In The Adoption Of Geopolymer Cement". *Minerals Engineering* 29 (2012): 89-104. Web. Winter, N .B. *Understanding Cement: An Introduction To Cement Production, Cement Hydration And Deleterious Processes In Concrete*. 1st ed. WHD

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Future Management of Survey Infrastructure within NSW

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Supervisors: Miss Jessica Smith

Keywords: Preservation, Survey Infrastructure, Future Management, Innovative Strategies.

1. Introduction

The need to accurately position people and infrastructure is integral to today's society and the way we live day to day. As such there is a substantial reliance on survey infrastructure as it is a fundamental layer that underpins the cadastre's integrity along with governing the positional and spatial accuracies of the construction, agricultural, surveying and defence industries.

It is inevitable that loss of survey infrastructure will occur as cities grow and develop; nonetheless how the profession manages survey infrastructure into the future will depend on a number of factors. This research will investigate the current legislative requirement to preserve survey infrastructure, what innovations are being implemented, who is the absolute owner, marking requirements and whether GNSS could replace ground monument moving into a digital world.

2. Background

There is an existential crisis (de Belin 2016) facing survey infrastructure as it is being destroyed at an exponential rate. Survey infrastructure is just like any other type of critical infrastructure that serves any city, and as such, requires the same amount of protection and preservation. This research should be the catalyst for the profession to address this issue and ensure the strategical future management of survey infrastructure.

3. Methodology

A tiered level approach was adopted by undertaking case study analyses of an international case, several state jurisdictions and two detailed case studies. A questionnaire was developed that forms the foundation of this research and was distributed to 128 NSW councils and four of NSW surveying institutions.

4. Key Outcomes

There were a total of 324 respondents to the online questionnaire and in addition to the respondents' answers there were 685 individual comments made. The New Zealand case study highlighted the critical importance of survey infrastructure and the role it plays in devastating times. The detailed case studies of Ryde LGA and the Blue Mountains revealed that irrespective of the LGA the destruction rate does not discriminate. A vital link was established between the valuation of property, and the valuation of the supporting survey infrastructure.

5. Further Work

Moving into a digital world and active GNSS networks, exactly how to establish this link with little to no monuments could provide advantages. Crowd sourced data from websites such as *Geocaching Australia* requires further investigation into how to best utilize this data source. One quarter of NSW Councils are members of DBYD, these councils should explore adding survey infrastructure as an additional layer into their asset management system.

6. Conclusions

This research forms the foundation needed to ensure the longevity and future ambitions for survey infrastructure for both the profession and the community. From the results of this project and in conjunction with the literature review, 10 recommendations will be put forward and if adopted could assist in shaping the future use, management, understanding and appreciation of survey infrastructure.

Acknowledgements

References

de Belin, F 2016, 'The Existential Crisis Facing Survey Reference Marks (Can the Cadastre Cope?)', in *ISNSW Dinner Meeting*: *Proceedings of the ISNSW Dinner Meeting* Sutherland.

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Automation & Optimisation of Soil Hardness Testing Device

School of Mechanical and Electrical Engineering

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Bachelor of Engineering
(Honours) - Mechanical

Supervisor: Mr Les Zeller, USQ, National Centre for Engineering in Agriculture (Research)

Keywords: Penetrometer, Automation, Conceptual Design

1. Introduction

Measuring soil hardness is a common practice particularly for sporting surfaces and racetracks. It is a way for groundsmen to see whether the soil is too compact and needs work. Current devices which are used to measure the soil hardness are often slow and inconsistent in their readings. This project is a research & design project which seeks to automate the measuring process to produce faster readings, covering larger areas in less time, improve repeatability of measuring action, and improve accuracy of the average soil hardness.

2. Background

Trigger Penetrometers and 'GoingSticks' are the most commonly used devices for testing. Both of these devices are handheld devices which require manually forcing the shaft into the soil. In situations where the user has to take a large number of readings to get an accurate soil hardness average such as on a sporting oval the process could take up to a whole day, depending on the size of the area and accuracy needed.

3. Methodology

A literature review was undertaken first to gauge what devices are currently being used and how effective they are. This confirmed that there is a need for improvement of current devices. A test was conducted at the Toowoomba Racecourse using both the USQ Penetrometer as seen in Figure 1, and the Turf Clubs Trigger Penetrometer to gauge what forces are acting on the shaft. A number of conceptual designs were then made and evaluated to find the best solution.

Figure 1 – USQ Penetrometer Testing

4. Key Outcomes

The conceptual drawings include a crankshaft type design, converting rotational motion into linear motion moving a probe up and down into the soil. The reaction force of the soil against the probe will determine the soil hardness, measured be a load cell. The device will be towed along and the probe will take measurements while the vehicle is moving around the ground enabling the measurements to be taken much quicker and giving a better indication of average soil hardness.

5. Further Work

There is still a lot to do at this stage, including the final design concept. Once the design has been finalised the models and drawings will be made, including FEA and associated calculations. Unfortunately there will not be enough time to build and test the final design.

6. Conclusions

The design will be tailored towards the sporting and horse racing industry due to the need for efficient measuring equipment. Although the outcome of this project is only a conceptual design it is hoped that the design could be prototyped in the future and potentially become an available product for interested companies.

References

Brisbane Racing Club. (2017). *Track Information*. Retrieved from http://www.brc.com.au

Stubbs, A.K., & Neylan, J.J. (2002). *Racetrack Management: A Manual for Racecourse Managers*. Retrieved from http://www.rirdc.gov.au

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Measuring tree DBH & height by using terrestrial laser scanner for forest management

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Weibin Kong

Bachelor of Spatial Science (Honours) Major Surveying

Supervisor: Dr Xiaoye Liu, USQ

Keywords: Terrestrial Laser Scanner, 3D modelling, tree inventory, tree data management

1. Introduction

Terrestrial laser scanner (TLS) is a modern laser scanning technology has been utilised in surveying industry for many years. Two of the biggest industries utilising TLS technology are building and mining industry. Using TLS for environmental monitoring purposes especially forest tree monitoring and modelling is a relatively new and continuing researched area.

The aim of this project is to collect and extract tree DBH (diameter at breast height) & height information from terrestrial laser scan data by using a free to air modelling software "3D Forest" then verify the accuracy of the extracted data by comparing to manually collected data .

2. Background

The research area is located in Lake Broadwater, Dalby. It is one of PPBio Australasia's RAPELD (rapid assessment surveys) long-term ecological research sites. The programme aims to assist agencies and land managers in collecting long-term data on biodiversity assessment on public and private lands.

3. Methodology

The project site has been divided into 18 plots (figure 1). A number of laser scan had been carried out by using FARO Focus 3D scanner nut due to limited time only first plot scan data will be examined. Scanned data will have two stage process: stage one is using FARO SCENE to reduce the data then stage two is to using "3D Forest" software to extract tree DBH and height information. The final step is to conduct addition scans near USQ Toowoomba campus with tradition survey method to verify scan data accuracy.

Figure 1 - Locations of 18 permanent plots and transect grid at Lake Broadwater

4. Key Outcomes

Early findings show 3D Forest software is capable of generate tree height and DBH information from registered point cloud and the outcome data can be in real-world coordinate system. But the accuracy of the data is also heavily rely on manual editing thus getting useful information can be very time consuming and requires 3D point cloud editing knowledge.

5. Further Work

Only one plot of research area has been exam, there are other 17 plot with scanned data can be examined by using 3D Forest software. Different and robust verification process is required.

6. Conclusions

3D Forest is a very useful tool for generating tree inventory information and it has a lot potential in tree data management but because it is an open to air software, thus it has lots of bugs need to be fixed before it can reach its full potential.

Acknowledgements

References

Hero, J Castley, G & Lollback, G 2012 'PPBio Lake Broadwater Field Manual Draft', Environmental Futures Research Centre, School of Environment, Griffith University.

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Volume Reduction of Household Recyclable Waste

School of Mechanical and Mechatronic Engineering

Bryce Lamb

Bachelor of Mechatronic Engineering

Supervisors: Dr Tobias Low, USQ

Keywords: Plastic, Glass, Recycle

1. Introduction

Recycling in Australia is becoming an essential way of life for everyone to do their part for the environment, reducing the cost to recycle can reduce the price of using recycled materials for manufacturing. Reducing the volume of household recyclable waste ensures more material to be transported taking up less volume.

The development of a device that eliminates the wasted space for objects such as jars and bottles, plastic or glass. The device consists of two methods for the volume reduction of the materials. This will ensure a higher density of material reducing wasted space.

2. Background

Australia is already a very proactive recycling country and with city areas becoming more and more dense area becomes expensive. Figure 1 shows that the amount of total waste is increasing although the amount of landfill waste has not increases, therefore with increased recycled waste more infrastructure is needed. If processes can be implemented at the head of the recycling chain costs and time can be reduced in the whole process.

3. Methodology

Large Industry methods were compared for energy sources and requirements, this gauged what methods would be the most efficient for the selected materials that needed to be processes. A scaled down assembly of the main mechanical processes which are a single rotor shredder and a jaw crusher principle. These where created through 3D printing and machining, this then allows for the implementation of the electrical components for a full working scaled design. Once all working the mechanical and electrical components can then be fully integrated into a final design.
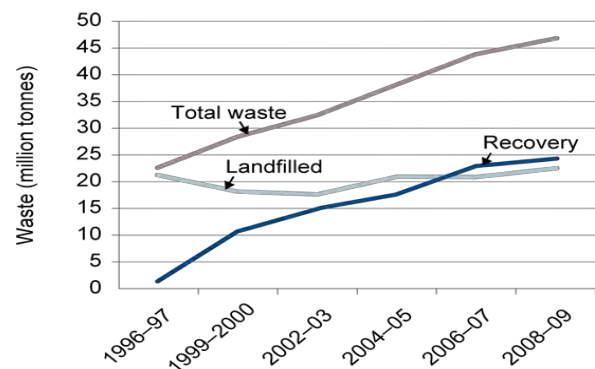
Figure 1 - Waste generation, disposal and recovery in Australia, (Department of Sustainability, Environment, Water, Population and Communities 2013)

4. Key Outcomes

The device is to be used at a domestic setting from 240V power, must be simple and safe to operate. The device size will allow for it to be placed in areas as small as courtyards or inside the home. Also the machine must be modular to allow for modifications or repairs to be completed with ease.

5. Further Work

A full development/assembly and destructive testing on the whole system to improve and optimise strength would be beneficial to the future development of the device. The application of smart technology integrated with a touch user interface or like technology would benefit the future of the project.

6. Conclusions

This Project will allow for the development of a device to assist in ensuring the simplicity and ease of recycling in Australia continues through the use of user based recycling methods to assist in the whole recycling process.

References

Healey, J 2010, *Recycling and Waste Management,* Vol 305, the Spinney Press, Australia.

Randell, P, Pickin, J, Grant, B, 2014, "*Waste generation and resource recovery in Australia Reporting Period 2010/11*" version 2.6, Department of Sustainability, Environment, Water, Population and Communities, Blue Environment Pty Ltd, Victoria Australia,

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

100

Analysis of the Accuracy of Emerging Consumer Photogrammetry Techniques

Sponsor – School of Civil Engineering and Surveying

Julian Lamont

Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr Albert Kon-Fook Chong, USQ

Keywords: Accuracy, Photogrammetry, Smartphones

Figure 1 – Photogrammetry Mesh of Environment

1. Introduction

This project is focused on the accuracy of consumer level photogrammetry as it is accessible, it can yield extremely accurate results and it can potentially be done on a low budget. While there has been some research on the accuracy of photogrammetry, it is largely focused on large format or professional photography and expensive software programs.

2. Background

Current developments such as high resolution smart phone cameras and photogrammetry software that doesn't require camera calibration have improved accessibility to photogrammetry and have the potential to supplement current measurement techniques, but their accuracy is unclear. By analysing the accuracy of the result from a phone camera and Autodesk ReMake, there is potential to unlock a cheap and accessible scanning solution.

3. Methodology

To test the accuracy of the photogrammetry technique a test environment (see Figure 1) was captured using ideal photogrammetry technique and compared against high quality total station control data. This was analysed for accuracy, distortion and feature detail identification and modelling. As the best case was established, the steps required capturing and processing the scene were reduced to try to make the process as accessible as possible.

4. Key Outcomes

The work so far has established that a high quality model can be established, but as it is labour and time intensive the possible uses for this are limited. Further tests have shown that as you try to save time and cut corners you run a high risk of not getting a result. Smartphones are particularly sensitive to light conditions so successful registration of points in variable lighting is one of the barriers for this to become a mainstream technique.

5. Further Work

There is always ongoing research in this type of project, but the main focus is still on getting a high quality mesh with the least amount of field time, equipment and preparation of the environment.

Related work beyond the scope of this project will be on the next generation of photogrammetry software such as models generated in real time from video so you have instantaneous feedback on the registration of points.

6. Conclusions

It is possible to get a high quality result from a smartphone camera and ReMake, but you still need an understanding of your individual equipment and good photogrammetry technique. The data can quickly degrade and not even register if you aren't aware of the limitations of phone cameras and the software. Following certain rules such as placement of targets or landmarks and redundancy of data are paramount to the success.

Acknowledgements

I'd like to thank Dr Albert Kon-Fook Chong, my USQ supervisor.

References

Waldhausl P, OC (1994), *3X3 Rules for simple photogrammetric documentation of architecture*, International archives of Photogrammetry and remote sensing, vol. XXX, no. 5, pp. 426 – 9.

Sapirstein, P (2016), *Accurate measurement with photogrammetry at large sites*, Journal of Archaeological Science, vol. 66, pp. 137-45.

Schenk, T (2005), *Introduction to Photogrammetry*, The Ohio State University Department of Civil and Environmental Engineering and Geodetic Science, 2070 Neil Ave., Columbus, OH 43210.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

101

Experimental analysis of the performance and emissions of waste cooking oil biodiesel with ABE additive as an alternative to mineral diesel

School of Mechanical and Electrical Engineering

Mitchell Lawler

Bachelor of Engineering (Honours) – Mechanical

Supervisors: Dr Andrew Wandel, USQ

Keywords: Biodiesel, Performance, Emissions

1. Introduction

This experimental research project aims to evaluate the performance and emission enhancements of a waste cooking oil biodiesel blend that utilises the combustion benefits of the Acetone-Butanol-Ethanol (ABE) additive. This is being done in the hope of deriving a biodiesel blend that requires less mineral diesel and doesn't put a strain on food resources like other popular edible derived biodiesels.

2. Background

Currently majority of the most popular biodiesel blends are derived from edible based sources such as palm and soy bean oils. This creates potential for a food vs. fuel dynamic in the future. Therefore, there is a need for research into increasing the performance properties of waste cooking oil biodiesel by utilising additives to make it a more appealing alternative to consumers.

From reviewing the literature, conclusive findings have been found for ABE to improve combustion of neat diesel.

This project extends on those findings to analysis if ABE can have the same improvements on WCOB blends.

3. Methodology

A 4-stroke single cylinder Yanmar diesel engine was used to collect performance and emissions data on 6 biodiesel blends and a 100% diesel control, as shown in table 1.

Measurement equipment such as a gas analyser, pressure transducer and thermal couple gathered data which then was translated into quantitative properties including brake power, exhaust temperature, brake specific fuel consumption and emission concentrations. With the data collected across the different blends, the influence of ABE on waste cooking oil biodiesel could

1. 100% Diesel		
	0% ABE 100% biodiesel	10% ABE 90% biodiesel
10% biodiesel blend 90% Diesel	5	6
20% biodiesel blend 80% Diesel	2	3

Table 1 - Fuel mixtures for testing with their priority.

be determined and hence evaluate its potential in being used widely in improving the combustion properties of WCOB.

4. Key Outcomes

By performing the experimental testing outlined, an optimum blend solution is hoped to be found that will have improved performance over regular WCOB and reduced emissions. Ideally the outcome of this project is to create a substitute to mineral diesel and edible derived biodiesels until a more sustainable alternative is discovered.

5. Further Work

Currently the biodiesel blends are yet to be tested, although these should be able to be completed before the conference.

6. Conclusions

The conclusive findings will be whether ABE shows the same improvements in performance and emissions on WCOB as it does on mineral diesel. With the findings, hopefully others will be more likely to use a renewable fuel.

Acknowledgements

References

Fayyazbakhsh, A., & Pirouzfar, V. (2017). *Comprehensive overview on diesel additives to reduce emissions, enhance fuel properties and improve engine performance,* Renewable and Sustainable Energy Reviews, 74, 891-901.

Yadav, A. K., Khan, M. E., Dubey, A. M., & Pal, A. (2016). *Performance and emission characteristics of a transportation diesel engine operated with non-edible vegetable oils biodiesel*. Case Studies in Thermal Engineering, 8, 236-244.

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102

Climate Projection of Extreme Sea Level Events Along the Queensland Coast

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr. Zahra Gharineiat, USQ

Keywords: Satellite Altimetry, Tide Gauge, Tropical Cyclone.

1. Introduction

The Queensland coastline, specifically in the northern region is familiar to and frequented by tropical cyclones. Seasonally these cyclones may occur during the wet season from November to April. Australia has adapted to the coastal lifestyle, with approximately 85% of the Australian population living in coastline regions for social, economic and environmental reasons.

In recent findings of the past 20 years, the global average rate of sea level rise has been found to be 3.2mm/per year where comparatively in Northern Queensland these rates have found to be at almost three times the global average, around 7-10 mm per year since 1993.

2. Background

Northern Queensland populations reside and rely on the coastline for tourism, agriculture and transport as an economical means of living, to which the occurrence of combined extreme sea levels with the emergence of severe tropical cyclones (as seen in Figure 1) can bring high disruptive impact to, where monitoring, observation, and planning for such events is necessary.

3. Methodology

This research is a comparison based, produced through the collection of available satellite and tide gauge data over the past 20 years to form a comparative model.

4. Key Outcomes

The project will likely form outcomes such as a comparison between satellite altimetry and tide gauge sea level data associated with global warming and an
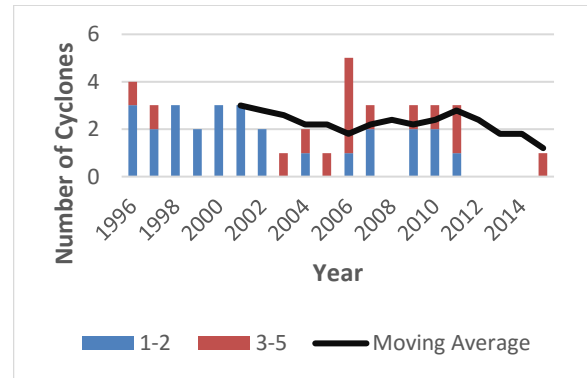
Figure 1 – Annual Cyclone Categorical Occurrences

acceleration in sea-level rise, an assessment of the vulnerability of coastal areas in Northern Queensland to larger storm surges associated with global warming and an acceleration in sea-level rise. The project would specify the impact and correlation of global warming due to rising sea levels and their effect on tropical cyclones experienced in coastal Northern Queensland.

5. Further Work

Once the altimetry observations for Northern Queensland coastal locations have been collected, the data will then need to be averaged in conjunction with the tide gauge data to discern whether a relationship between tropical cyclones and sea-level rise is evident.

6. Conclusions

From the comparisons and findings of the project, this research may offer some relevance and updated insight to all coastal populations with respect to the Northern Queensland region this includes possible relevance to local populations, regional councils, coastal management, and planning services.

Acknowledgements

References

Department of Climate Change, 2009, Climate Change Risks to Australia's Coast, First Pass National Assessment, Australian Government

Department of Climate Change and Energy Efficiency, 2012, The critical decade Queensland climate impacts and opportunities, Australian Government

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Hydraulic Investigation into the Practical Applicability of the ISLEX Smart Siphon

Faculty of Health, Engineering and Sciences

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Bachelor of Civil Engineering (Honours)

University of Southern Queensland

Supervisors: Dr Malcolm Gillies, USQ
          Mr Gavin Kelly, ISLEX Plastics

Keywords: Irrigation, Siphon, Hydraulics

1. Introduction

Produced commercially since the 1960s, cotton has developed into one of Australia's leading agricultural industries and fundamental global agricultural exports. The Australian Cotton Industry provides the world cotton market with over $2 Billion annually while also providing an economic foundation to rural communities.

Although the Cotton Industry provides an important role throughout rural Queensland and New South Wales there is still a major decrease in labour supply. The major requirement for labour is throughout irrigated cotton and the watering requirements and field maintenance.

2. Background

This lack of skilled labour throughout the irrigated cotton growing region provides the requirement for automation within the agricultural field. This requirement has been identified by ISLEX Plastics, who have designed Pipe through Bank (PTB) systems with the capability to be fully automated, thus mitigating the requirement for significant labour presence. The only limiting factor is the ability to effectively forecast and manage the run time of the systems themselves.

3. Methodology

The major requirement for the conducted testing was the investigation into any limiting factors which may provide the opportunity to effectively restrict the flow through the system. This restriction in flow came through the investigation into restrictors placed at the entry location, varying head levels as well as the addition of extra entry area. The testing was conducted within a controlled environment (within the Hydraulics Laboratory) and involved the investigation into the effect of varying head levels on the flow rate.
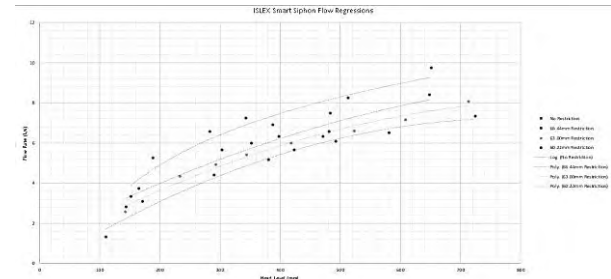
Figure 1. Siphon Rating Curves

4. Key Outcomes

In following the previously defined methodology it was tentatively discovered that the flow rates of the restrictors under varying head levels is now generally attainable through the use of the defined rating curves. The curves provide a general understanding of the expected flow patterns throughout the system, including the effects of the added restrictors.

5. Further Work

Further work which could potentially be completed is a detailed cost analysis into the transition of a farm from labour through to fully automated systems. Further to this an analysis into the effect of a free outfall at the flow exit to predict erosion patterns could also be conducted to further mitigate labour requirements.

6. Conclusions

The project provides usable data to the farmers who are potentially interested in incorporating the units into their growth patterns. The data provides the capability to effectively forecast required flow rates and incorporate the data into usable irrigation techniques.

Acknowledgements

References

Chin, D. A., 2000. Flow in Closed Conduits. In: M. Horton, ed. Water-Resource Engineering. Upper Saddle River: Prentice Hall, p. 65.

John Roberson, J. C. M. C., 1998. Closed Conduit Flow. In: J. W. a. Sons, ed. Hydraulic Engineering. s.l.:Library of Congress, p. 222.

Opaka, J. S., 1992. Improving the Efficiency and Uniformity of Surface Irrigation of Cotton, Toowoomba: University of Southern Queensland.

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Design of high accuracy wireless tilt sensor system for measuring rail sleeper movement in remote areas

School of Mechanical and Electrical Engineering

Andrew Leslie

Bachelor of Electrical and Electronic Engineering
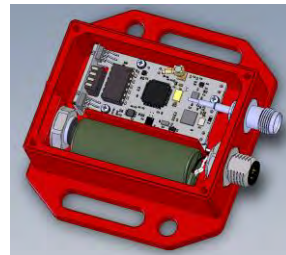
Supervisors: Mr Mark Phythian, USQ

Dr Andrew Ward, Intellidesign

Keywords: LoRa, Tilt sensor, Calibration, Rail.

1. Introduction

A need for monitoring rail sleeper movement has arisen from tunnelling works nearby freight rail lines. Long term movement detection is required to gauge the effect of the works on the rail system. A simple battery operated tilt sensor system based on 3 axis MEMS accelerometers and the low power wireless technology LoRa will be designed to address this need.

While this may seem straight forward, the calibration method to get high accuracy measurements to small percentages of a degree needs to be researched and implemented.

2. Background

This project will build on existing TS-1 wired tilt sensors and the PCP-100 gateway currently offered by Intellidesign. Design changes will be required to incorporate the LoRa wireless technology and improve the tilt sensor's ability through hardware and software.

3. Methodology

The methodology employed for this project commenced with research on requirements for the sensors and wireless system. A set of basic requirements for the hardware to achieve was specified to ensure focus on the task at hand. From here the hardware could be designed and manufactured. Software was written and implemented on the sensor node and gateway to interact with each other. The tilt sensor could then be tested for sensor accuracy and compared to ideal (no errors) results through the use of a MATLAB model.

4. Key Outcomes

Figure 1 shows the initial hardware designed with the LoRa implementation. Measurements made with this

Figure 1 – Designed LoRa, MEMS based tilt sensor

prototype sensor node identified some flaws in the system design that need to be addressed. As these issues related to the accuracy of the tilt sensing a revision of the design was required. A second prototype has been constructed and tests are ongoing.

5. Further Work

At the time of writing, the calibration method for the sensors are still being implemented and tested. If time permits a complete system test with the gateway can be performed. Additional work may be done to examine the effect of harsh vibration from trains on the sensors themselves.

6. Conclusions

The conclusions drawn so far are that the tilt sensing system should be able to perform the required task with some modifications to hardware and software. Long term testing will ultimately prove its usefulness to the rail industry.

Acknowledgements

I would like to thank my employer, Intellidesign, for giving me the time and access to the production equipment for my research and testing. I would also like to thank Mark Phythian for guidance on achieving my goals. Most importantly I'd like to thank my partner Linda for her support for the duration of this project.

References

Gheorghe, M.V. (2016). Advanced calibration method for 3-axis MEMS accelerometers. International Semiconductor Conference (CAS), 81-84.

RailCorp NSW. (2016). ESC210 - Track Geometry and Stability. Asset Standards Authority.

LoRa-Alliance. (2017). *LoRa-Alliance https://www.lora-alliance.org/*

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Remote Data Acquisition

School of Mechanical and Electrical Engineering

Luke Lloyd

Bachelor of Engineering (Honours) (Electrical and Electronic) and Bachelor of Business (IT)

Supervisors: A/Prof Alexander Kist, USQ

*Keywords:* Remote, IoT, LoRa, Arduino, Raspberry Pi, sensor

1. Introduction

Traditionally, telecommunications infrastructure has been cited as a barrier to agricultural innovation, but with the growth of the Internet of things (IoT) industry, these problems are beginning to be solved through low powered, low cost sensor nodes. This project focuses on implementing a data acquisition system that operates in a remote environment with no telecommunications or power infrastructure. It comprises of low cost, low powered sensors that collect and transmit sensor data over long distances to a gateway which uploads sensor data to the cloud for viewing.

2. Background

The world population is increasing, including demographic changes in global income and increased dietary standards, furthermore increasing climate uncertainty mean that crop yield increases must be achieved by better resource management. Remote data acquisition and sensor networks enable the measurement of water, temperature, humidity and pH to allow farmers to make better decisions regarding planting, fertilising and harvesting crops in a practice known as precision agriculture (Ferrández-Pastor et al. 2016). Current remote data acquisition methods involve storing data for later manual retrieval and real-time transmission of remote sensor data via satellite and mobile networks based on proprietary systems.

3. Methodology

The prototype was designed with a Raspberry Pi base station that has capability to receive sensor data from up to 20 nodes simultaneously and upload data to the cloud platform ThingSpeak. Each node is comprised of a battery powered Arduino microcontroller and an RFM95W 915Mhz LoRa transceiver module which transmits sensor data to the gateway. The gateway is situated at a location that has access to power and
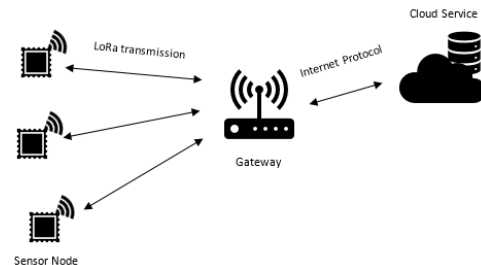
Figure 1 – Remote data acquisition schema

telecommunications infrastructure. Figure 1 outlines the physical schema of the remote data acquisition system.

4. Key Outcomes

The outcomes for this project are a remote data acquisition system that can retrieve sensor data in fields with no telecommunications or power infrastructure and that is low cost, to increase consumer interest (Thomas et al. 2016) and can upload data to the cloud for viewing.

5. Further Work

Further work is required to receive sensor data consistently at distances greater than 2km, implement power saving features to further reduce energy consumption of the Arduino microcontroller.

6. Conclusions

This project scalability is dependent on the gateways capability of how many nodes it can communicate with. Furthermore, energy consumption is largely dependent on node transmission intervals and therefore a compromise between transmission distance and energy consumption must be arrived at. This project is a low cost, open source solution that can be implemented by people who want to invest time developing a system to meet a specific need.

Acknowledgements

References

Ferrández-Pastor, F, García-Chamizo, J, Nieto-Hidalgo, M, Mora-Pascual, J & Mora-Martínez, J 2016, 'Developing Ubiquitous Sensor Network Platform Using Internet of Things: Application in Precision Agriculture', *Sensors*, vol. 16, no. 7, p. 1141.

Thomas, D, McPherson, R, Paul, G & Irvine, J 2016, 'Optimizing Power Consumption of Wi-Fi for IoT Devices: An MSP430 processor and an ESP-03 chip provide a power-efficient solution', *IEEE Consumer Electronics Magazine*, vol. 5, no. 4, pp. 92-100.

Passive Vacuum Distillation – Automatic Process Control

Sponsor – School of Mechanical and Electrical Engineering

Steven Loakes

Bachelor of Engineering (Honours) - Mechatronics

Supervisors: Mr Andreas Helwig

*Keywords:* Passive Vacuum Desalination,

1. Introduction

In many parts of the world, sustainable freshwater resources are insufficient to support existing human usage. Water stress will become more severe and widespread with increasing global population and improving living standards in parts of the developing world. One of the potential means of meeting future water needs is seawater desalination.

2. Background

The objective of this project is to design an electro-mechanical controls system appropriate for autonomous operation of PVD plant

Passive Vacuum Distillation (PVD) refers to the distillation of fresh water at low pressure and relatively low temperature. A vacuum is established in both an evaporator and condenser vessel, each of which sit above a tall column of water ($\approx$10m). Seawater flows into the device under the influence of atmospheric pressure while concentrated brine and fresh water flow out of the device under the influence of gravity. A temperature gradient of $30 - 50°C$ is required to drive the distillation process, this can be established using solar thermal collectors and a heatsink such as the ocean.
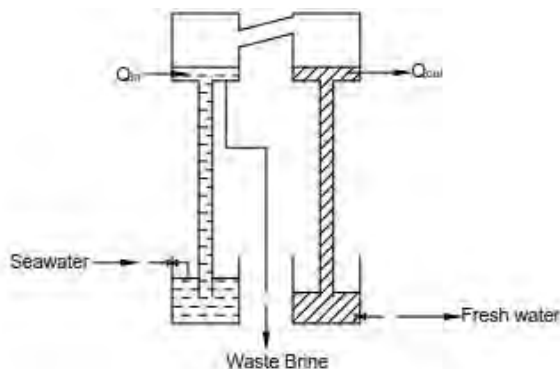
Figure -1 Basic PVD Configuration

3. Methodology

As there are not yet any productive examples of PVD plant in operation it is first necessary to determine a model configuration which would best satisfy real world requirements. A conceptual design process including control system was undertaken to produce a system that could potentially operate successfully. Control systems design considerations were:

- Operational Safety Analysis
- Sensors & Actuators
- Controller programming

4. Key Outcomes

- Selected a plant combination optimised for longevity and complexity.
- Evaluated a low cost pipe based configuration.
- Design Development of an automatic controls system

5. Further Work

- Utilise CFD tools to evaluate the performance of linear evaporator setup.
- Explore the potential applications of phase change energy storage
- Further develop the control system architecture for modular expansion of plant and multi-stage arrangements.

6. Conclusions

Sustainable solutions for desalination are needed at both the large and small scales to meet future needs. This project partly addresses the challenges to deployment with solutions for autonomous operation and the selection of appropriate technology.

Acknowledgements

References

Al-Kharabsheh, S. & Goswami, D. Y., 2003. Theoretical analysis of a water desalination system using low grade solar heat. s.l., s.n., pp. 279-285.

Kalogirou, S. A., 2005. Seawater desalination using renewable energy sources. Progress in energy and combustion science, Volume 31, pp. 242-281.

Shah, M. & Strong, M. F., 2000. Food in the 21st century: from science to sustainable agriculture. s.l.:World Bank Publications.

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Optimisation of Wear Resistance of Non-metallic Wear Parts in Pumping Components

Faculty of Health, Engineering and Science

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Bachelor of Engineering (Honours) (Mechanical) Bachelor of Business

Supervisors: Dr. Steven Goh, USQ

Mr. James McDougall, ITT PRO Services

Keywords: non-metallic material, tribology, testing, bearing, pumping, wear, efficiency.

1. Introduction

The project sponsor, ITT ProServices is considering optimising wear resistance in non-metallic wear parts in pump components. As such they have requested the undertaking of the research project on wear and tribology and the results of this investigation will be used to select suitable non-metallic materials to be used in pump components.

2. Background

ITT ProServices is a fully integrated pump service provider, with a full portfolio of premier industrial products complementing a range of high-end pumps for high profile organisations. This study will aim to investigate optimum materials for vertically oriented pumps which would improve pump efficiency thereby giving ITT a competitive advantage in the aftermarket. This project will give a better understanding of the performance of non-metallic components in dry running applications.

3. Methodology

The methodology used in the research project is the Ashby Methodology. After reviewing literature on different potential materials, a methodology needed to be identified to help select the material that had the most attributes towards the goals of the project. The Ashby methodology has four main steps to follow the selection process, which are; translation, screening, ranking and supporting information. Please see Figure 1. for material selection chart.
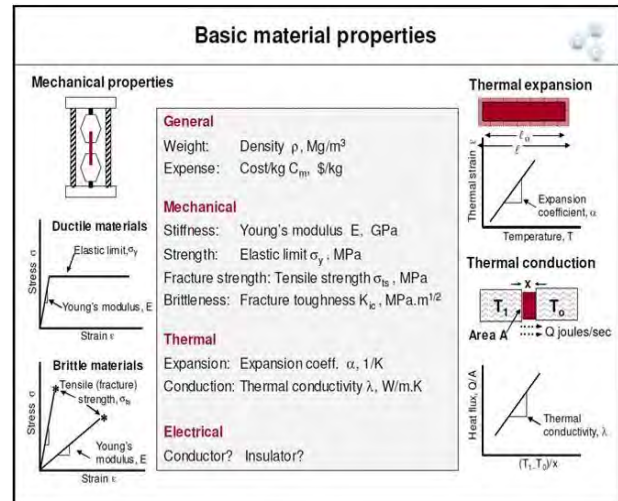
(Ashby, 1999) Figure 1 – Basic Material Properties

4. Key Outcomes

So far by employing the methodology for material selection, potential materials to meet the intended outcomes have been identified. The identified materials for testing are Green Tweed AR1, Vesconite Hilube, Mikasa F. F. Bearings and Dupont Vespel. Currently the project is at the point of waiting for material manufacturers/ suppliers to supply sample materials so that testing can commence.

5. Further Work

Test bay is almost complete whilst waiting for material samples for testing. After testing, results plotting and evaluation still need to be done.

Acknowledgements

I would like to thank ITT ProServices for giving me that opportunity to undertake and sponsoring this project. I would also like to thank James McDougall, for the support through the whole project. And mostly I would like to thank my supervisor, Dr. Steven Goh, for all his help and guidance throughout the project.

References

Ashby, MF 1999, Materials Selection for Mechanical Design

Finite element simulation of a Sustainable Hybrid Sandwich Panel under bending using Strand7

School of Civil Engineering and Surveying

Brett Maguire

Bachelor of Engineering Honours

Supervisors: Prof Yan Zhuge

Keywords: FEM, Hybrid sandwich panel, adhesive

1. Introduction

With a society driving the need to use more sustainable construction materials; research was undertaken by Jauhar Fajrin for the development of a hybrid sandwich panel technology. The project investigated the use of natural fibres as a layer between the core and thin sheet material to increase the flexural capacity of panels. This project developed a finite element model to gain better understanding of the failure mechanism of the panel and optimise the behaviour.

2. Background

Sandwich insulation panels have become increasingly popular due to their light weight and strength under bending. The panels are easily constructed in comparison to alternative structural materials and options on the market. Understanding the analytical behaviour of panels with an intermediate layer under loading provides future engineers with the confidence to design more efficient sandwich structures.

3. Methodology

The project has been broken into three stages, summarised below;

1. A detailed literature review into the failure of adhesive and other materials that makeup the panels.

2. Building of the models in strand7, including the adhesive layer and running of the non-linear finite element analysis.

3. Present the Strand7 analytical results with the experimental work completed by Jauhar.
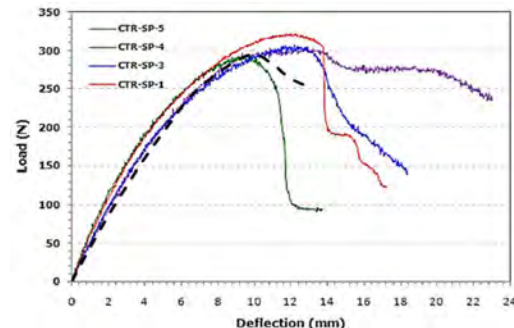
Figure 1 - FEM results compared to experimental results

4. Key Outcomes

The adhesive plays a significant role in the failure of these panels, the outcome of this research is to determine the behaviour of adhesive under bending and hence determine a defined failure load of the panel in Strand7.

5. Further Work

Once a defined failure load of the panel has been established, a parametric study could be undertaken to optimise the hybrid sandwich panel design.

6. Conclusions

Analysing the different types of panels in Strand7 and collecting the data has provided adequate proof that the analytical work matches the experimental work undertaken by Jauhar. This knowledge will enable engineers to design efficient sandwich structures.

Acknowledgements

References

Fajrin, J 2013, *'Sustainable Hybrid Composite Sandwich Panel with Natural Fibre Composites as Intermediate Layer'*, Research thesis, University of Southern Queensland, Toowoomba.

Ignjatovic, M 1998, *The yield behaviour of a structural adhesive under complex loading* / Mladen Ignjatovic, Peter Chalkley and Chung Wang, DSTO Aeronautical and Maritime Research Laboratory

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Evaluation of Trimble Active Targets with an obstructed line of sight

School of Civil Engineering and Surveying

Phillip Marriott

Degree: Bachelor of Spatial Science Honours (Surveying)

Supervisor: Assoc Prof Peter Gibbings, USQ

Keywords: Trimble, Active target, Automatic Target recognition

1. Introduction

This research project was carried out on the basis that there is very little research into Trimble Active targets and focused on two main objectives:

Determine if Active targets are more vulnerable to errors than traditional prisms with automatic target recognition measurements when obstructed.

Determine if it is possible for a Total Station to track a reflection of an Active target and if so can it measure a distance to the reflection.

2. Background

Trimble Active targets are a form of 360 degree target that differ to traditional prism based targets by utilising infrared emitting LED's that are tracked by the Total Station which is claimed by Trimble to eliminate the chances of tracking a false target (Trimble Navigation Limited, 2016).

3. Methodology

The Active targets were tested by setting up a Total Station and taking measurements to each of the unobstructed targets chosen in the testing then setting up a series of obstructions and repeating the measurements to determine the effect the obstruction had on the measurement. This process was repeated using two types of Active target and one regular prism based target over eight different distances ranging between 24 m and 481 m. Figure 1 shows the effect a sheet of 8 mm glass had on distance measurements taken to the three targets.

The false tracking of reflection testing was undertaken by establishing a target and placing a reflective surface that would cause a reflection viewable by the Total Station. The Total Station was then turned to the reflection to determine if it could be tracked and measured to. The search function in the instrument was also used to identify the possibility of the Total Station finding the target in a search.

Figure 1: 8 mm Glass obstruction distance errors

4. Key Outcomes

The obstruction testing found that there is a noticeable difference that Active target technology has on measurements when they are obstructed. Some of the obstructions caused higher errors in some of the measurements but in some circumstances the errors were much less than when measuring to a regular prism.

The reflection testing found that all targets were capable of being measured to with gross errors present and the Active targets being more prone to error.

5. Further Work

Testing the absolute precision of Active targets compared to regular prisms or testing multiple Active targets selected on the same channel to determine their susceptibility to track the wrong target would be useful research.

6. Conclusions

Active targets will maintain tracking better when obstructed and the AT360 Active target was the least susceptible to errors caused by the obstructions. The Total Station can measure to a reflection of all targets tested but was more prominent with Active targets.

Acknowledgements

References

Trimble Navigation Limited. (2016). Robotic Total Stations Brochure. Westminster, Colorado, United States of America: Trimble Navigation Limited.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Reliability of Internal Coordinate Quality Indicator Values for Trimble RTK GNSS measurements

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours) (Surveying) (BSHP)

Supervisor: Assoc. Prof. Peter Gibbings, USQ

Keywords: RTK, GNSS, Internal coordinate quality indicators.

1. Introduction

The use of Real – Time Kinematic (RTK) Global Navigation Satellite Systems (GNSS) within the field of surveying has increased exponentially due to greater access and ease of use. The introduction of Network RTK systems through Continuously Operating Reference Stations (CORS) has contributed greatly to this. Due to the growing dependency on RTK GNSS configurations and for the benefit of the surveying profession, it is important to understand the reliability of these measurements. The Internal Coordinate Quality Indicator values (CQ values) that are generated on the surveyor's controller are designed to reflect the RTK GNNS precisions when conducting field work; through intensive error modelling and estimation, but recent research has brought their reliability into question (Trimble Engineering and Construction Group 2006).

2. Background

This research project will address the absence of technical information related to the formulation of CQ values. The investigation expands upon previous papers produced by Edwards et al. (2010) and Janssen and Haasdyk (2011) that assessed the performances of Network RTK services; by examining both Single – Base and Network RTK GNSS configurations. Whilst placing particular emphasis on logging times and the reliability of these observations.

3. Methodology

Field work was conducted on the observation deck, located on the roof of Z Block (USQ Toowoomba Campus). Two receivers were configured on a modified tribrach arm (see Figure 1.0) and measurements were recorded over a two – day period. The methods established were influenced by both past investigations and the recommended standards and guidelines that have been put forward and adopted by professional bodies (for example, Surveyors Board of Queensland).

Figure 1.0 – Modified tribrach arm configuration.

4. Key Outcomes

Currently, the outcome achieved is the determination that the weighted mean used for TOPO point measurements is not consistent with the arithmetic mean. This finding resulted in the method used to record the two - day dataset being augmented from methods used in past investigations. Further findings will be a result of the comparison of CQ values and the actual precisions.

5. Further Work

This research is limited by testing equipment from only one manufacturer (Trimble), subsequent investigations could include a variety of systems. Additionally, further work may be instigated to develop alternative CQ value generation techniques.

6. Conclusions

Initial findings suggest that increased logging times have a positive influence on the reliability of measurements and CQ values. A clearer determination will be made when the primary dataset is reduced and analysed.

Acknowledgements

References

Trimble Engineering and Construction Group (2006). *Trimble R8 GNSS System: RTK Precisions.* Trimble Engineering and Construction Group. Dayton, Ohio.

Edwards, SJ., Clark, PJ., Penna, N & Goebell, S (2010) An examination of network RTK GPS services in Great Britain. Survey Review, 42(316), 107-121

Janssen, V & Haasdyk, J (2011). *Assessment of Network RTK Performance using CORSnet – NSW.* International Proceedings of the Internal Global Systems Society Symposium. Infrastructure and Geodesy, University of New South Wales.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Road network improvement and maintenance strategy for the Port of Burnie

Sponsor – Tasmanian Ports Corporation Pty Ltd

James Martin

Bachelor of Engineering (Hons)
Major Civil Engineering

Supervisor: Mr Trevor Drysdale, USQ

Keywords: Traffic Study, Port, AADT

1. Introduction

The Port of Burnie, managed by the Tasmanian Ports Corporation Pty Ltd (Tasports), is located on the northwest coast of Tasmania and is the largest general cargo port in the state handling containerised cargoes and most bulk commodities including minerals, forestry and petroleum products while also accommodating visiting cruise ships during summer. Freight volumes through the Port of Burnie are expected to grow in the with the possible reintroduction of international container shipping and growth of forestry exports expected to lead to corresponding increase in traffic volumes on the port's road network requiring a traffic study to develop an understanding of traffic movements.

2. Background

The traffic volumes and movements within the port need to be fully understood to enable the planning of future capital improvements and maintenance works. A traffic study focusing on the port will provide the necessary baseline data for the design of capital improvements to the road network with a thorough understanding of the vehicle types and movements within the port. The study will enable the improvement of the design of future road maintenance projects to ensure the expenditure achieves the most economical results for Tasports.

3. Methodology

The traffic study utilised time lapse cameras to record traffic movements at two key locations on the port road network (Figure 1) from which manual traffic counts were conducted to determine traffic volumes, vehicle classifications, commodities transported and turning movements. Seasonal adjustment factors were derived from historic weighbridge data and cargo volume throughputs which enabled the calculation of Annual

Figure 1 – Congestion at Port Weighbridge

Average Daily Traffic (AADT) which can be used in the assessment of road pavements.

4. Key Outcomes

AADT for the port's main roads have been determined along with an understanding of the turning movements at the ports roundabout, vehicle configurations and distribution commodities transported. Seasonal adjustment factors have determined from cargo volumes and weighbridge data in place of traditional long term traffic data.

5. Further Work

Tasks yet to be completed in the project include the review of road geometry and assessment of the suitability of existing pavements.

6. Conclusions

A traffic study of the port of Burnie road network will provide a baseline for the future development of the port roads as traffic volumes increase with increased freight volumes and new or evolving trade.

Acknowledgements

I would like to thank my employer Tasmanian Ports Corporation for their sponsorship of this project and my colleagues for their assistance with required resources and support.

References

Austroads. (2013). Guide to Traffic Management, Part 3: Traffic Studies and Analysis (C. Han & J. Luk Eds. 2 ed.). Sydney, NSW, Australia: Austroads Ltd.

DSG. (2015). Tasmanian Freight Survey 2014-15 - Data Summary. Tasmanian Government Retrieved from http://stategrowth.tas.gov.au/__data/assets/pdf_file/0004/139504/Tasmanian_Freight_Survey_Report_FINAL_2014_25.pdf.

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Fabric Filter Shaker Drive Crank Assembly Operational Analysis

School of Mechanical & Electrical Engineering / Lendlease Services

John Martin

Bachelor of Engineering (Mechanical)

Supervisors: Mr Andreas Helwig, USQ

Dr Ray Malpress, USQ

Keywords: Fabric Filters, Finite Element Method, Fatigue Life

1. Introduction

Mt Piper Power Station (MPPS) is a 1,400 MW power station located two hours west of Sydney near the NSW country town Lithgow. Since the commencement of operations in 1993 there have been ongoing failures in the fabric filter infrastructure, which has impacted the environmental efficiency of the fabric filter, increased maintenance requirements and subsequent operating costs. A review of the performance of the Howden fabric filter infrastructure located at MPPS, and subsequent application of findings to industry wide fabric filter infrastructure, is the focus of this dissertation.

2. Background

Efficiency of dust removal, as described by Wang et al (2004), is the key consideration in fabric filter design and specifically the shaker drive crank assembly (SDCA), the major fabric filter component responsible for delivering forces to the filtration infrastructure. A series of studies undertaken by Dennis (1975) describe the correlation between the primary loading inputs, including; quantity of shakes per cycle, shaking frequency, shaking amplitude and fabric filter bag acceleration. Understanding the impact of these variables is critical to analysing the existing design and the development of any design recommendations.

3. Methodology

To gain an understanding of the SDCA failures, an analysis of the proprietary design and associated design iterations was undertaken. This involved reviewing the fabrication and quality assurance process, the current maintenance regime and inspection of failed SDCA components. The various designs were then modelled with simulated loading applied. Following this

Figure 1 – Typical SDCA Design Failures

assessment, a root cause of the failures along with contributing factors were identified and used as the basis for proposing design modifications and refinement to the fabrication and quality assurance process.

4. Key Outcomes

Through modelling and stress simulation of the proprietary design and various iterations of this design, the stress raisers apparent in the design have been verified. This has provided the basis for developing a modified design which minimises the impact of the stress raiser.

5. Further Work

The next step is to verify the actual loading conditions and the associated endurance limit, with a view to undertaking further modelling and fatigue analysis to verify the performance of the proposed design/s.

6. Conclusions

Through the application of modern modelling techniques to the SDCA, a potentially more cost effective design can be developed. Further, there is the opportunity to modify the quality assurance process associated with the SDCA fabrication.

References

Dennis, R and Wilder, J.E., Fabric Filter Cleaning Studies, EPA/650/2-75-009, US Environmental Protection Agency, Washington DC, 1975

Wang, L.K., Pereira, N.C and Hung, Y.T., 2004. Air Pollution Control Engineering. Humana Press

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Renewable energy generation using stormwater detention basins

Sponsor – School of Civil Engineering and Surveying

Andrew May

Bachelor of Engineering (Civil)

Supervisor: Justine Baillie, USQ

Figure 1 – example DRAINS model output

Keywords: detention, micro hydro, subdivision

1. Introduction

This project is focused on determining if implementing micro hydro electricity generation at a stormwater detention basin in Toowoomba is a viable form of electricity generation to offset the energy consumption typically required for a residential subdivision.

2. Background

Human society relies heavily on unsustainable fossil fuels for electricity generation and therefore, renewable 'zero emission' technologies need to be considered for electricity generation.

On-site stormwater detention is implemented to mitigate post-development peak stormwater discharge to pre-development rates, usually in the form of a detention basin that require a large surface area.

This project investigates additional opportunities for improved utilisation of the area already required for detention basins, providing a benefit to the community.

3. Methodology

Intensity Frequency Duration (IFD) data was obtained from the Bureau of Meteorology and used to create a DRAINS model for on-site stormwater detention basin design. Historical rainfall data was acquired and used to create hydrographs for inclusion in the model to obtain potential performance of a hypothetical micro hydro power generator based on past storm events. The theorised power generation was compared with assumed energy consumption (e.g. street lights) for a residential development and applicable feedback tariffs to obtain a financial benefit to the implementation of the technology. The financial benefit was compared with assumed capital and operating cost to determine if the implementation of the technology is financial viable over a 20 year period.

4. Key Outcomes

The key outcomes of this project are to determine the potential energy generation of implementing small scale hydroelectricity and compare this with the typical consumption requirements of a residential subdivision. The financial viability of the proposal will be assessed by comparing the financial benefits against costs associated with the proposed works.

5. Further Work

Further work on this project includes finalisation of the stormwater modelling and the cost benefit analysis associated with implementing the technology.

6. Conclusions

This project will determine the energy generation potential of implementing micro hydro and compare the benefits of implementation against costs incurred.

Acknowledgements

References

Australian Government: Geoscience Australia 2016, *Australian Rainfall and Runoff (ARR)*, Australian Government, Canberra, Australian Capital Territory (ACT)

International Energy Agency (IEA) 2012, *Technology Roadmap: Hydropower*, IEA

Queensland Government 2007, *Queensland Urban Drainage Manual (QUDM)*, Queensland Government, vol. 1, 2nd edn, Brisbane, Queensland

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Investigation into the effects of microwave drying soil for moisture content testing

Sponsor – School of Civil Engineering and Surveying

Jessica McDonnell

Bachelor of Engineering (Honours) (Civil)
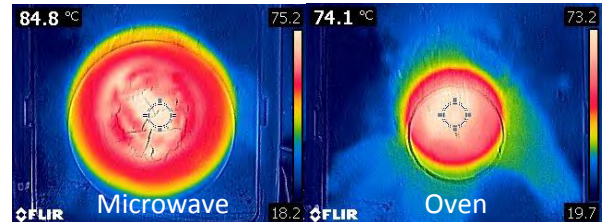
Supervisor: Dr Habib Alehossein, USQ

Figure 1 – Heat Distribution within a clay sample from both microwave and oven heating (McDonnell, 2017)

Keywords: microwave oven, soil, moisture content

1. Introduction

Soil moisture content has various applications within the planning, construction and agricultural industries. It is of particular importance in geotechnical engineering testing and applications as the compaction characteristics and engineering properties of the soil are greatly influenced by the moisture content. One widely accepted method that is used to determine soil moisture content is the Oven Drying Method, this method is often used in engineering testing and applications due to its reliability. However, one of the major disadvantages of this method is the time required for heating. Microwave oven technology not only has the potential to increase the efficiency and time of heating but can assist in reducing the energy and cost of running the heating processes. This dissertation focuses on the effects that microwave oven heating has on the moisture content of soil and aims to optimise the effects of microwave drying to improve the reliability of the process for application within the industry.

2. Background

It is important to explore alternative processes for moisture content testing to improve time and cost efficiencies in application. Existing knowledge is built on by investigating the effects of the microwave heating process on specific soil types. The increased efficiency of microwave oven drying can speed up testing processes thus reducing costs of laboratory tests. The increase in resource efficiency due to the reduced time, energy and labour of the microwave oven drying method will increase its desirability within practice.

3. Methodology

Using the methods outlined in the Australian Standards, the properties of the soils will be determined and classified. Microwave testing will be conducted on multiple soil types and thermal images will be recorded. To determine the accuracy of the microwave testing methods the standardised oven drying method will be used for comparison.

4. Key Outcomes

Upon completion of this paper relationships between the microwave heating process and soils will be identified and recommendations will be provided to improve the reliability of the process.

5. Further Work

During the time of writing experimental testing and analysis of results are currently underway. If time persists modelling of the heat distribution will be conducted.

6. Conclusions

Initial microwave oven testing has identified differences in comparison to the oven drying method. Further work will be completed to identify key relationships and to provide recommendations.

Acknowledgements

References

Gaspard, KA (2002), *Rapid drying soils with microwave ovens*, Louisiana Transportation Research Center, Louisiana

Gilbert, PA (1988), *Computer controlled microwave oven system for rapid water content determination,* US Army Corps of Engineers

Perez-Foguet, A & Huerta, A (1998). *Modelling microwave drying of soils*, Technical Report No. MA. 009

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Analysis of Engineered Cementitious Composites for Grouting Reinforcement to Concrete Members

Sponsor –School of Civil Engineering and Surveying
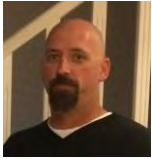
Chris McEvoy

Bachelor of Engineering
(Hons) - Civil

Supervisors: Yan Zhuge, USQ

Buddhi Wahalathantri, USQ

Keywords: Engineered cementitious composites (ECC), Near surface mounted (NSM), Fibre reinforced polymers (FRP).

1. Introduction

Extending the operational life or improving capacity of concrete structures not only makes sense but is an environmentally sound practise as well. The strengthening or rehabilitation of deteriorated concrete sections can be achieved by adding additional reinforcement. This paper examines the role the binder material plays in the near surface mounting of fibre reinforced polymer bars.

2. Background

Recently, FRP products are being retrofitted to RC members due to their high tensile strength and resistance to harsh environmental conditions. In order to gain the full benefit of this material, the grout which binds the bar to the existing concrete must be able to handle the stresses involved. This raised the following questions for the researcher:

- What grout mixture should be used;
- Are some alternatives susceptible to a colder curing environment?

3. Methodology

Multiple sets of samples were prepared with a specific ECC mixture and a standard cement-sand grout used to bond FRP bars to grooved concrete blocks. 1 set of each binder material was cured under normal conditions while a second set of ECC specimens was cured at a constant 2.8°C.
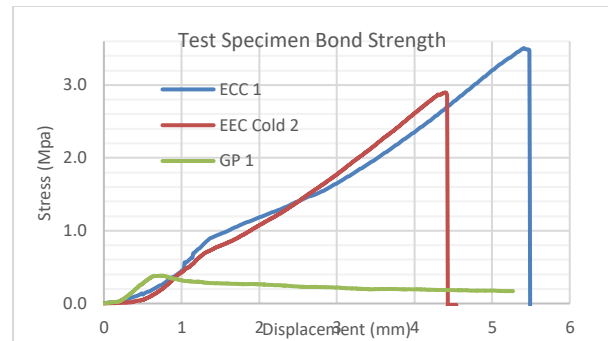
Pull-out tests were conducted in order to determine the tensile load required to cause bond failure. The type of failure was also noted for further analysis. Stresses experienced by one specimen from each set are shown in Figure 1.

Figure 1 – Bond Strengths

4. Key Outcomes

Analysis of gathered data so far reveals the ECC specimens achieved a much higher bond strength that the standard cement-sand specimens, i.e. approximately 9 times greater. ECC samples cured at a significantly lower temperature reached 92.6% of those cured in normal conditions. Cracking of some concrete members may have contributed to specimens failing prematurely.

5. Further Work

Development of a predictive model is ongoing.
Recommendations for additional future research include:

- increased sample size and concrete strength;
- curing of specimens at temperatures just slightly below and above 0°C;
- Extended exposure to harsh conditions e.g. a high salt environment.

6. Conclusions

ECC mixtures were not as effected by curing temperature as was expected. Additional consideration of results is required before further conclusions are made.

Acknowledgements

References

De Lorenzis, L. & Teng 2007, 'Near-surface mounted FRP reinforcement: An emerging technique for strengthening structures', *Composites Part B: Engineering*, vol. 38, iss. 2, pp. 119-143

Ceroni, F., Pecce, M., Bilotta A. & Nigro, E.2011, 'Bond behavior of FRP NSM systems in concrete elements', *Composites Part B: Engineering*, vol. 43, iss. 2, pp. 99-109.

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Own investigation into the shortage of Registered Land Surveyors in New South Wales

Sponsor – School of Civil Engineering and Surveying

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Bachelor of Spatial Science Honours Surveying Major

Supervisors: Miss Jessica Smith, USQ

Keywords: Shortage, aging, change.

1. Introduction

The objective of the dissertation is to ascertain whether there is currently a shortage of registered land surveyors in New South Wales. It will attempt to determine what is causing the shortage, what the implications of the shortage are and what the shortage means for existing surveyors. In an attempt to alleviate this problem, this dissertation will include recommendations, which will be given to the Board of Surveying and Spatial Information of New South Wales (BOSSI).

2. Background

The registered surveyor population is aging. In 2016 the average age of the 917 registered surveyors was 53 years old, with over 130 already beyond the retirement age of 65 and more than 175 will be at retirement age in the next 5 years (Spiteri, 2016).

The shortage of registered land surveyors could have a devastating impact on the construction industry. A decline in numbers could lead to longer project times, increased costs and decreases in productivity for individuals, companies & even the NSW Government.

3. Methodology

In order to gain a snapshot on the surveying industry I intend to gather a range of data from surveying professionals who are currently working in the surveying industry. This data will predominantly come from a questionnaire I have developed, reports & papers, interviews and personal communication from professionals in the industry. The methodology will be both qualitative, where I will be using direct data from my results and quantitative, where I will be using key words, excerpts and any trends that may exist in my data.
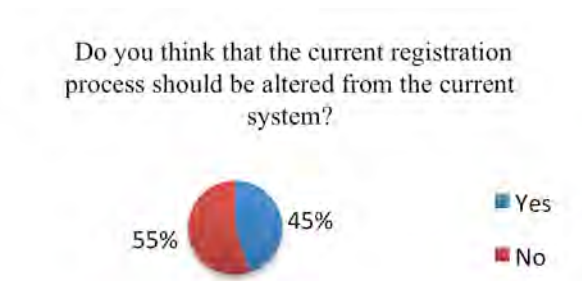
Figure 1 – Changing the Registration Process

4. Key Outcomes

The questionnaire produced some interesting results and trends. The overall results revealed that 61% of respondents intended on becoming registered in the future, yet only 44% were current financial candidate surveyors and only 33% had completed one or more board examinations. As displayed in figure 1, 45% of respondents revealed that they think the current registration process should be changed. With 63% of unregistered surveyors supporting a change. While 21% of unregistered surveyors wouldn't recommend a career in surveying compared to 5% of registered surveyors.

5. Further Work

Further work could be done on re-educating the public on the importance of surveyors in the community

6. Conclusions

The statistics above reveal that there are surveyors out there who want to become registered; yet the current registration process seems to be stalling them. There also appears to be some dissatisfaction in the industry, mostly amongst the unregistered surveyors.

Acknowledgements

I would like to thank my supervisor, Jessica Smith for all of her help throughout the project.

References

BIS Shrapnel 2015, *Determining the Future Demand, Supply and Skills Gap for Surveying and Geospatial Professionals: 2014 – 2024*, BIS Shrapnel for Consulting Surveyors National, Retrieved 12 September 2016.

Spiteri, M (2016), *BOSSI Statistical Review 2015-2016*, Board of Surveying and Spatial Information of NSW, Retrieved 12 September 2016.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Quantisation of Coal Slot Bunker Contents

School of Mechanical & Electrical Engineering

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Bachelor of Engineering
(Electrical & Electronic)

Supervisors: Dr Les Bowtell, USQ
              Mr David Bell, CS Energy
              Mr Mirza Salama, CS Energy

Keywords: Coal Power Station, Coal Slot Bunker, Control System.

1. Introduction

CS Energy is a government-owned corporation, holding a mixed portfolio of plant and energy market assets across Queensland. Callide Power Station (B&C) has a total generating capacity of 1,510 MW. The on-site slot bunker is a key tactical asset providing four days of active storage supply for Callide (B&C) boiler units. The research project has been scoped to address the internal control and measurement system that determines the real-time contents of the bunker.

2. Background

There have been recent incidents of spontaneous combustion of stored coal, which interfere with plant operation and create unsafe environments. Attempts to address the uncertainty of fluid dynamics and system accuracy have failed to return conclusive findings.

The current measurement system employed within the sloth bunker returns 17 numeric values for each side of the bunker via a 4-20mA control system. Alternative systems provide 3D representations of the volumetric contents however fail to provide useable data.

3. Methodology

This project focuses on the initial development and fundamental operation of an operational system to accurately quantise the volumetric contents of the slot bunker. A scaled model of the bunker was constructed, with a motor and stepper-drive to simulate the operation of an overhead tripper. One ultrasonic probe and one thermal probe were driven along the centre axis of the model to confirm small-scale operation.

Please see Figure 1 for cross-section of slot bunker.
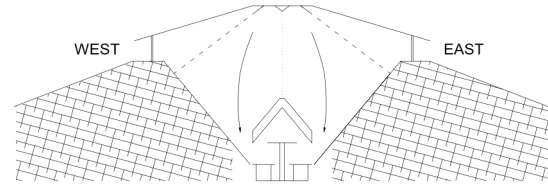
Figure 1. Longitudinal plane of Callide Slot Bunker identifying coal flow.

4. Key Outcomes

The testing phase of this project was extended due to complications with PLC operations, however sensor movement suggests test results should be confirmed before next week; both level and temperature data sets.

5. Further Work

This project has established an opportunity for further development with the intent of designing a marketable product that will add value to the coal power industry. There is very little academic work concerning coal slot bunkers and there is much to be learned and verified around the management of such a strategic asset. Electrical, mechanical, and chemical engineering disciplines can each go further into this niche area.

6. Conclusions

The major conclusion from this research project is that it is possible to quantise the contents of a coal slot bunker from ultrasonic and radiometric sensors traversing an overhead path. It has demanded multidisciplinary knowledge and incorporates a broad range of electrical & electronic applications, presenting many opportunities for further design and innovation.

Acknowledgements

References

VASEL, R., KEMPER, G., SCHUHMANN, R. & KÖNIGER, F. 2008. New Airborne Thermal Infrared Photogrammetric Applications and Sensors for Moisture Detection The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.

TAYLOR, R. & SHIRVAIKAR, M. Performance analysis of range sensors for a real-time power plant coal level sensing system. 2010 42nd Southeastern Symposium on System Theory (SSST), 7-9 March 2010, 188-193.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Performance of Water Sensitive Urban Design Bioretention Systems on the Gold Coast

Faculty of Health, Engineering and Sciences

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Bachelor of Engineering (Civil)

Supervisors: Dr Antoine Trzcinski, USQ

Keywords: Bioretention, field, performance

1. Introduction

Bioretention systems are a Water Sensitive Urban Design technique used to manage and treat stormwater runoff and protect urban infrastructure and aquatic ecosystems. They involve a basin where stormwater collects and is filtered through dense vegetation and a filtration layer, reducing sediments and contaminants and slowly releasing runoff into stream systems. This research project investigated existing bioretention systems on the Gold Coast to discover trends in design, construction and maintenance that were affecting their performance.

2. Background

When used appropriately, bioretention systems provide effective treatment of stormwater quality. Poor outcomes can still result however due to design, construction and maintenance practices. This study aimed to investigate whether these practices were ensuring that design objectives and performance outcomes were being achieved.

3. Methodology

Bioretention systems on the Gold Coast were identified from City of Gold Coast and privately owned assets. Catchment areas were defined for each system. Field testing of each asset included taking measurements, inspecting inflow and outflow regimes, quantifying vegetation coverage and testing soil hydraulic conductivity using the single ring infiltrometer procedure pictured in Figure 1. Field data was collected in GIS software and modelled using MUSIC software to determine whether water quality performance objectives were being met.

4. Key Outcomes

The research into field performance of bioretention systems on the Gold Coast indicated that the majority of systems were not meeting water quality performance objectives. Lack of vegetation coverage within the

Figure 1 – Single ring infiltrometer test procedure (FAWB 2009)

system was a common issue affecting performance of the systems.

5. Further Work

Further work could involve taking water samples at inlet and outlet for water quality testing and comparison with modelling results. While the research addressed water quality objectives, water quantity objectives could also be studied.

6. Conclusions

It was found that bioretention systems on the Gold Coast were not achieving field performance in line with their design and performance objectives. While general maintenance of systems was being carried out to remove gross pollutants and weeds, vegetation coverage and performance levels had not been maintained. Monitoring programs as well as maintenance programs for bioretention systems could help to ensure that design levels of water quality treatment continue to be achieved during the asset life.

Acknowledgements

References

City of Gold Coast, *City Plan Version 3,* 2016, CoG Coast, City of Gold Coast, Gold Coast, QLD.

FAWB 2009, *Stormwater Biofiltration Systems Adoption Guidelines*, Planning, Design and Practical Implementation, Monash University, Melbourne, VIC.

Water by Design 2014, *Bioretention Technical Design Guidelines (Version 1.1)* Healthy Waterways Ltd, Brisbane, Brisbane, QLD.

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An Investigation into harvesting electrical energy from plants through the Rhizo-deposition process in Australian environmental and climatic conditions

Sponsor –School of Mechanical and Electrical Engineering

Stuart Miles

Master of Engineering Sciences (Power Engineering)

Supervisors: Mr Andreas Helwig, (Electro-Mechanical Engineering) USQ

Keywords: Rhizo-deposition, Plant Microbial Fuel Cells(PMFCs), Bio-electrochemical System(BES).

1. Introduction

Renewable energy technologies are being increasingly integrated into social, commercial and governmental life. The development of solar, wind, hydro, geothermal, ocean and bio energies will cause major reductions in traditional power generation, providing a more sustainable future. This may prevent the further degradation of the planet, by reducing our "uneven footprint of human consumption and related environmental impacts." Drigo et al (2009).

2. Background

A BES is considered to be a Microbial Fuel Cell (MFC) if electrical energy is harvested from it. Relatively small amounts of energy can be harvested through the Microbial processes as a result of Photosynthesis and Rhizo-deposition operation. Improving the efficiency of this electron harvesting process is the basis of the research project.

3. Methodology

By constructing battery cells it is proposed to produce electrical output at low levels. Each cell comprises of a tray, containing Titanium wire for anode and cathode, a growing medium, a plant species, a polymeric membrane filter and Carbon Felt inert electrode. The project was not aimed to out-perform renewable technologies, but to investigate outputs from <1 m^2 PFMCs and compare these results. This may determine if proportionally, PFMCs can deliver a cost effective addition to renewable technology.

4. Key Outcomes

There are four main factors affecting the operational efficiency of the cell; Plant health, solar radiation,
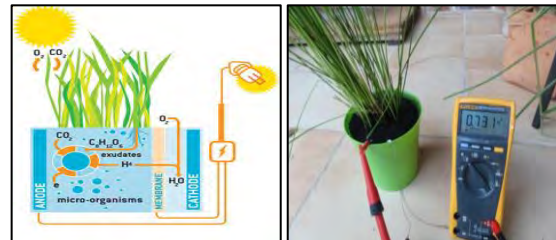
Figure 1 - Model of a plan Microbial Cell. Courtesy of Strik D, et al 2008. Early experiment results of 0.731 V output from Australian native plant Juncus Usitatus.

Temperature and root density. By altering the characteristics of the cells, these factors have been as practicably optimised in order to achieve a hierarchy of goals; light a low power LED, light a number of LEDs, charge a LV battery, running a two-tier pond system

5. Further Work

To this point in time, the output current has limited the successful completion of the Project goals. Continuing steps are being taken in order to increase the current levels.

6. Conclusions

Interpreting the results and measurements of the PMFCs, only low levels of power are generated. From the six month recording period of power output, it can be deduced that if a larger scale with correct plant species and condition were implemented, PMFCs could be practically developed and further explored. There are apparent difficulties with the existing small scope of the project and some of the materials used are expensive in terms of supply logistics and availability.

Acknowledgements

References

Drigo, B. et al. (2009). Shifting carbon flow from roots into associated microbial communities in response to elevated atmospheric CO2. PNAS June 15, 2010 107, No. 24 10938-10942.

Strik, D.P.B.T.B. et al. (2008) Renewable sustainable biocatalyzed electricity production in a photosynthetic algal microbial fuel cell (PAMFC). Appl. Microbial. Biotechnol. 81, 659–668.

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Solar thermoelectric generation in a vacuum with water cooling

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering
(Honours) (Mechatronic)

Supervisor: Andreas Helwig, USQ

Keywords: Thermoelectric power generation, solar, vacuum.

1. Introduction

The project seeks to establish the performance characteristics of a typical commercially available bismuth telluride (Bi_2Te_3) thermoelectric generator (TEG) under various conditions when exposed to solar radiation. Where the TEG operates by generating an electrical potential when a temperature differential is established across the two main surfaces, the intent is to investigate various methods to increase the temperature differential and therefore, power generated.

2. Background

Examining alternative energy sources is a critical part of transitioning from CO_2 intensive technologies to more sustainable options. TEG technology has been around since the 1950s however, inherent inefficiencies in their lattice superstructure has made their application in power generation limited. Recent advancements in materials technology at the nano-scale has mitigated some of these problems by improving device thermal characteristics with high-performance nanostructured materials and the use of a vacuum to limit convection losses (Kraemer et al., 2011).

3. Methodology

Research was carried out to determine which techniques could be applied to a TEG to improve power generation under solar conditions. The following elements were chosen for further investigation:

- Vacuum conditions
- Water cooling
- Optical concentration

A basic test unit was built (Figure 1) and its performance characteristics were examined with and without vacuum conditions. The test was repeated where the passive
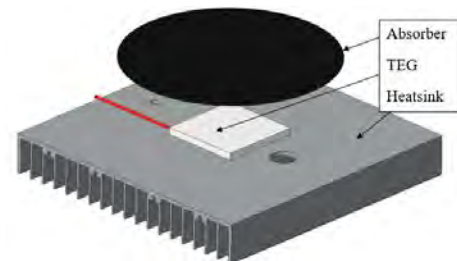
Figure 1 – TEG test unit with passive heatsink Diagram

heatsink replaced with a water-cooled unit. Optical concentration through a Fresnel lens was applied to the water-cooled unit. Hot and cold-side temperatures, voltage, current and power measurements were taken and recorded using a datalogger. The datalogger was built using an Arduino prototyping platform with thermocouples and current monitoring sub-systems.

4. Key Outcomes

Research shows that hot-side temperature can increased by using a vacuum (2×10^{-1} Pa). The water-cooled heatsink was better able to keep a low cold-side temperature and therefore saw a better response in power generation.

Solar optical concentration significantly increased the power generation potential. The difference between vacuum and non-vacuum conditions was less pronounced.

5. Further Work

Large scale tests are required to evaluate TEG solar systems at levels that are practical for real world systems.

6. Conclusions

This research shows that TEG systems are providing a promising option for solar generation power systems and previous limitations are being overcome with advanced manufacturing techniques.

Kraemer, D., Poudel, B., Feng, H.-P., Caylor, J. C., Yu, B., Yan, X., Muto, A. (2011). High-performance flat-panel solar thermoelectric generators with high thermal concentration. *Nature materials, 10*(7), 532-538.

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Electronic GateMate

Sponsor - School of Mechanical and Electrical Engineering

Steven Morris

Bachelor of Engineering (Honours) (Electrical and Electronic)

Supervisors: A/Prof Alexander Kist

Keywords: IoT, LoRa, Arduino, Raspberry pi

1. Introduction

The concept of the Internet of Things (IoT) is to connect everything to the internet for the purpose of sensing the physical environment, controlling 'things' and gathering data.

This project seeks to investigate the concepts of remote sensing, long range radio technology and the IoT to solve an issue Origin Energy is having with accessing assets located on rural properties.

2. Background

Origin Energy currently performs production operations in the Surat Basin, QLD. These operations consist of many gathering and pipeline assets located on privately owned rural properties which need to be accessed for routine activities. An issue has been identified in which many gates are left in the incorrect state, either opened or closed resulting in the unintended restriction or allowing of cattle movement across the property. This not only impacts Origin through the payment of compensation to land holders to repay mustering costs and the like, it also on impacts the relationships Origin has with the land holders it works with. A solution is required to remotely monitor the state of these gates to allow operations staff to proactively reduce these incidents.

3. Methodology

The methodology used for the project was to identify possible solutions and technologies available, develop a system to sense the gate, utilise long range wireless technology to transport the sensed data and build an application to allow the data to be made useful. The system was then tested to confirm the system operation and identify any areas for improvement.

Figure 1 – Electronic GateMate End Node

4. Key Outcomes

The system uses the LoRa radio technology to communicate between the gate end node and the network gateway. Field testing confirmed that this is can be feasibly achieved up to a range of 15km. With the use of a high gain antenna this was extended out to 26km. The method used to sense that gate has gone through an iterative design, build, test cycle and uses a calculated magnetic heading to sense the gate state

5. Further Work

Further work is required to strengthen the reliability of the data transmission with some error checking and acknowledgement tasks and to also improve the application to allow users to view and utilise the data effectively

6. Conclusions

This project has been able to quantify the issues that Origin has been having with property access gates. A feasible solution to the problem has been identified with the Electronic GateMate.

References

Murphy, F, Popovici, E, Padraig, W, Magno, M, Foote, K, 2015, *Development of a Heterogeneous Wireless Sensor Network for Instrumentation and Analysis of Beehives,* IEEE, pp. 346.

Petajajarvi, J, Mikhaylov, K, Pettissalo, M, Janhunen J, Iinatti, J, 2017 *Performance of a low-power wide-area network based on LoRa technology: Doppler robustness, scalability and coverage*, International Journal of Distributed Sensor Networks, vol 13, no 3.

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Real-time strategy game control for Mobile Robots

Sponsor – School of Mechanical and Electrical Engineering

Joshua Muhldorff

Bachelor of Engineering Honours (Mechatronic)

Supervisor: Tobias Low

Keywords: Robotics, Control, Unity

1. Introduction

This project aims to explore the potential of Real-time Strategy Game Control for Mobile Robots. This will be accomplished by developing a program to run a visual input (Xbox Kinect Sensor) through an existing game engine (Unity). A testing process will then be undertaken as the research component of the project to determine the success.

2. Background

'Real-Time Strategy Game Control for Mobile Robots' is a faculty offered project at the University of Southern Queensland with the intent of filling the gap in literature around navigation of mobile robots in remote and limited access locations with the utilisation of strategy game control.

While technology has made great advances in recent times there is still many applications where mobile robots are required, but are limited in control and situational awareness due to a lack of a reliable wireless networks, with and adequate bandwidth, where mobile robots are frequently needed. This project aims to help reduce the limitations of mobile robots.

3. Methodology

The methodology for the project involves a large development stage where a code is developed to present information from the Xbox Kinect input, shown in figure 1, through the Unity game engine. From this stage the testing and research criteria can be covered by assessing the success of the code.

In the code development stage, the depth map from the Kinect sensor is to be captured through unity. This will provide information of objects locations in a 3-Dimensional manner where colours represent depth. Methods will be used to transform this to a basic top down view, presenting obstacles as blocks at their

estimated position. The colour image from the Kinect sensor will be disregarded for simple environments but utilised in more complex situations.

Figure 1 – Xbox Kinect Sensor

4. Key Outcomes

Key outcomes of the project are all in the development of the code. While the project is incomplete at this stage, major milestones include successful integration of the Kinect sensor to Unity, isolation of a floor to be removed as an obstacle and initial identification of object distances.

5. Further Work

An element that can be addressed from the project through further work is applying the system to a mobile robot for further development and testing.

6. Conclusions

At the current stage of the project conclusions are yet to be reached. Upon completion of the code development it is expected conclusions will be reached in regards to the success of using a game engine as a control method for mobile robots.

Acknowledgements

References

Bartneck, C., Soucy, M., Fleuret, K., & Sandoval, E. B. (2015). *The robot engine - Making the unity 3D game engine work for HRI.*

Cook. *Mobile Robots: Navigation, Control and Remote Sensing*: John Wiley & Sons Incorporated.

Tzafestas, S. G. (2014). *Introduction to mobile robot control* (First ed.). Waltham, MA: Elsevier.

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Uniformity and energy use of Australian lateral move irrigation machines

Sponsor – CRDC & National Centre for Engineering in Agriculture.

Benton Munro

Bachelor of Engineering (Honours) (Agricultural)

Supervisors: Dr Joseph Foley, USQ

Keywords: lateral move, application uniformity, energy consumption.

1. Introduction

Lateral Move (LM) irrigation machines, common throughout the Australian cotton industry, are typically pressurised by a supply pump coupled to a diesel engine mounted on the pump cart of the machine. This hydraulic system is governed by both the pump performance and engine power curves.

2. Background

The aim was to investigate the effect that engine speed has on both the irrigation performance of a LM (application uniformity) and the energy consumption; and to determine if a relationship exists between both. This was done in an attempt to aid growers in better managing their LM machines.

3. Methodology

Field tests were conducted at several different engine speeds for each LM machine. Emitter flow rates were measured using an electromagnetic flow-meter while the total discharge was measured using a portable clamp-on transit-time ultrasonic flow-meter. Pressures at the pump and along the machine were measured using hand held pressure gauges, including a vacuum gauge for the suction manifold. Brass tees and valves were fitted to the engine fuel lines to allow for measurement of the diesel consumption rates at each engine speed. Finally, an automatic level was used to conduct field profile surveys at the approx. positions of each field test. The analysis consisted of determining the Christiansen's coefficient of uniformity (CU), pump operating points, system energy lines, including plots of CU against fuel consumption rates, emitter flow rates and fuel consumption against machine flow rate.
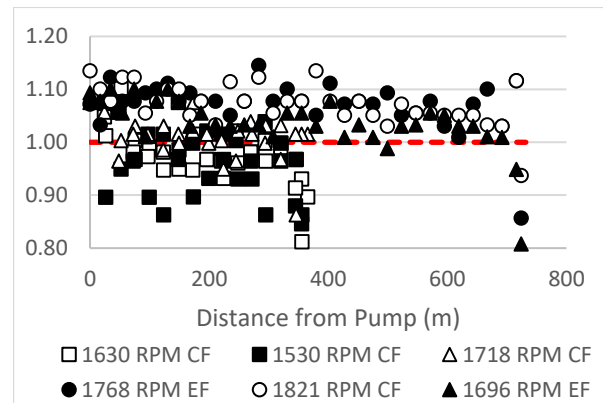
Figure 1 – Emitter Flow Rates along LMs

4. Key Outcomes

While five LMs were fitted out for field testing, nine field tests on three LMs has been completed along with analysis determining CUs, pump total dynamic heads and operating points, field profiles and energy lines. A plot of the normalised emitter flow rates against distance from pump has been produced for a centre feed (CF) and end feed (EF) LM. The design flow rate is indicated by the red dashed line (Figure 1).

5. Further Work

While no specific relationship has been identified as yet, further investigation is required. A cost analysis is also required to estimate the extent of the incurred costs due to increased energy consumption rates.

6. Conclusions

At this stage, it has been identified that an increase in engine speed and, hence, machine flow rate causes a significant increase in energy consumption.

Acknowledgements

References

Foley, J.P., & Raine, S.R. (2001). *Centre pivot and lateral move machines in the Australian cotton industry.* (*Publication* 1000176/1) NCEA. USQ. Toowoomba.

Smith, P., Foley, J., Bray, S., Montgomery, J., Wigginton, D., Schultz, J., Van Niekerk, R. (2014). *A Review of Centre Pivot and Lateral Move irrigation installations in the Australian Cotton Industry.* NSW DPI. Orange.

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NSW Control Network: User Errors vs Network Errors using CORSNet

Sponsor – Delfs Lascelles Consulting Surveyors

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Bachelor of Spatial Science (Honours)

Supervisor: Prof. Jessica Smith, USQ

Keywords: SCIMS, CORSnet NSW, Network Adjustment.

1. Introduction

In NSW the Survey Control Information Management System (SCIMS) is the central registry for spatial data related to survey monuments throughout the state. SCIMS provides the coordinates and other related information like Class and Order for all established survey marks within NSW.

The use of GPS technology has seen a rapid rise over the last ten years. Continuously Operating Reference Station (CORS) is the next phase in GPS technology. CORS receivers continuously observe and correct satellite signals to provide highly accurate positioning data.

2. Background

The main aim of the project is to test the existing network of survey control marks using the CORSNet NSW infrastructure, to assess the errors associated with the published coordinates available through SCIMS.

Since the CORS network was developed in NSW, the use of the system has increased. The ability to quickly provide coordinate values is one of the main advantages of the CORS system, but what are the errors associated with CORS supplied data. Is it possible to determine the errors associated with the values published with SCIMS.

3. Methodology

The CORSNet infrastructure in NSW will be utilised to collect coordinate data related to established survey control marks within SCIMS. Two study areas will be selected; comprising between 20 and 25 established survey control marks.

The collected CORS data will be reduced and adjusted within a commercial available software program, Trimble Business Centre. The reduced and adjusted coordinate values will be compared to the related SCIMS values and an assessment on the errors will be made.

4. Key Outcomes

So far after the collection of all CORS data and the reductions and adjustments of the fast static data for both study areas the results are very positive. Considering the achievable accuracies of GPS there appears to be very little errors associated with the published coordinates available in SCIMS. These findings confirm the rigorous network adjustment that is required before any coordinates are published in SCIMS for any survey control marks.

The reduction and adjustment of the RTK data remains which will provide a check on the rapid static outcomes. It is anticipated that the RTK data will not be as accurate as the fast static. There is no reason that all aims for this project cannot be achieved in the time remaining.

5. Further Work

Final reduction of RTK data for both study areas. The final conclusions and project writing will continue.

6. Conclusions

Initial conclusions are that any errors present in the networks are based on user errors and equipment capabilities. It would appear that the errors associated with the network itself are very minor.

Acknowledgements

References

Santo, M,C., Souza, C,B. (2000). A Practical Evaluation of the GPS Rapid Static Method. Geomatic, 54(4), 425-431.

Langley, R,B. (1998). RTK GPS. GPS World, September, 1-5.

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Development of a low cost, remotely accessible condition monitoring system for a power transformer

Sponsor – Diamantina Power Station

Shane Nolan

Bachelor of Engineering
(Honours) (Power)

Supervisors: Dr David Thorpe, USQ

Dr Les Bowtell, USQ

*Keywords:* Asset management, condition monitoring, Raspberry Pi.

1. Introduction

Condition monitoring of power transformers provides quantitative data allowing asset managers to make informed maintenance decisions. This project investigates the asset management strategies and condition monitoring techniques applied to power transformers. A low cost, remotely accessible condition monitoring system is designed, built, installed and tested to minimise the need for regular visual inspections.

2. Background

Transformers are critical components in a power station. Continuous online monitoring of partial discharge, transformer hot spots and insulating oil is now available, however a visual inspection remains one of the simplest techniques available for assessing transformer health. Whilst effective, visual inspections are time consuming, expose personnel to being in proximity of energised high voltage equipment, and the quality of inspections varies depending on the skill/ training of the operator.

3. Methodology

An extensive literature review was conducted on power transformer asset management strategies, condition monitoring techniques, and applications of the low cost Raspberry Pi computer. The assembled system consists of a Raspberry Pi 2, modified Python programs to control a Pi-camera, FLIR Lepton thermal camera and a DHT11 moisture sensor. Remote access was achieved via Wi-Fi and a laptop. Figure 1 is a thermal image of a power transformer radiator taken by the condition monitoring system.
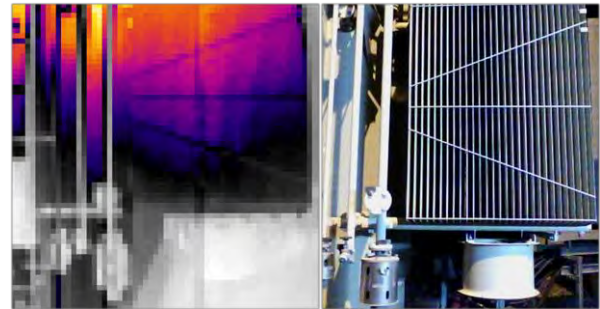
Figure 1 – Transformer thermal image

4. Key Outcomes

A remotely accessible condition monitoring system was developed for around $1200. Based on a Raspberry Pi, it includes a camera for monitoring oil level gauges, a thermal camera for identifying transformer hot spots or blockages in the cooling system, and a moisture sensor for monitoring the breather silica gel condition.

5. Further Work

Remaining tasks are to evaluate the practicality of installing this system onto all power transformers at Diamantina Power Station, or other remote sites.

6. Conclusions

A low cost, remotely accessible condition monitoring system can potentially replace visual inspections. Benefits include reduced labour costs, better data quality and increased safety by minimising personnel working in proximity of energised high voltage equipment.

References

Abu-Elanien, AEB, & Salama, MMA (2010). Asset management techniques for transformers. *Electric Power Systems Research*, 80 (4), 456-64. Retrieved from http://www.elsevier.com/locate/epsr

Bagavathiappan, S, Jayakumar, T, Lahiri, BB, & Saravanan, T (2013). Infrared thermography for condition monitoring – a review. *Infrared Physics & Technology,* 60, 35-55. Retrieved from http://www.elsevier.com/locate/infrared

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Analysis of a High Performance Hydraulic System by Numerical Methods

School of Mechanical and Electrical Engineering

Jake Norley

Bachelor of Engineering

(Mechanical)

Supervisor: Dr Ruth Mossad, USQ

1. Introduction

A high performance hydraulic system has been given by the sponsor. The system consists of a piston being accelerated at high speeds, from stationary to 12.5 m/s in 65mm. This piston then pushes fluid through a logic element valve and around a passage. The system has been known to be somewhat inconsistent and there is currently no method of analysing the fluid flow. The project aim is to identify areas of inefficiency and possible improvement in the hydraulic system.

2. Background

The hydraulic system has worked well for the sponsor for the last 20 years. However, with high customer expectations it is always necessary to seek improvements to stay ahead of competitors. There is a knowledge gap which exists within the company as to how the system operates, filling this gap is essential to enable the sponsor to improve their product.

3. Methodology

An analysis was performed on the system by numerical methods. The computational fluid dynamics package ANSYS was used to simulate fluid flow in the system to determine the flow characteristics. Firstly, steady state simulations were developed with defined inlet and outlet boundary conditions. For these, the valve is moved to different positions between tests. Transient analysis were then developed using the Dynamic Mesh tool to include fluid structure interaction which governs the fluid motion as the piston pushes the fluid, and as the fluid opens the logic element valve. The results are then analysed to determine the flow characteristics.
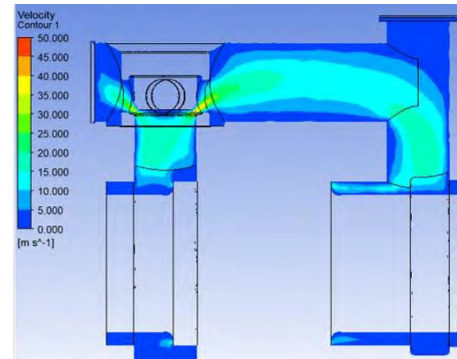
Figure 1: Velocity Profile Cross Section of High Performance Hydraulic System

4. Key Outcomes

Steady state simulations have been run with the valve at different opening levels. A clear, arced fluid path can be noticed in Figure 1 with valve opening having an expected effect on the flow. It was noticed that the orientation of the valve influences the flow rate through the valve and in the top part of the passage, and this was noted as an area of possible improvement.

5. Further Work

The three-dimensional transient analysis is to be run, implementing dynamic mesh to include fluid structure interaction. The results are then to be analysed. The analysis and recommendations could be implemented to the system in the future.

6. Conclusions

It is evident that even the steady state simulations can provide information to the sponsor which would not otherwise be available. The transient analysis will provide even more information to improve the system.

Acknowledgements

References

Guo, X., Huang, J., Quan, L. & Wang, S. (2015). Transient Flow Field Chraracteristic Analysis of Poppet Valve Based on Dynamic Mesh 6DOF Technique. *Fluid Power and Mechatronics 2015 International Conference*, 928-933. doi: 10.1109/FPM.2015.7337248

Pritchard, P. (2011). *Fox and McDonald's Introduction to Fluid Mechanics*. New Jersey: John Wiley & Sons, INC.

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Fuzzy Solar Hot Water Heater Controller

Faculty of Health, Engineering and Sciences

David Ogilvie-O'Neil

Bachelor of Engineering (Honours)

Supervisors: A/Prof Alexander Kist, USQ

1. Introduction

One of the most significant improvement in quality of life comes from improvements in personal hygiene. Hot waters significants to improvements in hygiene are not to be understated, assisting the breakdown of grease and bacteria.

Production of domestic hot water accounts for a considerable amount of energy consumption. Solar hot water heaters provide an efficient mechanism for heating water, making use of free solar energy. Unfortunately they fall short in their energy efficiency when solar radiation is not abundant.

This project investigates the suitability of a fuzzy controller to reduce energy consumption associated with the heating of domestic water.

2. Background

The prevailing control method of the water heating element in solar hot water systems is a simple thermostat control, maintaining hot water at a pre-set temperature. This is done without regard of user requirements or environmental conditions. Resulting in inefficient use of heating energy.

Fuzzy controllers in combination with low-cost sensing devices will allow for control of the electric heater, proving hot water only when it is required. The fuzzy controller shall approximate solar radiation and house hold occupancy to determine hot water heating requirements.

3. Methodology

Base line sensor data was gathered from sensors deployed in the field. Data was then transmitted via WiFi to a web based data collection utility. The data was analysed to provide both fuzzy rule sets and control parameters for the fuzzy controller.
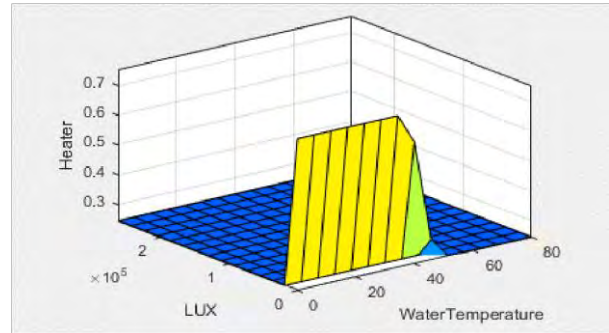
Figure 1 - Fuzzy Control Surface

Using MATLAB a Mamdami fuzzy controller was developed to control the final element (The hot water heating element). The fuzzy control was then implemented on an Arduino microcontroller, providing a system which is capable of heating water at peak times only when the house is occupied and there is insufficient solar radiation to provide low cost water heating.

4. Key Outcomes

Low cost sensors used in conjunction with a fuzzy controller can be to approximate available solar radiation and determine the required supplemental heating of water. Resulting in an overall reduction in heating costs.

5. Further Work

Further improvements are required to improve the algorithms used for determination of the occupancy and solar radiation. Improved resolution and understanding of solar radiation data and occupancy periods will improve the control algorithm, and the overall efficiency of the system.

6. Conclusions

Improvements in the control of simple domestic products can achieve an overall reduction in the domestic energy consumption, without a negative consumer experience.

Acknowledgements

References

Kalogirou, S. A. (2014). Solar Energy Engineering: Processes and Systems (2nd ed.). US: Academic Press.

Kleiminger, W., Beckel, C., & Santini, S. (2015, 2015). Household occupancy monitoring using electricity meters.

Ross, T. J. (2004). Fuzzy logic with engineering applications (2nd ed.). Oxford: Wiley-Blackwell.

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Roadwork signage analysis and general road user driving behaviour through construction sites

Sponsor – School of Civil Engineering and Surveying

Callan Paige

Bachelor of Engineering (Honours) (Civil)

Supervisor: Dr Soma Somasundaraswaran, USQ

Keywords: Traffic management, safe, roadwork

1. Introduction

Currently, there are numerous road construction worksites that are providing new or upgrading existing assets. Works entail the likes of providing overtaking lanes, road widenings and new intersection treatments. Whilst these activities are occurring, it is essential that motorists and workers are safe. Many hazards are possible within the road transport environment, including driver behaviour. Continuing near miss and fatality incidents at roadwork sites, calls into question the effectiveness of traffic control to motorists.

2. Aim

To undertake a multidisciplinary investigative approach to traffic control effectiveness. The research intention is to make a valid contribution to improving safety at roadwork sites for workers and the public.

3. Literature Review

It is clear from the literature that the ongoing safety of workers, the correct installation of control devices, erratic motorist behaviour and contractors compromising worker safety by not complying with safety standards are constant critical concerns (Doyle and Addison 2006; Walker and Calvert 2015).

4. Methodology

The methodology for this project entailed observing and analysing driver behaviour at two job sites. Further to this, different signage alternatives were carried out on the two sites and identified if there were any changes to drivers disobeying roadwork signage. To further assess the context around traffic control, a questionnaire is also proposed to be undertaken by Council staff and a private traffic control company.

Interviews will also be held with various key stakeholders to obtain specifics relating to safety and legislative obligations.

5. Data Collection and Analysis

Figure 1 is a graphical output of driver behaviour at a road construction job site based on observations.
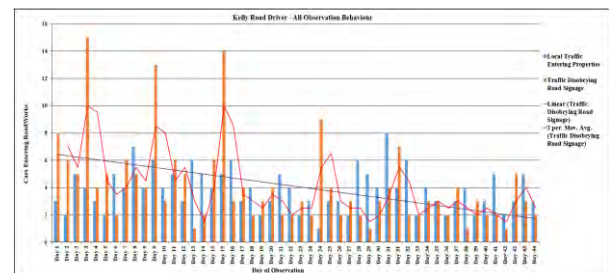
Figure 1 – Driver Observation Behaviour

The data analysis effort will focus on identifying any trends in the data or potential treatments that alter behaviour.

6. Results and Discussion

The research will be crucial in qualitatively assessing the effectiveness of traffic control. Of particular interest will be the issues faced by the traffic management industry. At this early stage, trialling alternative treatments are demonstrating change in driver behaviour.

7. Conclusions and Expectations

Strategic formulations will be made in an effort to improve the safety of road users and workers, and this may be adopted by stakeholders in the traffic management industry.

Acknowledgements

I would like to thank the research participants and Sarah for their overwhelming support and encouragement throughout this major research endeavour.

References

Doyle, N. & Addison, M. 2006, Safety around roadworks. It's a two-way street. Looking after roadwork safety – Main Roads experience, Australian Transport Research Forum, Gold Coast, Queensland.

Walker, G. & Calvert, M. 2015, Driver behaviour at roadworks, Elsevier Ltd and The Ergonomics Society, Edinburgh.

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Portable Infant Monitoring Device

School of Mechanical and Electrical Engineering

Bruce Parrey

Bachelor of Engineering (Hon)
Major Electrical and Electronic

Supervisors: Mr Mark Phythian, USQ

Figure 1 – Circuit Block Diagram

1. Introduction

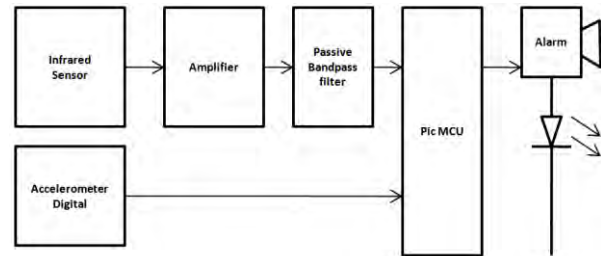The use of home monitors to help prevent life threatening conditions like SIDS has been long studied; however no conclusive evidence has been found that justifies medical professionals recommending a monitor for a healthy infant. Current information indicates that the use of a monitor can have negative emotional side effects for the care-givers, causing anxiety as a result of false alarms.

Although such side effects may occur there are possible benefits of monitors alerting care-givers to Apparent Life Threatening Events, for example a child choking. The care-giver may then be able to intervene and save the child's life.

The aim of this project is to design a highly reliable portable monitor that limits or removes concerns about emotional stress so they can be recommended, or at least considered impartially for home use.

2. Background

The use of home monitors for infants is currently a common practice with new parents. These monitors are generally not endorsed by organisations like SIDS Australia but the development of a highly reliable monitor could change this. Current monitors, generally, use only one sensor and the focus is towards when the infant is sleeping.

3. Methodology

Current research on infant/medical monitors was done to determine best methods and possible drawbacks. A design was developed that included an infrared sensor for blood monitoring and an accelerometer for digital motion monitoring, see Figure 1. A program was then developed to monitor for the heart beat from both sensors and provide a warning should something be wrong. The final stages of the project include testing and refinement of the program algorithm.

4. Key Outcomes

The key outcome of this project is to design a working prototype of an infant heart rate monitor that utilises two sensors for greater reliability.

5. Further Work

At the conclusion of this project further work in producing a final product that includes communication for downloading of information, a program/app for users and a proper case that can be worn by an infant over long periods.

6. Conclusions

In shifting focus towards preventing Apparent Life Threatening Events it is hoped that a monitor can be accepted by medical professionals and used to save the lives of infants in a diverse range of situations.

Acknowledgements

References

Committee on, F & Newborn (2003), *Apnea, Sudden Infant Death Syndrome, and Home Monitoring*, *Pediatrics*, vol. 111, no. 4, pp. 914-7.

Pantelopoulos, A & Bourbakis, NG (2010), *A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis*, IEEE Transactions on Systems, vol. 40, no. 1, pp. 1-12.

SIDS and Kids (2009), *Information Statement: Home monitoring* National SIDS Council of Australia.

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Estimating the State of Charge of the Nickel Iron Battery

Sponsor – School of Mechanical and Electrical Engineering

Ian Parry

Bachelor of Engineering (Electrical and Electronic)

Supervisor: Assoc. Prof. Tony Ahfock, USQ

Keywords: Nickel-Iron Battery, Battery State of Charge.

1. Introduction

Originally patented and commercialised in 1901 by Thomas Edison for use in early 20th century cars, the Nickel Iron battery is now being investigated for use as stationary storage for off-grid applications.

In comparison to other battery chemistries, the combination of the following advantages and disadvantages enable this battery to be an appropriate choice for stationary applications:

- It can survive frequent cycling of about 11,000 rotations to 80% Depth of Discharge compared to around 1,000 cycles for lead acid batteries,
- Without the use of lead, cadmium or acid, it is a more environmentally friendly alternative,
- It has minimal maintenance with the ability to withstand overcharge and over-discharge, and
- With almost no possibility of thermal runaway if the terminals are shorted, it is safer, however,
- They are heavier than other battery types, and
- They have a lower specific energy.

This research project will attempt to estimate the Nickel-Iron Battery's State of Charge (SoC).

2. Background

The SoC is an indication of the quantity of electricity in the battery in relation to its practical capacity with the given past and future discharge conditions or discharge rates.

This is an important battery parameter to determine in a battery management system to preserve the longevity of the battery and to optimise all the available charge.

The project will attempt to link experimental results with the chemical theory to the battery discharge model equation (1.1) developed by Tremblay and Dessaint.

$$V_{batt} = E_0 - K \frac{Q}{Q - \int i\,dt} \cdot \int i\,dt - R \cdot i + \underbrace{}_{Polarisation\ Voltage}$$

$$A \cdot \exp\left(-B \cdot \int i\,dt\right) - K \frac{Q}{Q - \int i\,dt} \cdot i^* \underbrace{}_{Polarisation\ Re\,sis\tan ce} \quad (1.1)$$

3. Methodology

1) Obtain an understanding of the electrochemical processes involved in a rechargeable battery, 2) From existing literature on battery modelling, determine the battery parameters required to model the SoC, 3) Conduct the SoC experiments, and 4) By curve fitting, analyse the experimental results to the model and the battery chemistry.

4. Key Outcomes

The expected outcomes from the project are that the battery voltage during experimental discharge follows equation (1.1), similarly for the associated charge equation, and this can be explained by the chemistry.

5. Further Work

The project's experimental work is being conducted at the time of print, thus experimental data is progressing and analysis of this data will follow.

6. Conclusions

The project's conclusions can be formed after completion of the experimental work and the analysis.

References

Chang, W-Y 2013 'The State of Charge Estimating Methods for Battery: A Review, *ISRN Applied Mathematics*, vol. 2013, p. 7.

Jackovitz, JF & Bayles, GA 2002, 'Iron Electrode Batteries' in Linden, D & Reddy, TB (Ed.), *Handbook of batteries*, 3rd ed., McGraw-Hill, New York, pp.25.1-25.26.

Tremblay, O & Dessaint, L-A 2009. 'Experimental validation of a battery dynamic model for EV applications', *World Electric Vehicle Journal*, vol. 3, no. 1, pp.1-10.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

131

Scour Profile Investigation of a Culvert Floodway

School of Civil Engineering and Surveying
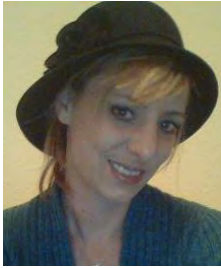
Tahnee Parsons

Bachelor of Engineering

(Honours) (Civil)

Supervisors: Dr Buddhi Wahalathantri, USQ

Dr Jahangir Alam, USQ

Keywords: Scour, Culvert, Flood

1. Introduction

Floods within Australia cause considerable devastation, with primary damage and reparation costs being to the road network. Low level stream crossings such as floodways and culverts often require repair or replacement works after major flood events. In general, failure mechanisms have been identified due to scouring and/or blockages. This study aims to investigate culvert scour potential in a granular river bed medium with varied flow conditions.

2. Background

Flood events have a severe impact on Australia's social and economic growth. In Queensland, about 85% of damage within 2010/2011 floods were road related. pavement damage and damage to bridges, floodways and culverts. Scour has been reported as one of the common failure mechanism for culverts and floodways. (Wahalathantri, Lokuge, Karunasena, & Setunge, 2015).

Currently, there hasn't been a national standard method developed to estimate scour potential around culverts and floodways. Scour potential depends on both flow profile and soil properties of the river bed. Through research of the literature it was found there has been very limited research on scour. Therefore, comprehensive studies are needed to develop a nationally accepted framework to estimate scour potential around culverts.

3. Methodology

The project involved a series of laboratory experiments using a scaled culvert model at different flow rates. Analysis included scour potential effects of bed material size, culvert blockage and rock protection downstream of the culvert. The project involved a series of measurements to record the flow profile and scour profile around the culvert.

Figure 1 – Culvert scouring under high velocity conditions

4. Key Outcomes

Current findings indicate that the scour profile has a close relationship with the location and form of the hydraulic jump. Also, results indicate that a culvert blockage intensifies scouring downstream of the culvert. Implementation of rock protection at the culvert outlet significantly reduces the impact of scouring.

5. Further Work

Further research beneficial to the project includes analysis within ANSYS, which is a 3D computational fluid dynamics program to compare results. As the study focussed on cohesive materials, research of non-cohesive materials would be another key area to investigate.

6. Conclusions

Findings indicate that an Australian Standard should be implemented in culvert design with regards to scouring. This standard should also include culvert protection methods and maintenance levels that culverts should adhere to.

Acknowledgements

References

Wahalathantri, B.L., Lokuge, W., & Setunge, S. (2015). Vulnerability of Floodways Under Extreme Flood Events, *Natural Hazards Review,* 04015012

May, R.W.P., Ackers, J.C., & Kirby, A.M. (2002). *Manual on scour at bridges and other hydraulic structures*, Westminster, London.

Austroads Ltd. (2013). *Guide to Road Designs Part 5B: Drainage- Open Channels, Culverts and Floodways*, Austroads Ltd, Sydney, Australia.

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132

Physio-Exercise-Bike Adaptation for use by person with restricted knee-bending range

Sponsor – Faculty of Health, Engineering and Sciences

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Bachelor of Engineering

Major Mechanical Engineering

w0101139

Supervisors: Chris Snook, USQ

Keywords: biomechanical, exercise-bike, rehabilitation

1.   Introduction

Using an exercise-bike is an important rehabilitation tool for many injuries. If the user has a limited knee bending range it can be impossible to complete a single revolution of the pedals. This project tackles this problem and has produced 3 designs for shortening the crank-arm, thereby reducing the amount the knee *must* bend – at the top of the pedals revolution – in order to complete 360° cycles of rotation. The 3 versions are:

- Fixed (bolted) crank-arm attachment
- Sliding crank-arm attachment
- Mechanically assisted crank-arm attachments, 2 versions: Linear actuator version and a Stepper motor with T8 leadscrew version

2.   Background

About 20% of people with a fracture to the lower femur (condyle) will have complications which can lead to a lengthy delay in bone union. During this time, the thigh bone can become extremely osteoporosed. The extensive scar tissue, resulting from the necessary surgery can also affect the muscles ability to control of the lower leg; this is known as a knee 'lag'.

The ideal therapy for both conditions is rehabilitation on an exercise-bike. Unfortunately, following reduction to a fracture in the condyle area, there is frequently bone misalignment which severely limits the knee bending ability (flexion and extension). More than 90 degrees of flexion is required to use any cycling apparatus.

3.   Methodology

Work started on the simple fixed and sliding designs, produced primarily to verify that the initial idea was a workable concept, Both, acceptable, models were assessed, and the two afore mentioned mechanically assisted designs were tweaked prior to being produced. An Arduino Uno with a DK Electronics Motorshield

Figure 1 – Vertical Testing Rig for Stepper Motor

was chosen as the motor driver for both designs, due to its compact size, and simple operation.

4.   Key Outcomes

Two simple and two mechanically assisted working models have been produced using off-the-shelf items. The initial project constraint was to use only simple tools found in the average garage, however, to improve the general workmanship of the components, a competency of the Cairns branch of "Men's Shed" metalworking department was obtained to better complete the motor assisted versions.

5.   Further Work

Models are complete. Testing, from four available models, for the most suitable stepper motor, is almost finished. A video showing some of the models in action will be produced for use during the presentation in September of 2017.

6.   Conclusions

A total of four *working* versions are available depending on the individual need, and the person's skillset or that of their helpers. The mechanically assisted version components may cost less than $100, the fixed and sliding versions, considerably less; none require specialist expertise to produce.

Acknowledgements

References

Medscape, Femur Fractures, *Overview, Medical Explanation*, viewed 7 May 2017. <http://www.medscape.com/orthopedics>.

Boxall, J. (2013). *Arduino Workshop*. San Francisco, CA, USA.: No Starch Press, Inc.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

133

Analysis of Kinetic Energy Recovery System Retrofit in conjunction with Internal Combustion Engine Vehicles.

Sponsor – School of Mechanical and Electrical Engineering

Ken Kehinde Peters

Bachelor of Engineering Honours (Mechatronics)

Supervisors: Dr Ray Malpress, USQ

Keywords: Kinetic energy recovery, In-wheel motor, Retro-fit

1. Introduction

Despite the progression and evolution of Electric Vehicles (EV), Internal Combustion Engine Vehicles (ICEV) remain the main vehicle of choice. While the ICEV retains its popularity, a question arises as to whether there is potential to implement advanced technologies, specifically Kinetic Energy Recovery Systems (KERS) found in EVs into ICEVs to reduce pollution and increase fuel efficiency.

This dissertation determines the potential for KERS to become a standard feature on ICE powered vehicles in the future, by investigating the total implementation cost and fuel efficiency benefits of retrofitting to a light commercial ICEV.

2. Background

KERS is the transformation of the energy of the moving vehicle to stored energy during vehicle braking. The recovered energy is either stored, for later use, or converted back to kinetic energy, providing additional acceleration for the vehicle during take-off (Clegg 1996). KERS usually incorporates the use of a flywheel or electric generator system and battery to store energy under braking.

Protean Electric have developed a KERS retrofit with the use of an electric motor generator mounted in the wheels of an ICEV. Mass production of the unit has not yet begun and there is limited information available of the affordability and viability of the design in comparison to purchasing a new or second-hand hybrid vehicle.

3. Methodology

A literature review determined pre-existing KERS technology, as well as examined the technical aspects of implementing KERS in ICE vehicles. An electrical storage system was chosen with the use of Protean
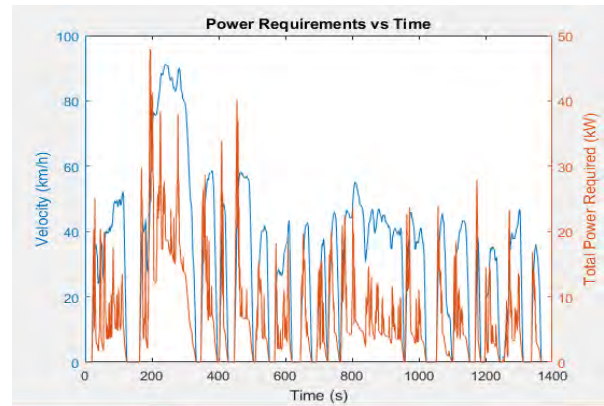
Figure 1- Power requirement vs driving cycle events

Electric In-wheel motors. Technical analysis based on urban and extra urban drive cycles were carried out to determine the vehicles fuel consumption and recoverable regenerative energy. MATLAB was chosen as the modelling technique to simulate the performance of the engine during operation of the two drive cycles.

4. Key Outcomes

The expected outcomes include reduction of net fuel consumption, identification of battery storage capacity required and the material and implementation costs. It is expected that the yearly savings in fuel consumption will provide repayments for componentry and implementation costs of the system. The efficiency of retro-fit is close to that of a standard Hybrid EV, although the implementation and material cost is greater compared to the purchasing of **a** Hybrid EV.

5. Further Work

Develop a controller which interacts in real time between the wheel motors, the ICE and the electronic control unit to extract the best efficiency from the hybrid system and diagnose any possible failure behaviours before they occur.

6. Conclusions

In-wheel electric motor retrofit is a viable option for light commercial vehicles providing manufacturing and implementation cost is kept at a minimum.

Acknowledgements

I would like to thank my supervisor, Dr Ray Malpress, for his ongoing support and advice.

References

Clegg, SJ 1996, *A Review of Regenerative Braking Systems.*, The University of Leeds, http://eprints.whiterose.ac.uk/2118/>.

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134

Chemical Stabilisation Alternatives for Marginal Materials found within the Cobar Region

Sponsor – Cobar Shire Council

Adrienne Pierini

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Supervisor: Dr Andreas Nataatmadja, USQ

Keywords: Soil stabilisation, alternative stabilisers, lignosulfonate.

1. Introduction

Chemical stabilisation is a process that is used to improve the material properties of a soil such as strength and durability to make it suitable for a variety of applications. Soils used for road construction purposes that require improvement are referred to as marginal materials. Traditionally chemical stabilising agents such as lime and cement have been used to improve the material properties of these types of soils, however more recently alternative stabilisers have been gaining popularity within industry.

2. Background

The Local Government Area of Cobar is the second largest Shire in New South Wales with a size of 45,609 square kilometres. Due to the size of the region Cobar Shire Council is responsible for maintenance of 2,500km of rural and regional roads of which 2,000km is unsealed road. These unsealed roads are mostly natural surface and can generally be classified as marginal materials. These roads cause Council problems every year in terms of frequency of maintenance required, associated costs and safety considerations for road users.

3. Methodology

This project was developed to be delivered in five key stages: Resource and soil sample collection, material classification testing, binder testing, data collection and analysis and write-up.

4. Key Outcomes

A key outcome of this project is to identify the effectiveness of a range of alternative stabilising agents in treating sampled marginal materials found within the Cobar region in terms of practical implications, cost, and improvement in material properties (in particular a

Figure 1 – Material Classification Testing

reduction in moisture susceptibility). As a result Cobar Shire Council may use this information as part of their road works projects with beneficial results.

5. Further Work

Binder testing has not yet been completed at this stage, and thus further data collection and analysis is required.

6. Conclusions

Currently binder testing results and analysis is unavailable as binder testing is yet to be completed. Final conclusions will be presented in the completed dissertation.

Acknowledgements

References

Jegandan, S., Liska, M., Osman, A.A.M., & Al-Tabbaa, A. (2010). Sustainable binders for soil stabilisation. *Proceedings of the Institution of Civil Engineers – Ground Improvement*, 163(1), 53-61. doi: 10.1680/grim.2010.163.1.53

Rios, S., Viana da Fonseca, A., & Bangaru, S.S. (2016). Silty Sand Stabilised with Different Binders. *Procedia Engineering*, 143(1), 187-195. doi: 10.1016/j.proeng.2016.06.024

Zandieh, A.R., & Yasrobi, S.S. (2010). Study of Factors Affecting the Compressive Strength of Sandy Soil Stabilized with Polymer. *Geotechnical and Geological Engineering*, 28(2), 139-145. doi: 10.1007/s10706-009-9287-7

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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An Investigation into the Use of a RTK GNSS and a Digital Depth Sounder for Mapping a Tidal River Bed

School of Civil Engineering and Surveying

Jared Pinkstone

Bachelor of Spatial Science (Surveying)(Honours)

Supervisors: Assoc. Prof. Peter Gibbings, USQ

Keywords: GNSS, echosounder, Tidal.

1. Introduction

Traditionally, surveying through water catchments has been conducted through the use of either traditional land surveying techniques, or through the use of hydrographic survey techniques. As we look into the future, we are always looking to improve our methods and techniques in order to achieve a more viable outcome with regards to safety and accuracy. Topographic surveys are often met with a water storage of some type, and often the surveyor would use traditional techniques which can be seen as both hazardous and inaccurate. The aim of this dissertation was to compare and contrast the accuracies associated with the use of a GNSS receiver linked with a digital depth sounder and compare them to traditional land surveying techniques.

2. Background

The project allows the wider surveying community to have an understanding of both how a digital depth sounder is incorporated into a GNSS, along with the accuracies affiliated when undertaking a survey with a body of water greater than 1 metre deep. The project is important to the surveying community as it provides a means of testing this form of data collection, also allowing for hydrographic survey techniques to be incorporated into land surveys.

3. Methodology

Tidal waters were used to undertake the surveys. Low tide allowed for the reference surface survey to be undertaken, where minimal water was apparent on the bank, whereas high tide allowed for enough water to be beneath the transducer and the surface to collect data.

Traditional survey techniques was also undertaken at high tide with a kayak and long pole.

4. Key Outcomes

As expected, the traditional survey techniques surface data was quite similar to the reference surface due to the limited water beneath the boat along with clear visibility to the bottom, allowing for any obstruction such as vegetation or marine life to be seen. The data sets which was of concern related to the depth sounder, where the datasets were approximately 70mm higher in elevation across the majority of the survey site. There were sections which were clearly interfered with, whether that was from marine life or possible GNSS errors. The data collection stage however was much easier and safer in comparison to traditional survey techniques, making for a more viable method of data acquisition.

5. Further Work

The next stage in testing would be to undertake surface data in deeper water, allowing for surveys to be tested in environments such as dams.

6. Conclusions

The future is looking more promising, as a new means of survey surface data acquisition is becoming more convenient and usable within a survey company. The use of depth sounding equipment linked together with a GNSS allows the wider survey community to map water catchments with ease, allowing for a more viable pickup with regards to safety and accuracy.

7. Acknowledgements

References

Reid, D., Scalabrin, C., Petitgas, P., Masse, J., Aukland, R., Carrera, P. and Georgakarakos, S., 2000. *Standard protocols for the analysis of school based data from echo sounder surveys*. Fisheries Research. Calfiornia Marine Habitat Task Force, 1999. *Mapping Technology Review Final Report: EarlyImplementation of Nearshore Ecosystem Database Project.*

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Total Safety of Separated Cycleways through Major Cities

Sponsor – School of Civil Engineering and Surveying

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Supervisors: Mr Trevor Drysdale, USQ

Keywords: Separated Bikeways, Cyclists and Safety

1. Introduction

Many major cities across Australia and across the world increasingly understand the need for modal shifts into sustainable transport. To improve the focus on cycling as a viable alternative, many cities are incorporating separated bike lanes within their road networks. Separated cycle lanes are separated bicycle facilities that run alongside a roadway separated from vehicular traffic by a physical barrier, such median islands with concrete kerb, landscaped buffer zones or painted medians with flexible bollards.

This project assesses lessons learned from around the world, through design factors and the implementation of separated cycle lanes. It attempts to capture the current state of implementation, while still appreciating that our understanding of this facility type is still in its infancy and regular need for an extended design flexibility.

2. Background

It has become widely recognises that separated bicycle facilities increase bicycle rider safety and encourage more people to cycle. This report will generally focus and reflect on the local guidelines and address the details contained within them forming the basis for this investigation and refinement.

3. Methodology

This report will detail proven methodologies for assessing specific engineering elements of the separated cycle lanes. This will include cycle lane widths based on patron capacity and function, surfacing treatments for general thoroughfare and conflict locations. Also, separation details, such as physical barriers, landscaped buffers, and painted median separation and the use and effectiveness.

Figure 1 – Sample Separated Cycleway (Boston USA)

Based on research into cycle lane performance studies, this report will scrutinise and detail all elements associated with the construction of cycle lanes to ensure a complete, holistic outcome is achieved.

4. Key Outcomes

The key outcomes of this project have been based around the research and assessment of the current standards and applications of separated bikeways. This research also undertook testing and investigation of physical separation devices on the market, these tests yielded results that can be used for genuine application.

5. Further Work

There will be refinement of the assessments carried out, with the purpose to ensure a design procedure can be produced.

6. Conclusions

The current research and investigations related to the implementation of separated cycle lanes are in their infancy, however, internationally there is substantial progress with construction and delivery to work towards. The design parameters and standards which are continually being employed in Australia are working towards best practice and this report investigates and details the separation devices and treatments.

Acknowledgements

I would like to acknowledge the valued assistance from Mr Trevor Drysdale. I would also like to acknowledge the professional assistance from Engineering officers from Department of Transport and Main Roads (QLD) and also from Brisbane City Council.

References

SWOV Fact sheet, 2009, Cyclists. SWOV Institute for Road Safety Research, The Netherlands.

Technical Note 128 Selection and Design of Cycle Tracks. 2014, Department of Transport and Main Roads.

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Residual Chlorine Improvement in Woodhill Water Supply Zone

Sponsor – Logan City Council

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Supervisors: Dr Vasanthadevi Aravinthan, USQ

Mr Chris Pipe-Martin, Logan City Council

Keywords: Chlorine, Residual, Improvement

1. Introduction

The need for this study was identified when commissioning a new chlorine dosing unit at the Woodhill reservoir. It was assumed at the time that the new chlorine dosing facility would improve the chlorine penetration through the network.

After commissioning it was identified that the residual chlorine level did not penetrate as far into the network than previously estimated. This study investigates the reasons behind the lack of chlorine penetration and the methods used to improve the chlorine residual.

2. Background

In January 2015 and January 2017, a positive result for Escherichia coli (*E. coli*) was found in the Mundoolun reservoir. To deactivate and prevent the growth of harmful bacteria in drinking water, chlorine is commonly used. Higher residual chlorine levels ensure disinfection yet have undesirable taste and odour issues aa well as pose a health risk.

3. Methodology

To determine the extent of the chlorine residual, a model was developed and calibrated with data from the field. This model was then used to trial different techniques to reduce chlorine decay and extend chlorine penetration through the network. An example of reducing chlorine decay in a reservoir is shown in Figure 1.

Figure 1 – Reservoir Passive Mixing

4. Key Outcomes

Testing the different techniques in the model gave interesting results. Much of the chlorine residual in the network could be improved by changing the operational philosophy of the network. However, additional chlorine dosing units were required to ensure the entire network met the Australian Drinking Water Guidelines (ADWG).

5. Further Work

After operational changes are made, the residual chlorine levels in the network are to be monitored. The model is to be recalibrated and the need for additional chlorine dosing units are to be reassessed.

6. Conclusions

To ensure the entire network meets ADWG guidelines for chlorine residuals, a combination of operational changes and capital works is required.

Acknowledgements

References

Black & Veatch Corporation, 2010. White's Handbook of Chlorination and Alternative Disinfectants 5th ed.. Hoboken: John Wiley & Sons.

National Resource Management Ministerial Council, 2011. Australian Drinking Water Guidelines 6, Version 3.2 (Updated Feb 2016), s.l.: s.n.

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Compressive Behaviour of Concrete Columns Repaired with a Prefabricated Fibre Reinforced Composite Jacket

School of Civil Engineering and Surveying

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Bachelor of Engineering (Honours)
Bachelor of Business and Commerce

Supervisor: Dr Allan Manalo, USQ

Keywords: FRP jacket; composites; repair; columns

1. Introduction

The corrosion of the steel reinforcement costs Australia approximately $13 Billion annually. The traditional repair methods use the same material that was used in the original construction and as such deteriorate the same way causing an endless repair cycle. There is a need therefore to find an effective alternative to repair deteriorating concrete structures especially those exposed to the marine environment.

2. Background

Currently, a new fibre reinforced polymer (FRP) jacket with an easy-fit and self-locking mechanical jointing system for repair of existing structures was developed. However, the contribution in the structural capacity in the repaired structure is still undefined. This project aims to investigate behaviour of concrete columns repaired using the FRP jacket to evaluate the effectiveness of this new repair system.

3. Methodology

Four concrete columns of 1m high and diameter of 250mm were prepared and tested under a 2000kN machine in the CFM laboratory, as seen in Figure 1. The load and deformation of these columns under load were analysed.

4. Key Outcomes

Investigate the behaviour of reinforced concrete columns repaired with a composite jacket, this can be seen in Figure 2.

Acknowledgements

I would like to thank all of those who have supported me throughout this process including: Dr Ginghis Maranan and his research Manalo et al. (2013) and Manalo et al. (2014). I would also like to thank Mr Ali Mohammed as well as the CFM staff. This project is supported by Joinlax Pty Ltd.

Specimen	Description
S1	concrete column only
S2	concrete column with infill only
S3	concrete column with infill and FRP sleeve
S4	concrete column with infill and FRP

Figure 1. Test set-up for columns
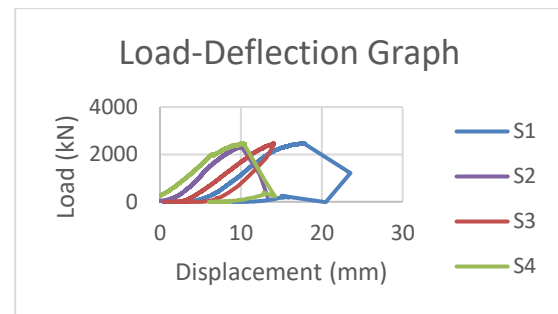
Figure 2: Load Deflection graph

5. Further Work

Further analysis of the strain gauge readings is to be done.

6. Conclusions

Based on the results of the experiment, the following initial findings were drawn:

- FRP jacket provides extra strength, however is minimal.

- FRP jacket reduces deflection of the column

- FRP jacket without joint performed better than FRP jacket with joint

- Column with FRP jacket and joint was performed better than concrete column only

References

Manalo, A. C., Karunasena, W., Sirimanna, C. & Maranan, G. (2013). *Fibre composites pile rehabilitation and concrete formwork jacket: concept development and finite element analysis*, Swinburne University of Technology

Manalo, A. C., Karunasena, W., Sirimanna, C. & Maranan, G. B. (2014) Investigation into fibre composites jacket with an innovative joining system, Construction and Building Materials, 65, 270-81.

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139

An investigation into the effect of changing the parameters of flight height, image overlap and the number of GCPs on the accuracy of an aerial photogrammetry survey over a road surface, an assessment of the suitability of aerial photogrammetry for road conformance testing

William Quihampton

Bachelor of Spatial Science Honours (Surveying)

Supervisors: Dr Albert Kon-Fook Chong

Keywords: Photogrammetry, Aerial, Road

1. Introduction

The motivation for this project came from a realisation of the potential for aerial photogrammetry to be utilised in the area of road conformance/compliance testing. A literature review determined further research into this area was required before aerial photogrammetry could be utilised for such a purpose.

The research thus far has been used to determine the extent to which the flight parameters of flying height, image overlap and the number of ground control points effect the accuracy of an aerial photogrammetric survey over a road surface. This project has used the results obtained to assess the suitability of aerial photogrammetry for the purpose of road conformance testing.

2. Methodology

A major part of this project involved the collaboration and analysis of numeric data which was produced as the result of survey field work and its' subsequent processing. An analysis of the results and a determination of their validity of was undertaken by utilising existing knowledge in conjunction with information obtained as part of the literature review.

To assist in the comparison and analysis of various data sets the information was graphed. An example of one graph used in the analysis of data can be seen in Figure 1. Figure 1 demonstrates how the calculated height of a point may deviate from its true position (referred to as Z error) with a change in flight height.
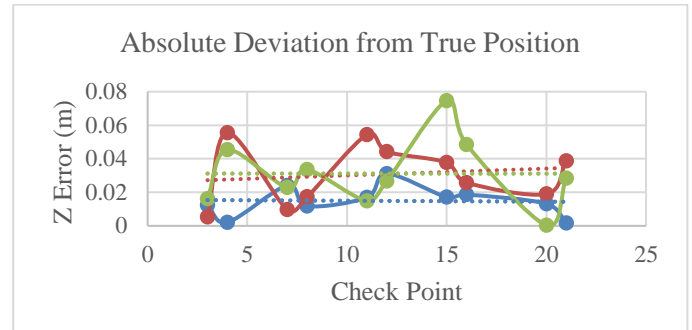

Figure 1: Effect of flight height on the standard deviation of Z error

3. Key Outcomes

The preliminary results of this research demonstrate that aerial photogrammetry can produce results that are accurate enough for some level of conformance testing. However, the results have proven to be unpredictable, with the results achieved at this stage not necessarily reflecting what was expected prior to completing this research.

4. Further Work

Further processing will be undertaken in an attempt to remove some of the errors that may have been induced into the results due to lack of understanding of the processing software

5. Conclusions

Further processing and analysis of results needs to be undertaken before any definitive conclusions can be drawn.

Acknowledgements

I would firstly like to thank Peter Coffee of Minor Details for the considerable assistance that he has provided in helping me to undertake this research.

Secondly, I would like to thank my supervisor Dr Albert Kon-Fook Chong for his help in completing this project.

References

Jiang, R, Jáuregui, DV & White, KR 2008, 'Close-range photogrammetry applications in bridge measurement: Literature review', *Measurement*, vol. 41, no. 8, pp. 823-34.

University of Southern Queensland 2011, *SVY 3202 Photogrammetry and Remote Sensing*

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Managing Marginal Quality Irrigation Water for Sustainable Sugarcane Production

Sponsor: TPC Ltd, School of Civil Engineering and Surveying

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Agriculture

Supervisor: Dr John Bennett, USQ

Keywords: soil structure, irrigation, water quality, soil health

Fig 1. The effects of sulphur amendments on soil irrigated with MQW on three parameters of soil structure (EDP - exchangeable dispersive percentage; CROSS - cation ratio of soil stability)
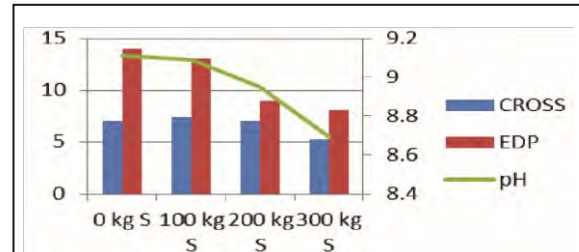
1. Introduction

Sustainable sugarcane production depends on healthy soils. The use of poor or low quality irrigation water adversely affects the soils structural stability, and introduces an excess of salts. This combination of effects results in reduced plant quality and yield. This project investigates the use of calcium (Ca) and sulphur (S) sources, as well as amended composts of the sugarcane by-product, mill mud (MM), as a method of reducing undesirable marginal quality water (MQW) effects. The aim is to develop a preliminary model for the targeted amendment of these composts in order to address specific water quality issues

2. Background

Marginal quality water has deleterious effects on the health of agricultural soils by causing salinity and/or enhanced dispersivity (Ezlit, Bennett, Raine, & Smith, 2013). Ca reduces the deleterious effect of sodium (Na), while S reduces the deleterious effect of water alkalinity. MM has a high Ca content, due to the sugar milling process, and may be a sustainable ameliorant for marginal quality water. Amending MM composts with further Ca and/or S may be a way to enhance ameliorant effect.

3. Methodology

i. Develop a model in PHREEQC (Parkhurst & Appelo, 2013) and HYDRUS-1D (Simunek, Senja, & van Genuchten, 2005) for predicting the effects of soil amendments and validate by hindcasting the results of a three year field trial

ii. Determine pH and EC evolution during the composting of mill mud

iii. Leach MM treatments to determine major cations (Ca^{2+}, Mg^{2+}, Na^+, and K^+) availability

iv. Use empirical data to create a model framework for compost amendments in addressing specific water qualities.

4. Key Outcomes

- S amendment trials conducted at TPC Ltd were successful (Fig 1), although application rates were insufficient for the Na^+, K^+, and $HCO3^-$ concentrations within the applied water
- TPC had previously deemed this management method unsuccessful, but these results indicate the system could be optimised for production
- Compost evolution trials and leaching trials ongoing

5. Further Work

This project will develop a preliminary model framework based on compost data and water quality inputs, but will require further validation with multiple compost sources in terms of nutrient evolution and availability related to compost breakdown.

6. Conclusions

Thermodynamic modelling identified water specific treatment to minimise soil degradation was successful. This enables sugarcane production system optimisation, reinforcing the requirement for a standardized model framework.

References

Ezlit, Y. D., Bennett, J. M., Raine, S. R., & Smith, R. J. (2013). Modification of the McNeal Clay Swelling Model Improves Prediction of Saturated Hydraulic Conductivity as a Function of Applied Water Quality. *Soil Science Society of America Journal, 77*(6), 2149-2156. doi:10.2136/sssaj2013.03.0097

Parkhurst, D. L., & Appelo, C. A. J. (2013). PHREEQC (Version 3.3.10.12220): United States Geological Survey.

Simunek, J., Senja, M., & van Genuchten, T. (2005). Hydrus-1D (Version 4.16.0110).

Behaviour of concrete columns with different levels of steel corrosion and repaired with a composite jacket

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Bachelor of Engineering (Honours), Major (Civil)

Supervisors: Dr Allan Manalo, USQ

Keywords: Composite; Corrosion; Repair

1. Introduction

The corrosion of steel reinforcement in concrete structures is major problem facing around the world. The current repair methods involve applying steel or concrete jackets, which undergo the same corrode process as did the original materials. The use of non-corrosive fibre composite jackets for repairing deteriorated concrete structures is now increasing.

2. Background

Recently, a new fibre reinforced polymer jacket fitted with an easy fit and self-locking mechanical joint for the easy repair of reinforced concrete structures have been developed. Testing of this product is required to determine its behaviour while in use. Therefore, this project is conducted to determine the effectiveness of this jacket in repairing concrete columns with different levels of simulated corrosion damage.

3. Methodology

Four steel reinforce concrete columns were prepared and tested; one without damage for control specimen, three with simulated steel corrosion, i.e. 0%, 25% and 50% and repaired with composite jacket. These columns were tested under a 2000kN capacity hydraulic cylinder and complete with strain gauges in the CFM laboratory. The applied load, deformation and strains were measured and the failure behaviour was observed carefully.

4. Key Outcomes

Analyses and compare the data recorded form the testing phase to determine each columns behaviour when repaired with the fibre composite jacket as shown in figure 3.

Figure 1 – Setup for Testing

Figure 2 – CC1 after testing
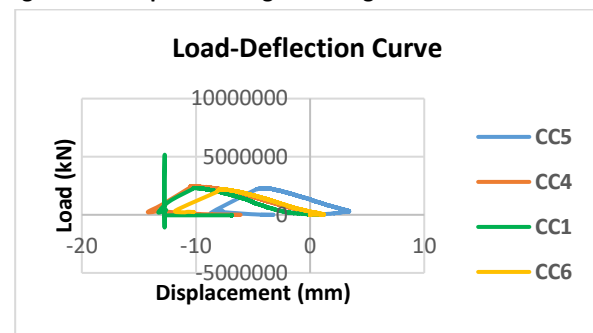
Figure 3 – Load Deflection Curve

5. Further Work

Further analysis of the strain gauge readings is to be conducted. Theoretical predictions of the behaviour of the columns repaired with composite jackets.

6. Conclusions

Based on the analysed results of the experiment, the following initial findings included

- The jacket provides a slight increase in strength

- The 25% corroded columns behaviour was closer to the control than 50% specimen

Acknowledgements

References

Pessiki, S. (2001). *Axial Behavior of Reinforced Concrete Columns Confined with FRP Jackets | Journal of Composites for Construction | Vol 5, No 4. Ascelibrary.org.*

Karbhari, V., & Gao, Y. (1997). *Composite Jacketed Concrete under Uniaxial Compression— Verification of Simple Design Equations | Journal of Materials in Civil Engineering | Vol 9, No 4. Ascelibrary.org.*

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142

Spinning Reserve and Renewable Energy Penetration

How much spinning reserve does South Australia need?

Sponsor – Faculty of Health, Engineering and Science

Greg Richards

Bachelor of Electrical/Electronic Engineering

Supervisors: Supervisors: Mr Andreas Helwig, USQ

Keywords: Spinning Reserve, Renewable Energy, Frequency Stability.

1. Introduction

The inspiration for this project has been driven by the political and biased commentary regarding the cost and reliability of the South Australian Power Network as the state strives to achieve ambitious renewable energy targets. As this is a very broad topic it has been refined to focus on the specific reasons established for the state-wide power outage in September 2016, which has been identified as a failure to control the networks frequency within tolerable limits. An analysis of the impact of renewable energy's impact on this is provided as well as technical and market based recommendations to improve the reliability of the network during contingency events.

2. Background

With renewable energy's installed capacity expanding throughout the Australian National Electricity Marketplace gaining an understanding of how the renewable energy sources affect the ability of the network to react to contingency events and regulation of frequency is important to ensure the reliability of the network into the future.

3. Methodology

A model developed in Matlab (shown in figure 1) was used to create a power network model which can be used to initiate contingency events and record the resultant frequency response of the system. By simulating a variety of worst case scenarios of generation mixes and contingency events limits can be found for the reliable operation of the network. These results of the simulation will then be used to propose system control and network management options.
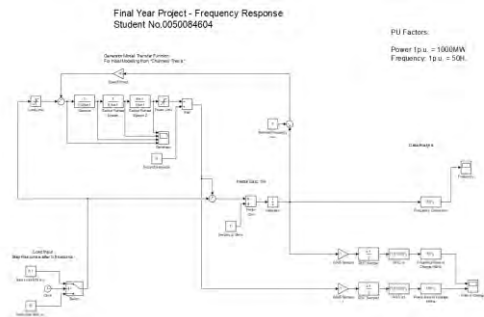
Figure 1 – Matlab Model of Electricity Network

4. Key Outcomes

The key learning from the project was determining the significant impact removing traditional turbines has had on the spinning reserve in the NEM. By modelling different storage/generation types it is shown an adequately planned network can remain stable and reliable with a high percentage of renewable energy installed. Modifications to the current market rules will also improve the costs of power generation with increased renewable energy.

5. Further Work

Further work to improve the model to include the entire NEM and further develop the generators to more accurately reflect the network.

6. Conclusions

The key outcome of the project was to debunk the political and biased commentary surrounding the reliability and security of an energy network with increased renewables penetration. With proper planning and front end engineering a successful transition to renewable energy can be achieved.

Acknowledgements

References

AEMO: Electricity Industry Conference: Secure Operation of South Australia, 2016. Available at: https://www.aemo.com.au/-/media/Files/Media_Centre/2016/SA-System-Strength.pdf

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143

Optimal Erosion Weir Design Selection

Sponsor – School of Civil Engineering and Surveying

Simon Richardson

Bachelor of Engineering (Hons)

Supervisors: Dr Md Jahangir Alam, USQ

Keywords: Weir selection, Erosion, Minim Energy Loss (MEL).

1. Introduction

Soil erosion is the displacement of soil by water or air. It can damage the environment and can be a burden to landholders. Reducing the velocity of the flow is one method that can minimise instream erosion.

A weir is one method to reduce the velocity of flow. There are no guidelines for determining if a weir design is fit for purpose.

This project's aim is to develop an optimised design for landholders that can be used to reduce erosion on their properties with low risk of negative consequences.

2. Background

A weir can reduce the stream velocity and in turn the erosion potential. However, a weir under larger storm events can increases the upstream depth which could have unintended consequences such as flooding.

There are limited resources available to landholders on the implementation of weirs to reduce erosion, especially weirs designed to be Minimum Energy Loss (MEL) structures.

3. Methodology

Modelling various sites with the weir implemented was the approach taken. By modelling these designs, conclusions could be drawn on the effectiveness of each design under various flow conditions. Two sites were selected that had different soil, topographical and rainfall properties. This data was collected and used in the river modelling software HEC-RAS which models the flow properties and sediment transport. Each weir design was modelled and the differences recorded. The designs will then have their properties changed and re-trialled to optimise the design to one that best limits

Figure 1 - Gowrie Creek Stream Gauge (Water Monitoring Information Portal, 2011)

erosion. A cost benefit analysis can then be generated based on the results of the modelling.

4. Key Outcomes

Modelling of the designs and their optimisation and the sediment transport modelling need to be completed. The cost of implementing each design needs to be estimated. Guidelines can be developed after these results are documented.

5. Further Work

This project will produce design options that will limit the velocity upstream and downstream of the design. Due to scope restraints, no modelling will be conducted on the localised erosion due to the installation a weir. E.g. the effect of turbulent flow immediately post-weir or sedimentation build-up immediately upstream of the weir.

6. Conclusions

Final conclusions have not been drawn however early results indicate that the MEL weir design will prove to be most effective under high flow conditions. The other conclusion is evident so far is that all instream structures can reduce the velocity however their effectiveness is highly dependent flow rates

Acknowledgements

I would like to thank my family for their support. I would also like to thank Md Jahangir Alam for his guidance and support. Most of all I want to thank my wife Heidi. Without your support, I could never have finished this degree, let alone project.

References

Queensland Government, (2011). Gowrie Creek Stream Gauge, Queensland Government, Brisbane, viewed 5th August 2017, <https://water-monitoring.information.qld.gov.au>

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Use of Shape Memory Polymers (SMP) in Engineering Applications

School of Mechanical Engineering

William Robb

Bachelor of Mechanical Engineering (Honours)

Supervisors: Dr Jayantha Epaarachchi, USQ

Keywords: SHAPE MEMORY POLYMER COMPOSITES

1. Introduction

It is widely understood that composite materials offer better material characteristics compared to 'pure' material systems; such as metals, ceramics and polymers. These characteristics that a composite possesses, is motivation to try and create a component/device that is superior to similar objects produced from 'pure' materials.

2. Background

Over recent years, SMP's have been getting a lot of interest focused towards them. They are primarily related to a small family of shape memory materials, such as shape memory alloys (SMA's) and ceramics (Hiltz 2002). However, SMP's have showed much greater promise for their use in a wide variety of applications.

3. Methodology

Upon writing these abstract two tests had taken place. One was using a DMA machine to measure the material properties of the specimens. These were material properties directly related to SMP's. Such as finding the glass transition temperature, the shape fixity ability and the shape recovery ability. The other test involved using an MTS uniaxial machine to test the longitudinal tensile strength.

4. Key Outcomes

The key outcomes of this project include:

- Determining the material properties of the pre-peg carbon fibre composite lay up
- Designing a deployable structure that utilises the shape memory effect to its advantage

Figure 1: Shows specimens after being tested to failure.

- Determining the problems associated with shape memory composites. Such as testing and storage.

5. Further Work

SMP's are a relatively new research area, and thus there are still numerous areas of further research to pursue. In relation to this project, some further work would involve producing many different mechanical components to determine their viability in various engineering applications.

6. Conclusions

Due to being required to write this abstract a lot earlier than when my project testing is due to be finished, very little conclusions can be drawn. I will address this in my presentation.

Acknowledgements

I would like to thank my supervisor Jayantha Epaarachchi for helping guide me through the project. He helped a lot with supplying me with my material and sorting out my testing. I would also like to thank Wessam Al-Azzawi, Madhubhashitha Herath and Brian Lenske for helping me during my lab testing.

References

Budinski, KG & Budinski, KM 2010, Engineering Materials Properties and Selection, 9th edn, Pearson, Upper Saddle River, New Jersey.

Hiltz, JA 2002, 'Shape Memory Polymers – Literature Review', Defence R&D Canada – Atlantic, August 2002

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145

Evaluation and Cost Comparison of Pacific Highway Projects
Sponsor - Road and Maritime Services

Mitchell Rowles

Degree: Civil Engineering

Supervisors: Dr Jo Devine, USQ

School of Civil Engineering and Surveying

Keywords: Road Safety, Pacific Highway and Society

1. Introduction

This research paper aims to quantify and evaluate the effort of road safety impacts/improvements of a typical 25km pacific highway project in this case the pacific highway upgrade of Sapphire to Woolgoolga located in northern NSW which has a high concentrated traffic volumes from the local community of Coffs Harbour. This paper looks into the factors that have contributed to the road safety impacts of the new alignment; such factors include the road alignment (horizontal/vertical alignment), road furniture and minimising hazard severities, traffic volumes, and different driver characteristics (gender, age, etc.) all have impacts. In order to provide findings into the economics and effectiveness of the upgrade.

2. Background

The primary aim of this dissertation report is to investigate and document the improvements to the cost of the community and the potential cost saving as a result of providing a safer road network through applying some of these safe system approaches as part of the design and construction of the highway upgrade. It is the overall opinion of the community to expect a high level of road safety and that the new road network upgrades will produce high quality road safety outcomes, due to the high media profile that exists as a result of the aftermath of a incident or crash particular on a major highway such as the pacific highway in Australia in today's world.

3. Methodology

Extract crash data from internal RMS Crash Link Data database for both the existing and upgraded highway in relation to crash incident severities along with the final upgrade costs values from RMS internal records. Analysis and generate comparative graphs of crash incidents between both the existing and upgraded highway. Assign community costing values to crash incidents for both the existing and upgraded highway and conduct a cost/benefit analysis using the community cost of crashes versus the project costs as raw data. Provide conclusion of findings about the economics and effectiveness of the highway upgrade.

4. Key Outcomes

This research paper aims to quantify and evaluate the effort of road safety impacts/improvements of a typical 25km pacific highway project in this case the pacific highway upgrade of Sapphire to Woolgoolga located in northern NSW.

5. Further Work

Investigation into other pacific highway projects in showing, comparisons in terms of road safety impacts and improvements across different projects

6. Conclusions

That there are significant improvements in the road safety impacts and reduction in the fatality rate and that the economics and effectiveness of the highway upgrade is a productive and viable solution.

7. Acknowledgements

I would also like thank my family and my employer, the NSW Roads and Maritimes Services and in particular my fellow work colleagues who have assisted in my project and overall studies. I would also like to acknowledge the support of the University of Southern Queensland and their assistance throughout my university time.

8. References

Transport for NSW. (2014). 'Road Traffic Crashes in New South Wales'. *NSW Centre for Road Safety.* Sydney, NSW, Australia.

Australian Government, Department of Infrastructure and Regional Development, Road Safety, 8th of June 2016, https://infrastructure.gov.au/roads/safety/

Austroads (2006), 'Guide to Road Safety - Part 1: Road Safety Overview'. Sydney, NSW, Australia (Second Edition).

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Stormwater Management Solutions for Flat Terrain

Sponsor – School of Civil Engineering and Surveying

Meredith Ryan

Bachelor of Engineering
(Honours) (Civil)

Supervisors: Mr Ian Brodie

Dr Joseph Foley, USQ

Keywords: Stormwater, Stormwater Management, Low Impact Design

1. Introduction

With increasing population levels, urban development is expanding to areas previously considered undesirable for human habitation. With increased development and associated increased percentage of impervious surfaces comes increased stormwater runoff which need to be managed for the safety of people, property and the environment.

This project aims to consider areas of flat terrain and solutions to the challenges associated with stormwater management (Hoban et al, 2007).

2. Background

Urbanisation has disrupted the natural hydrological processes for thousands of years requiring the need for management of stormwater (Yao et al., 2017). As urbanisation spreads to areas where flooding and health hazards are more predominant, the traditional method of 'out of sight, out of mind' piped reticulation may need supplemented, if not replaced, with more recent concepts and technology such as Low Impact Design.

3. Methodology

This research project was undertaken as a desk study to identify current methodology and more recent developments. The design aid was developed utilising methods and concepts identified throughout the research process.

To validate the design aid, a case study of a recent development for aged care purposes is to be undertaken. This process is intended to highlight improvements in the design aid and the original design process and utilised methods.
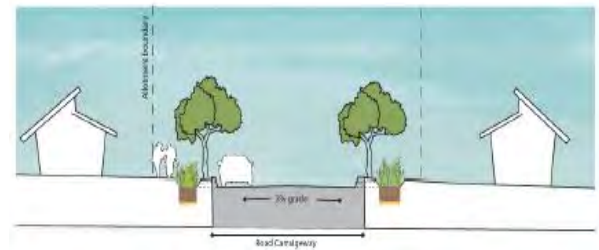
Figure 1 – Infiltration swales as a method of Stormwater Management in Urban Areas (Water by Design, 2009)

4. Key Outcomes

The key outcome of the research project is the development of design guidance for areas where the terrain itself is the challenge. It is intended that the guide may provide a basis for efficient multidisciplinary land development design.

5. Further Work

In this research project and case study, there has been a limited scope of an urban environment. However, as flat topography is not a problem specific to developed areas, it would be possible to expand the design aid to a rural setting and deal with the differing land use, space and public expectations.

Acknowledgements

References

Hoban, A., Eadie, M., & Rowlands, L. (2007). *Urban design solutions for stormwater treatment on flat sites*, Barton, A.C.T.

Water By Design. (2009). *Concept Design Guidelines for Water Sensitive Urban Design*. Brisbane.

Yao, L., Chen, L., & Wei, W. (2017). Exploring the Linkage between Urban Flood Risk and Spatial Patterns in Small Urbanized Catchments of Beijing, China. *International Journal of Environmental Research and Public Health, 14*(3), 239. doi:10.3390/ijerph14030239

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Medication Robot (Path Finding)

School of Mechanical and Electrical Engineering
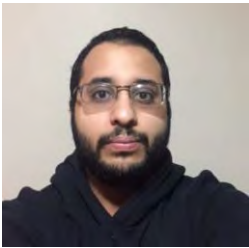
Ali Saleh

Mechatronics engineering

Supervisors: Dr Tobias Low, USQ

1. Introduction

Robotics is emerging field of science that is merging many disciples engineering like electrical engineering, mechanical engineering, computer science and many other under one umbrella. The basic purpose of designing robot is to lessen the burden of the human being to perform the automated task more quickly and efficiently as compared to any human being. This is an implementation project that will focus on path finding in a specific environment that is tested through 3D robotic simulation.

2. Background

This project is very important as it can contribute into making improvements for robotics in the medical field. Also it will help engineers who are developing robots in the medical field by giving them more options and ideas to expand upon in their projects.

3. Methodology

The methodology and process for this project is shown in the following block diagram:
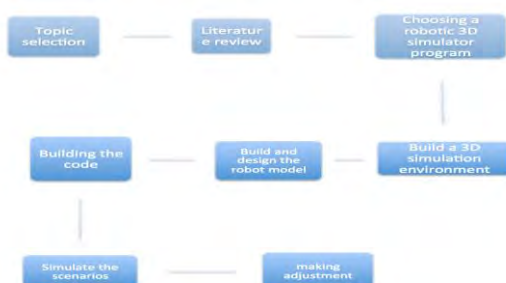
From the diagram it is shown that after the literature review the goals and objectives for this project are set. A 2D simulation program called STDR is selected to showcase the pathing difficulties that face a robot that is designed for providing services in a hospital environment and providing solutions. For the simulation to start couple of things are needed. First building the environment since STDR is the program of choice it is included. Secondly building the model for the simulated robot. Thirdly designing a pathing algorithm that serves the purpose of this project and building the code using C language. Forth choosing and testing to find appropriate sensors that will guide the robot throughout the path from point A to point B. Finally making adjustments and improvements to get better results.

4. Key Outcomes

The key outcomes of this project are:

1- building the most efficient simulation runs that could save time for nurses.

2- providing recommendations for sensors that will work in a hospital environment

3- providing solutions for obstacle avoidance in a hospital environment.

5. Further Work

Further work can be done with this project by exploring the possibility of real time prototyping. Furthermore modifications can be done to improve the obstacle avoidance algorithm.

6. Conclusions

This project will help future development for robots in the medical fields I areas such as:

1. To automate the laborious work done by the nurses in the hospitals.
2. To provide quick and easy services to the patients.
3. To give medication to the patients on their exact schedule.
4. To provide help to the patients in emergency situations.
5. To save time of the medication staff

Acknowledgements

References

Aminian, K. (2006). Monitoring Human Movement with Body-Fixed Sensors and its Clinical Applications.
http://dx.doi.org/10.1155/2015/736138

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148

Wide Area Protection using Synchrophasors

Faculty of Engineering and Surveying

Danielle Saunders

Bachelor of Electrical and
Electronic Engineering

Supervisors: Catherine Hills, USQ

Anthony Kenwrick, Powerlink

Keywords: Sychrophasors, Wide Area Protection, SIPS

1. Introduction

The objective of this research project is to determine if wide area protection using synchrophasors is viable for implementation in North Queensland. The use of synchrophasors system-wide or in a specific corridor can provide risk mitigation and enhanced security by continuous and close monitoring (Ali, Hussain & Aftab 2015). This real-time monitoring enables a real-time response to mitigate the risk of network overloads and disruption. This research project aims to evaluate if synchrophasor technology can assist in a more robust grid design and promote network reliability when paired with traditional System Integrity Protection Schemes (SIPS).

2. Background

Transmission electricity networks can become unstable in as little as 200 milliseconds, which is too fast for human management. Failure to adequately monitor and manage the network can lead to widespread blackouts. North Queensland has implemented a solution to overcome this issue which will be evaluated for efficiency and effectiveness against the synchrophasor scheme proposed within this dissertation.

3. Methodology

This research project will identify the different design options available to integrate into the existing North Queensland transmission system by determining the cost for standalone Phasor Measurement Units (PMUs) and Phasor Data Concentrators (PDCs) utilised in the solution. The design process will consider the current protection and communication solutions installed and the geographical locations of the equipment involved.
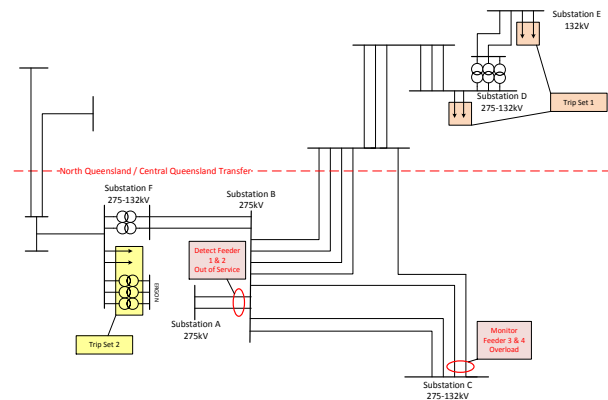
Figure 1 – Transmission Network Configuration

4. Key Outcomes

This research has resulted in the design of a synchrophasor based SIPS that will monitor and detect the loss of parallel circuits between Substation A and Substation B as shown in the Figure 1.

This dissertation compares the solution developed for North Queensland with the currently-implemented design. Once a simplified design has been tested and evaluated, a recommendation will be proposed as to whether wide area protection using synchrophasors should be implemented in the Queensland transmission network.

5. Further Work

The construction and testing of a simplified solution is yet to be completed. This will allow an informed recommendation resulting from an evaluation of the performance.

6. Conclusions

Synchrophasor based protection can be more efficient than traditional techniques used in transmission systems. This dissertation evaluated their suitability for use in the North Queensland corridor.

Acknowledgements

I would like to thank my supervisors Catherine Hills (USQ) and Anthony Kenwrick (Powerlink Queensland). I would also like to thank my husband Daniel Saunders and my close friends and family for supporting my studies over the past eight and half years.

References

Ali, I, Hussain, S & Aftab, A, 2015 'Communication modeling of Phasor Measurement Unit based on IEC 61850-90-5', *2015 Annual IEEE India Conference*, New Delhi, pp. 1-6.

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Numerical Simulation of fibre composite machining process

Sponsor – School of Mechanical and Electrical Engineering

Khaled Seraj

Bachelor of mechanical Engineering

Supervisors: Assoc Prof Belal Yousif, USQ

1. Introduction

In this project, first of all we discussed composite materials and machining processes for manufacturing. Applications of composites and how they are going to benefit us in the field of science and technology. Characteristics and manufacturing techniques of composite materials have been discussed. After that, modelling and simulation techniques for the analysis of composite materials and machining processes and different numerical techniques regarding it.

2. Background

Numerical techniques are used to improve the quality of the finished by keeping the productivity level and cost at a same level. Now we can easily analysis the effects of micro-cracks, voids and their formations inside the structure by using numerical simulations. As the technology becomes more and more advance new and improved analysis and design techniques and methodology are developed.

Recently, great advances are made in the numerical modelling of manufacturing processes including machining processes which allows the integration of material behavior with the process parameters and controls. The main purpose is to reduce the material losses, defects, improvement in the part properties and quality (Maranhão & Davim, 2010). In order to achieve such objectives, techniques like finite element analysis of microstructures, phase transformations, solidification modeling and use of statistical regression for process optimization are being used in the industry. Moreover, Artificial Intelligence AI techniques are being utilized for improving the properties and reduction in defects by reverse engineering methodology (Voelcker & Hunt, 1981).

3. Methodology

Composite materials consist of two or more different kind of materials which then combine give superior properties. Some of the composites are natural like wood while some categorize as man-made composite materials like Fiber metal based materials. Now a day, composite materials are now being used in almost all the industries like sport goods, automobile industry, safety equipment are now being utilizing the perks of such material as well as in aerospace industry. Composites made from high strength fibers like Kevlar are now saving thousands of lives as bullet proof vests, fire fighter suit are made from them.

4. Key Outcomes

The initial modelling is built based on Figure 1.the initial results showed that the machining parameters significantly influence the surface finish of the composites.
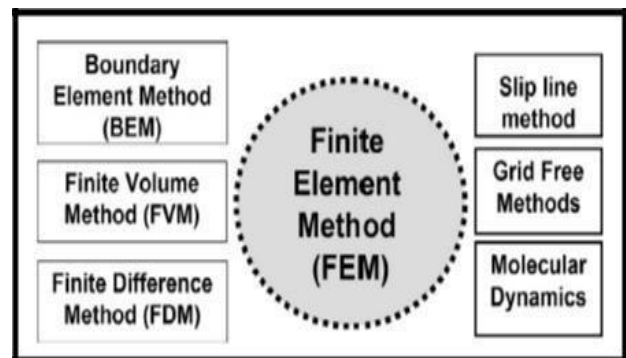

Figure 1 analysis (Comsol)

5. Conclusion and Further Work

W Operating parameters and composites structure are the key of the surface finish of the composites. Interaction of the fibers with the matrix is important as well. Mechanical properties of the fibres and the matrix are essential parameters in the material removal during the machining. Further study is required to identify the optimum operating parameters during the machining especially with hole drilling process.

References

Maranhão, C., & Davim, J. P. (2010). Finite element modelling of machining of AISI 316 steel: numerical simulation and experimental validation. Simulation Modelling Practice and Theory, 18(2), 139-156.

Voelcker, H. B., & Hunt, W. A. (1981). The role of solid modelling in machining-process modelling and NC verification (0148-7191). Retrieved from.

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Using Spatial models to Improve Information to enable better off the plan apartment purchases decisions

Sponsor –School of Civil Engineering and Surveying

David Setter

Bachelor of Spatial Science.

Supervisors: Dr Glenn Campbell, USQ

Keywords: Real Estate, VR modelling, decision making

1. Introduction

The information provided when purchasing off-the-plan apartments is currently limited to 2D floor plans, brochure pictures and display models. This paper explores how incorporating spatial models can improve the deliverance of information advance purchasing decisions.

2. Background

Current methods of displaying off-the-plan developments are restricted to paper plans and display models. What this research has enquired into is the incorporation of spatial models on a public platform such as Google Earth to deliver a more concise method of delivering accurate information of the proposed development.

3. Methodology

After the initial research into existing feasible technology, the paper explored the quality of the products, public accessibility, and distribution. Next using Notepad++, coding was written to enhance the information delivered to the client. *Figure 1* displays the spatial model with nodes to walkthrough the apartment in Google Earth.

4. Key Outcomes

Researching into the existing technology, it was practical to adopt the platform Google Earth as it is the most popular application. Successfully importing the spatial model along with an accurate viewport projections from the development. Collating relevant information typical to what is delivered in off-the-plan displays, giving the client an enhanced way to understand the development and what is being offered.
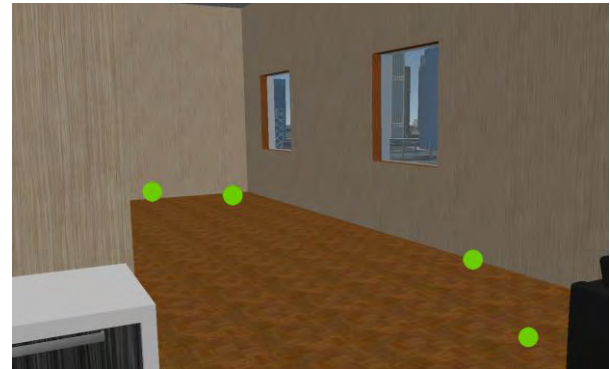
Figure 1: Spatial model of apartment within GoogleEarth

5. Further Work

The creation of an automation process can be an extension to this work and it may be deemed necessary to explore this concept further. Augmented Reality is becoming progressively consumer friendly, and whilst currently the technology is not feasible the implementation of AR into the estate industry may revolutionise the distribution of information.

6. Conclusions

The incorporation of spatial modelling into off-the-plan purchasing decisions has enhanced the way in which information can be delivered to the prospective buyer. Incorporating the Google Earth platform in delivering information has allowed the buyer to gain a better understanding to what exactly is being offered. However, many restrictions are in place within Googles' software. For example, adding a "streetview" walkthrough of the model is only available to known and trusted accounts.

Acknowledgements

References

Kunz, A *et al* (2016). *Real walking in virtual environments for factory planning and evaluation.* Procedia CIRP 44 (2016) 257-262.

Opoku. R. A. & Abdul-Muhmin, A.G. (2010). *Housing preferences and attribute importance among low-income consumers in Saudi Arabia*. Habitat International 34 (2010) 219-227

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Mine Subsidence Survey Monitoring by UAV

School of Civil Engineering and Surveying

Jeremy Seymour

Bachelor of Spatial Science

(Honours) (Surveying)

Supervisors: Zarah Gharinitat, USQ

Figure 1 –point cloud from i software

Keywords: Mine subsidence, UAV, Monitoring, Accuracy

1.   Introduction

This project is to assess the viability of the use of UAV to carry out mine subsidence surveys against current methods. Using UAV and photogrammetry processing we produced a point cloud and compared it against survey data form current survey methods, total station and GNSS. The project could then be implemented with further research over a larger scale site.

2.   Background

Mine subsidence survey is a requirement for underground coal mines in NSW. The data is gathered over different stages of a longwall retreat. The information is used for future planning of potential surface subsidence within and around the mine lease eg rail lines, highways etc. So finding faster and more cost effective ways to measure mine subsidence is important to maintain surface subsidence planning models.

3.   Methodology

Using a UAV platform to take aerial photos and generating a point cloud using Pix4d software for comparison in CAD to current survey methods. Determining the X,Y,Z differences at each subsidence mark to determine the accuracies required are achievable.

4.   Key Outcomes

To determine if mine subsidence surveys can be measured with the use of a UAV and the comparison of the data with current survey methods, total station and GNSS. Reviewing the different data sets and seeing the differences achieved.

5.   Further Work

The ideal end result is to be able to do all the subsidence surveys by UAV platform. Further work could then be done on a larger scale project and over different terrain using UAV based LiDAR sensors to generate the point cloud.

6.   Conclusions

At this time the outcome of the project is non-conclusive. Further analysis and processing is required to produce conclusive results.

Acknowledgements

References

Uysal, M., A. S. Toprak and N. Polat (2015). "DEM generation with UAV Photogrammetry and accuracy analysis in Sahitler hill." Measurement **73**: 539-543
I. Balenovic, H. Marjanovic, D. Vuletic, etc. Quality assessment of high density digital surface model over different land cover classes. PERIODICUM BIOLOGORUM. VOL. 117, No 4, 459–470, 2015

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Applications of UAV's in Floodplain Mapping

Sponsor – Department of Water Western Australia
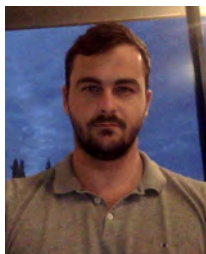
Richard Smeaton

Bachelor of Spatial Science

(Honours) Surveying

Supervisors: Dr. Xiaoye Liu, USQ

Mr Andrew Watson, Department of Western Australia

Keywords: Floodplain mapping, UAV, Digital terrain model

1. Introduction

A floodplain is the area adjacent to a river which is inundated during a flood event. These areas need to be managed to ensure the right balance of development and environmental conservation is upheld, and to ensure that the risk to human life and property is mitigated. At the core of floodplain management is the floodplain map. This project seeks to identify whether UAV's can be used in the process of generating these maps through photogrammetric techniques.

2. Background

Currently the standard practice for creating floodplain maps is to use a manned aircraft fitted with LIDAR, the aircraft fly's over a target area emitting a laser pulse to measure ranges from its on-board sensor, to the ground. This is an expensive task, and not efficient for small study areas. The potential to use UAV's for this task has been identified as a cost efficient alternative. This dissertation will provide the methodology and expected accuracies obtainable using a UAV's for floodplain mapping.

3. Methodology

For this study an area which was previously mapped using LIDAR technology, was selected see Figure 1. Using ground control points, a phantom 4 pro plus drone and Pix4d software, a floodplain map of the same area was generated. This was compared to the existing map and the differences between the two were reported on.

Figure 1 – Floodplain map of study area.

4. Key Outcomes

A comparison of the two techniques described will provide floodplain managers the methodology and expected accuracy's that can be obtained using UAV's for floodplain mapping.

5. Further Work

The recommendations included in this dissertation have been based on a comparably low cost UAV. The use of survey specific UAV's could produce more accurate results. Considerations to different site conditions should be assessed, and the methodology may need to be modified to suit differing conditions.

6. Conclusions

The key outcome of this dissertation will be determining the positional accuracies obtainable through the use of UAV's for floodplain mapping, and identify whether the results provide a sufficient alternative to LIDAR for creating floodplain maps.

Acknowledgements

References

Suh, J., & Choi, Y. (2017). Mapping hazardous mining-induced sinkhole subsidence using unmanned aerial vehicle (drone) photogrammetry. Environmental Earth Sciences , 1-12.

Tonkin, T., & Midgley, N. (2016). (G.-C. N.-f.-M. Photogrammetry, Ed.) Remote Sensing , 1-8.

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Hot Graphite Models in Axisymmetric Configurations for Re-entry Simulation in Wind Tunnels

School of Mechanical and Electrical Engineering

Leon Snuderl

Bachelor of Engineering (Honours) - Mechanical

Supervisors: Prof. David Buttsworth, USQ

Keywords: Atmospheric re-entry, heat transfer, hypersonic wind tunnel.

1. Introduction

The project presented aims to develop the capability for thermal atmospheric re-entry phenomena to be investigated using the hypersonic wind tunnel located at the USQ Toowoomba campus. The goal is to construct an apparatus compatible with the facility, and provide a means of heating a sample material to the conditions which spacecraft experience during atmospheric re-entry flight.

2. Background

The wind tunnel facility is specifically equipped and utilised for the study of hypersonic fluid flow, evaluating aerodynamic performance of sample objects. Expansion into the realm of heat transfer would allow for the study of phenomena such as the oxidation and ablation of materials within hypersonic fluid flow conditions. Oxidation and ablation being prime examples as they are fundamental aspects of design consideration for the development of heat shield technologies for use on spacecraft. The project will create opportunity for such studies to be undertaken with the inclusion of hypersonic aerodynamic conditions.

3. Methodology

Gaining familiarity with the atmospheric re-entry conditions, potential methodologies of replication and the heat transfer theory involved is the first stage in the project. A trial experiment outside the wind tunnel would then be conducted with an initial apparatus as shown in Figure 1. Subsequently the experiment would be integrated into the wind tunnel to assess compatibility with hypersonic simulation.
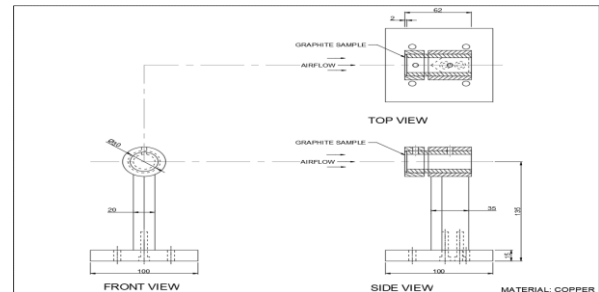
Figure 1 – Initial apparatus concept for 30mm graphite disc sample.

4. Key Outcomes

The initial experiment will test an oxygen-acetylene flame heat application process on the graphite samples. In conjunction, two-colour pyrometer cameras will be used to capture the heat intensity and distribution on the front face of the sample. The subsequent experiment will test the feasibility of integrating such a system within a wind tunnel for hypersonic simulation.

5. Further Work

The trial experiment and integration of the apparatus into the wind tunnel will be completed in September 2017. It will require an apparatus configuration which maximises the heating application while minimising the disruption to fluid flow around the sample.

6. Conclusions

The apparatus will be deemed suitable or not following the simulation in the hypersonic wind tunnel. Having a successful simulation will provide a foundation apparatus upon which oxidation and ablation may be experimentally investigated in the future.

Acknowledgements

References

Anderson, J. D. (2006). *Hypersonic and high-temperature gas dynamics*. (2nd ed.). Reston, Virginia: American Institute of Aeronautics and Astronautics.

Cengel, Y., & Boles, M. (2011). *Thermodynamics an engineering approach*. (7th ed.). New York: McGraw-Hill.

Pritchard, P. J., & Mitchell, J. W. (2015). *Introduction to fluid mechanics*. (9th ed.). Hoboken, New Jersey: John Wiley & Sons.

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Development of Crash Modification Factors Using Selected Remedial Measures at Signalised Cross Intersections

Sponsor –School of Civil Engineering and Surveying

Aruthra Somasundaraswaran

Bachelor of Engineering (Honours) Majoring in Civil Engineering

Supervisors: Mr Trevor Drysdale, USQ

Industry Partner: Department of Transport and Main Roads

Keywords: Road safety, Crash Modification Factors, Intersection analysis

1. Introduction

Over the years transportation has become an integral part of everyday life. As the use of transportation has increased so has the importance for safer travel. Many government initiatives and research has been initiated and conducted with the aim of producing safer roads for everyone. Every year road crashes cost the society many lives, substantial injury and many billion dollars (Littman 2009). It is therefore important to examine the issues that cause these accidents and determine how to reduce them. In Queensland Australia 43.5% of fatal crashes occur at intersections as at intersections there many conflicting mauvers that increase the risk of a crash occurring. This study aims to propose appropriate safety measures to the problematic signalised cross intersections in Toowoomba.

2. Background

In order to improve the safety of these intersections it is important to identify and understand the factors that contribute to the crashes at these intersections. If the factors that contribute to crashes at intersections can be identified then a more specific model can be developed to propose countermeasures to combat the issue. Existing research in the area of intersection analysis has identified that using Safety Performance Functions (SPFs) is an effect way to improve road safety.

3. Methodology

To investigate the crash frequency at an intersection the Negative Binomial and Poisson distribution will be utilised. One the factors that contributes to crashes at intersections have been identified the Empirical Bayes method will be used to detect the intersection that in in
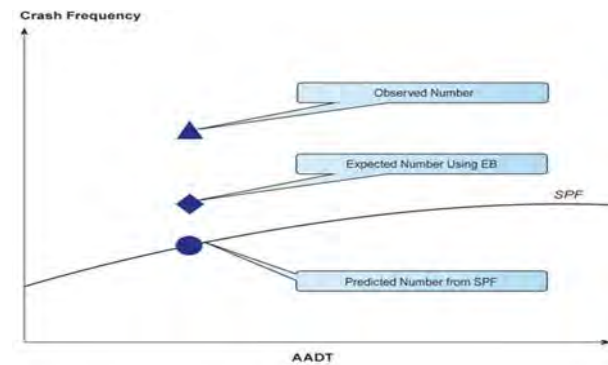
Figure 1 – Empirical Bayes Method   Source: HSM (2011)

need of attention. The developed SPFs will then be used to estimate values for Crash Modification Factors (CMFs) at the selected intersections.

4. Expected Outcomes

The analysis of the intersections is expected to produce a comprehensive research about the factors that cause or affect road crashes in Toowoomba. This will help propose suitable strategies to improve the safety at cross intersections.

5. Further Work

Further research prospects include analysis on the effectiveness of combined CMFs at intersections.

6. Conclusions

The key outcome that the project hopes to achieve is a locally developed model to analyse cross intersections in Toowoomba in the expectation that the outcomes of the research will help create safer roads for the community.

Acknowledgements

References

Litman. T (2009) *Transportation Cost and Benefit analysis.* Victoria Transport Policy Institute

HSM, (2011) *2.0 Planning: Problem Identification.* U.S Department of Transport

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Develop a policy to address the risk of rear end crashes on high-speed rural roads

School of Civil Engineering and Surveying

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Bachelor of Engineering (Honours) (Civil)

Figure 1 – Offset rural channelised left turn treatment (Department of Transport and Main Roads 2014)

Supervisors: Dr. Jo Devine, USQ

Keywords: Rear-end collision, tailgating, inattention, and distraction

1. Introduction

Rear-end crashes are one of the most frequent crash types occurring on South Australian roads (Baldock et al. 2005). This project aims to develop a decision rating tool to assist road traffic practitioners to identify a suite of the cost-effective road based safety treatments that are relevant to preventing rear-end collisions. It has been developed for use with low volume, high speed rural arterial roads and will prioritise, using a ranking system, when used to assess multiple intersections or junctions.

2. Background

Rear-end collisions account for a total of 40% of all Compulsory Third Party (CTP) claims resulting in 25% of CTP costs on Australian roads (Austroads, 2015). The Department of Planning, Transport and Infrastructure (DPTI) receive numerous requests annually from the public to install channelised left or right turn lanes or pavement widening type treatments on rural intersections or junctions to address the risk of rear-end and right-turn crashes, however, these types of projects are usually cost prohibitive and difficult to justify on a warrant and/or proactive basis.

3. Methodology

To facilitate the completion of this research project, a quantitative methodology using sensitivity analysis was employed. The research was accomplished in four stages; Stage 1 was a review of the available literature to identify contributing factors and determine a suite of cost-effective treatments. These were then tabulated matching factors and treatments. Stage 2 was to construct a weighted risk based decision tool. Stage 3 includes data collection from identified study locations. in order to validate the decision tool. Finally, the decision tool was tested.
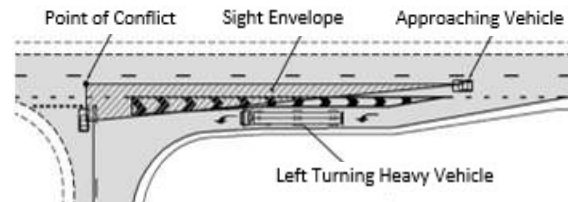
4. Key Outcomes

Through research of the literature, contributing factors and a suite of cost effective treatments that contribute to prevention of rural rear-end crashes was identified. Completion of the project will result in development of a decision rating tool used to assign a risk rating to problematic rural intersections, thus prioritising intersections for treatment and enabling identification of possible treatments.

5. Further Work

Further work within this project includes a statistical validation of weighted scoring factors used in the decision rating tool and testing of the tool. Future research may include a cost benefit analysis to budgeting purposes.

6. Conclusions

The decision tool being developed will enable the use of geographical information system (GIS) technologies to assist road technicians to make initial desktop assessments of problematic intersections, thus saving time and expenditure by recommending possible proactive treatment solutions.

Acknowledgements

References

Austroads 2015, *Investigation of Key Crash Types: Rear-end Crashes in Urban and Rural Environments*, AP-R480-15, Austroads, Sydney, NSW.

Baldock, M, Long, A, Lindsay, V & McLean, A 2005, *Rear end crashes*, CASR018, Centre for Automotive Safety Research.

Department of Transport and Main Roads, *Road Planning and Design Manual* 2014, Department of Transport and Main Roads, Queensland Government, Queensland.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

Future Trend of Retaining Walls in South East Queensland

School of Civil Engineering and Surveying

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Bachelor of Engineering
(Honours)

Supervisors: Dr Weena Lokuge, USQ

Mr Ching Meng Tan

Keywords: Pressure, Soils, Retaining.

1. Background

From household backyards to major infrastructure projects the selection of an appropriate retaining system is critical to achieve the economic, aesthetic and performance requirements set out by clients and design standards alike. With an industry climate that demands value for money, the optimisation of wall design is critical for both the client and the contractor. The project builds on existing retaining wall design methods in an attempt to further improve the performance standard set by engineers in the industry.

2. Methodology

The design theories and construction methodologies of multiple commonly placed walls in the South East were examined, and conclusions drawn relating to aesthetics, performance, cost and malleability. The bored pier retaining wall was selected to undergo an elemental design analysis. The purpose off the analysis was to identify short comings in current design iterations and optimise a design solution suitable for immediate industry use.

3. Key Outcomes

The project thus far has provided notable findings particularly with regard to the reinforced concrete elements of the wall. It has identified the potential to increase the performance capabilities of the bored pier retaining wall by manipulating member selection from those currently being used in the industry.

4. Further Work

The project still requires the finalisation of the finite element software in order to further validate and define the optimisation of elements for the retaining wall.
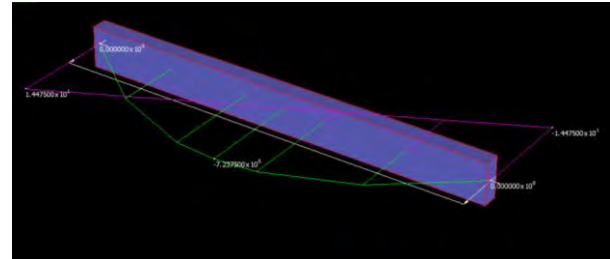
Figure 1 - Earth retention element subjected to lateral earth pressures

Research into alternative materials would be an appropriate continuation of this work in the effort to provide comparable structures with a sustainable outcome.

5. Conclusions

Thus far the project has identified key design rectifications that would greatly improve the performance ability for currently used iterations of wall design. On completion of the study optimised elements will be provided for consideration in the construction industry.

Acknowledgements

References

Al-Khafaji, A & Andersland, O (1992). *Geotechnical Engineering and Soil Testing*, Oxford University Press, Oxford.

Das B (2010). *Principals of Geotechnical Engineering,* Stamford, Connecticut, Cengage Learning.

Fenton, G Griffiths, D & Williams, M (2005). 'Reliability of Traditional Retaining Wall Design', *Geotechnique,* vol 55, no. 1, p. 55-62, viewed 10 April 2017, <https://books.google.com.au/books>

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Transmission system protection relay design and testing philosophies

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Electrical & Electronic)

Supervisors: Dr Andrew Hewitt, USQ

Keywords: Commissioning, Protection Relaying and Transmission Substation.

1. Introduction

The electrical power industry uses protection schemes to protect the stability of network, protect the infrastructure from damage while also protecting the public and employees from harm. Protection relays are an integral part of this scheme, being the device that evaluates information from other devices in the scheme to react and isolate the faulted portion of the network.

2. Background

The protection relays in a transmission network have been evolving. From electromechanical to the latest numerical relays that are considered intelligent electronic devices (IED's). With these advances have come complex devices that can achieve multiple functions. The design and testing of the relays have had to evolve with these devices. During the evolution of the relays the commissioning engineers have philosophized of what is deemed sufficient for the relay to be considered fit for purpose.

3. Methodology

Analysing current practices, philosophies and standards to establish what is thought to be acceptable it the testing that is needed to test and commission protection relays in a transmission power environment. Looking at the protection relays, identifying possible failure points associated. Allowing the examination of possible causes and assessment of the consequences was achieved using a hazard and operability study (HAZOP). This assessment identified parts if the protection relays design that requires verification in the commissioning process.
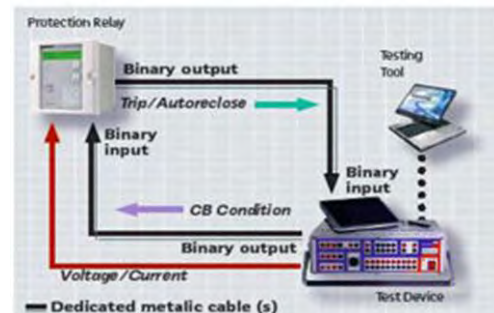

Figure 1 – Conventional test method connections

4. Key Outcomes

The methods and practices too safely, reliably and efficiently test and commission protection relays with confidence in the verification method that the device along with settings and scheme used is fit for purpose.

5. Further Work

Additional research into the practices used in other countries and Extend the research to all sectors of high voltage protection testing from generation to distribution and industry to evaluate differing situations.

6. Conclusions

With the constant evolving of the technologies used in protection relays there will always be changes in the way that these devices are tested and proved to be fit for service. With a system to evaluate and handle the changes the procedure developed in this project may help.

Acknowledgements

I would like to thank my supervisor for the support and guidance through this research, with special thanks to the contacts on linked in that responded to questions asked by myself through this project and last but not least my Wife and children who have managed to live with me during my University study and are still by my side.

Bibliography

Ohashi, HIAK 2008, *High Performance IEC 61850 GOOSE and Protection Relay Testing*, viewed 20 July 2017, <https://www.pacw.org/fileadmin/doc/WinterIssue08/protection_Toshiba_winter08.pdf>.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Modelling Supply Channel Seepage and Analysing the Effectiveness of Mitigation Options

Sponsor – School of Civil Engineering and Surveying

David Taylor

Bachelor of Civil Engineering (Honours) Major Civil

Supervisor: Mrs Justine Baillie, USQ

Keywords: irrigation, channel, seepage

1. Introduction

This project investigated the effectiveness of seepage mitigation in irrigation channels through the use of a modelling tool. The tool was created using Microsoft Excel from existing research and was setup to simulate any channel with a number of mitigation options.

2. Background

Supply channels are used extensively throughout Australia, to distribute water to farms, however great losses can occur over large distances due to evaporation and seepage. A common solution to seepage losses is through channel linings, usually a flexible membrane such as polyethylene.

These channel linings often come at great cost. A recent example is the government funded project in Trangie, NSW where the local channel network was lined with a membrane costing a total of $115 billion. This research project set out to justify the costs of such scenarios.

3. Methodology

Research was conducted on existing data into seepage losses before and after the installation of mitigation on typical channels. The data was then used to create a modelling tool in Microsoft Excel for which the characteristics for any channel could be entered and a number of seepage mitigation options analysed simultaneously. Due to the complications in estimating seepage, the model accounts for three different methods of seepage calculation

The model was used to estimate seepage for a number of case studies. The costs of each mitigation option were analysed in terms of dollars per ML of water saved.

1. Enter site characteristics		
Channel Sections (May Change Name)	Section 1	Section 2
Soil type	None	None
Seepage (L/m²/day) -	0	0
Seepage (L/m²/day) +	0	0
Existing mitigation	None	None
Effectiveness (%) -	0	0
Effectiveness (%) +	0	0
Channel Shape	Trapezoidal	Trapezoidal
Side slope: H/V (If Trapezoidal)		
Bed width (m)		
Water depth (m)		
Channel section length (m)		
Expected seepage (L/m²/day) -		
Expected seepage (L/m²/day) +		
Irrigation days/year		
Wetted perimeter (m)	0.000	0.000
Cross-sectional area (m²)	0.0000	0.0000

Figure 1 – A sample screenshot from the created model showing the data entry section for site characteristics.

4. Key Outcomes

- Existing seepage models were reviewed with other research for data to populate the model

- A new seepage model was created to simulate seepage losses in any given channel

5. Further Work

The project has been completed as intended, however further research should be conducted into the seepage losses that may occur after a channel has settled. More comprehensive soil seepage data is also needed to better simulate Australian conditions.

6. Conclusions

All the case studies analysed found negative net benefits for any proposed mitigation. Costs for water savings ranged from $19,590 to $1,337,142 per ML of water saved.

Acknowledgements

References

ANCID. (2004). *Remediation costs, benefits.* Retrieved 4 29, 2016, from http://www.channelseepage.org.au/5_remediationCosts.html

Smith, R. J. (1982). Seepage from Earthen Channels - a Review. *Agricultural Engineering Conference.* Armidale: Institution of Engineers Australia.

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Sediment loads in runoff from construction and development sites

Sponsor – School of Civil Engineering and Surveying

Rosemaree Thomasson

Bachelor of Engineering (Environmental)

Supervisor:

Dr Ian Craig, USQ

Keywords: sediment loads, water quality impacts, suspended solid analysis

1. Introduction

Development sites usually involve after site selection, vegetation removal, excavating and reshaping of landscape. In recent times, especially in rural south east Queensland, development of sites has involved an aggressive approach, leaving denuded, disturbed soil exposed to wind and rain. This disturbed soil is easily eroded and transported by wind and runoff. If the runoff from the site is not controlled, storm water discharges carry large sediment loads allowing turbid waters to enter local water ways and surrounding farm land, causing physical, chemical and biological harm to the local environment.

2. Background

In recent times the runoff from development sites in rural areas have not been closely monitored to make sure the operations are compliant under the appropriate Federal and State Government legislation.

Surrounding farm lands, in the local area, have been inundated with site runoff causing erosion and siltation of dams, thus decreasing the quality of stock drinking water. To gauge the extent of this problem, an analysis of water in a local creek was carried out.

3. Methodology

Step1. Photographic evidence; collection of water samples, collection of dead fish, downloaded rainfall from BOM involved the first step.
Step2. Fish analysis was by Queensland laboratories.
Step3.USQ Engineering Water Laboratory's equipment was used to analyse the particle and chemical content of water samples, as well as, the measurement of the electrical conductivity, turbidity and pH.
Each sample was also scanned.

4. Key Outcomes

Developers realise their social responsibilities and manage sites in the most sustainable manner possible leaving a smaller footprint upon the surrounding communities.
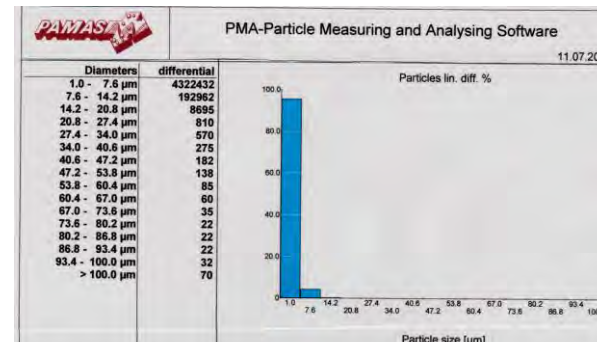
Figure 1: Shows the percentage of particles differentiated by diameter, suspended in creek water sampled within 24 hours of a 275 mm rainfall on 30 March, 2017.

5. Further Work

Tasks remaining to be completed are water analysis of runoff from rain events in spring, analysis of soil taken from above the development and cement dust analysis. Resources are not available to discover the point source of the pesticides that are suspected to cause a fish kill. Further work needs to be done to gauge the most acceptable systems that approach the natural hydrology system, to alleviate sediments from leaving the site.

6. Conclusions

The information already collected shows that developments in rural south east Queensland are not managing runoff from sites appropriately.

Acknowledgements

I would like to thank my supervisor Dr Ian Craig for his patience, assistance and support in the development and writing of this report.
I would also like to acknowledge Dr Friederike Eberhard for her expertise and assistance in water analysis.

References

Goonetilleke, A.,Thomas, E., Ginn, S. and Gilbert, D., 2005, 'Understanding the role of land use in urban stormwater quality management', *Journal of Environmental Management*, vol. 74, pp. 31–42. www.sciencedirect.com/science/article/pii/S030147970180X

Patil, S.S., Barfield, B.J. and Wilber, G.G., 2011, 'Turbidity modelling based on the concentration of total suspended solids for stormwater runoff from construction and development sites', *World Environmental and Water Resources Congress 2011*: *Bearing Knowledge for Sustainability, America Society of Civil Engineers.*

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Design flood estimation based on GRADEX

School of Civil Engineering and Surveying

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Bachelor of Engineering Honours (Civil)

Supervisors: Dr Malcolm Gillies, USQ

Keywords: Hydrology, GRADEX, Peak Estimation

1. Introduction

Estimating stormwater discharge is a key aspect of civil engineering, as it guides the design of stormwater infrastructure. In Australia, the Australian Rainfall and Runoff guidelines (AR&R) are used for estimating peak stormwater discharges. In France, a method called GRADEX is used, this method assumes that at a point the ground surface becomes saturated at which point any additional rainfall becomes runoff, allowing for a quick and accurate estimation of peak discharges.

2. Background

The GRADEX method utilises rainfall data rather than peak historical events, this is considered a more accurate and reliable data source, hence a method producing more reliable results. To date the GRADEX method has received little attention in Australia. It is the intent of this project to investigate the GRADEX method in Australian conditions.

3. Methodology

This project involved five stages, these included conducting a literature review on the history of GRADEX in Australian Conditions. Analysing rainfall data for 20 sites in North Queensland. Undertaking a GRADEX style flood estimation analysis on these sites. Then undertake a comparison flood estimation analysis using AR&R Log Pearson III (LP3) method. Using the LP3 as the control, the 1 in 10 and 1 in 100year events were compared to determine the suitability of the GRADEX method in Australian conditions.

4. Key Outcomes

This projects key outcome is to determine whether the GRADEX method is suitable in Australian Conditions. Then determining if GRADEX methods are suitable in Australia then are there standardised approaches that can be used across the method for ease of application.
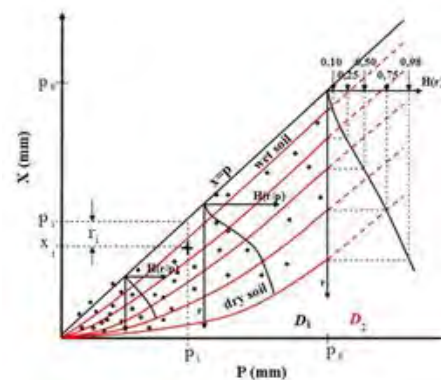

Figure 1 - Schematic chart showing rainfall volumes (p) and flood volumes (x) relationship. (Naghettini et al. 2012)

5. Further Work

This project has only considered only North Queensland sites, trialling GRADEX in Victorian catchments impacted by snowfall would be beneficial. As GRADEX methods are considered less accurate in catchments with snowfall. The project also identified that arid catchments don't work as well, further analysis into this would confirm this finding.

6. Conclusions

GRADEX methods can produce accurate results in Australia when compared against the LP3 method. Though catchments that experience less rainfall do cause some issues with the methods reliability, in general the method works well in catchments up to 10,000km^2 that receive moderate rainfall and have a frequency to flood events.

Acknowledgements

References

Naghettini, M., Gontijo, N., & Portela, M. (2012). Investigation on the properties of the relationship between rare and extreme rainfall and flood volumes, under some distributional restrictions. Stochastic Environmental Research & Risk Assessment, 32(6), 1729-1740 doi 10.1029/96WR00200

Swain, R.E., England Jr, J.F., Bullard, K.L., & Raff, D.A., (2004). Hydrologic hazard curve estimating procedures, Dam Safety Research Program Research Report DSO-04-08, US Department of Interior, Bureau of Reclamation, Denver, Colorado.

ENG4903 Professional Practice 2, University of Southern Queensland, Toowoomba, Australia.

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Evaluation of Unmanned Aerial Vehicle (UAV) Data Accuracy for the Surveying Profession

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours) (Surveying)

Supervisor: Dr Xiaoye Liu, USQ

Keywords: UAV, Accuracy, Surveying

1. Introduction

The rapid rise in the use of the affordable rotary Unmanned Aerial Vehicles (UAV) for collecting imagery has provided the professional and amateur user alike an opportunity to deliver various forms of spatial data to third parties. Access to low-cost additions sold alongside the UAV i.e. GNSS rovers, has allowed users opportunities to provide geo-referenced Digital Elevation Models (DEM) to clients without fully appreciating the accuracy of the data when compared against the appropriate methods of measurement.

The aim of the project is to determine the output accuracies of various surface types, referenced against two flight heights, whilst also considering two separate methods of measurement to control the data output.

2. Methodology

A distinct site was selected from the findings of the literature review, testing the limitations of the data output from the UAV system. Typical features were included in the survey such as concrete, roads, buildings, fencing and services to name a few. The site was flown at two heights, 15m and 40m. The Ground Control Points (GCP) used to control the imagery were also measured utilising two systems, one being the Total Station, and the other being a GNSS rover connected to the Continuously Operating Reference System (CORS). The various data sets will be compared against baseline data collected from the Total Station and analysed to provide an achievable accuracy at the 95% confidence level.

3. Key Outcomes

The paper discovered limitations of various surface types, and some surfaces such as concrete and bitumen

Figure 1 – UAV rotary drone

can be measured utilising this method and still achieve tolerances set by some government agencies. The findings also provide the achievable accuracies of the various surface types when compared against the two flight heights and the two methods of measurement with unexpected results.

4. Further Work

Investigations into data accuracy when considering recent innovations such as RTK receivers attached to the small UAV systems, including receivers attached to ground control points. Additionally, the data accuracy being further away from ground control points and the potential warping of a DEM should be investigated.

5. Conclusions

The rotary UAV system can be used to obtain reliable outcomes in certain conditions with surprisingly accurate results when compared with the Total Station and GNSS methods of measurements. It should be noted the use of the system to provide comprehensive data collected from one set of measurements, at one flight height is not recommended.

Acknowledgements

I would like to thank Dr Xiaoye Liu for being available throughout the project and for her guidance in the preparation of this paper.

References

Anderson, R., 2017. *Improving the accuracy from your Aerial Survey Drone | Commercial Drones Blog | Aviassist.* [online] Aviassist. Viewed 29/04/2017 <http://aviassist.com.au/improving-accuracy-aerial-survey/>

CASA, 2017c, Australian Government Civil Aviation Safety Authority, Canberra ACT, viewed 16/04/2017 < https://www.casa.gov.au/modelaircraft>

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Mechanical Battery Designed for Domestic Solar Power Storage

Sponsor – Own Project

Alex Trangmar
Mechanical Engineering

Supervisors: Mr Bob Fulcher, USQ

Keywords: Flywheel, Energy, Storage

1. Introduction

Since the conclusion of solar bonus schemes solar feed-in tariffs are no longer subsidised by the state governments. With energy retailers setting this price the profitability of domestic solar PV systems has been significantly reduced.

Energy storage systems allow solar producers to improve their solar self-consumption. Their energy can be stored until such times that it may be required instead of having to buy it back from the retailer at a much higher cost. Energy storage technologies must be efficient and cost effective enough to ensure the cost is not outweighed by energy supply cost.

2. Background

Chemical batteries are perhaps the most suited technology to the application; however their manufacturing cost and limited lifespan restrict these systems as a financially viable solution. Mechanical energy storage technologies have proven effective for large scale applications. Small scale applications are far less common due to low energy densities or geological requirements.

A modern flywheel design aimed at the storage requirements and duration of domestic energy usage may be an alternative to chemical energy storage.

3. Methodology

The rotor design of flywheel storage system is most critical to determining its characteristics. A preliminary design has been developed using a similar approach that Abrahamsson, Hedlund, Kamf, and Bernhoff (2014) used that includes a carbon-fibre reinforced polymer shell, active magnetic bearings and vacuum chamber enclosure.

The model has been simulated under expected operational conditions for standby losses, frictional and aerodynamic losses. Various solar production data and typical power load profiles several household have been applied to the simulation.
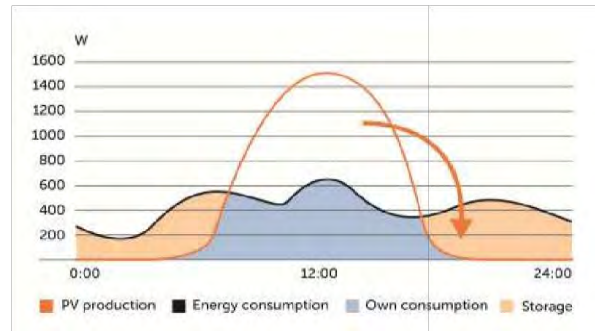
4. Key Outcomes

Determine if a flywheel ESS is technically feasible for application of improving domestic solar self-consumption. Identify the key design parameters that are most critical to ensuring the design will succeed.

5. Further Work

Design and build a working prototype to test the validity of the model and simulation.

Test data will identify deficiencies in the design and allow for improvement in subsequent designs.

6. Conclusions

Flywheel systems are susceptible to high rates of self-discharge due to losses from friction and drag on the rotor. Energy density and system efficiency are significantly lower than that of chemical battery systems.

Acknowledgements

References

Abrahamsson, J., Hedlund, M., Kamf, T., & Bernhoff, H. (2014). High-Speed Kinetic Energy Buffer: Optimization of Composite Shell and Magnetic Bearings. *IEEE Transactions on Industrial Electronics, 61*(6), 3012-3021. doi:10.1109/TIE.2013.2259782

Solar Choice. (2017). Solar energy self-consumption explained - Solar Choice. Retrieved from

http://www.solarchoice.net.au/blog/solarself-consumption-overview

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Self-Sustaining UGV- Development & Implementation of a Smart Charing System

School of Mechanical Engineering

Robert Treasure

BEngH (Mechanical)

Supervisor: Dr Tobias Low

Keywords: Innovative, Technology, Robotics

1. Introduction

My proposal is to provide a solution to the limited power source of small electric UGV's. While battery technology is improving regeneration will inevitably be required at some point. On-board solar regeneration is not a new concept however UGV's are often required to operate in regions where solar energy maybe sparsely or unevenly distributed. The goal of this project is to offer a system that is able to detect regions of high density light and plan an optimal path to guide the UGV through these lit areas to harvest maximal energy via the PV cell.

2. Background

Current systems overcoming finite power supplies limit UGV mission capabilities as they typically rely on battery transfer/charging stations or inclusion of hybrid fuel systems. Both of these systems require pre-defined, rigid mission paths. This prevents deviation from the defined route somewhat reducing the exploitation of the UGV's capabilities. Through development of this proposal greater benefits of UGV missions could be realised.

3. Methodology

In order to achieve a realisable system the UGV will be required to pause at each target location to harvest the required energy. The problem seemed to be choosing the path and optimising the route.

Before commencing research some rudimentary calculations were carried out in order to estimate power requirements for the UGV. This information allowed a preliminary guide as to the size requirements of the solar array. While there are no standards to be adhered to for array size/UGV base ratio it was important to know that a solar collector could be selected that could meet pre-determined power requirements while not being overly large compared to the UGV.

Building of the UGV chassis and supporting hardware was time consuming. Off the shelf components have been used where possible to reduce build time although the main driver (consisting of a micro-controller and two high power Hbridges) to control the UGV's motors was a custom design. Plans for this were adapted from those available on the internet.

The UGV control software was designed and compiled using Arduino IDE. This program was specifically written for the custom control board. Image acquisition and processing is accomplished using a Raspberry Pi running Open CV, an open source image acquisition program. The Raspberry Pi is responsible for rudimentary navigation and path planning/optimisation.

Figure 1 Completed UGV

4. Key Outcomes

To date the project has been successful. Further testing and development is still required however a system that is able to detect light and provide navigational information to these areas is possible. Furthermore the goal has been achieved using nonspecialised hardware and simplified algorithms.

5. Further Work

The UGV and vision system is operational and has been tested. Simplified algorithms for path planning have been implemented and require further development. Further testing and collation of data will be required for verification of the path optimisation system. Mounting of the solar array is required, once fitted final verification can be conducted.

6. Conclusions

Solar regeneration is a viable option to extend the mission capabilities of UGV's. Limitations of the system may be obvious and unavoidable in certain situations. Smaller solar panels could potentially be utilised although replenishing time will be increased. With focus placed on system efficiency optimisation this proposal may offer a realistic solution to mission ready UGV's.

References

D Nelson, D Barber, T McLain, R Beard, (No Date), 'Vector Field Path Following for Small Unmanned Air Vehicles', Research Paper

Adrian Rosebrock, Pyimagesearch, 2017, pyimagesearch, from http://www.pyimagesearch.com/start-here-learncomputer-vision-opencv/

Brodericka, J., Hartnerb, J., Tilburya, D., Atkinsa, E. (2014), Modeling and Simulation of an Unmanned Ground Vehicle Power System Mission Energy Prediction for Unmanned Ground Vehicles Using Real-time Measurements and Prior Knowledge, Journal of Field Robotics, 30(3), DOI: 10.1002/rob.21453

Evaluation of the Emergency Vehicle Priority System on the Sunshine Coast

School of Civil Engineering and Surveying

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Bachelor of Civil Engineering, Honours

Supervisors: Trevor Drysdale, USQ

Keywords: Emergency vehicle priority, traffic signals

1. Introduction

Time is a critical factor in responding to an emergency. In the modern urban environment, this response often involves the navigation through a traffic network to provide appropriate assistance by trained professionals. As urban density increases, providing emergency response to a situation becomes increasing difficult as the existing infrastructure struggles to keep pace with traffic congestion and demand. The need to reduce, or simply maintain reasonable response times to emergency situations has led to the development of emergency vehicle priority (EVP) systems. These systems aim to provide emergency vehicle heightened priority through a traffic network such that they may attend an emergency as quickly as possible.

2. Background

In order to address the issue of emergency response, the STREAMS EVP system has been developed by TRANSMAX. This EVP system utilised GPS tracking, and signal controlling software to provide emergency vehicles with prioritised green signals whilst en-route to an emergency. Evaluating the performance of this system on the Sunshine Coast is crucial in ensuring that the system is performing as intended, and being implemented where it is needed most

3. Methodology

To assess the performance of the STREAMS EVP system, both qualitative and quantitative measures were used. The quantitative time savings at intersections along an arterial corridor were found, and the theoretical safety impacts of the STREAMS EVP system were assessed and are summarised in Table 1. The current system coverage was reviewed and discussed with relation to strategic road corridors and individual intersections.

Table 1 - EVP Safety Impacts for Nicklin Way Intersections

Movement classification	Average conflicts present traversing against a Red signal
Arterial through	2.11
Arterial to side approach	2.97
Side approach through	4.13
Side approach to arterial	3.61

4. Key Outcomes

This research project shows that EVP systems are an important consideration for traffic networks both now, and in the future. Forcing a Green signal for an emergency vehicle along Nicklin Way can improve the road safety of both general road users, and emergency crews by eliminating conflict points and reduce travel time whilst responding to emergencies.

5. Further Work

Further work to be considered would be to analyse road crash data directly from the emergency services to determine any changes to the occurrences of crashes and near missed for emergency crews acting with the aid of EVP. Further comparative investigations may also wish to focus on alternate regions for EVP impact analysis.

6. Conclusions

This research shows the effect on both travel time, and road safety for emergency services through implementation of the STREAMS EVP system. Consideration should be made regarding better utilising current infrastructure to solve immerging transportation problems.

References

AARB, (2015), *Performance Evaluation of Gold Coast Emergency Vehicle Priority System'*. Contract report. ARRB Group Ltd. Vermont South, Victoria

TRANSMAX, (2015), *Emergency Vehicle Priority (EVP)*. TRANSMAX, Milton, Queensland, viewed online 28th February 2017, <https://www.transmax.com.au/~transmax/cms/images/pdfs/Publications/EVP_Case_Study.pdf>

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Evaluating the effectiveness of Overflow Relief Structures in reducing wet weather sewer overflows

School of Civil Engineering and Surveying & Queensland Urban Utilities

Megan Turner

Environmental Engineering

Supervisors: Dr Malcolm Gillies, USQ

Mr Peter Smith, QUU

Figure 1: Tideflex "duckbill" valve install installed on overflow relief structure outlet pipe in Norman Creek

Keywords: overflow relief structure, wet weather sewer overflow, backflow prevention valve

1. Introduction

Overflow relief structures (ORS) are designed in sewerage reticulation to enable an overwhelmed system to discharge directly into a waterway and therefore prevent overflows at more sensitive sites such as private property. However, in high rainfall events, the stormwater system can be just as overwhelmed as the sewerage system and high creek levels can prevent overflow relief structures from operating effectively. Furthermore, design and maintenance issues with the ORS flap valves, can cause stormwater backflow into the sewer network.

2. Background

Uncontrolled sewer overflows are an expensive, emotive and public health issue faced by sewer providers. Improved function of overflow relief structures can improve the wet weather performance of the sewer network and reduce customer impacts.

3. Methodology

As a trial, Queensland Urban Utilities installed alternative backflow prevention valves including the "duckbill" (figure 1) and "check" styles on eight different overflow relief structures. Using these sites as case studies, the research investigates if these valves have improved wet weather resilience of the network by comparing the incidence and severity of wet weather overflows both before and after installation. To aid the analysis, sewer modelling software Infoworks CS and established QUU models are used to simulate various peak wet weather flowrates and different ORS discharge conditions including free-flowing, closed and variable based on the head-loss curves of the valves.

4. Key Outcomes

The analysis indicates that the customer impact of wet weather overflows has reduced in all trial catchments except for one. In the catchment where conditions have not improved, other factors such as a new trunk main and changes in the pump station operation make it difficult to draw conclusions about the effect of the ORS modification.

5. Further Work

With approximately 800 overflow relief structures located across the QUU service area, the next step is to identify other sites to trial the new styles of backflow prevention valves.

6. Conclusions

The research indicates that new types of backflow prevention valves such as "duckbill" and "check" styles improve the performance of overflow relief structures and the wet weather resilience of the sewer network.

Acknowledgements

References

Pollard, P, Leeming, R, Bagraith, S, Greenway, M & Ashbolt, N 2005, 'Impacts of sewage overflows on an urban creek', Water (Switzerland), vol. 32, no. 1, pp. 27-32.

Bolle, A, Demuynck, A, Bouteligier, R, Bosch, S, Verwey, A & Berlamont, J 2006, 'Hydraulic modelling of the two-directional interaction between sewer and river systems', 4th International Conference on Water Sensitive Urban Design; Book of Proceedings, Monash University, p. 896.

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An Accessibility Investigation of the Gold Coast Light Rail System

Sponsor – School of Civil Engineering and Surveying

Tammee Van Bael

Bachelor of Spatial Science (Honours) (Urban and Regional Planning)

Supervisors: Dr Marita Basson, USQ

Dr Michael Grosvenor, USQ

Keywords: Accessibility, Gold Coast Light Rail, Public Transport.

1. Introduction

The reliance of the private motor vehicle and the negative detrimental effects of this reliance is now being realised. Public and active transport is being promoted as the favoured form of transport, with planners developing ways to shift public preference towards public transport. Accessibility to a public transport network has been identified as an important factor to consider in seeing this shift (Saghapour, Moridpour, & Thompson, 2016). This research project aims at investigating the accessibility of the Gold Coast light rail, and possible recommendations to improve accessibility.

2. Background

Increasingly the importance of accessibility to public transport patronage is being realised, with transport planners and policy makers focussed on ensuring public transport is highly accessible. The Gold Coast light rail is relatively new, having opened in 2014. Therefore, accessibility needs to be investigated to ensure equitable access to all individuals.

3. Methodology

An accessibility framework was developed based on the research from the literature review. This framework was used to determine the level of physical accessibility of the Gold Coast Light Rail. Three stations (Gold Coast University Hospital, Southport, and Cavill Avenue Stations were rated on various accessibility factors. The social accessibility was determined using the accessibility based upon travel time and travel cost (El-Geneidy et al., 2016).

Figure 1 – Gold Coast Light Rail Route

4. Key Outcomes

The key outcomes of this project currently are:

- Development of an accessibility to measure various factors considered important.
- Results suggest that accessibility is above average yet improvements could be made.

5. Further Work

Further work beyond this project could include a comparative analysis of accessibility of the Gold Coast light rail with other systems in Australia and globally.

6. Conclusions

This project aims to determine the level of physical and social accessibility of the Gold Coast light rail. With recommendations made on how to improve the accessibility. This will ensure all individuals on the Gold Coast have equitable access to public transport.

Acknowledgements

References

El-Geneidy, A., Levinson, D., Diab, E., Boisjoly, G., Verbich, D., & Loong, C. (2016). The cost of equity: Assessing transit accessibility and social disparity using total travel cost. *Transportation Research Part A: Policy and Practice, 91*, 302-316.

Saghapour, T., Moridpour, S., & Thompson, R. G. (2016). Modeling access to public transport in urban areas: Public Transportation. *Journal of Advanced Transportation*.

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EFFECTS OF UNEVEN TERRAIN ON AGRICULTURAL SELF-PROPELLED SPRAYER BOOM STABILITY

School of Mechanical Engineering and Surveying

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BEng(Honours) Majoring in Mechanical

Supervisors: Dr Steven Rees, NCEA

Mr Bruen Smith, NCEA

Keywords: Agriculture, Stability, Accelerometer

1. Introduction

Boom Sprayers are an important part of delivering herbicides and pesticides to crop land in Australia. On sprayers, whether stand-alone self-propelled units or "Tow behind" units are all affected by the terrain that they must travel over. Smooth ground is vastly different to rough terrain. Common sense dictates that the more undulating and rough the path the sprayer takes the more the spray boom will move. Some growers and agricultural researchers are concerned that the boom is moving far too much.

2. Background

The research project undertaken has been useful in adding value to the research of the behaviour of spray booms. This is important because it provides a pedestal for further research into the sprayer industry, ultimately optimising efficiency of farming worldwide.

3. Methodology

In order to find the movement of the boom accelerometers were placed at fixed points along one side of the boom (See figure 1). The sprayer was then driven along a test track for the sake of consistency. 3 runs were made at different speeds for a range of workable data. The raw data from the accelerometers was processed to obtain results

Rear end of Spray rig, showing Boom (Schaben Industries)

4. Key Outcomes

The research project and accompanying testing revealed the useable limits of the tested boom sprayer. As hypothesised the faster the machine travelled the more unstable the boom became. Using the spray patterns and spray angles of different nozzles available on the commercial market the useable limits of the boom were found.

5. Further Work

This research project allows for several branches of future dissertations including but not limited to using different methods to determine the movement of the boom and also the design of a spray boom that is more effective at delivering consistent chemical to the crop.

6. Conclusions

It is important to note that not all self-propelled boom sprayers are created equal and thus each different model of machine will behave in a different way. As a result, the findings can only be used by the manufacturer of the machine that the test was conducted on. The method used to obtain results in this research project can be used in the future to get similar results from other machines.

Acknowledgements

References

Jung, C. & Chung, W., 2011. *Design of Test Tracks for Odometry Calibration of Wheeled Mobile Robots.* Available at: http://journals.sagepub.com.ezproxy.usq.edu.au/doi/10.5772/45712

Reynaldo, E., Machado, T., Taubinger, L. & Quadros, D., 2016. *Vertical and horizontal oscillation of three models of self-propelled boom sprayers,* s.l.: Revista Brasileira de Engenharia Agrícola e Ambiental.

Magri, B., 2015. *Farmers academy.* [Online] Available at: https://www.fwi.co.uk/academy/lesson/boom-stability1

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A Qualitative Assessment of Close Range Photogrammetry for use in measuring Stratas/Stratums

Sponsor – School of Civil Engineering and Surveying

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(Surveying)

Supervisors: Miss Jessica Smith, USQ

Keywords: Photogrammetry, Strata, Photomodeler

1. Introduction

This project is based on a qualitative assessment of Photogrammetry for the use in measuring stratas and stratums. The current method of completing stratas is by using an electronic tape to measure in between structures, however due to advancements in technology Photogrammetry could be used to complete the same process in less time. This study will test the accuracy and applications Close Range Photogrammetric methods have when compared to traditional survey methods which will overall simplify surveying methods, without compromising accuracy.

2. Background

This dissertation will assess the application of Close Range Photogrammetric methods for the implementation in strata/stratum surveys with the intention to replace the traditional method. As a result of unit construction booming in urban city centres due to the high demand of living within Sydney, strata plans are becoming more extensive and complex, which is placing additional pressure on the declining number of qualified surveyors. This project intends to investigate whether close range photogrammetry methods can reduce the time a surveyor is on site without compromising quality

3. Methodology

A site that is representative of a typical strata subdivision was chosen. Multiple control points were placed and measured, in conjunction with measurements required to draft a strata plan. The information was processed in CivilCad to produce a coordinated system for the points and a 3D model was generated in AutoCad. Using a high resolution camera, photos were taken in a 360° rotation at various intervals within the site. The photos were collated and processed through Photomodeler, generating a 3D coordinated model for comparison. The coordinates of the control points were exported into excel from both Photomodeler and CivilCad to compare the accuracies of the method.

Figure 1 shows the positioning of the control points (green) completed when measuring the strata traditionally.

Figure - 3D model from Traditional Strata measurements

4.Key Outcomes

Testing of the Photogrammetric data is ongoing but is near completion. Providing the calibration of the camera is done correctly and an accurate 3D model is created, the coordinates of the control points can be exported and compared. If the accuracy is acceptable, the overall work time and effort to complete a strata will be minimised using the improved method.

5.Further Work

The processing of the photos into Photomodeler still needs to be completed. Once the Photogrammetric model is completed the coordinates can be compared. Future work could consist of comparing the use of a Total station in stratas rather than an electronic disto. Close Range Photogrammetry in measuring complex strata spaces (units with voids and obstructions) could also be assessed to determine the practicality of the method used in the study.

6.Conclusions

If the accuracy of the Photogrammetric methods are acceptable for a strata plan, the pressure to complete a large plan for a surveyor will be reduced. It will save the surveyor time, effort and various expenses.

Acknowledgements

I would like to thank my supervisor Miss Jessica Smith for all her help for this project. Miss Jessica Smith has provided me with unparalleled support and wisdom which has enabled me to push myself to produce my highest efforts.

References

DeChant, L 2011. Advancements in Close Range Photogrammetry for Crime scene reconstruction. viewed 23 of May 2017

Alsadik. B 2014. Guided Close Range Photogrammetry for 3D modelling of cultural Heritage sites. Viewed 23 of May 2017.

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Road Ice Skid Resistance Treatments on Upper Natone Road, Tasmania

Sponsor – Burnie City Council

Alec Walsh

Batchelor Civil Engineering (Honours)

Supervisor: Dr Andreas Nataatmadja, USQ Senior Lecturer, School of Civil Engineering and Surveying

Keywords: Road, Ice, Skid Resistance

1. Introduction

Black ice consists of a thin layer of ice on the road surface and if not adequately monitored and addressed, can result in serious or fatal motor vehicle accidents. Microclimate and friction provided by the road seal plays an integral role in the initial formation of ice and the subsequent available skid resistance. Surfacing treatments, such as de-icing chemical, are often applied to road surfaces to melt ice and snow, and maintenance practices, such as the placing crushed aggregate (gritting), may improve skid resistance and provide additional traction when ice is present.

2. Background

In this paper, Site 1, on Upper Natone Road at Horse Shoe Bend, is an asphalt sealed rural road, on a steep downhill grade and shaded by forestry plantations. This site annually receives a gritting treatment to improve the road texture and alleviate the problem caused by black ice. Some concerns have been raised with this treatment and a review, together with alternatives are considered.

Site 2, on Upper Natone Road between Kara Road and the Ridgely Highway is steep section of sprayed seal rural road, subject to regular Higher Mass Limit (HML) vehicles. As a result of heavy axle repetitions, the seal has been polished, together with bitumen bleeding to surface. In this case, ultra-high pressure water blasting has been used to return some texture to the road surface; however a sustainable reseal is required.

3. Methodology

This paper considers the skid resistance and macrotexture of various seal treatments, using locally sourced aggregates of different polished aggregate friction values (PAFV), subjected to black ice. Frozen samples were developed using domestic refrigeration and testing was undertaken using a Portable Pendulum Skid Resistance Tester, generally to AS1141.42:2017. Comparisons are made with the Modified Surface Texture Depth (Pestle Method) to Austroads AG:PT/T250. Various maintenance treatments, are also tested to determine their macrotexture and skid resistance effects.

Image 1 – Portable 'Skid Resistance' Tester

4. Key Outcomes

The study is intended to show the relationship between macrotexture depths and skid resistance, with early testing indicating a direct relationship and reduction in wet skid resistance with reduced macrotexture, accentuated by ice formation. From results, seal design and maintenance recommendations are to be developed to assist the Burnie City Council to inform future maintenance and surfacing for Upper Natone Road.

5. Further Work

Further studies may consider friction coarse open-grade asphalt, excluded from this study due to costly application in a rural environment; preferred on roads subject to ice formation, due to open texture and drainage benefits.

6. Conclusions

Improvements to microclimate, through reduced shading, and good drainage are the best means to cost effectively reduce black ice. Chemical pre-treating a site with de-icing agents can reduce ice formation, but once ice has formed, gritting can be beneficial, if not left post thaw.

Re-texturing using ultra-high pressure water blasting can improve skid resistance, but should be conducted early in a seals life, as the benefits reduce with stone polishing.

Subject to final test results, a coarse textured seal, such as a 14mm sprayed seal of high PAFV is expected to provide improved iced skid resistance over those of a lesser surface macrotexture.

Acknowledgements

References

AS1141.42: 2017, *Australian Standard - Methods for sampling and testing aggregates - Method 42; Pendulum friction test,* Standards Australia Limited

Austroads 2008, *Modified Surface texture depth (Pestle Method), AG:PT/T250*, Austroads Inc.

Jamieson, N.J 2011, *'Skid Resistance effects of common treatments for Frost and Ice – Mineral Grit and CMA'*, 3rd International Road Surface Friction Conference, Safer Road Surfaces ‑ Saving Lives, ARRB Group Ltd, Gold Coast,

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Effect of ultrasonic treatment on an Australian anaerobic digester

Sponsor – Unity Water and Royce Water Technologies Pty Ltd

Mansell Wellings

BENH (Instrumentation and Control Engineering)

Supervisors: A/Prof Bernadette McCabe, NCEA, USQ

Keywords: Anaerobic Sludge, Ultrasonic, Wastewater

1. Introduction

The waste activated treatment process removes nutrients, organic solids, and inorganic solids from waste water. These solids are removed or "wasted" to a process such as anaerobic digesters for treatment prior to disposal.

While anaerobic digesters are designed to have working lives of 25 years or more, they are often found working outside of their designed parameters. This is usually brought on by unforeseen surges in population growth. To help with this, pre-treatments have been developed to increase digester performance.

2. Background

One type of pre-treatment is ultrasonic. This is where ultrasonic energy is used to break apart sludge floc and generate some cell lysis. The combination of which is meant to improve digester performance.

While there are a number of functioning ultrasonic systems worldwide there have been no recorded applications of ultrasonics in Australia and as such there is currently no data on the subject to aid in engineering decisions.

3. Methodology

Trial of the ultrasonic technology was conducted on a full scale anaerobic digester located at Maroochydore STP. A commercially available ultrasonic reactor was used to sonicate a partial feed of anaerobic sludge. Figure 1 shows the Ultrawaves reactor. Data was taken before and after switching on the trial. From this data performance of the digester will be defined.
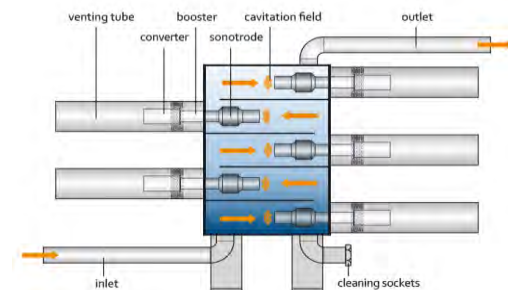
Figure 1 - Ultrawaves Reactor

4. Key Outcomes

The key performance indicator for this process was volatile solids destruction. While the data is still being analysed early indications show that the treatment has had no discernible effect on the process. This however, was due to numerous breakdowns not related to the ultrasonic technology which affected the process as a whole.

5. Further Work

After all of the break downs have been rectified it would be beneficial to run the trial again to acquire more data.

6. Conclusions

According to the literature an increase in performance is to be expected when using the ultrasonic technology. While the data doesn't show this, I believe there would be an increase under normal running conditions.

Acknowledgements

References

Balmer, P, Spinosa, L, Bien, JB, Kempa, ES, Tiehm, A, Nickel, K & Neis, U (1997), 'The use of ultrasound to accelerate the anaerobic digestion of sewage sludge', *Water Science and Technology*, vol. 36, no. 11, pp. 121-8.

Barber, WP (2005), 'THE EFFECTS OF ULTRASOUND ON SLUDGE DIGESTION', *Water and Environment Journal*, vol. 19, no. 1, pp. 2-7.

Kim, J, Park, C, Kim, T-H, Lee, M, Kim, S, Kim, S-W & Lee, J (2003), 'Effects of various pretreatments for enhanced anaerobic digestion with waste activated sludge', Journal of Bioscience and Bioengineering, vol. 95, no. 3, pp. 271-5.

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A Distributed Sensor Array for Rapid and Low-Cost Deep Oceanic Air Crash Localisation

School Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Mechatronic)

Supervisor: Dr Tobias Low, USQ

Keywords: underwater locator beacon, hydrophone, piezoelectric transducer

1. Introduction

It is well known that aircraft carry flight data recorders to assist in crash investigation, and these have acoustic underwater locator beacons (ULBs) attached to facilitate recovery from submerged crash sites. The project seeks to develop a new method for locating ULBs that is both lower in cost than conventional methods, significantly faster, and that is successful in circumstances where existing techniques fail, such as very large search areas, particularly deep water, or other non-ideal conditions. The approach uses a large array of low-cost sensors.

2. Background

Currently ULBs are found using a hydrophone array that is attached via a cable to a ship and towed over the search area. The array must often sink more than 500m to get below the seasonal thermocline, and this requires a large tow vessel that must physically traverse the search area in a grid pattern – something that is time consuming, expensive and vulnerable to weather conditions (Stone et al, 2011). The proposed solution would be deployed from aircraft during the search for floating wreckage and would be unaffected by weather.

3. Methodology

The project methodology involved researching current techniques, relevant standards, specifications, operating conditions and component information.   Prototype design included the circuit schematic, PCB layout, firmware programming and 3D modelling. Isolation testing was performed in a bathtub (Figure 1) and a vertically oriented pipe with integrated testing in a pool. Field testing will be performed in a lake.
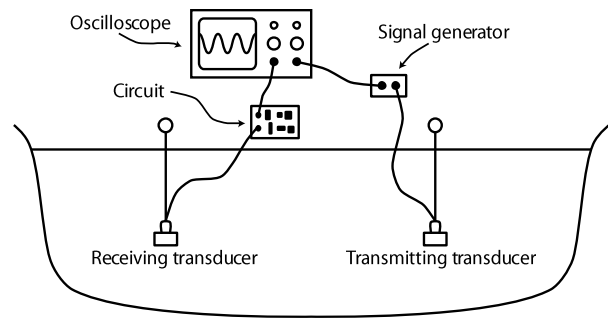
Figure 1 – Bathtub hydrophone circuit test

4. Key Outcomes

The prototype has been designed and key components have been tested in isolation and in a partially integrated state. The low-cost objective was achieved using a small number of inexpensive components, almost no moving parts, and importantly, no pressure vessel.

5. Further Work

For the current project, the prototype still requires field testing, which is expected to be at least partially successful. Looking beyond, further work is required on the hydrophone sensitivity, as well as the general robustness and reliability of the mechanical components. It will also be necessary to add a GPS receiver and satellite transmitter.

6. Conclusions

The feasibility of using an array of inexpensive sensors to locate underwater acoustic beacons has been demonstrated. With further work, it is hoped that this approach may yield significant cost savings over conventional methods.

Acknowledgements

References

Stone, L. D., Keller, C., Kratzke, T., Strumpfer, J. (2011). *Search Analysis for the Location of the AF447 Underwater Wreckage.* Report to Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile. Reston, Virginia: Metron Scientific Solutions.

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Evaluation of DTM Accuracy Based on Different Flying Heights of UAV on A Uniform Surface

Sponsor – Terramap Surveys Pty Ltd

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Bachelor of Spatial Science

Supervisors: Dr Albert Chong, USQ

Mr Alex Symonds, Terramap Surveys

Keywords: UAV, Flying Height and DTM

1. Introduction

Application of aerial photogrammetry in engineering and spatial science brings a number of benefits. There is a significant increase of UAVs during past few years in the various field including defense, safety, agriculture, recreational, surveying, natural resource management etc. In the context of surveying, UAVs are being used for graphical or thermal asset assessments, to develop high-resolution 3D aerial maps, stockpile volume calculations and topographic surveys.

2. Background

The flying height of an UAV has a considerable influence on the quality of the aerial images which will be finally impact on the quality and accuracy of the DTM generated by particular aerial photographs. With changes of flying heights, it directly effect on scale of image and ground resolution of the image. There is an area with minimum studies related to UAV flying height, usage of ground control points and its effectiveness on final outcome.

3. Methodology

The UAV will be flying over the ground surface with different restricted height intervals. As a control, the conventional surveying with total station will be undertaken. The all ground control points will be included in both surveys. The field UAV and conventional data will be processed using *Pix4Dmapper* and *terramodel* software respectively. The final DTM processed by UAV images will be compared DTMs developed by other method to assess accuracy of UAV method This could be a system diagram, a photo showing a key specimen or a graph that summarises main results

Fig 1.Flying Pattern

4. Key Outcomes

As outcome of the project, the most accurate flying height to be determined with respective number of ground control points. Further, cost, processing time and convenience with respect to flying height will be determined and finally most suitable flying height will be selected as practical application.

5. Further Work

It is important to undertake the project in different uniform surfaces such as playground with small slope, highway, airport etc. which will provide more opportunity to compare and contrast between different methods.

6. Conclusions

The scale will change with flying height and typical vertical photo in a true flat ground will produce accurate map. The incidences of relief create differences in scale due to the perspective view of the camera lens.

Acknowledgements

References

Manyoky, M. et al 2011, Unmanned Aerial Vehicle in Cadastral Application, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences

SenseFly 2017, eBee-The professional mapping drone, Viewed on 28 April 2017, <https://www.sensefly.com/drones/ebee.html>

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Using Partial Discharge Testing Techniques for Condition Monitoring of Vacuum Circuit Breakers

School of Electrical and Mechanical Engineering

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Bachelor of Engineering Honours (Power)

Supervisors: Andreas Helwig, USQ

Mr Robert Bates, Ergon Energy

1. Introduction

Since the 1960's Electricity Supply Companies around the world, including Australia, have purchased and installed Vacuum Circuit Breakers (VCB) for use in their medium voltage networks. The design has proven to be relatively inexpensive as they are intended to be maintenance free for at least 20 years and has also maintained an excellent service record with relatively few significant failures or records of deterioration.

2. Background

Partial Discharge Testing is a non-destructive condition monitoring testing method widely used for various tests in the High Voltage industry. According to CIGRE (2014), there is less than a 1 in 10000 chance of failure due to loss of vacuum within the first few years. Data collected for the research is detailed in Figure 1, and shows all VCB's produced, compared to the number of failures from 1965 to 1985.

3. Methodology

Partial Discharge Testing is utilised to determine the Partial Discharge results and to attempt to ascertain the vacuum health within a VCB. By utilising the Omicron MPD600 test set, the unit can detect varying levels of Partial Discharge which will indicate various levels of vacuum change within the vacuum interrupter chamber.

4. Key Outcomes

It is proven that Partial discharge occurs across VCB contacts when there is a loss of vacuum. Ideally, the
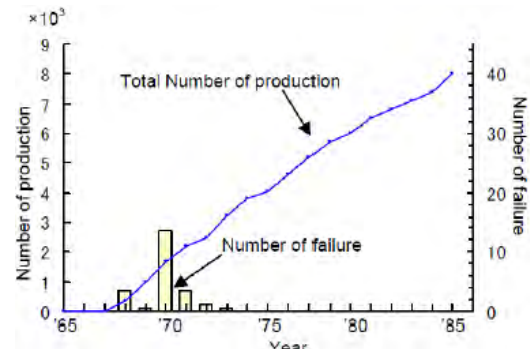
Figure 1 - Failure of VCB per year due to vacuum failure

intent is to develop a suitable Safe Work Practice that field test technicians can utilise to determine potential VCB failure.

5. Further Work

Further work is required to complete a suitable SWP that is able to be utilised within the Electricity Industry.

6. Conclusions

Successful design of the testing method and subsequent SWP will provide significantly better condition assessment ability for the Electricity Distributors such as Ergon Energy. All devices fail eventually and by understanding the probable lifespan of the current in-service VCB's it is expected that owners can make more informed decisions for their operating risk profile.

Acknowledgements

References

Falkingham L, & Reeves R, 2013, 'An appraisal of the insulation capability of vacuum interrupters after long periods of service', *2013 2nd International Conference on Electric Power Equipment - Switching Technology (ICEPE-ST)*, Matsue, 2013, pp. 1-4

Schellekens,H, 2014, 'Continuous vacuum monitoring in vacuum circuit breakers', *2014 International Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV)*, Mumbai, pp. 465-468

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Flexural behaviour of precast concrete slabs reinforced with hollow composite systems

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Keywords: FRP, Hollow Core, Concrete, Slab, Wall, Flexural, Reinforcement.

1. Introduction

Precast concrete solid slabs have been extensively in the building industry. Solid reinforced concrete (RC) slabs are heavy in weight and use significant amount of concrete to manufacture. Hollow core RC slabs are now being manufactured to minimise the weight and the usage of materials. However, the hollow core creates some issues as they are prone to shear failure. There is a need therefore to stabilise the hollow core for a more effective precast concrete slab systems.

2. Background

Hollow composite reinforcing system has recently been developed to create hollow core in RC slabs. This composite system has four flanges to bond more effective in concrete. However, there is no study conducted yet to determine the effectiveness of hollow composite reinforcing system in enhancing the flexural behaviour of concrete slabs, which is the main aim of this study.

3. Methodology

Three sample 180 mm thick slabs were prepared with different reinforcement configurations as listed in Table 1. These slabs were then tested to flexural failure in simply supported 4 loading configuration and the results were then analysed.

4. Key Outcomes

Investigate and understand the flexural behaviour of slabs reinforced with hollow composite reinforcement systems. The results shown in Figure 1 demonstrate that the slab reinforced with hollow composite systems has capacity twice that of solid RC slabs. This indicates that the thickness of this slab can be further reduced to carry the same load carried by solid RC slabs but at significantly lower weight and lesser material usage.

5. Further Work

Works to be completed on this project include:
- Theoretical analysis of the samples

Further Research on this subject could include:
- Shear behaviour and FEM analyse
- Configurations such as columns and beams

Specimen	Description	Test Set Up
S1	Solid,	
S2	PVC Hollow Core	
S3	FRP SR Hollow Core	

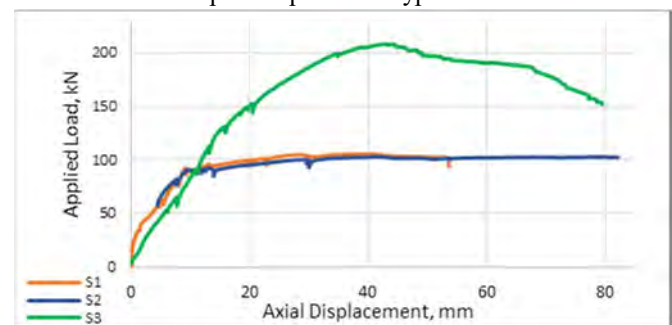Table 1. Test Setup and Specimen Types

Figure 1 Applied Load Vs. Displacement Results

6. Conclusions

Based on results obtained
- FRP reinforcement is a beneficial technology
- Slabs reinforced with hollow composite systems can have twice the strength of solid RC slabs of the same thickness
- Concrete structures could be made lighter and more cost effective using hollow composite systems.

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References

NPCAA 2003, *Hollow Core Flooring Technical Manual*, National Precast Concrete Association Australia.

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