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Heads of Schools Welcome

A very warm welcome to the University of Southern Queensland, Toowoomba Campus for the 2018 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 Undergraduate Engineering and Built Environment Conference 2018.

The Project Conference, inaugurated in 1998, is being attended by all penultimate and final year engineering and surveying students. This year there are about 500 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 Andrew Hewitt, Dr Ray Malpress, Dr Andreas Nataatmadja and Dr Wijitha Senadeera 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 Mr Sean Davidson 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 2018

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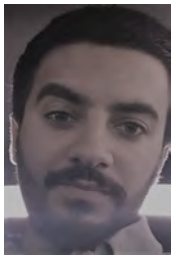
Shear strength properties of low roughness rock joints

Sponsor – Kuwait Cultural Office

School of Civil Engineering and Surveying, Faculty of health, Engineering and Sciences
University of Southern Queensland



Faisel Alenezi

Bachelor of Civil Engineering (Honours)

Supervisors: Dr Ali Mirzaghorbanali
Andreas Helwig

Keywords: Shear strength, rock joints, three dimensional roughness, various roughness ratios, normal stress

1. Introduction

Joints in a rock mass have a significant effect on the shear strength and deformation properties of the rock. Different experimental research projects have been performed since the last decades on the rock joints using the conventional direct shear apparatus under constant normal load (CNL), where the normal stress which acts on the joint was assumed to be constant during the shearing process. Hence, this project aims to investigate shear strength properties of rock joints under low normal stress values for various joints having three dimensional roughness distribution.

2. Background

The investigation in this research plays a vital role in rock excavations process and slope stability (Mirzaghorbanali et al. 2014). In this study testing was conducted based on four different normal loads, ranging from 0.1 to 0.7 MPa. The values of shear strength versus shear displacement was recorded for various rock joints having three different roughness magnitudes. This is intended to replicate planar to high rough rock joints surfaces

3. Methodology

In this study, initially a comprehensive literature review was carried out to classify past studies in the field of shear strength of rock joints, considering both clean and infilled joints. Three dimensional printer which is available at the Engineering School of University of Southern Queensland was incorporated to make moulds of low roughness rock joints. Samples were prepared using concrete on prepared moulds and left undisturbed to cure for a month before testing. Samples achieved 40 MPa of Uniaxial Compressive Strength after a month curing. Rock joints samples then were positioned inside direct shear testing machine and sheared for various normal load values at the rate of 2 mm/min.

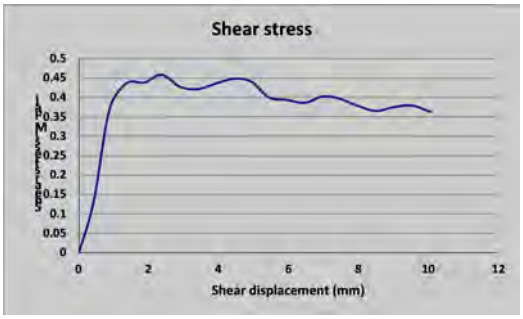


Fig. 1 – Double shear testing results

4. Key Outcomes

As shown in Figure 1, the values of shear strength increased almost monotonically up to yield point after which a number of different cycles of hardening and softening behaviour was observed. The peak shear load value decreased after each cycle due to rock joint surface degradation. In addition, it was noted that the value of shear strength is a function of normal strength as per Mohr-Coulomb frictional equation. The shearing of rock joints was associated with a dilatational process due to overriding of asperities. The dilation angle diminished during shearing because of roughness damage.

5. Further Work

Despite meticulous care being taken, there are some unavoidable limitations, this study will be further extended to include the following that has been studied as part of this investigation. Firstly, effect of shear rate on shear strength of rock joints for various normal loads. Secondly effects of shear rate on shear strength of rock joints for various roughness magnitudes.

6. Conclusions

Three-dimensional printer was shown to be an effective machine in replicating join roughness. This enabled thorough investigation of joint shear strength, having three dimensional roughness distribution under various normal load values. It was concluded that the value of shear strength is a function of joint roughness and normal stress, showing an increasing trend with increase in the values of roughness magnitude and normal stress.

7. Acknowledgements

I would like to thank my supervisors for their help and guidance. I would like to thank Daniel Eising and Peter Gregor for their support in various stages of this research work.

References

Mirzaghorbanali, A., J. Nemcik, and N. Aziz, *Effects of cyclic loading on the shear behaviour of infilled rock joints under constant normal stiffness*

Tensile strength properties of grout products commonly used in Australian civil and mining industries

Sponsor – MINOVA and Jennmar Australia

School of Civil Engineering and Surveying, Faculty of health, Engineering and Sciences

Abdullah Alfahed

BACHELOR OF ENGINEERING (HONOURS)

Supervisors: Dr Ali Mirzaghorbanali
Peter Gregor

Keywords: Tensile Strength, Curing time, Water to grout ratio.

1. Introduction

In recent advancement of engineering innovation, grout product has gained much attention in underground mining operation and strata reinforcement design. This is because grout is used for mechanical anchoring the rock and cable bolt to provide better load transfer capacity over large span of excavated underground roofs. This study is primarily intended to investigate experimentally tensile strength properties of Stratabinder HS and BU100 grout product which are widely incorporated in Australian civil and mining industries. In particular, this study will investigate the effect of curing time on tensile strength properties of grout samples using direct (dog bone) test.

2. Background

Before 1940 wooden timber was popularly used to support the underground mining roof in Australia. Due to the deteriorate character of the timber and ineffective load transfer, frequent failure of roof structure and rip collapses was the common phenomenon. Due to this timber was replaced by rock bolting technology where bolts are anchored at the bottom of the drill hole by using grout or resin. Here, grouts act as a binding medium between the surrounding rocks and cable bolts. The cable or rock bolting systems mainly consists of four components including strands, wedge and barrel, grout or resin and rock transferring the load to the deeper rock strata. Hence, possible overloading and any defects of an item may cause failure of whole systems. As noted by Mirza et al. (2016) cable bolt failures were attributed by premature failure of grout. However, no evidence was found for cable bolt failure by strand rupture. Hence, the efficiency of load transfer in encapsulated rock bolting technology is greatly influenced by the mechanical properties of grout or resin.

3. Methodology

The experimental program consists of preparing dog bone samples in order to investigate tensile strength properties of grout products. For this purpose, 60 samples were prepared based on the water to grout ratio as specified by the industry. Samples were cured at 1, 7, 14, 21 and 28 days before test. In order to investigate the tensile strength properties dog bone methodology was used according to ASTM D638-02a, using tensile testing machine at the University of Southern Queensland laboratory.

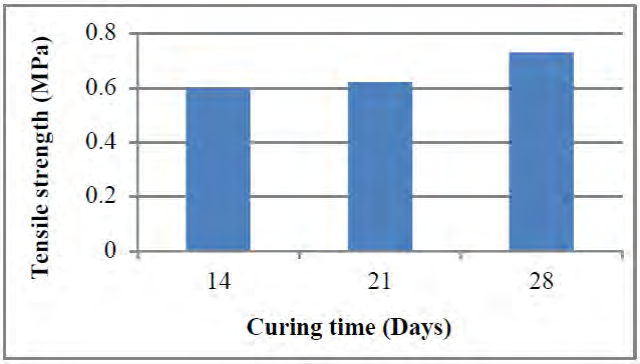


Fig. 1– Variation of tensile strength with various curing time

4. Key Outcomes

The test result showed (Fig.1) the tensile strength of 18 dog bone samples that were prepared at water to grout ratio of 0.28 and cured at 14, 21 and 28 days periods before undertake the tensile test at constant loading rate of 0.2 mm/min. As shown in Fig.1, the average tensile strength increases with the increase of curing time and the increment for 21 days curing periods was found very small compared to the 28 days curing periods. In addition, Modulus of Elasticity was found highest for 21 days curing period and lowest for 28 days period. This suggests that tensile strength of Stratabinder HS grout shows increasing trend with the increment of curing time but MoE decreases after 21 days curing periods.

5. Further Work

Experimental study will continue with the aim of investigating tensile strength properties of BU100.

6. Conclusions

The tensile strength increases with the increase of curing time. This study will provide clear understanding on load transfer mechanism and installation process of rock and cable bolt in mining operation.

7. Acknowledgements

I would like to thank MINOVA and Jennmar Australia for providing grout products.

8. References

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Coordinated control of UAV swarm using multi agent control scheme

Student Name: Abdulaziz Almarri,,Bachelor of Engineering Mechatronic
Supervisors: John Billingsley, USQ

Keywords: control, multi agent systems, UAV

1. Introduction

Recently, unmanned aerial vehicles (UAVs) are being increasingly used in a variety of applications including commerce, entertainment and military sectors. One of the key advantages of UAVs is the ability to be controlled in groups. In this project, a group of UAVs, which is referred to as a UAV swarm surround a target. Given the dynamic nature of the problem, the controller must continually update the direction of movement for each agent to track the target while maintaining a suitable arrangement.

2. Background

Nowadays, UAVs are gaining increasing mission competence thanks to the capability of target inception in groups. In addition, the pilotless nature of UAVs makes them favorable over airplanes in remote and hostile missions. The military applications of UAVs range from surveillance operations, destruction of opponent air defense, air support and accurate strike missions.

This project is focused on the case of target interception using a group of UAVs. The main challenge is to coordinate the movements of the group so as to prevent collisions while achieving the objective of target interception.

3. Methodology

The target interception problem comprises of identifying an appropriate formation which minimizes the probability of escape for the target. To achieve this goal, the UAVs must encapsulate the target by forming a polygon around it, the shape of which is determined by a top-level controller.

The mechanism of operation the UAV swarm is illustrated in Fig. 1. Initially, the UAVs are arranged in a V-shape form. The target, which is shown as a red star, is moving towards right hand side to escape from the swarm. To encapsulate the swarm, the top-level controller commands changing the arrangement from V-shape formation to pentagon formation. The low-level control scheme then controls the movement of individual UVAs so that the desirable formation is obtained. Consequently, the target is encapsulated by UAVs.

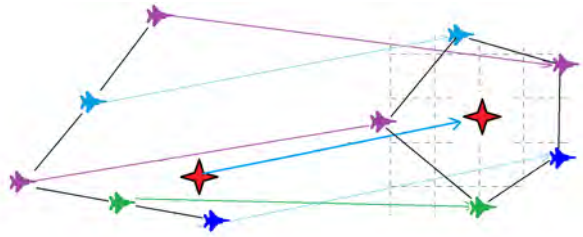

Figure 1 –Target encapsulation using a UAV swarm

4. Key Outcomes

In this project, the objective of target interception is accomplished by changing the acceleration of each UAV based on consensus protocol. This way, each UAV is attracted towards its assigned location within the formation graph.

5. Further Work

The next stage is to implement the control algorithm in in the form of a game, where the gamer plays the role of the target. While the gamer attempts to escape the swarm, the control algorithm updates the thrust force of each UAV to achieve the control objective.

6. Conclusions

The main advantage of the proposed consensus-based control method is the lack of a centralized controller, which ensures robustness in the case of a unit failure.

Acknowledgements

I would like to thank my supervisor, John Billingsley, for his support and constructive suggestions.

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Combustion of Castor oil diesel engine

Sponsor - School of Mechanical Engineering

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Bachelor of Mechanical engineering

Supervisors: Dr. Saddam H. Al-lwayzy, USQ

Dr. Talal Yusaf, USQ

Keywords: Biodiesel, Castor Oil, Diesel Engine, Engine Performance, Emissions

1. Introduction

Fossil fuel reserves are depleting, and environmental concerns are increasing. In this regard, as illustrated in Fig. 1, consumption of energy produced from the renewable source has rapidly grown since the 1990s and is expected to grow faster in the coming years. Thereby, studying renewable sources for energy production such as Biodiesels is of prime importance for the future (Das, Sarkar, Datta, & Santra, 2018).

2. Background

Non-edible vegetable oils are an attractive source for producing biodiesel as their consumption for biodiesel production will not increase food prices (Azad et al., 2016). In comparison with other non-edible vegetable oils, more oil can be produced from the castor oil seeds, and its plants endure diverse climate conditions. However, the viscosity of the raw castor oil for biodiesel is too high to be used in diesel engines (Das et al., 2018). To solve this problem, various procedures are proposed. Among them, transesterification is the most promising one (Azad et al., 2016). Nevertheless, even the esters produced by transesterification have to be diluted with the petrodiesel to avoid engine modifications.

3. Methodology

In this project, three different blends of castor oil will be studied experimentally, and their combustion characteristics will be investigated by studying various quantities such as the cylinder pressure that is generated by burning the fuel and heat release. The experimental investigation will be performed on the GUNT engine platform.

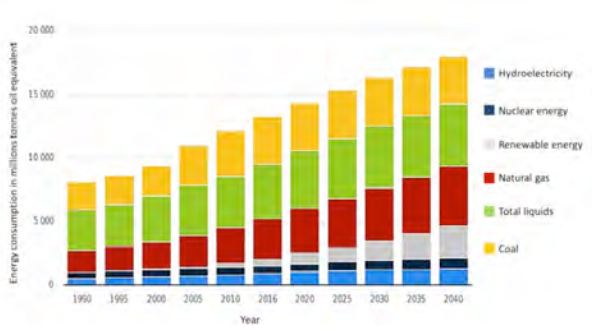

Figure 1 - Projected global energy consumption from 1990 to 2040 (Statista, 2018)

4. Key Outcomes

Results obtained from the previous experimental investigations on the performance of castor oil blends usage in diesel engines are sparse and sometimes contradictory . The key outcome of this project will be a new set of experimental data that can enhance our knowledge regarding the combustion characteristics of castor and can also be used for critical evaluation of the previous studies (Das et al., 2018).

5. Further Work

Experimental investigations should be completed, and data be gathered and analysed.

6. Conclusions

Castor oil is non-edible vegetable oil with promising potential for biodiesel production. Nonetheless, experimental data regarding its combustion in diesel engines is not enough and further studies are required.

Acknowledgements

I would like to express my sincere appreciation to my supervisors for their advice and guidance.

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Time Optimal Controller Design & Implementation for an auto TCD Probe

Sponsor – School of Mechanical Engineering and Mechatronics

Mezaid Almutairi

Bachelor of Engineering Honours

(Mechatronics)

Supervisors: Professor Paul Wen, USQ

Keywords: Optimal Control, TCD, LQR

1. Introduction

Transcranial Doppler ultrasound (TCD) is a non-invasive ultrasound method used to examine the blood circulation within the brain. Doctors use TCD to determine the amount of blood flow to certain areas of your brain. During TCD, inaudible sound waves are transmitted through the tissues of the skull. These sound waves reflect off blood cells moving within the blood vessels, allowing the radiologist to interpret their speed and direction. The sound waves are recorded and displayed on a computer screen.

2. Background

The basic working principle of TCD is based on the famous principle of the Doppler Effect. According to this principle, the frequency of the reflected ultrasound wave is different from the frequency of the transmitted ultrasound wave depending upon the direction and speed of the moving red blood cells. The difference between the frequency of the transmitted and reflected sound waves is (Doppler Shift) in Frequency, and it is directly proportional to the speed of the blood.

3. Methodology

Pointing the probe to the right direction manually is a challenging job, which is experience dependent and very time consuming. To cope with this problem, temporal window algorithm is proposed as shown below in Figure 1. Rather than scanning all the possible points to find the strongest acoustic signal, expected region of the temporal window into four virtual grids of size N × N, and each cell of the grids is scanned in systematic way. In this way, total number of scanned points reduces which shorten the search time of the auto TCD probe.

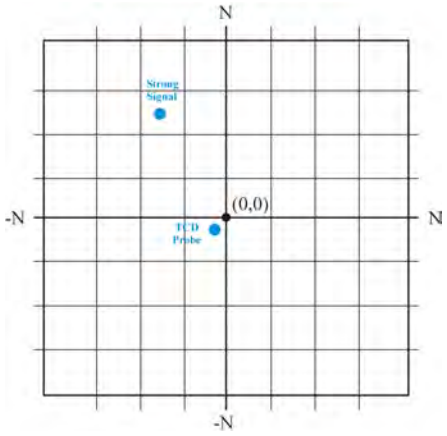

Figure 1: Temporal Window Algorithm

4. Key Outcomes

The key outcomes of this research project are;

1. To propose the algorithm which can reduce the search time of the auto TCD probe.
2. To develop the mathematical model of the TCD probe and simulate it using MATLAB.
3. To design the controller to control the dynamics of the TCD probe combining the optimal linear quadratic controller (LQR) and temporal window algorithm to shorten the search time of the strongest signal reflected from the tissues of the skull, implement this using MATLAB/Simulink.

5. Further Work

In this project, the design of the optimal controller combining LQR and temporal window algorithm will be proposed and simulated using MATLAB/Simulink. As further work, the performance of proposed controller can be tested practically with auto TCD.

6. Conclusions

The optimal controller proposed in this project can effectively shorten the search time of the auto TCD probe. The proposed controller can revolutionize the field of current auto TCD probing.

Acknowledgements

I would like to offer my gratitude to my supervisor Professor Paul Wen for his support and guidance at all stages of the completion of the project.

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The effect of octane number and energy content of the fuel containing ethanol as additive on combustion properties and engine performance

Sponsor - School of Mechanical and Electrical Engineering

Student Name; Batel Al-Rashidi

Degree: Bachelor of Mechanical Engineering.

Supervisors: Saddam Al-Lwayzy, USQ. Khalid Saleh, USQ

Keywords: Octane number, Ethanol, SI Engine performance

1. Introduction

The need to minimise the level of greenhouse gas emissions generated by the combustion of fossil fuel and the continued increase in the price of purely petroleum based products such as gasoline and diesel have necessitated research and adoption of alternative fuels. Alcohol, biodiesel and vegetable oils have been identified as viable alternative fuel options (Babu and Subramanian, 2013).

2. Background

Gasoline contains compounds that are used to boost the octane content of the fuel so as to improve the anti-knock characteristics of the fuel. Some of these compounds include TEL (Tetra Ethyl Lead), aromatics such as benzene and toluene, and MTBE (Methyl Tertiary Butyl Ether). All of these compounds are associated with poisonous air pollutants, smoke and smog among other emissions.

Ethanol has thus been proposed in this project as an alternative to improve the properties of gasoline. Ethanol is found to have wide flammability and since it is oxygenated it burns more readily which has the effect of reducing the levels of HC and CO emissions. In addition to this, addition of ethanol to gasoline leads to an increase in the octane values of the gasoline-ethanol blend created.

3. Methodology

Experiments will be carried out to investigate the effect of ethanol on the levels of emissions generated when it is combusted in an S.I engine. Three fuels will be used, Fuel 91, Premium Gasoline Fuel 98 and blend E10.

4. Key Outcomes

Studies carried out by Sharma & Lal (2015), and Pal (2014) on the use of the ethanol blends all show that the level of CO, NO_x and HC emissions were all reduced, while the volume of CO_2 was increased. This was attributed to; the presence of oxygen in the ethanol, also the A/F ratio of ethanol promotes a leaner air-fuel mixture which led to improved combustion of the fuel.

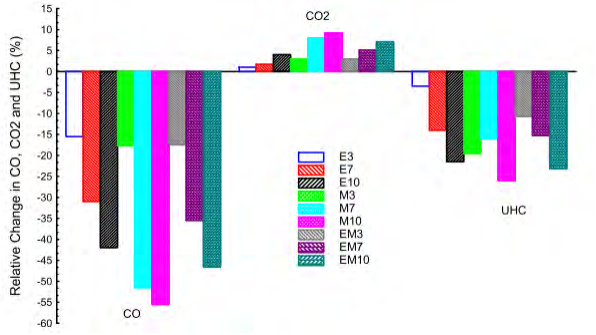

Figure 1 Change in CO, UHC and CO2 for different percentages by Ethanol and Methanol (Elfasakhany, 2015)

5. Further Work

The experimental phase of the project is still in progress. It will not be possible to operate the engine to speeds of up to 2400 as was intended due to operational limitations of the engine.

6. Conclusions

From the literature review that has been carried out on studies carried out over the years, it has been observed that the level of emissions such as CO, UHC and NO***x*** are all reduced with the combustion of ethanol blends

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Improving biodiesel combustion using commercial diesel treatment additive

USQ – Faculty of Health, Engineering and Sciences

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Bachelor of Engineering (Mechanical)

Supervisor: Dr Saddam Hussen Al-Lwayzy, University of Southern Queensland

Keywords: Biodiesel, Chemtech fuel additive, Combustion.

1. Introduction

Petroleum diesel fuel is extensively used in diesel engine because of its low cost, high stability, high efficiency and flexibility in the various operating conditions of the engine. Despite of these benefits, there are also many disadvantages associated with the diesel fuel e.g. it is depleting with passage of time, its emissions contain toxic pollutants which cause several diseases, depletion of ozone layer, formation of acid rain and reduction in visibility (A. Sydbom et al, 2001).

Adding additives to the biodiesel fuel blend might increase the performance of the engine and combustion characteristics. This project aims to investigate experimentally the performance and combustion characteristics of diesel engine fueled with blends of biodiesel and diesel with different percentages of commercial Chemtech fuel additive.

2. Background

Biodiesel is usually obtained from various types of oils like vegetable oil, palm oil, rapeseed oil and rice bran oil. It is produced by a chemical process known as transesterification. Transesterification reaction is shown in figure 1. Researches have proved that blends of biodiesel with additive fuel are compatible with the diesel engine and can be used in engine without modifications or with little modification (S. Imtenan et al, 2014).

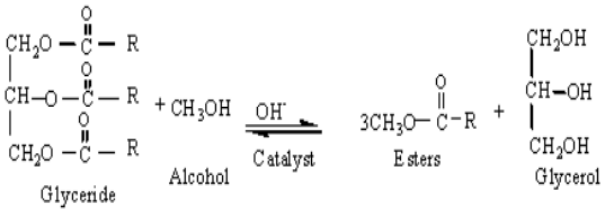

Figure 1: Transesterification reaction

3. Methodology

The methodology to be adopted to achieve the project aim consists of literature review and collecting relevant information, experimentation at the engine setup available in P7 USQ, collecting and analysing data, and finally comparing the findings with others work. The project resources require for this study include fuel viscometer, engine setup, diesel fuel, biodiesel, Chemtech fuel additive, gas analyser and glassware. All these resources are available in P7 USQ.

4. Key Outcomes

The expected outcome is that blend of biodiesel with standard diesel and Chemtech fuel additive will improve engine performance and combustion characteristics. Engine performance and combustion parameters will be measured in experiments.

5. Further Work

Experimentation at engine setup, collecting results and drawing conclusion is remaining in this project.

6. Conclusions

Expected conclusion is that adding Chemtech fuel additive will improve engine performance and combustion characteristics of diesel engine.

Acknowledgements

University of Southern Queensland is acknowledged for providing full support in using engine test facility. Also, I would like to thank Dr Saddam Hussen Al-Lwayzy for giving the opportunity to complete this research work. His supervision, expertise, guidance and support in conducting work is gratefully acknowledged.

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Effect of fibre content on coconut coir fibre reinforced epoxy composites

Faculty of Health, Engineering and Science

Essa Alwazzan

Bachelor of Engineering (Honours) - Mechanical

School of Mechanical and Electrical Engineering

Supervisor: Dr Mainul Islam

Keywords: Coir fibre, polymer composites, fabrication, properties

1. Introduction

This research project focuses onto the effect of fibre content on coir fibre reinforced epoxy composites. The main purpose of this project, is to study the effect of fibre content variation on coconut coir fibre reinforced epoxy composites. The project will study the mechanical behaviour of the coir fibre reinforced epoxy composites, the effect of loading fibre and length on the mechanical features such as tensile strength, and also flexural strength.

2. Background

Fibre reinforced composites have been applied in various applications due to their many benefits like their cost of production which is low, they are easy to fabricate and they are stronger compared to other polymer resins that are neat. Due to this, more research has been directed at coconut coir fibre with the aim of manufacturing value added goods (Da Costa, 2015).The project is vital in my field of study since there is a great opportunity that can be utilized in the fabrication of composites that are coir based so that they can be used in wider range of applications such as in construction of buildings, blocks and blocks along with flooring tiles plus reconstituted wood.

3. Methodology

The organic fibres are pulled out of the husk of the coconut fruits. The coir group is gathered from local sources and are used as reinforcement. In line with the test standards, the composites' tensile strength is obtained by use of the universal testing machine. The epoxy resin is bought from suppliers as the matrix material (Carlos, 2015). The surfaces that are fractured of the composite specimens are studied by scanning electron microscope.

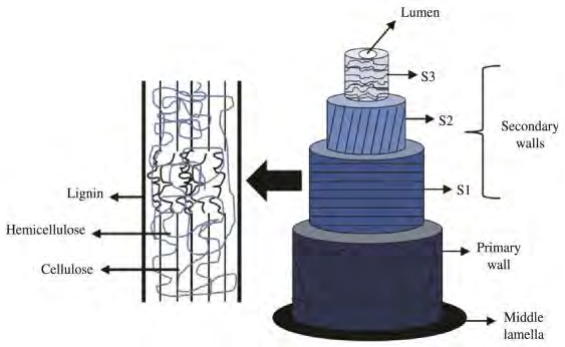

Figure 1: Parts of coir fibre *(Carlos, 2015)*

4. Key Outcomes

Through this project I have been able to come up with different contributions to the engineering field and other related fields. The project has enabled me to outline the physical and chemical components of coir fibre, fabrication of the coconut fibre reinforced epoxy composites with different fibre content, it has also enabled me to identify failure mechanisms and also characterization of the mechanical properties of the composites through tensile and flexural testing.

5. Further Work

I have been able to achieve my main objective in this project; however, I have not touched on the uses of coir fibre with respective in composites. I am yet to look at the current status of coir fibre with regards to the its status of research.

6. Conclusion

There is an increase in the use of composites that are natural based because they have many benefits. Through the project I was able to study and comprehend the various properties of coir fibre when reinforced by epoxy composites, I was also able to understand its tribological properties. The project enabled me identify failure mechanisms and also characterization of the mechanical properties of the composites through tensile and flexural testing.

Acknowledgements

I would like to thank the Allah for guiding me through this project, my family for standing with me and my supervisor for the continued support that he has given me. This project was sponsored by the Faculty of health, engineering and sciences.

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Type 1-4 Wind Turbine Generator Fault Analysis for Grid-Integration

Sponsor – School of Mechanical and Electrical Engineering

Peter Anderson

Bachelor of Engineering (Honours) (BENH)

Supervisors: Dr Tony Ahfock, USQ

Mr Peter Tree, Essential Energy

Keywords: Wind Turbine Generator (WTG), Transient, Protection.

1. Introduction

The ongoing investment, development and construction of Wind Turbine Generators (WTG), require appropriate assessment and awareness of the fault current characteristics a WTG exhibits during grid faults and the effect this has on the grid protection scheme and security of supply.

2. Background

Type 1-4 WTGs are fully-coupled, partially-coupled or decoupled from the grid. The coupling method produces varying short-circuit contributions (SCC) during faults which may include high DC offset transients. This SCC alters the characteristic impedance of the grid, by which relays are used to clear fault with classic protection schemes.

3. Methodology

The project methodology has involved the development of equivalent circuit models which represent Type 1-4 WTG's in parallel with a grid connection, undertaken using Matlab (see figure 1). A transient study has been undertaken for each WTG type to determine the SCC of each generator. The results of the fault current studies have been applied to the Gunning Wind Farm case study site, using industry modelling software (PSSE Sincal) to determine the impact a WTG has on the grid protection scheme.

4. Key Outcomes

The methodology has produced results which indicate that a Type 1 WTG will have the largest fault current contribution due to its direct-coupling. The connection of a WTG to the grid alters the characteristic impedance of the network, which may result in relay discrimination and fault clearance constraints.

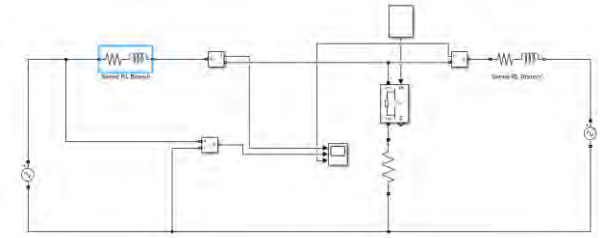

Figure 1 – Equivalent circuit diagram, Type 1 WTG.

5. Further Work

The project may be extended upon through detailed, mechanical model development which may extend upon the representation and modelling of WTGs from a grid-protection perspective.

6. Conclusions

A WTG connection to grid will alter the impedance characteristics which determine relay operation within a protection scheme. These connections must be analysed separately under a range of scenarios to ensure the security of the grid remains uncompromised.

Acknowledgements

I would like to acknowledge the incredible support and guidance provided by my supervisor, Tony Ahfock. I also acknowledge my employer, Essential Energy for the provision of study assistance, Andrew McIntyre for the assistance with leave and my partner, friends and family for ongoing support.

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Concept design of cargo aircraft on-board loader

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours)
Major Mechanical Engineering.

Supervisor: Ray Malpress, USQ

Keywords: Design, aircraft, cargo.

1. Introduction

Modern civilian cargo aircraft are dependent on ground service equipment (GSE) at the airports they land and take-off, to load and unload their cargo. For cargo aircraft, this limits their operations to major airports. With increasing demand for pharmaceutical cargo, charter, ad-hoc, and disaster relief flights (Boeing, 2017) – the ability to load and unload cargo from cargo aircraft at any airport, will allow operations independent from GSE.

2. Background

Many airports do not have the necessary GSE available to load and unload cargo aircraft. To increase the capability of cargo aircraft, a device allowing the unloading and loading of cargo irrespective of GSE availability is required.

3. Methodology

Research found several on-board loader designs that were capable of loading and unloading cargo aircraft, including the Boeing on-board loader pictured in figure 1. However, these designs all had significant shortcomings.

To improve on-board loader designs; alternative solutions were explored, design standards were consulted, and limitations of compatible aircraft and cargo were researched.

Using this information, a design specification was created. From the specification a concept on-board loader design was created. The design included major components, key capabilities and limitations. The concept design was then evaluated using the design specification for functionality, weight and size limitations, as well as FEA analysis of major components and an estimate of on-board loader cost.

Figure 1 – Boeing on-board loader (Kopp & Goon, 2004).

4. Key Outcomes

Cargo aircraft on-board loader's have been manufactured previously. However, an improved design would not require aircraft modifications and have the ability to deploy and stow from a side cargo door. An on-board loader with these capabilities would be compatible with 90% of civilian cargo aircraft.

5. Further Work

Further work on this project may include; detailed design, increasing the number of aircraft that the on-board loader is compatible with, supporting larger ULD/pallets, and improving the design to allow it to be stowed on the lower cargo deck of an aircraft.

6. Conclusions

An improved, side-door deployable on-board loader was designed. This design is suitable for 90% of modern cargo aircraft and will allow cargo loading and unloading independent of GSE.

Acknowledgements

Thanks to my supervisor, Ray Malpress who has provided invaluable direction and guidance in researching this topic. Also, thank you to Captain James Boland - Qantas, for the original research project idea. A special thanks to my wife, children, parents and friends who have supported me throughout my academic studies.

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Integrated Water management at USQ

Sponsor – School of Civil Engineering and Surveying

Luke Badart

Bachelor of Engineering Honours (Civil)

Supervisor:

Justine Baillie, USQ

Keywords: Stormwater Harvesting, Rainwater Harvesting, Urban Rainfall Runoff Modelling, Storage Behaviour Analysis, Reservoir Performance.

1. Introduction

This project aims to determine whether the Ipswich USQ Campus could benefit from utilising more local water resources through stormwater and rainwater harvesting. A combination of water accounting, rainfall runoff modelling, storage behaviour analysis and cost benefit analysis will be undertaken to determine the viability of harvesting methods at the USQ Ipswich Campus.

2. Background

Rapid urbanisation is increasing pressure on water supply infrastructure, stormwater drainage and natural waterways (Mitchell 2001). As a result of this integrated urban water management principals are being increasingly adopted with goals to reduce pressure and reliance on water infrastructure and damage to waterways. These goals are generally achieved though reduction in demand of potable supply, supplementing where possible with alternate water sources and reducing stormwater volumes entering waterways. Harvesting stormwater and rainwater is being more frequently adopted as a solution to achieve these goals (Mitchell 2001).

USQ currently employs water saving methods on their campuses such as; reusing air-conditioner condensate, efficient fixtures and harvesting rainwater and stormwater on some campuses (USQ 2014).

3. Methodology

Initial work involves characterising water use on USQ campus through water accounting methods. To do this historical water use data is analysed to produce a water balance for the Ipswich Campus.

Rainfall runoff modelling will then be used to determine daily runoff volumes produced by the campus available to be harvested through rainwater and stormwater harvesting schemes. The rainfall runoff modelling process will be undertaken using a software package named 'Aquacycle' (Mitchell 2001). Aquacycle was produced to model the urban water cycle, the model structure is shown in figure 1 below.

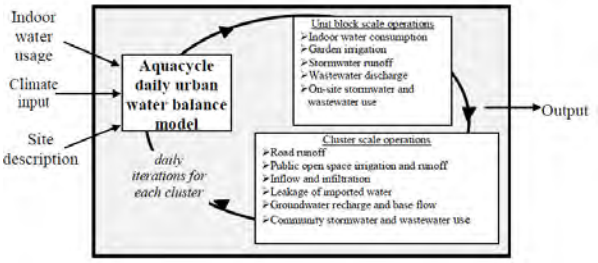

Figure 1: Model Structure of Aquacycle (Mitchell 2005)

Using simulated runoff volumes storage behaviour analysis is then used determine the performance of rainwater and stormwater harvesting stores for varying configurations. Economic analysis will then be undertaken to determine the most viable outcome and to ultimately determine the plausibility of any new water harvesting scheme at the Ipswich USQ Campus.

4. Further Work

There are many avenues of further work for this project especially in the area of Water Sensitive Urban Design stormwater treatment methods and modelling off site impacts associated with stormwater and rainwater harvesting at the Ipswich USQ Campus.

5. Conclusions

Modelling is still being undertaken at the present stage from which the conclusion will be drawn.

Acknowledgements

I would like to thank my supervisor Justine Baillie for aiding me to produce a sound project. I would also like to thank my friends and family for helping me during my studies.

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Experimental Investigation on the Structural Behaviour of GFRP Reinforced Concrete Railway Sleepers

School of Civil Engineering and Surveying

Angel Baker

Bachelor of Engineering (Honours) (Civil)

Supervisor: Dr Allan Manalo, USQ

Keywords: Railway, sleepers, glass fibre reinforcement (GFRP)

1. Introduction

There is currently no design guidelines for the design of concrete sleepers reinforced with glass fibre reinforced polymers (GFRP) bars. This project focused on analysing the suitability of concrete railway sleepers reinforced with glass fibre reinforced polymers (GFRP), with special attention being given to the detailed design of the GFRP reinforcement and appropriately analysing the developed sleeper design and behaviour in comparison with AS1085.14 design requirements.

2. Background

Prestressed concrete sleepers possess many characteristics which make it a more desirable sleeper material compared to other traditional materials such as timber and steel. However, the current problem within the railway industry is sleepers (of all materials) failing before their given design life. Corrosion of the steel is the main cause of failure associated with prestressed concrete (Ferdous & Manalo, 2014). GFRP bars are corrosion resistant therefore, this project aims to explore the suitability of concrete sleeper reinforced with GFRP bars.

3. Methodology

The methodology applied to achieve the intended key outcomes of the project was planned broadly in two stages, which are as follows:

Stage 1 - FEM analysis performed in Strand7 (shown in Figure 1) to determine maximum bending and shear stresses (positive and negative) of the proposed sleeper section under different ballast pressure. Verification of the modelling was required and completed by comparing Strand7 results to the results obtained from the BOEFF analytical solution.

Stage 2 - Fibre model analysis completed to provide a detailed design of the GFRP reinforcement and overall sleeper specimen, using results identified from the Strand7 analysis.

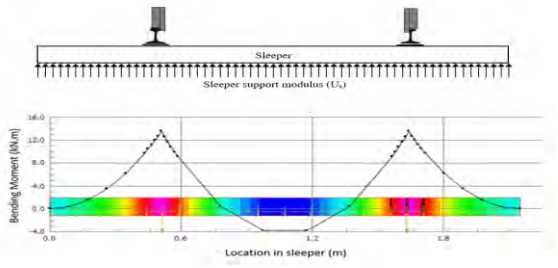

Figure 1 – Schematic diagram of sleeper (above) and bending moment in sleeper (below)

4. Key Outcomes

The key outcomes of this project so far have included Strand7 modelling determining the maximum design bending stresses and shear stresses. The results indicate the maximum positive bending and shear stresses occur when a distributed rail load is applied with a low ballast pressure. Outcomes of modelling also indicated the maximum negative bending and shear stresses occur when a point rail load is applied with a high ballast pressure.

5. Further Work

Further work to be conducted includes experimental testing in accordance with AS1085.14 procedures to assess the structural performance of the developed sleeper in comparison to AS1085.14 design requirements.

6. Conclusions

Initial modelling has identified the maximum bending and shear stresses of the proposed sleeper section and allowed detailed design to be completed. Further work will be undertaken to identify structural performance of developed sleeper and provide appropriate recommendations.

Acknowledgements

I would like to thank my supervisor for his guidance throughout this project, and also my family and friends for their ongoing support and encouragement.

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Investigating the Transient Sonochemical Efficiency of a Magnetostrictive Transducer under Resonant Conditions

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Electrical and Electronic Engineering)

Supervisors: Dr Leslie Bowtell, USQ

Keywords: magnetostrictive transducer, resonance, sonochemistry

1. Introduction

Using ultrasound to increase the effectiveness of chemical disinfectants has become increasingly popular in water treatment systems. Irradiating an aqueous solution with intense ultrasound results in cavitation where the growth and collapse of micro-bubbles in the solution cause localised regions of extreme temperatures and pressures. Such conditions are sufficient to cause the dissociation of water and the production of free hydroxyl radicals ($OH^{\cdot}$) which is highly reactive.

Combined ultrasound and chemical treatment has been used in many applications from killing microorganisms to industrial processes. Much research has focused on comparing the chemical process with and without ultrasonic treatment and different operational frequencies. This project focused on developing a feedback methodology as a first step towards investigating the sono-chemical effects at different frequencies in the region of resonance.

2. Background

In November 2016 white spot disease was first detected at all 7 prawn farms on the Logan River in South-East Queensland. Since then production has been shut-down at these farms and the cost to industry and government has been more than $100 million. This project forms part of a larger effort by the USQ and local industry to develop a water treatment system to remove the disease from intake water as it is pumped into the farms so that production can be restarted. Combined ozone and ultrasonic disinfection has been identified as a viable option where ultrasonic treatment is necessary to achieve industrial flow rates. Energy efficiency will be a key indicator of system viability. The outcomes of this project will go towards identifying possible efficiency gains in the operation of the ultrasonic transducer.

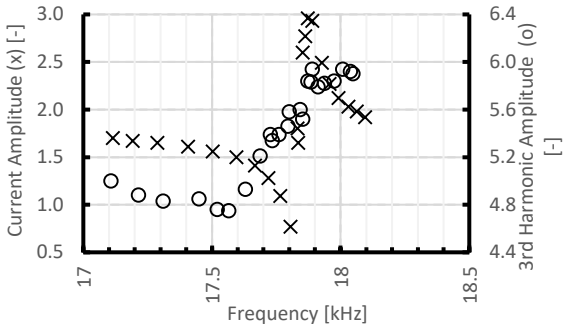

Figure 1 – Frequency dependant amplitudes

3. Methodology

A Terfenol-D ultrasonic transducer was driven by a square wave amplifier controlled by a PLC. Within the region of resonance, apart from the audibly noticeable changing cavitation activity, both the shape and amplitude of the current waveform vary. The methodology of investigating waveshape using the 3rd harmonic was adopted from Xia, 2016. An active filter circuit was developed and assembled on a PCB to amplify this harmonic content show as ‘o’ in Figure 1. An amplifier, rectifier, and smoothening circuit was prototyped to extract a DC voltage proportional to the current waveform amplitude suitable for analogue input into a PLC shown as ‘x’ in Figure 1.

4. Key Outcomes

Figure 1 compares the two methods for analysing the current waveform for frequencies in the region near resonance. The amplitude of the current waveform is better representative of the resonant behaviour than the amplitude of the 3rd harmonic

5. Further Work

Investigate the sonochemical effects at frequencies near resonance using iodine dosimetry.

6. Conclusions

The amplitude rather than the 3rd harmonic of the current waveform should be used as feedback signal in a closed loop control of the ultrasonic transducer.

Acknowledgements

My supervisor Les for his continued support.

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A Comparative Study of Fixed vs Mobile Laser Scanning for Accurate Internal Measurements

Chris Barre

Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr Xiaoye Liu, USQ

Keywords: Terrestrial Laser Scanning, Mobile Laser Scanning, TIMMS.

1. Introduction

Fixed Terrestrial Laser Scanning (TLS) has gained substantial traction within the surveying industry over the past decade. Mobile Laser Scanning (MLS) is an advancement in the that collects point cloud data from a mobile platform, usually fitted with LiDAR (Light Detection and Ranging) and a range of other sensors to help determine the position of the platform.

2. Background

A new system known as TIMMS (Trimble Indoor Mobile Mapping Solution) specialises in capturing 3D point cloud data in GNSS denied area such as the service tunnel area mapped for this study. This paper looks at determining if this platform is suitable to map a complete treatment plant to provide a 3d data set for the owner.

3. Methodology

In this study, data was collected with a FARO Focus 3D X330 and the TIMMS. A total station was used to radiate to black and white checkerboard targets, the coordinates determined by a least squares adjustment were used as known control points for the georeferencing process. The FARO and TIMMS point clouds were georeferenced onto the same datum. Once on the same datum two planes and several pipes were segmented out from both point clouds for analysis. The accuracy of the point clouds was analysed by looking at the pipe diameters determined from each data set. The quality of the data was analysed by determining how well the modelled pipes and planes fit their respective point clouds.

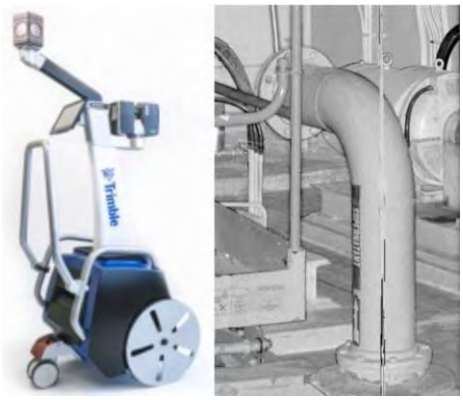

Figure 1 – TIMMS with Pipe 1 Scan

4. Key Outcomes

The results of this study indicated that the accuracy of the FARO and TIMMS were similar. However, the results from the surface analysis indicated that the quality of the TIMMS data was noticeably lower.

5. Further Work

A future study is required to analyse more complex features. These features should include valves, pumps and joins of pipes. This would give an in-depth understanding of what the accuracy and quality of the TIMMS data is when looking at complex features.

6. Conclusions

The study concluded that the TIMMS should be used to obtain a full data set of the treatment plant service tunnels. It should then be complemented with data from a fixed Terrestrial Laser Scanner in areas that require more detail or a higher quality of data.

Acknowledgements

I would like to give thanks to my supervisor, Dr Xiaoye Liu, who has provided guidance and consideration during the completion of this dissertation. I also appreciate the use of equipment and data from Taylors Development Strategists. Finally, I would like to thank my friends and family for their continued support.

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Investigation into the effect of materials and angle of incidence on reflectorless measurements

Sponsor – School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours)

Supervisor: Jessica Smith, USQ

Keywords: Reflectorless total stations (RTS), angle of incidence, reflective surface type, surveying

1. Introduction

Reflectorless total stations are commonly used within the surveying profession, using a simple, quick, automatic measurement process. This allows these measurements to be recorded without the use of placing a prism (reflector), nor a second person, only requiring a clear line of sight. Automatic measurements however, provide potential for obstructions, target materials and colours, distance and other variables to impact accuracy of instrument measurements. It is therefore vital for any potential errors to be researched, provisions made for these errors and results disseminated in order to minimise any errors. This research will focus on the impact of different target materials and the angle of incidence on the accuracy of measurements through the RTS, so as to minimise the impact these will have in real life scenarios.

2. Background

In the field surveyors encounter various target materials, along with different colours that can potentially prevent a precise reading (James 2016). Other variables such as angle of incidence, distance, battery capacity, environmental impacts were also shown to impact the accuracy of the distance measured (James 2016; Beshr & Elnaga 2011). This was demonstrated with all instruments, showing that the fault lies with the technology, not one single manufacturer.

3. Methodology

The measurements were undertaken with two manufacturers' RTS (Trimble & Leica), in order to reduce any equipment error and will take place at the Caboolture EDM baseline, providing infrastructure for accurate measurements. Materials used were: rendered brick, aluminium edging, hardwood, softwood and concrete all painted white to eliminate the variable of colour. The different angles of incidence tested included: 60, 45, 22.5, 0, -22.5, -45, -60. Qualitative analysis was used to analyse the data through Microsoft Excel where

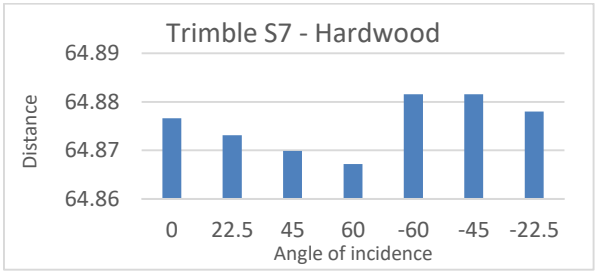

Figure 1 – Angle of incidence comparison

tables were created to reflect the error rate of the angle of incidence of certain materials and comparing between materials. Preliminary data analysis shows increasing error with increased angle of incidence (eg. Figure 1).

4. Key Outcomes

The measurements have been undertaken and data imported into Excel. Currently key outcomes show that with the increase of the angle of incidence there is an increasing error rate with further analyses to be completed. These results are interesting as they are in contrast to research found by James (2016) whose research showed little difference under 30º

5. Further Work

To complete this research, data analysis will be further explored in order to discover the extent of any errors and whether there are any systematic errors that can be mathematically modelled, so to reduce these errors within the professional field. Further research could involve testing other materials with other colours as well as testing horizontal and vertical angles.

6. Conclusions

While definitive conclusions have not yet been established, it can be seen that the aim of this research will be achieved with all materials and angles of incidence measured with analyses to be performed.

Acknowledgements

I would like to thank my supervisor Jessica Smith for her invaluable input, Lawson Becker who assisted with the measurement collection and Kingsley Becker for assistance in building the measurement apparatus.

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Developing a maintenance framework for Floodways

School of Civil Engineering and Surveying

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Bachelor of Engineering (Honours) (Civil Engineering)

Supervisors: Dr. Wenna Lokuge and Professor Karu Karunasena

Keywords: *Asset management, Floodways, Maintenance framework.*

1. Introduction

In Australia, floodways are not currently under any frequent inspection or condition assessments unless in the event of a natural disaster. The current strategy has the potential to cause more damage to the communities' assets and resilience. Thus, any delays on maintaining these critical structures can have negative effects on the resilience of the region communities. Therefore, this project works towards developing a maintenance framework for the floodways to enhance the resilience of rural communities.

2. Background

LVRC is facing flooding impacts on a more regular basis causing considerable amount of damage to the council's assets. In recent flood events that occurred in 2011 and 2013 caused significant damage to the floodways in LVRC area. The damage caused to the floodway in 2013 lead to the failure of road network leaving some rural communities isolated.

3. Methodology

A data analysis will be conducted with the available floodway inspection data and photos provided from LVRC. The available floodway data and photos are limited. The analysis will consider the current and previous condition states of each available assets with two or more inspection data sets. Then, the current available asset photos (Figure 1) will be linked with the current condition states to determine the current condition state of the floodway asset. Floodway photos of each condition will then be implemented into the maintenance framework under each floodway component.

Figure 1: LVRC - Floodway asset condition state 1.

4. Key Outcomes

Potential outcomes are to implement the maintenance framework for floodway to reduce the delays between the repair of defective structures in a post natural disaster events to improve the resilience of the rural communities.

5. Further Work

Site visits with an inspector will be necessary to gain more comprehensive information on the condition state of the floodway.

6. Conclusions

The development of the maintenance framework is yet to be determined.

Acknowledgements

I would like personally to thank my supervisors, Professor Karu Karunasena, Dr Weena Lokuge and my Family and Friends for their ongoing support, feedback throughout the entire project. Also, LVRC for supplying the data to make this research project possible.

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Impacts of Implementing High Efficiency Sediment Basins for Land Development Sediment Control within the Canberra Region

School of Civil Engineering and Surveying

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Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Rezaul Chowdhury, USQ

Keywords: Sediment, Land Development, Construction

1. Introduction

With an increasing public awareness of environmental issues, and an increasing acknowledgement of professional and corporate responsibility, land development professionals face an ongoing concern with how to best manage sediment runoff from active construction sites.

High efficiency sediment basins, or HES basins, are an emerging technology, in limited practice in Australia, which group together existing sediment basin practices with automation technologies to provide a better treatment option for construction runoff (Robson 2013).

2. Background

Sediment capture devices such as basins work to prevent sediment and pollutants from reaching the downstream environment (McCaleb 2008) but may only provide the bare minimum requirements for water quality. Poor water quality outcomes around sediments are detrimental to downstream ecosystems, populations and settlements.

3. Methodology

The research will attempt to model the efficacy of a HES basin in the context of Canberra, ACT with a scope of consideration that includes the impacts of or on the local environment, soil types, maintenance/ease of use, costs and public perception.

4. Key Outcomes

Preliminary analysis suggests that basin size can be reduced by implementing a HES basin when compared to the standard authority requirements, refer Figure 1.

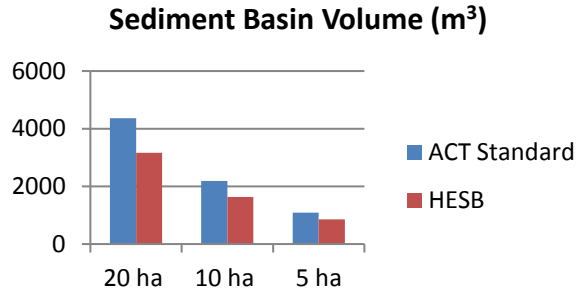

Figure 1 – Comparison of required basin volumes for different catchment sizes

This system is also expected to provide improved water quality. It is expected that HES basins will be found to be cheaper in both capital and operational cost, further proving the case for their use in the region.

5. Further Work

Physical testing of the HESB model is the next step for this research project. Collecting data from this real world implementation would allow further comprehension of the possible efficiencies, and provide some validation of this research.

6. Conclusions

Efficiencies and environmental improvements in the Land Development industry with the Canberra region can potentially be found by implementing HES basin technology.

Acknowledgements

Rezaul Chowdhury, for your expertise and advice.

Ben Cargill and Max Bomben, for all the support over the years, and the time off work.

Kieran Vale, for your unconditional love, support and the countless pep talks.

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Transient Behaviour of Three Phase STATCOMs

Sponsor – School of Mechanical and Electrical Engineering

Mark Bell

Bachelor of Engineering Honours (Power)

Supervisors: Dr Andrew Hewitt, USQ

Keywords: STATCOM, Negative Phase Sequence, DC-Bus Analysis, Reactive Power Compensation.

1. Introduction

The safe and efficient operation of a three-phase, AC electricity network is heavily dependent on system stability. Keeping a network stable requires close monitoring and maintenance of the voltage profile, under both balanced and unbalanced network conditions. Critical to this profile is the management and control of reactive power flow.

Traditionally controlled through the coordinated switching of discrete reactive power devices, such as capacitor and reactor banks, significant advances in high power electronic devices has paved the way for a new breed of dynamic reactive power controller.

Flexible AC Transmission Systems (FACTS) refers to the family of devices and schemes that utilises this technology to enhance the stability and dynamic capabilities of modern AC transmission networks.

One member of the FACTS family, and the focus of this dissertation, is the Static Synchronous Compensator (STATCOM).

2. Background

While the performance of STATCOMs under balanced network conditions has been well researched, their behaviour, in particular that of the DC-Bus in the presence of Negative Phase Sequence (NPS) voltages (unbalanced network) is not so well understood.

This project builds on previous USQ research, by modelling the DC-Bus using state space representations that are capable of accounting for system losses and finite time constants not previously considered.

3. Methodology

State space equations were developed for each of the converters switching states. These were then used to build a MATLAB model to simulate and analyse the STATCOMs performance.

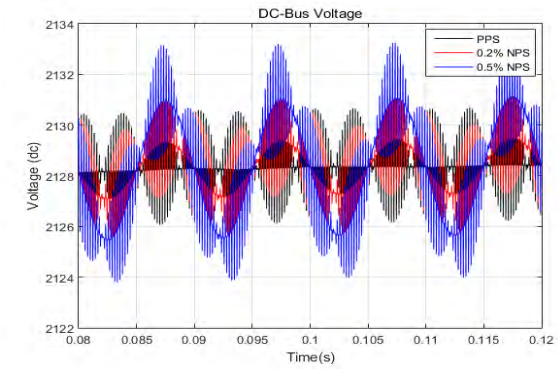

Figure 1 – STATCOM DC-Bus Profile due to NPS Voltages

4. Key Outcomes

The development of a three phase state space representation of a STATCOM, to model and investigate the behaviour of the DC-Bus voltage in the presence of network unbalance.

The model provides for an improved understanding of the STATCOMs steady state operation when subjected to NPS voltages.

Increased understanding has applications in specification development, promoting optimisation in the design, and network integration of STATCOMs.

5. Further Work

Use of the model to better understand the impact of the DC-Bus capacitor size, with the intent of reducing and managing the extent of the voltage ripple.

6. Conclusions

The preliminary results from the state space analysis show the ripple in the DC-Bus voltage is heavily dependent on the level of unbalance in the network, as shown in Figure 1.

Acknowledgements

I would like to thank Dr Andrew Hewitt for his continual willingness to avail me of both his time and knowledge in completing this project. In particular, in the development of the state space derivations and associated numerical model.

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Disused mine subsidence detection with Differential Interferometric Synthetic Aperture Radar (DInSAR)

School of Civil Engineering and Surveying

Joshua Benn

Bachelor of Spatial Science (honours) major Surveying

Supervisors: Dr Glenn Campbell, USQ

Keywords: DInSAR, Subsidence, Remote sensing

1. Introduction

The earth's surface is continually observed by remote sensing satellites utilising Synthetic-Aperture Radar (SAR). SAR data can be interrogated using an established technique known as differential interferometric synthetic-aperture radar (DInSAR). The method uses two or more SAR images to generate interferograms, or maps of surface deformation, using difference in phase of returning radar waves to the satellite (Geoscience Australia, n.d.).

The objective of this project is to investigate if DInSAR is suitable for large scale monitoring and detection of mine subsidence caused by abandoned and disused coal mines.

2. Background

Subsidence of the earth's surface can result in significant structural damage and associated maintenance costs for infrastructure and developments. Subsidence can be due to different causes such as active and abandoned mine workings, soft soils and tunnelling. Monitoring of subsidence over large areas can be time consuming and expensive.

Newcastle in New South Wales is an example of where large-scale subsidence monitoring could benefit. The first coal mine in Australia was located in Newcastle in the 1790's (NSW Government, 2018) and due to the extent of mining over the following centuries and city expansion, large areas of Newcastle continue to be impacted from abandoned mine workings.

3. Methodology

Using SAR data to produce interferograms over the greater Newcastle region, results were analysed to indicate regions of interest where phase difference could represent subsidence. The intention of the project is to detect subsidence caused by disused/abandoned mines and validate any results achieved by quantifying against data obtained from alternative surveying techniques. Figure 1 illustrates preliminary results where a difference in phase in the line of site from the satellite is observed with a simple heat map.

Figure 1 – Preliminary Results

4. Key Outcomes

A significant outcome of this research is the possibility to accurately map the extents of subsidence and the degree of impact. The accuracy and precicision will be better understood and further work as listed below will allow for trends to be analysed over time.

5. Further Work

Investigation into different satellite missions and the available wavelengths for suitability with subsidence detection. Persistent scatterer time series analysis research for analysis of trends over time.

6. Conclusions

Early indications suggest that DInSAR is an excellent tool for large scale analysis of subsidence. Results illustrate that subsidence is detected through interferogram analysis and there is a need for such a method.

Acknowledgements

I would like to acknowledge my colleague Nathan Roberts, who planted the idea after reading about it in a scientific publication. My supervisor Glenn Campbell for clear and concise guidance, therefore keeping me on track.

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Implementing a New Structural Design and Detailing Process to Improve Project Outcomes

School of Civil Engineering and Surveying

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Bachelor of Civil Engineering

(Honours)

Supervisors: Dr Jo Devine, USQ

Mr Stan Wydmanski, Prospect Solutions Pty. Ltd.

Keywords: Workflow, Shop Detailing, Structural Design, Fabrication, Project Overruns.

1. Introduction

Over the past two decades structural engineering design tools and systems have advanced greatly. Industry focus is on the technological advancements improving the actual structural design, focus needs to also be towards the fundamental workflows themselves.

Current practice within the Australian mining industry has the structural design phase flowing onto a separate shop detailing (fabrication documentation) phase.

This project conducts a research evaluation study to assess the application of a combined structural design and detailing processes, whereby the shop detailing component is completed by the engineering team.

2. Background

Current practice exposes projects to heightened risks for overruns to project schedule and costs. The design passing from engineers to detailers relies heavily on the detailers' interpretation and understanding to maintain the design intent. Areas which require additional information result in technical queries, which in turn lead to delays and additional costs. Worst case scenario is misunderstood design or incomplete detailing leading to rework and costs on site during erection.

3. Methodology

The new workflow will be applied and evaluated on real structural design projects within the Australian mining industry. Both quantitative and qualitative results will be achieved. Quantitative results such as reduction in technical queries and costs. Qualitative results such as improved information flow and management.

The evaluation research study will be conducted using the Better Evaluation Rainbow Framework (Visualise Data 2018), overall structure shown below in Figure 1.

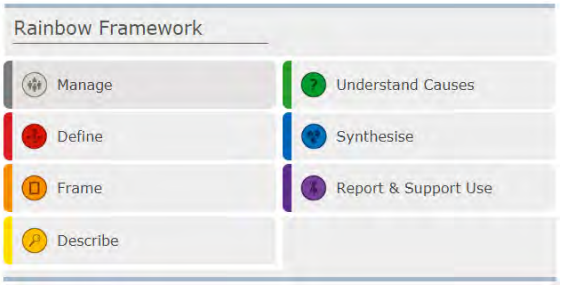

Figure 1 – Rainbow Framework (Visualise Data 2018).

4. Key Outcomes

The key outcome for the evaluation is to determine whether the combined workflow is of overall benefit to project delivery. The beneifits will be measured by reduction in costs, improvements to management and schedule.

Keeping the detailing together with the design component has already proven to simplfy change management, improve communication and reduce technical queries.

5. Further Work

The research evaluation relies on the client engagement. In many instances it has proven difficult to have the client fully adopt a new workflow. More projects will need to be delivered in this manner, firming up the potential benefits of such an approach.

6. Conclusions

This research evaluation study showcased the benefits of combining workflows. Challenges were identified in having the industry adopt these changes. Ultimately, constant review and evaluation of any accepted industry practices should always be taking place.

Acknowledgements

I would like to take the opportunity to thank Dr Jo Devine for all her project guidance and input.

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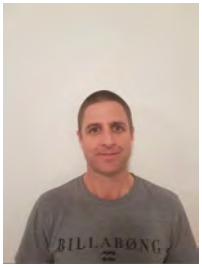
The Positional & Relative Uncertainty of Existing Boundaries

School of Civil Engineering and Surveying



Ben Blackburn

Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr Glenn Campbell, USQ

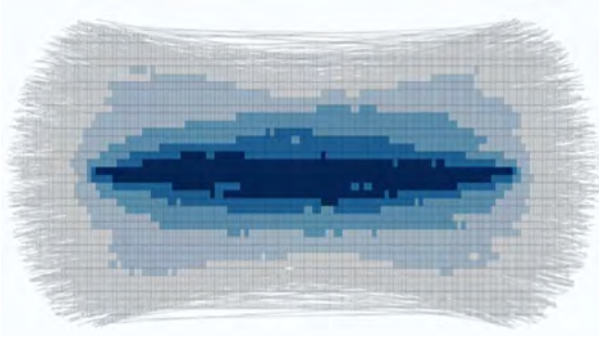


Figure 1 – Heat Map representing uncertainty of a line (QGIS)

Keywords: Positional Uncertainty, Relative Uncertainty, Cadastral Boundaries.

1. Introduction

Positional Uncertainty (PU) and Relative Uncertainty (RU) are recently introduced techniques used by spatial scientists to evaluate the absolute and relative quality of coordinates. The cadastre is a fundamental data set that has not traditionally had estimates of quality assigned to its elements.

This paper utilises PU/RU estimations to develop a generic PU value for any boundary corner/reference mark on a survey plan on the basis of the plans age and applies the PU estimates to boundary lines.

2. Background

Working groups such as ISCM's Cadastre 2034 and 3D QLD have identified a survey-accuracy cadastre as a key-driver to the role of future cadastral systems.

To implement a digital survey-accurate cadastre the effects of adjustments made when integrating new boundaries with existing need to be understood and end-users of the digital boundary need to understand spatial uncertainties.

PU estimation techniques for points have been studied extensively, however techniques for lines lack validation from real data.

3. Methodology

The research design is quantitative, although the general nature of the research question - (What is the PU/RU of existing boundaries?), resulted in the adoption of an exploratory research design. Starnet software was used for PU calculations of coordinates, QGIS used to develop PU areas over boundary lines (Figure 1) and then validated by formulae in existing literature.

4. Key Outcomes

Methodology was established to estimate a generic PU value to a survey plan on the basis of age to aid in the modernisation of digital cadastres. QGIS software has validated stimulation and analytical techniques of line PU estimations in existing literature.

5. Further Work

Development of methods to adjust digital boundaries on the basis of a lines uncertainty rather than a corner.

6. Conclusions

The exploratory nature of the research and the many factors effecting the spatial relationships of boundaries give a small insight into a complex issue.

Acknowledgements

I would like to thank Dr Glenn Campbell for mentoring and supporting me throughout this project.

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Great Barrier Reef environmental management review

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

eesa boalbanat
Bachelor of Engineering
(Honours) (Environmental Engineering)

Supervisors: Dr.Ian Graig
Keywords: great Barrier Reef, pesticides, environment.

1. Introduction

Great Barrier reef, known as the largest structure made by living organisms, is a vast ecosystem spanning a large area off the coast of Queensland, Australia. It is recognised as a world heritage, as it offers many one-of-a-kind attractions and its biodiversity is also unique. Recent environmental impacts have caused disturbance in the life cycle of this massive structure, and the last two or three years have seen considerable damage to this coral reef. Unless remedial actions on a state and international levels are taken, this trend is likely to worsen with dire consequences.

2. Background

Among a number of environmental and man-made risk factors threatening the health and life of the coral reef, the major one is perhaps the bleaching phenomenon. The data shows that the 2016 bleaching was a major disaster with some reefs having 29 percent of their corals bleached, while in other areas the percentage was around 75. The principal cause of this event is identified as rising temperature, driven by global warming.

3. Methodology

In this project, a brief introduction of the Great Barrier Reef has been made, which is to provide an understanding of the elements of the reef and how it can be affected by various factors. This is followed by looking at the major risk factors contributing to the damaging of the reef. Each factor was investigated and a case study looking into the bleaching event of 2016 was investigated with rather more depth. Finally, a number of precautionary and remedial measure are introduced, followed a personal estimate of the future of the reef is provided. The internet resources and case reports released by the Australian governing bodies were studied and reported.

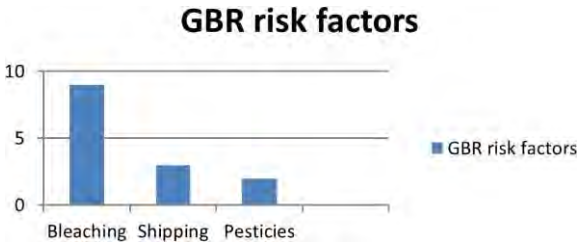

Figure 1 - Sample Diagram

4. Key Outcomes

From this project, a number of key ideas and outcomes can be concluded. Firstly, an awareness of the seriousness of the threat levied to the GBR. Secondly, how global warming is playing a crucial role, and that this trend is still not exorable, and something needs to be done. Thirdly, other influences, such as shipping, by anchoring, or oild spills, as well as agricultural residues (pesiticides and nutrients) also contribute substantially to the damage. Finally, various managemnet schemes should be taken so as to minimise the hazardous effects of these factors.

5. Further Work

In the future work, a more in depth investigation can be made of the effect of sediment loading, pesticides, and crown of thorns starfish and algal blooms. These ideas were briefly mentioned in the current work, but an expasion on them can result in a more comprehensive study of the reef, and its requirements and threats can be better identified, and thus may be best prevented or mitigated.

Acknowledgements

Here I wish to thank my parents who made it possible for me to study and conduct such a research. I would also like to thank anyone or any magazine that allows free access of information on the Internet, particularly those whose publications focus on global issues and environmental ones that concern everyone.

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Using reactive power to prevent excessive rise in feeder voltage due grid-connected PV generation

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours)(Power)

Supervisors: Dr Tony Ahfock, USQ

Mr Matthew Hogan, EvoEnergy

Keywords: Embedded Generation, Reactive Power Flow, Voltage Stability

1. Introduction

The introduction of embedded generation within an electrical network alters the way a distribution system operates. A typical implementation of embedded generation will inject power back into the network at a unity power factor. The effects of altering the injection power factor has been investigated for the purpose of mitigating power quality issues, both existing and introduced through embedded generation.

2. Background

The increasing supply of photovoltaic embedded generation connected to LV networks has introduced excess electrical energy, particularly is residential area. The lack of demand for the excess energy can cause a significant rise in the network voltage, above compliant levels. In particular situations introducing a reactive component to the generation, it is possible to mitigate the voltage rise.

3. Methodology

For the purpose of analysis, a HV feeder was selected which had an existing significant connection of embedded generation in the form of a solar farm (1.8MW). To simulate the effects of altering the solar farms power factor, both the Newton-Raphson and Gauss-Seidel methods of load flow analysis have been implemented through MATLAB to model the existing feeder network. Historical data from EvoEnergy's data management system has been used to compare against the constructed model and validify the simulation results.

4. Key Outcomes

The simulation results identified that for the particular site, the use of reactive power flow by dynamically adjusting the the power factor could effectively stabilise the grid voltage for the connected feeder.

By sinking reactive power during solar farm production, the network voltage could be lowered to acceptable levels. It has also been identified that the inverter technology installed for this site also supports sourcing reactive power over evening periods which can be used to rise the feeder voltage during peak evening loading.

5. Further Work

Further work is required in the practical implementation for the proposed solutions. Documentation and contractual requirements between the distribution company and embedded generation operator need to be established during the approval processes to allow for the application of voltage stability.

6. Conclusions

The introduction of embedded generation can cause significant issues where the network is not designed to handle the exported energy. Where network impedance has a significant reactive component, reactive power flow can be used to improve the networks voltage profile.

Acknowledgements

I would like to thank my supervisor Dr Tony Ahfock for providing valuable input and guiding me along the project and Matthew Hogan from EvoEnergy for providing data as request and for his useful input. I would also like to thank my partner Emma for her support, understanding, and sacrifice.

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Shear behaviour of precast concrete slabs with hollow composite systems

Sponsor – Composite Reinforcing Systems, Pty Ltd.

Cameron Bone

Bachelor of Civil Engineering (Honours)

Supervisors – Assoc. Prof. Allan Manalo
Mr. Usama Al-Fakher

Keywords: *Concrete slabs, shear, hollow composite reinforcing systems.*

1. Introduction

Hollow core concrete slabs have been widely utilized in building and construction due to its reduced self-weight. Unfortunately, the hollow core of precast slabs are prone to collapse due to shear failure. Moreover, the available systems to increase the shear resistance of hollow core concrete slabs are not effective or difficult to implement (Wu et al, 2015). This study explores the use of a novel hollow composite reinforcing system, CRS to improve the shear resistance of hollow core slabs.

2. Objectives

The main objective of this study is to evaluate the shear behaviour of steel reinforced concrete beams with hollow composite reinforcing system (CRS). The specific objectives of the study are:

- To comparatively evaluate the shear behaviour between solid and hollow core concrete slabs.
- To evaluate the effectiveness of CRS in enhancing the shear strength of hollow core concrete slabs.
- To investigate the effect the slab width-to-CRS diameter may have on the shear behaviour of hollow core concrete slabs.

3. Research Methodology

Specimen details: Five 1200 mm length beams with varying widths were constructed for testing.
Beam S1 as the solid control beam (width = 200 mm), S2 as the hollow core control beam (width = 200 mm) and S3 – S5 having been reinforced with CRS (with widths 200 mm, 175 mm and 300 mm respectively).
Test set-up and instrumentation: Beams are tested under static 4-point bending test using a 2000 kN capacity loading equipment at USQ (see Figure 1 for example).

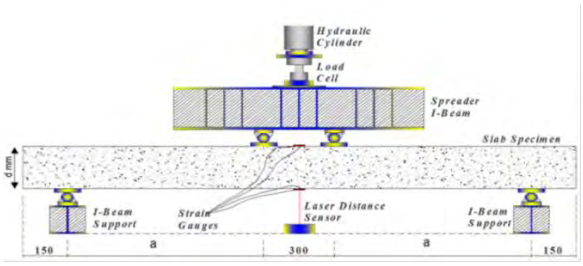

Figure 1: Test Setup

4. Results and discussion:

Failure mode

All beams failed in shear

Load, displacement behaviour

The solid (S1) and hollow (S2) beams produced similar ultimate load of around 120 kN (see Figure 2).
Beams S3 and S4 also have similar failed at an ultimate load of around 190 kN while beam S5 has the highest ultimate load of 261.21 kN.

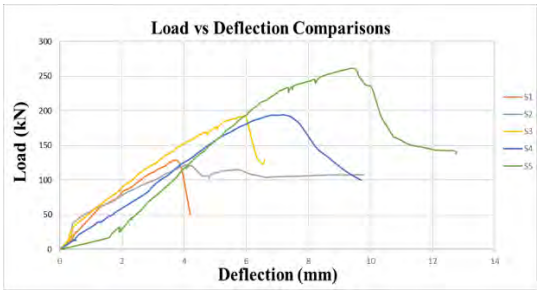

Figure 2: Load comparisons for all beam.

5. Conclusion

The following conclusions can be drawn from the results of this study:

- Hollow concrete slabs exhibited 3% decrease in shear strength to that of solid slab.
- The provision of CRS increased the shear resistance of the slab by up to 50%.
- As the beam width-to-CRS diameter ratio decreases, the shear strength of concrete slab increases due to the high contribution of the CRS.

Acknowledgements

Special thanks to the Composite Reinforcement Solutions (CRS) industry for providing the hollow composite reinforcing systems used in this study.

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Improved Mixing Closure for Multiple Mapping Conditioning Turbulent Combustion Model

School of Mechanical and Electrical Engineering

Daria Bontch-Osmolovskaia

Bachelor of Engineering (Hons) - Mechanical

Supervisor: Dr Andrew Wandel, USQ

Keywords: Turbulent combustion, Langevin models, Multiple Mapping Conditioning, MMC

1. Introduction

This project contributes to the development of the hybrid binomial Langevin Multiple Moment Conditioning (bL-MMC) modelling framework, used for simulating turbulent combustion. The development will be validated by simulating methane-air open jets as a step towards simulating diesel fuel combustion.

2. Background

Currently, much of the world's energy supply is dependent on burning fuels. Despite rapid developments in the renewable energy sector, it is essential to simultaneously develop better combustion technologies to improve our fuel supply.

Turbulent combustion computational models allow engineers to simulate the behaviour of jet flames and their output pollutants, greatly reducing the need for physical tests. This significantly saves on the costs of building and testing expensive equipment.

3. Methodology

The binomial-Langevin equations simulate the amount of mixing of the fuel and air. This is then used in the MMC equation to calculate the chemical species and sensible enthalpy. The resulting values are used to close the Reynolds-Averaged Navier-Stokes (RANS) transport equations and – ultimately – simulate the behaviour of the flame jet, including its turbulent eddies, molecular diffusion, chemical reactions and pollutant output.

The project used an existing computational code, written in Fortran. The results are graphed in MATLAB. The project contributed to the model by performing an updated simulation and validating it against prior simulations; by exploring the effect of the computational hardware and compilers on the code; and by introducing an updated mixing model into the code.

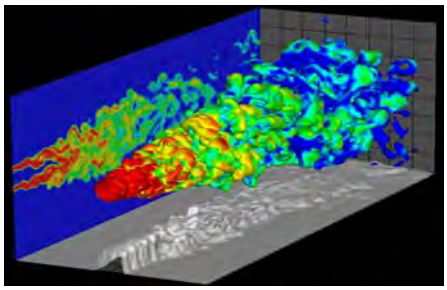

Fig. 1 - Isosurface of mixture fraction dissipation rate, illustrating turbulent combustion in an open jet (Purdue University, 2018)

4. Key Outcomes

The project has successfully explored the effect of computing hardware and software infrastructure on the behaviour of the code, including variations in the compiler options, and identified some approaches to mitigating the effects.

5. Further Work

The validation of the simulations against previous experiments and the new mixing model implementation need to be completed.

6. Conclusions

This research shows that these models are providing a promising option for turbulent combustion modelling, with the view of using them for simulating diesel combustion in near future.

Acknowledgements

Heartfelt thanks to my supervisor for his support and guidance, and an interesting research project. I would like to thank my husband Michael for supporting and encouraging me through my degree and this project.

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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.

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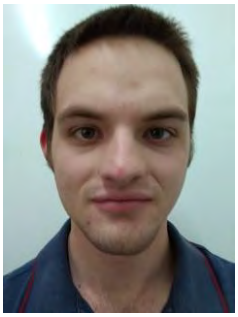
Hailstone Detection Using Vehicle Dashboard Cameras

School of Mechanical and Electrical Engineering



Zave Bradshaw

Bachelor of Engineering (Honours) (Computer Systems)

Supervisor: Ms Elizabeth McCarthy, USQ

Keywords: Computer Vision, Machine Learning, Matlab

1. Introduction

Hail causes significant damage each year to both property and vehicles across most parts of the world. A study conducted by the Highway Loss Data Institute found that over the period 2008-2014, $7 billion worth of vehicle insurance claims were made in the USA alone. Today, many cars have cameras mounted on their dashboards which, besides their current primary purpose, could potentially be used for an array of other purposes including the detection and analysis of visible weather events.

The primary goal of the project was to develop an algorithm that could utilise the footage from dashboard cameras, successfully detect the presence of hailstones, track their movement and determine useful characteristics such as mass, velocity or even a danger level classification.

2. Background

Research into the application of computer vision techniques in this area appears absent from the literature. The literature did, however, show that the use of computer vision techniques could be quite effective at solving problems related to detecting and tracking small objects.

3. Methodology

It was recognised that an understanding of the key characteristics of hail would be necessary to design the algorithm as it would need to test for these characteristics as part of detection. A dataset of open source videos from YouTube was prepared. This dataset included videos where hail was easily discernible, where hail was either not discernible or not present and everything in between. Algorithm development was then carried out in Matlab in an iterative process of design, experimentation and analysis which made use of its toolboxes for computer vision and image processing. As of writing, this development is ongoing.

Figure 1 – Rotated image of how falling hailstones typically appear to most dash-cams. The hailstone is visible as a very faint white streak. Their extremely fast movement and small size presents unique challenges.

4. Key Outcomes

Key outcomes which have been achieved include a literature review, the collation of a video dataset, a feature analysis of hail as it appears in typical dash-cam footage (apparent in figure 1) and a basic algorithm which uses Speeded up Robust Features (SURF) detection to detect these identified features.

5. Further Work

The algorithm currently does not have a threshold for the actual detection of hail though this is expected to be implemented. Due to the nature of the data, tracking and analysis may not be achieved. The final algorithm will be tested on data of varying quality to give a measure of its performance.

6. Conclusions

It is believed that the project has clearly defined the challenges that need to be overcome to achieve effective hail detection. The algorithm in its current state also demonstrates that hail detection is possible under the right circumstances.

Acknowledgements

A big thanks to Elizabeth McCarthy for the direction and support needed to complete this project.

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A Readjustment of a Geological Coal Model through the Generation of Theoretical Boreholes from Aerial Photogrammetry

School of Civil Engineering and Surveying

David Bredenkamp

Batchelor of Spatial Science Honours (Surveying)

Supervisors: Dr Kithsiri Perera, USQ

Keywords: Photogrammetry, Geological Modelling, Surveying

1. Introduction

The aim of this experimental project was to investigate and readjust an underground geological coal model in association with aerial photogrammetry. The primary objective throughout the experiment was to adjust the underground Geological Coal Model.

2. Background

An unnamed open cut coal mine was experiencing issues revolving around their coal seams fading in and out in certain regions of the operation. When uncovering these areas they would experience a lack of coal which was predicted to be of much greater volume within the geological coal model. As a result costs were overrun and targets were not met. Records showed that boreholes were located in a 400x400 meter grid. This caused the geological coal model to overlook the finer detail such as faults, melon holes and thinner unobtainable seams.

3. Methodology

What methodology did you employ addressing your problem? This could include qualitative or quantitative research methodologies, programming, or other specific tasks that were necessary to accomplish the outcomes of your project. You should include one diagram that represents a key aspect of your project. This could be a system diagram, a photo showing a key specimen or a graph that summarises main results. Make sure you include a heading and a reference to the figure. Please see Figure 1 for an example.

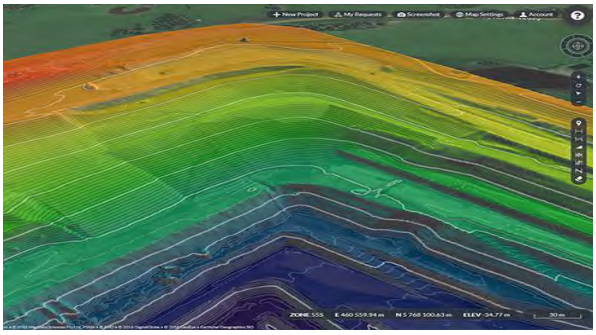

Figure 1 - Highwall Scan Generation from UAV Photogrammetry from Aeroeye, U.

4. Key Outcomes

Two techniques were investigated which were used to gather data required to adjust the model. The second technique was successful and permitted accurate and precise adjustments of the model while the other was not

5. Further Work

Future work would include a more in-depth investigation into improving the efficiency of compiling the gathered data into boreholes with aims to automate the processes involved.

6. Conclusions

Thus far the project has produced an improved geological coal model and proven that the theory of using aerial photography to conduct underground surveys such as coal modelling is achievable.

Acknowledgements

The author would like to thanks project supervisor, Kithsiri Perera for their help in achieving the following outcomes. Additionally, Chris Saunders, Sarah Hill and Eric Law of unnamed mine site for all of their help and guidance throughout the project in regards to software usage, geology and access to resources.

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Accurate 3-D Modelling from DSLR images for Residential Designs

Sponsor – School of Civil Engineering and Surveying

Liam Burgess

Bachelor of Spatial Sciences (Honours) (Surveying)

Supervisors: Dr Dev Raj Paudyal, USQ

Keywords: Photogrammetry, Digital Single-lens reflex (DSLR), 3D-Modelling, Laser Scanning

1. Introduction

The average cost of a site surveying for residential design can be varied from $1500-$2500 depending on the complexity of the project. The customers are looking for an affordable price with good quality. The hypothesis of this study is that modern advances in photography can reduce the costs of these surveys. The aim of this research project was to explore the cost effectiveness and usability of close range photogrammetry. It has investigated whether images taken from a regular digital single-lens reflex camera (DSLR) can be processed and converted into an accurate 3D point cloud model for residential renovation designs or not.

2. Methodology

This project compared close range photogrammetry and laser scanner created point clouds against the traditional total station survey to see how accurate a photogrammetric point cloud was and whether it could be utilised as a cheaper alternative to traditional methods. Figure 1 is the point cloud generated from single images taken from the DSLR.

Figure 1 – Point-cloud Generated from DSLR images

3. Key Outcomes

The generated point clouds using the 2D images were more accurate than that created by the laser scanner. 93% of the targets were accurate to 10mm using photogrammetric methods compared to the laser scanner that had 49% accurate to 10mm. The comparisons of feature dimensions were comparable between laser scanning and photogrammetry.

4. Further Work

Further work should investigate whether fewer photographs can be used to produce accurate point clouds. This research project conducted three photogrammetry sessions, two of which contained about 170 images each that resulted in extensive processing times due to the combined data file size of the images. One session only contained 70 images but the resultant point cloud was less accurate.

5. Conclusions

This research project successfully created accurate 3D point clouds from 2D images which were suitable for residential renovation designs. This project has demonstrated that images taken from a DSLR camera can be used for modelling purpose providing the images are acquired in a methodical manner ensuring sufficient image overlap is accounted for.

Acknowledgements

I would like to thank Dr Dev Raj Paudyal for his time and feedback but mostly thank my wife for occupying my young children whilst this paper was written.

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Elimination of Defects in Concrete Footpath

Mitchell Cahill

Bachelor of Construction (Management)

Supervisor: Dr Vasantha Abeysekera, USQ

Keywords: Footpath, defects

1. Introduction

The inspiration for undertaking this research project was due to observations regarding the frequency of defects that are present throughout footpaths. It was very surprising to see the clear majority of footpaths around both Brisbane and Springfield in some way shape or form have very noticeable defects which results in tripping hazards and costly repairs. Not only do these footpaths create a potential hazard, they are visually displeasing (Figure 1and Figure 2)

2. Background

This research project is important as it will hopefully uncover why these defects keep occurring. This will hopefully eliminate the need for costly repairs and replacements saving money for other types of infrastructure for the community

3. Methodology

The aim of this research project is to identify current defects and imperfections in design, construction and maintenance of footpaths and the elimination of such defects is the desired outcome. The literature provides guidance on why footpaths defects occur however defects are still seen as per the pilot study undertaken, particularly visual defects. Accordingly, the study undertakes a survey of footpath defects in the Springfield area to have a greater understanding of the problem. Defects are analysed using different framework to have a greater insight into the nature of the problem. The results then presented to selected industry persons followed up using a semi structured interview process with the aim of eliminating the occurrence of these defects.

Figure 1 – Structural cracking

Figure 2 – Visually displeasing repair

4. Key Outcomes

The main problems found were such defects as structural cracking, root infiltration and joint stepping. Maintenance minimisation guidelines for footpaths has been stated by the Department of Transport (2014) and it outlines guidelines and best practises on minimising pathway maintenance and aims to reduce these defects from occurring. However, throughout the analysis of footpath defects around Springfield that these defects are still present. This shows that the reasons for these defects have been identified but may not be being implemented or are being implemented incorrectly.

5. Further Work

There are several tasks that are still to be complete such as surveys of local users and stakeholders as well as systematically reviewing defects against what is stated in the literature. Uncovering solutions to fix these recurring defects would be the best outcome of this project or for future work.

6. Conclusions

Initial investigations show that footpath defects are a reoccurring problem. Literature provides an understanding of the causes but a pilot survey revealed that these still occur. It is hoped that with the data collected and analysis undertaken, this thesis will shed light on the issue of why these repetitive defects are still occurring and find ways and means to eliminate such defects.

Acknowledgement

I would like to acknowledge my supervisor Vasantha for all his assistance and guidance throughout my research project.

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Wi-Fi weather alarm for notification of optimal crop spraying conditions in agriculture

Sponsor – School of Mechanical and Electrical Engineering

Eddie Campbell

Bachelor of Electrical and Electronic Engineering (Honours)

Supervisor: Associate Professor Alexander Kist, USQ

Keywords: Agriculture, weather, alarm.

1. Introduction

This project is an implementation of a weather monitoring system in the form of mechanical and electrical sensors to monitor various weather parameters that affect the quality of chemical applied through a spray boom. The three most important parameters to monitor when spraying are; delta-T, wind-speed and wind direction. The sensors themselves are integrated into a pole mount station with a Wi-Fi microcontroller. This station connects to a web server on the LAN which then relays data to a server on the WAN. Both have web pages that enable data to be viewed. An alarm is also configurable on the WAN server.

2. Background

Monitoring of weather parameters is essential when conducting spraying operations to ensure the quality of the job, and prevent spray drift. The BOM (n.d.) has provided guidelines for what are reasonable weather conditions for spraying.

3. Methodology

The project design largely followed a systems engineering approach. The whole system was divided into two sub-systems (Figure 1). Weather station and silo 'communications' tower. The design requirements of the weather station were mainly determined by standards maintained by the WMO (2014) on weather monitoring. Other standards from the ACMA and IETF were followed when configuring hardware in the silo 'communications' tower.

4. Key Outcomes

To date, the weather station has been transmitting data to both servers successfully for approximately two months. The accuracy of the sensors have been bench marked against other commercial instruments such as the Kestrel 3500DT handheld weather meter and were found to be within tolerance for majority of measurements. Alarm functionality was also implemented using the Twilio progammable voice API. Users may set and alarm for the ranges of delta-T, wind speed and wind direction. Many other parameters are monitored but are not configurable in the alarm.

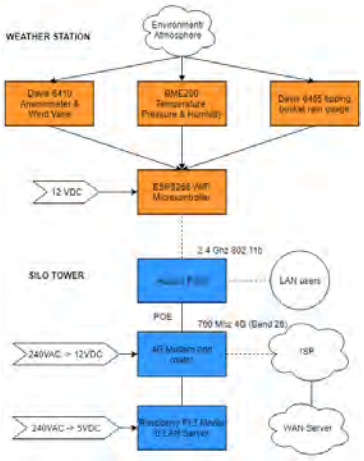

Figure 1 - System Diagram

5. Further Work

Future work on the project will include interfacing with a MySQL database to log data and produce current hourly, daily and weekly graphs of all parameters.

6. Conclusions

The project has successfully enabled automated monitoring of weather parameters relevant to spraying. Users can view these parameters at any time of day from any internet device anywhere. They may also configure an alarm based on these parameters.

Acknowledgements

Thanks to Assoc. Prof. Alexander Kist for his excellent support throughout the project, and brilliant contributions such as the idea of programmable voice instead of a phone app for the alarm. I would also like to thank my family for their support, sponsorship and providing the initial idea for the project.

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Characteristic Behaviour of Oil Contaminated Fine Aggregates in Concrete, Reinforced with Helix Re-Bar

School of Civil Engineering and Surveying

Mr Thomas Campbell

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Buddhi Wahalathantri, USQ
Dr Rajab Abousnina, USQ

Keywords: Oil Contaminated Aggregates, Concrete, Helix Re-Bar, sustainability, construction industry.

1. Introduction

Demand for construction materials is increasing at an alarming rate with continous population growth. Although, new materials are developed and tested by researchers, the concrete industry still highly rely on supply of raw materials such as aggregates and sand. Traditional concrete industry requires cleaner sources of sand with minimum impurities. However, population growth and resulting increased consumption of fossil fuels contribute to pollution of raw materials. For example, oil contaminated sand is a growing concern for the concrete industry.

This research aims to investigate properties of concrete when using oil contaminated sand. Based on the literature, 6 % oil contamination is used. Also the research is extended to investigate the performance improvemenet by using Helix Rebar along with contaminated sand.

2. Background

Global concrete construction has the highest demand for sand in the industry, thus contributing to sand being the most used non-renewable natural resource in the world. In 2012 the global use for sand in the construction industry was 3.7 billion tonnes, which has almost tripled since 1994 at 1.37 billion tonnes. However, it is highly likely that the concrete industry will need to use contaminated sand due to ever increasing use of fossil fuels as well as to minimise the demand for natural resources. Abousnina et al (2015) indicates that 6 % oil contamination level can be accommodated in expense of degradation of some compressive strength. Therefore, it is required to investigate alternative ways to improve the properties of concrete when using oil contaminated sands.

3. Methodology

This research is an experimental based study and relies on laboratory prepared and tested concrete samples. The experimental phase include, preparation and testing of concrete with and without using oil contaminated sands and with and without using Helix micro rebars. Compressive strength and strength gain pattern is the main research focus of this study. Therefore, a series of standard concrete cylinders were casted and tested at the age of 1, 7 and 28 days. Also, the provision is made to measure the splitting tensile strength and the Young's modulus of concrete. The research is further extended to investigate properties of concrete when heated and subjected to different environmental conditions. The scope of this research is further extended to compare current findings with existing literature on oil contaminated sand.

4. Key Outcomes

To date it has shown that Helix Re-bar has increased both tensile and compressive strength in conjunction with contaminated aggregate mixtures.

5. Further Work

The experimental data is currently being analysed to draw main conclusions.

6. Conclusions

Current findings indicate that the use of Helix Re-bar increase the tensile and compressive strength of concrete. Also, results indicate that use of oil contaminated sand reduces the properties of hardened concrete.

Acknowledgements

I would like to thank my supervisors Dr Buddhi Wahalathantri for his guidance and expertise within the laboratory and Dr Rajab Abousnina for his support and expertise in the field. Furthermore, my sponsor Helix Pty Ltd. for the supply of materials.

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A Feasibility Study of a Multi-Storied Bamboo Structure

Jasmine Chai

Bachelor of Engineering (Honours) (Civil Engineering)

Supervisor: Dr Sourish Banerjee, USQ

Keywords: bamboo, finite element analysis, sustainability

1. Introduction

Bamboo culms have been used as a construction material in tropical and sub-tropical regions since ancient times. The plant delivers multiple benefits as a building material due to its rapid growth rates, abundance in climatically conducive environments, ability to reduce erosion, control water cycles and sequester carbon from the atmosphere.

Designers that have successfully built with bamboo, rely on traditional methods and insight gained from exposure to its behavioural properties. As such, the majority of today's designers view these methods of design and construction as risky and very few practicing engineers would seriously consider utilizing bamboo as a building material.

2. Background

The objective of this study is to determine the feasibility of adopting bamboo as a mainstream construction material and sustainable alternative to steel framed structures. This objective was driven by motivations to address the sustainability issues associated with steel production.

3. Methodology

The feasibility study will be conducted through an extensive literature search on bamboo structures, bamboo connections and the capacity for bamboo to provide adequate structural support,. This literature will facilitate a qualitative and quantitative comparison of structural steel and bamboo via the finite element method on Strand7. The finite element analysis will be conducted on the frames of two identical multi-storied structures; one constructed with bamboo culms and the other with structural steel.

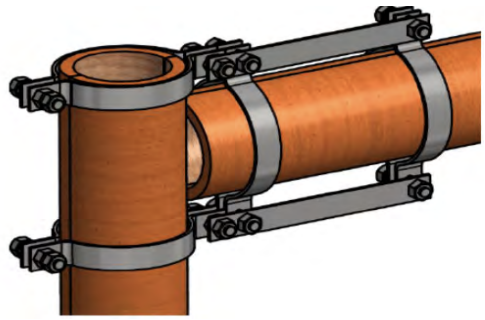

Figure 1: A type of steel clamp connector designed for bamboo

4. Key Outcomes

As bamboo culms are hollow, they tend to possess low buckling capacities when utilised as columns. The analysis results showed that utilizing bamboo culms as columns could not provide adequate resistance to axial loads transferred to the columns from beams. Therefore, the columns were modelled as concrete-filled bamboo culms. Overall, this solution resulted in a structurally sound bamboo model.

5. Further Work

Long-term practical experiments carried out on multi-storied bamboo structures, to better understand how different connection types (see Figure 1) behave and whether preservation techniques are effective, are needed.

6. Conclusions

With the exception of low buckling capacities, the study has shown that a multi-storey frame predominantly built with bamboo culms, is able to resist loads and provide adequate serviceability. Building with bamboo as a mainstream construction material is possible if more engineers are willing to explore this sustainable alternative.

Acknowledgements

I would like to thank my father, supervisor and close friends for listening to my ideas during the preliminary stages of this journey and offering helpful advice whenever I hit a roadblock.

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Backup Relay for 66kV Hub Substation Protection in the High Voltage Distribution Network

Sponsor-BHP

Tarisai Chandigere

Electrical and Electronics Major

Supervisors: Dr Paul Wen, USQ
Mr Ken McCabe, BHP

Keywords: Bus Zone; Differential Relay; Backup Protection.

1. Introduction

This paper is addressing the bus zone protection as an integral part of providing continuity, security and safety of power supply. Bus zone protection shortfalls not addressed during engineering design and commissioning can be detrimental to the supply of power. Redundancy of bus differential schemes with different operating characteristics will be implemented with no addition to the primary infrastructure. This paper will therefore look at:

- Understanding the concepts applied by relay elements to make a trip decision.
- The impact of settings on security and sensitivity.
- Testing the operating characteristics.

2. Background

The project is vital in mitigating the material risks associated with lack of redundancy. The material risks are monetary losses and safety risks which could result in injury or loss of life and plant.
Current numerical relays have backup protection schemes built within the relay which in this case would be directional overcurrent but this falls short in that a failure of the relay will lead in loss of both protection schemes. Utilising relays from different manufacturers implies that the strength in one relay covers the weakness of the other relay.

3. Methodology

The selection of quantitative methods gives required values for protection settings. Relevant applicable information was gathered through literature review of texts, manuals and research papers. CITECT, a SCADA software was used to get the loading and electrical parameters of the bus zone. These values were then used to perform calculations to determine protection settings for the new relay. As shown in

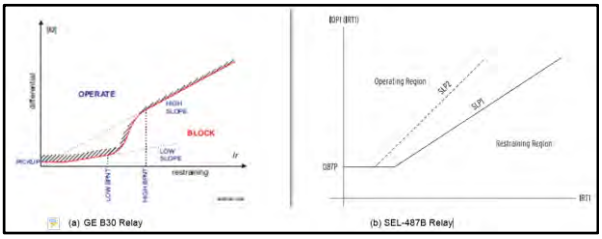

Figure 1 – Operating Characteristics of the GE and SEL Relays

Figure 1 the two relays have different operating characteristics. Simulation of different fault conditions is going to be conducted using the OEM software and a comparison of the two relays will be executed on DIgSILENT PowerFactory.

4. Key Outcomes

Applicable standards and cost of relay failure have been determined and collated into an opportunity framework. It has been ascertained that no primary equipment will be added. The challenge will be in designing redundancy to meet Australian Standards without changing the backbone infrastructure.

5. Further Work

Owing to time and resource constraints research into the use of Wi-Fi for communication in the differential scheme is not possible. This shall be covered in further works.

6. Conclusions

After project completion a viable backup protection scheme for the bus zone should be available.

Acknowledgements

I would like to acknowledge and thank my sponsor (BHP) and supervisors (Paul Wen-USQ and Ken McCabe-BHP who without their assistance this project would not have been possible.

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Investigate The Effects of Harmonics on High Voltage Regulation

School of Mechanical and Electrical Engineering

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Bachelor of Electrical and Electronics Engineering

Supervisors: Dr Paul Wen, USQ

Keywords: Harmonics, Voltage Regulation, AVR

1. Introduction

Maintaining the voltage within the statutory limits is a good electricity industry practice by Power Distribution companies. In Power Distribution the voltage regulation is done at the zone substation and on 11000/22000 volts feeders. The voltage regulation is controlled by an automatic voltage regulator (AVR) relay that has input voltage from step down instrument voltage transformer, stepping down 11000 volts to 110 volts.

2. Background

With the increase in photovoltaic micro embedded generations the high voltage regulation has become a challenge for Power Distribution companies. A recent investigation in high voltage complaints from customers revealed that voltage regulation was affected by harmonics. It was discovered that the automatic voltage regulator wasn't regulating properly due to the input voltage having higher harmonics level.

3. Methodology

Harmonics from power systems will be captured using the high-speed scope recorder and FFT analysis will be used to determine the harmonics component in the system data. This harmonics component and magnitude will be replicated using Doble Power Systems Simulator and applied to various types automatic voltage regulators. There are several types of automatic voltage regulators but only 4 types will be analysed in this research project. Some harmonics data captured from the secondary systems volts were applied to a voltage transducer and the results show error more than its rated class.

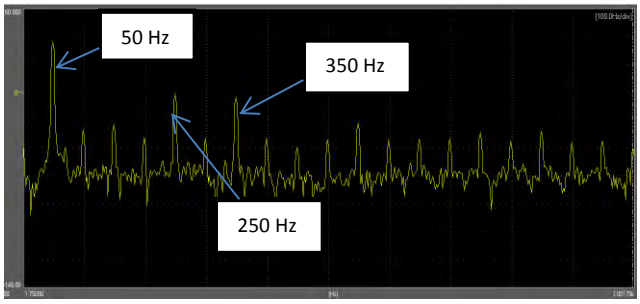

Figure 1 – Harmonics analysis of captured system data

4. Key Outcomes

The harmonics data captured shows that harmonics present in the power system affects the voltage regulation. The aim is to find out what type of automatic regulators are affected and report the outcome to power systems and design engineers. Some analysis on voltage transducers used in automatic voltage regulators has been done, sourcing and trailing of new true rms voltage transducers are in progress.

5. Further Work

As the PV micro embedded generation grows so will the challenge to regulate voltage. Further investigation will be required on the sources of harmonics and voltage regulation implementation on micro embedded generation inverters.

6. Conclusions

The results obtained from the testing of various types of voltage regulators will be analysed and compared to see which types are affected by harmonics. Testing on voltage transducer has shown that output is affected by harmonics and replacements are being trailed.

Acknowledgements

I would like to thank Ergon Energy and employees of Ergon Energy who have allowed and assisted with test instruments and testing. I would also like to thank my project supervisor Dr Paul Wen and family for continued support.

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Numerical investigation on the effect of scouring on the structural behaviour of corrugated steel culvert

Sponsor – School of Civil Engineering and Surveying

Dennis Chung

Bachelor of Engineering (Honours) (Civil) BENH

Supervisors: Dr Weena Lokuge, USQ

Prof Karu Karunasena, USQ

Keywords: Finite element modelling, Strand7, Corrugated steel culvert.

1. Introduction

First introduced in 1896, the corrugated steel pipe (CSP) continues to be used due to its low up-front and total life cycle costs that combine with strength, light weight, adaptability and flexibility makes it an obvious choice for many projects. While the design service life of a CSP is usually expected to be 100 years, many have failed before their service lives due to corrosion caused by scouring. The aim of this research project is to use finite element modelling method to study the effects of scouring within a steel culvert when subjected to different flow conditions, and how this in-turn affects the overall structural integrity.

2. Background

The strength of a corrugated steel culvert comes from the pressure of the surrounding compacted backfill to hold the pipe in place and allowing it to support the required load. But factors such as scouring and high pH level soil can cause corrosions to the steel, resulting in the culvert wall thickness to reduce overtime and eventually erodes away. From the literature review, completed as part of the research, it was found there is currently no research into the structural integrity of corrugated steel pipe when subjected to corrosion, with water flowing through it.

3. Methodology

The numerical method employed for this project is finite element modelling (FEM) using a commercial software called Strand7. As shown in Figure 1. the model is constructed by assembling the different components. By creating each component separately, the properties can be adjusted to represent their relevant materials. The base model is then modified to suit different scenarios such as, different wall thickness, different locations of corrosions within the culvert and different soil properties.

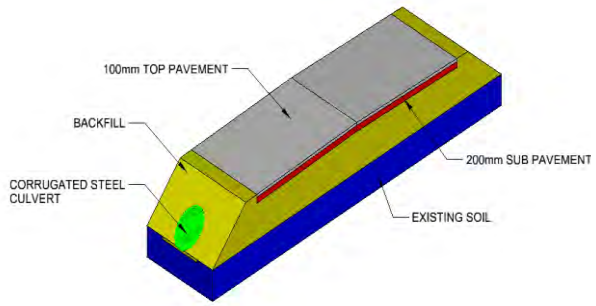

Figure 1 – FEM base model

4. Key Outcomes

To date the data suggests;

- Different velocity of water has no effects on the deflections of the CSP, whereas the hydrostatic pressure of the water does.
- Different corrosion levels within the culvert does influence the level of deflections.
- By reducing the elasticity level of surrounding soil can cause the culvert to deflect more.

5. Further Work

To determine how long a non-linear analysis of the model would take to process within Strand7.

6. Conclusions

Early results show that different levels of corrosion and water depth does affects the overall structural integrity.

Acknowledgements

I would like to thank my supervisors Weena and Karu for assisting me throughout this project.

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Estimating Input Voltages and Currents of Transformers from Output Side Measurements

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Electrical and Electronic Engineering

Supervisor: Associate Professor Tony Ahfock, USQ.

Keywords: Model, Transformer, Voltage.

1. Introduction

This project is to develop, test, and analyse a model that uses low voltage metering data and transformer nameplate information to estimate the input voltage and current of a transformer. The model needs to be able to account for balanced and unbalanced system conditions.

2. Background

In today's distribution environment there is a steady move towards smart grid technologies. As part of this, advanced metering infrastructure is being developed for low voltage networks. By using this metering data to calculate the input voltage at transformer's along a medium voltage feeder and then displaying it on the distribution networks SCADA system, the performance of the medium voltage feeder can be obtained and monitored.

3. Methodology

The crux of this project is to model the regulation of a transformer accounting for unbalanced load and supply conditions using a transformer's secondary values. To do this, sequence component theory is applied to calculate the sequence voltage drops in the transformer. These are then combined with the output sequence voltages. A ratio conversion accounting for tap position and transformer ratio is then used to calculate the input sequence components. These are then reconstituted into the input voltages and currents. Finally data is collected and analysed to validate the model. See figure 1.

4. Key Outcomes

The results obtained suggest that the model tracks the input voltage well. Using the transformer manufacturers test data for impedance appears to give the most accurate results followed next by using an impedance calculated using typical X/R ratio data. Considering the transformer impedance as purely reactive gives the worst result.

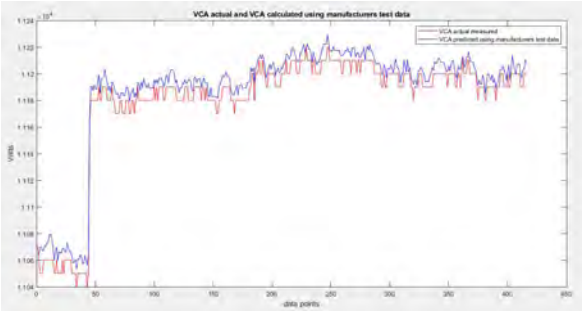

Figure 1 – V_{CA} measured (red) versus V_{CA} calculated (blue) using manufacturer's impedance data with a single phase load applied to phase C of the transformer output.

5. Further Work

There are many avenues for further work building on this project. These include, investigating the effects of magnetising losses and temperature compensation, investigating the effects of harmonics, allowing for reverse phase sequence and different vector groups, developing better typical X/R ratio data for small distribution transformers, and converting the model into a module that could be used in a metering device.

6. Conclusions

Results suggest that the model tracks the input voltage well in both balanced and unbalanced conditions. The best results were obtained using manufacturers test impedance data. Further work is required to develop the model to suit all operating environments.

Acknowledgements

I would like to acknowledge the following people for their guidance and support without which this project would not be possible. Associate Professor Tony Ahfock USQ, Rodger Griffiths Westpower's asset and engineering services manager, and my Family

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Effect of intersection angle on a time-gap based intersection sight distance model

Sponsor – School of Civil Engineering and Surveying

David Cole

Bachelor of Engineering (Civil)

Supervisors: Dr Soma Somasundaraswaran, USQ
Dr Owen Arndt, TMR

Keywords: Intersection sight distance, Time-based sight distance, Intersection model, Skew intersection.

1. Introduction

An intersection is considered skewed when the roads intersect at an angle other than 90°. Skewed intersections generally result in longer passing time for the vehicles through intersections. This means drivers generally have a longer distance to travel when crossing the intersection or making certain turning manoeuvres, which results in increased exposure within the intersection. The aim of this project is to determine if drivers require any additional time to safely undertake a crossing or turn manoeuvre at a skewed intersection compared with a 90° intersection.

2. Background

Cox and Cole (2013) identified issues with the Safe Intersection Sight Distance (SISD) model, which led to research to replace the SISD with a time-based intersection sight distance model. From research on a time-based intersection sight distance model (Cox & Cole 2013, 2016), it was identified that the effect of intersection skew (angle) would need to be further investigated for specified design vehicles.

3. Methodology

This project requires a substantial amount of simulation work in order to generate the data for analysis. The project has been broken into three stages: Stage 1 involves the creation of Acceptance Gap Evaluation Tool input data using 12d Model, AutoCAD, Vehicle Path and Vehicle Simulation design applications; Stage 2 is running the simulations using the MS Excel Acceptance Gap Evaluation Tool workbook as shown in Figure 1; and Stage 3 is collating and analysing the simulated results. In this process of simulation, modelling and analysis a parameter namely 'time-gap correction adjustment value' has been defined. Analysis include a comparison between the skewed intersections (70° and 110°) with a 90° intersection using MS Excel.

4. Key Outcomes

The major outcomes of this research project are:

1. Determine the reduced speeds of major road vehicles on various intersection angles, turn and crossing manoeuvres, grades and time-gaps combinations.
2. Build a relationship between time-gap correction adjustment values for various grades and design speeds.

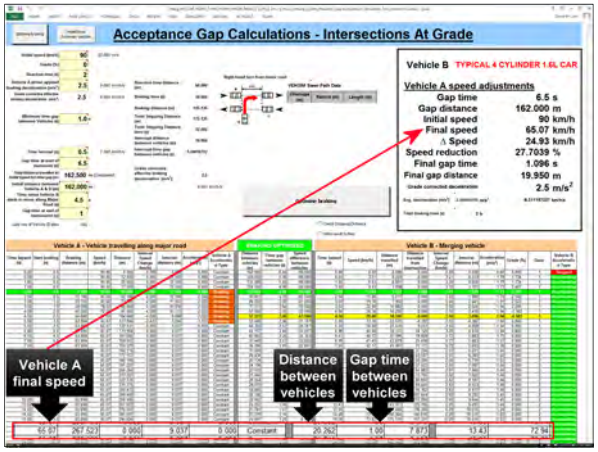

Figure 1 - Acceptance gap evaluation

5. Further Work

Simulations for four lane (2 lane 2 way) and six lane (3 lane 2 way) intersections have yet to be completed. If time permits more grade combinations will be simulated and compared for the 4 and 6 lane intersections.

6. Conclusions

The preliminary results indicate there may not need to be time-gap correction adjustment values for acute angle turn manoeuvres. However it is still too early in the analysis to dismiss the concept for introducing time-gap correction adjustment values.

Acknowledgements

I would like to thank Dr Soma Somasundaraswaran and Dr Owen Arndt for their guidance and support throughout the duration of this project.

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Bending behaviour of functionally graded polymer composite beams reinforced with Graphene nanoplatelets

Sponsor – School of Civil Engineering and Surveying

Aaron Coman

Bachelor of Engineering (Honours) (Civil)

Supervisors:

Karu Karunasena, USQ

Muni Rasappagari, USQ & The University of Adelaide

Keywords: Graphene, FGM, composites.

1. Introduction

Composite materials are used extensively to create products specifically tailored towards required applications. In recent years functionally graded (FG) materials and various matrix reinforcements have been researched to improve the mechanical capacity of products. With the recent discovery of graphene, there is the opportunity to research its use as a polymer reinforcement in order to further enhance the mechanical properties of FG structural sections.

2. Background

Graphene is a relatively newly discovered material. Extracted from graphite, it is comprised of single atom thickness carbon, in a honeycomb lattice. Graphene platelets (GPLs) have excellent mechanical properties with an elastic modulus 300 times greater than epoxy (≈1 TPa). This makes them excellent candidates to improve the mechanical properties of composites. Past research focused on numerical methods and non-FG materials. This study focuses on analysis using FEA computational modelling and functional grading in the thickness and length directions.

3. Methodology

Finite element analysis is used to study the bending behaviour of GPL reinforced FG polymer beams. Four linearly varying GPL distributions are assessed in either direction, based on methods developed by Song et al. (2017). Different boundary conditions are also studied; clamped-clamped, clamped-simply supported and simply supported-simply supported. The unidirectional beams are modelled in strand 7, with bending results being validated using research by Feng et al. (2017). The bidirectional beams are modelled similarly for theoretical analysis. Figure 1 shows one of these models, with darker colours representing higher volume fraction of GPL.

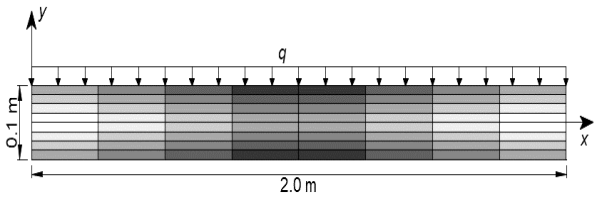

Figure 1 – Bidirectional beam model

4. Key Outcomes

Results indicate that the inclusion of small percentages of GPL reinforcement in the matrix increase the bending capacity of all the sections. Introducing functional grading indicates that bending capacity further increases when the highest GPL concentrations coincide with the highest bending stress. Based on these results, these composite beams can be tailored to suit specified situations based on support conditions and loading.

5. Further Work

The tasks remaining on this project include finalising the bidirectional models and completing the theoretical analysis. Should time permit, further adjustment to the GPL distribution will be undertaken to determine if deflection and bending stress can be further reduced.

6. Conclusions

The deflection in polymer beams can be reduced by the introduction of GPL reinforcement. By shifting the GPL concentration towards the areas of high bending stress, the deflection may be further reduced. This will help with the future design of GPL reinforced FG Polymer beams.

Acknowledgements

I would like to thank my supervisors Karu Karunasena and Muni Rasappagari for their support and guidance throughout this project.

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An Analysis of Thermal Storage of Solar Energy

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Electrical and Electronic Engineering

Supervisors: Dr John Billingsley, USQ

Keywords: Solar, Energy storage, Cost benefit

1. Introduction

The Project aims to evaluate and compare the efficiency of thermal storage of energy as opposed to direct capture techniques. With plans to develop a management system to maximize the cost benefit for the domestic end user. Specifically, regarding a grid connected solar powered home, with air conditioning, hot water system and pumped solar heating for the pool.

2. Background

Rising electricity prices in Australia (Figure 1) are a growing concern to the consumer and average household, especially by comparison to the consumer price index that household income is influenced by. A system to defend against these disproportionate increases is justified.

A major part of domestic electricity consumption is for heating, ventilation and cooling (HVAC). A project that seeks to maximize the energy efficiency of the household or business is one that has an increased potential in the current market. There are some products on the market which aid the consumer in making desirable energy choices, but none that take this approach.

3. Methodology

The analysis of thermal storage of solar energy took the approach of quantitative techniques. An existing home was used as the model for the project's potential feasibility. The decision to go this way, resulted in real world data, that is both relevant and accurate, mitigating the need for approximations and assumptions. It is also the way in which the completed project intends to interact with the supply it is monitoring and making decisions for, that is, in a real-time application of the findings.

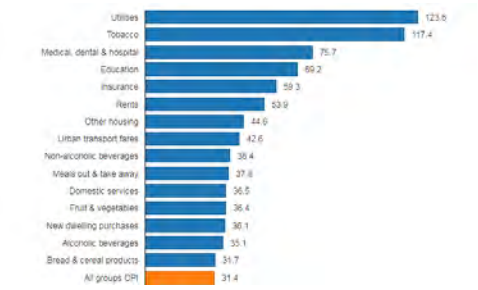

Figure 1 – Price rises over the last 10 years

4. Key Outcomes

The successful planning, preparation and implementation of the project has been an achievement. Through undertaking this research project, the modelling of an actual home energy system could be collated, analysed and its feasibility determined. The noteworthy observation has been that the components required are all readily available that are proven to make a measurable impact on the household HVAC efficiency.

5. Further Work

The realistic objectives were all able to be addressed in the timeframe. The extended objectives will not be able to be achieved during this period, and as such, are all options for ongoing work. There are plans to create a dashboard interface, and seek integration options with emerging peer to peer energy markets.

6. Conclusions

The message that should be taken away from this project is that there are numerous avenues by which independent households can benefit from utilising thermal storage.

Acknowledgements

I would like to thank Dr John Billingsley for providing keen insight into the direction that the project would eventually take. I would also like to thank my supportive wife, Taila Conway, who has been tireless throughout this year.

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An Analysis of the Effect of Free Station Traversing on the Uncertainties Associated with Control Points, in both an Open and a Closed Traverse

School of Civil Engineering and Surveying

Alexander Cook

Bachelor of Spatial Science (Honours)

Supervisors: Assoc Prof Peter Gibbings, USQ

Mr Michael Koschel, Minstaff

Keywords: Traverse, Resection, Free-station

1. Introduction

The use of resections in surveying is something that has started to become more commonplace with the increased on-board computing power of modern day total stations. It is more widely accepted now as a method of establishing a position, although there are still surveyors who don't see it as a viable method. Using resections as a method of traversing, is disregarded even more so.

The purpose of the project is to compare whether or not these resection traverse are a viable method of promoting survey control.

2. Background

Surveying works in Queensland, whether it be engineering works for Main Roads, Cadastral or Mining works for the Department of Natural Resources, Mines and Energies, or just everyday construction activities, professional surveyors are bound by specifications. The majority of these are the ICSMs SP 1 documents on control survey methods.

None of these documents, however, mention or deal with resections as a traverse technique, which has led to the proposition of this research. In this paper I will compare the accuracy of control points measured by a resection traverse to those established using an integrated control network by the guidelines set out by the various specifications.

3. Methodology

For the practical side of the research project, the field work will be separated into two components, the Control Network, and the Resection Traverse.

The control network will utilise GNSS field measurements, conventional field measurements, and differential levelling measurements. Since the purpose of the Control Survey is to create an accurate baseline for comparison, all components will be carried out to the various specifications.

Using previous research (Horemuž & Jansson, 2016; Marshall, 2007; Song, Zhao, Pu, & Li, 2016), I arrived at a set of criteria for my resection set ups (figure 1).

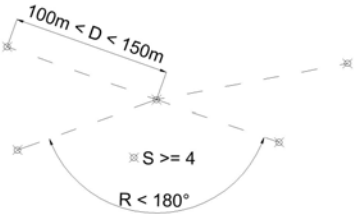

Figure 1: Resection configuration

As can be seen, the number of Targets (S) will be 4, the optimal distance from Total Station to Target (D) will be between 100 and 150m, and the minimum angular range (R) must be less than 180° between adjacent Targets.

4. Further Work

At the time of writing this document, the bulk of my Control Network is completed, with the remainder of my resection traverse yet to be finalised.

Further work in this field could be the potential to trial the resection traverse under different conditions, utilising more of fewer targets or a greater number of stations. Another potential area of exploration is directing the purpose to the traverse to specific area, rather than the general approach I have applied.

Acknowledgements

Getting this far for me has been an enormous effort, although I still have a way to go. I would like to thank my supervisor for his patience with last minute checks, and my partner Emma, on understanding that after coming home from weeks away working, I would need to spend my weekends at the uni campus.

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A Study on Formability Issues in Advanced High Strength Steel

Matthew Cook

Mechanical Engineering

Supervisors: Dr B.F. Yousif, USQ

Keywords: Steel, Formability, Advancement

1. Introduction

In a world where simply light-weighting or strengthening a vehicle isn't enough, advanced high strength steel (AHSS) is of interest as it can do both of those things as well as reduce emissions when compared to aluminium and carbon fibre [1].

The setback with AHSS is in its ability to be formed [1] and so the problem that this project aims to investigate is the difficulty in forming it. The key aims are: 1. Understand the complexity of currently known issues, 2. Uncover what has been done so far to attempt to record and rectify these issues, 3. Attempt utilising existing methodology to evaluate local formability of high grade dual phase (DP) steel.

2. Background

Currently, expansion on what AHSS is capable of in terms of shape complexity is a major area of interest for steel and automotive companies. The most prodigious AHSS to date is that of Medium Manganese Steel; capable of tensile strengths of over 2000MPa with an elongation of up to 10% ($1/3^{rd}$ of mild steel). Previous research has focussed on the formability of 600-980TS grade DP steel [2]. To build upon existing knowledge, this project has evaluated 1000YS/1200TS DP steel.

3. Methodology

Methodology presented by Terrazas, O.R. et al. (2017) [2] and partly from Kim, H., et al. (2017) [3] was investigated for the usage of Hole Expansion Ratio. Few specific tasks were to be undertaken. The steel was obtained and then processed into water cut and drilled samples at USQ. A small sample was mounted, polished and etched for examination under an optical microscope and SEM. The tooling required to conduct the HER needed to be designed. Once designed, the tests were conducted and samples were calculated for HER %. They were then examined under SEM and optical microscope (figure 1).

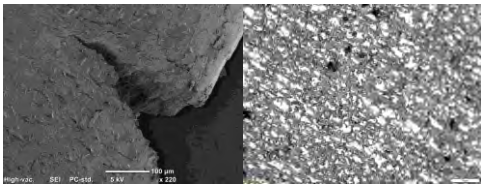

Figure 1: A) SEM inspection of edge cracking due to expansion. B) Optical inspection of microstructure.

4. Key Outcomes

It was found that the examined steel retained a HER of approximately 54%. This result is within range of expectation. Micro-cracking was examined and the material structure was understood based on previous methodology and research.

5. Further Work

Ideally the project will succeed in counting martensite colonies in the sample. Martensite is majorly responsible for strength as it is directly influenced by carbon. Thus, a volume fraction of martensite is desirable. From there, the carbon content in the martensite alone can be found.

6. Conclusions

The desirability of complexly shaped AHSS can be concluded as definitive. The key achievement is in understanding the influence of microstructure in the forming of AHSS. Steel has not yet finished advancing and breakthroughs are just around the corner.

Acknowledgements

I would like to thank my supervisor, Belal Yousif as well as Mohan Trada, Brian Aston and everyone at the university work shop for helping me make this possible.

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Development of Precast Concrete Boat Ramp Planks Reinforced with GFRP Bars

Sponsor – Queensland Department of Transport and Main Roads

Dean Cooper

Bachelor of Engineering (Honours) Civil Engineering

Supervisors: Dr Allan Manalo

Mr Omar AlAjarmeh

Keywords: GFRP, Boat Ramp Plank, Motion and Time

1. Introduction

In aggressive marine environments, the corrosion of the internal galvanised steel (GS) reinforcement is a major issue for precast reinforced concrete boat ramp planks (RC planks). In Queensland alone, the economic loss associated with the expenditures for the repair, rehabilitation, and maintenance of corrosion damaged boating infrastructures, including RC planks, is approximately $10 million per annum (Maritime Safety Queensland 2018).

2. Background

The issue of steel corrosion in RC planks could be eliminated by replacing the GS reinforcement with Glass Fibre Reinforced Polymer (GFRP) bars. GFRP bars are an attractive reinforcing material because of their corrosion resistant, light weight and high tensile strength properties (Manalo et al. 2014).

3. Methodology

The following methodologies were adopted to develop a cost-effective precast boat ramp plank reinforced with GFRP bars:

3.1 ***Motion and time studies*** of three design concepts (Figure 1) to compare and evaluate the fabrication methodologies, and corresponding material, equipment, manpower and time resources required in manufacturing the precast GFRP RC and conventional GS RC planks.

3.2. ***Four-point static bending test*** to evaluate the structural performance of the fabricated RC planks, and to determine the overall effect of type of reinforcement, reinforcement configuration, and compressive strength of concrete.

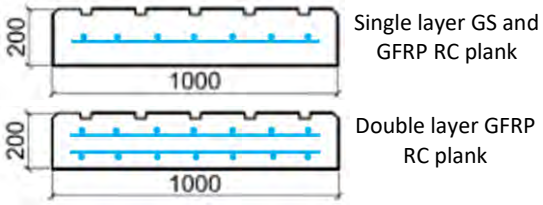

Figure 1 – RC plank reinforcement designs

4. Key Outcomes

The key outcomes from this work are as follows:

- The main differences in the manufacturing of GS and GFRP RC planks are the processes of bar assembly and mesh installation into plank formworks.
- With lean manufacturing, GFRP mesh fabrication and mesh installation could be 37% and 43% faster than the standard GS mesh fabrication and installation processes, respectively.
- Double layer GFRP RC planks had the largest failure load, this being 27% and 57% greater than single layer GS and GFRP RC planks, respectively.
- Double layer GFRP RC planks had a maximum bending moment-to-area of longitudinal bar ratio which was 40% and 128% greater than single layer GS and GFRP RC planks, respectively.

5. Further Work

Due to the success of this research, the next step is to develop technical drawings and specifications for RC planks reinforced with GFRP bars.

6. Conclusions

GFRP RC planks are easier, faster and require less resources to fabricate than GS RC planks. Double layer reinforced GFRP RC planks outperform single layer GS and GFRP RC planks in terms of overall load bearing capacity and design efficiency.

Acknowledgements

I would like to thank SkillCentred for manufacturing the RC planks and VROD Australia for providing the GFRP material.

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Detecting and Mapping Crop Stress using Sentinel Remote Sensing Imagery

School of Civil Engineering and Surveying

Timothy Curtis

Bachelor of Spatial Science (Honours) (Surveying)

Supervisor: Prof. Armando Apan, USQ

Keywords: Remote Sensing, Sentinel 2, spectral reflectance, vegetation indices.

1. Introduction

Crop stress is an issue that most farmers face and there is a vast array of environmental factors which determine the health of a plant. Such factors include water content (or lack thereof), pest and disease, soil nutrients and the topography of fields. As the quality of crops has a direct effect on the profits that farmers make, technology such as satellite imagery can be used to influence decisions on the farm. As such, the Sentinel 2 satellite, launched by the European Space Agency in 2016 and freely accessible by the public, acquires images in 13 bands on the electromagnetic spectrum. These images can be utilised with processing software to depict areas of crop stress which are not visible to the human eye.

2. Background

This project is significant due to the importance of the Australian agricultural industry. It is estimated that 48 percent of Australian land is managed by farmers and the economic contribution of farming produce in 2016-17 was 60 billion dollars (National Farmers' Federation, 2018). Moreover, satellite remote sensing can help to detect crop stress at an early stage, meaning that farmers can use the information to combat areas of stress, maintain crop yield and maximise profits.

3. Methodology

The methodology used to conduct the research included determining a study area and suitable fields for analysis, inspecting the fields and acquiring crop data from the landholder, acquiring satellite images of winter crop (every 2-3 weeks) and processing the images to create vegetation maps to highlight potential areas of crop stress (See Figure 1). This information will be analysed in conjunction with other data (such as topographic maps) to quantify areas of stress.

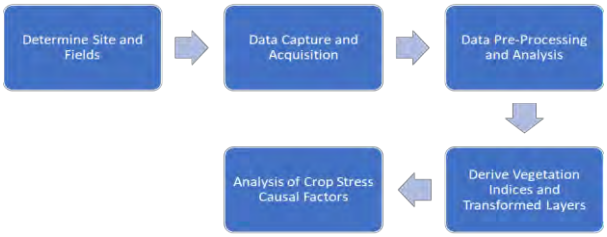

Figure 1- Methodology used in this project

4. Key Outcomes

The main outcome of this project is to successfully use Sentinel 2 satellite remote sensing imagery to detect areas of crop stress, which will be mapped using vegetation indices. If proven successful, the processes used in this project may be implemented into farming practices due to the low to minimal cost involved.

5. Further Work

The results derived from this project are limited to the specific area that was chosen and the type of crop analysed (barley). Determining the differences in results between different crop types, locations and soil types could be investigated in the future. In addition, comparing the results and accuracy of the Sentinel 2 images to other remote sensing methods could also be investigated further.

6. Conclusions

The use of Sentinel 2 imagery to detect and map areas of crop stress are expected to be useful for farmers to determine areas of stress. The information derived means that farmers determine potential mitigation methods to improve quality and yield of crops to maximise productivity on the farm. The methodology used in this project, if proven successful, could be successfully implemented into farming practices.

Acknowledgements

I would like to thank Professor Armando Apan for his guidance, supervision and support for this project. Without it, this project would have not been completed to the same standard.

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Utilisation of Turbo roundabouts to increase safety at existing double lane roundabouts within Queensland

School of Civil Engineering and Surveying

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Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Soma Somasundaraswaran, USQ

Keywords: Turbo Roundabouts, Safety, Geometry

1. Introduction

The use of roundabouts as a form of intersection has been largely adopted in Brisbane. To manage higher traffic volumes, two lane roundabouts are commonly used, however, additional safety risks are introduced. Therefore, there is a need to investigate alternative intersections such as the use of turbo roundabouts. The purpose of this study was to analyse road crash data for single and double lane roundabouts and assess the suitability of turbo roundabouts in Queensland's road network.

2. Background

The population in Brisbane is growing rapidly with extensive road networks being developed. Therefore, it is important to ensure the safest form of roundabouts are being designed and constructed. Turbo Roundabouts have been utilised successfully internationally, however there is limited research on the use of turbo roundabouts in Australia. Therefore, this study will undertake an investigation of the top ten most hazardous two-lane roundabouts in the northern suburbs of Brisbane and examine the suitability of turbo roundabouts.

3. Methodology

Preliminary analysis of the road crash data was undertaken comparing frequencies and crash types between single and double lane roundabouts. A combination of two performance measure methods identified from the Highway Safety Manual were utilised to rank the top ten worsts performing roundabouts in North Brisbane. Concept turbo roundabout designs were undertaken at the top ten sites. Turning path analysis, maximum entry path radii/fastest speed and sight distance checks are undertaken at each site.

4. Key Outcomes

Figure 1 shows the frequency of crashes at two-lane roundabouts as being significantly higher than single lane roundabouts. There is also a noticeable increase in sideswipe crashes at two-lane roundabouts. The crash rate method which considers traffic volumes has identified two-lane roundabouts as being more hazardous than single lane roundabouts.

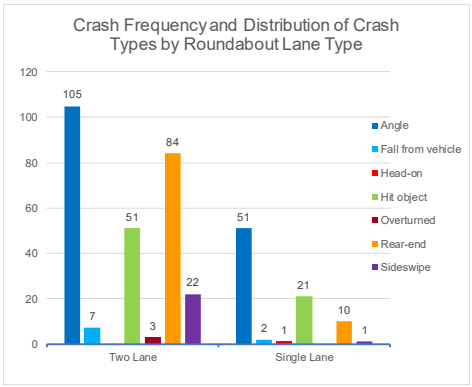

Figure 1 – Crash Frequency of types or crashes at North Brisbane Roundabouts

5. Further Work

The tasks yet to complete are the turbo roundabout concept designs and undertaking the design checks. Further studies into the suitability of turbo roundabouts for Australia could be in the form of feasibility or cost benefit analysis.

6. Conclusions

This project aims to propose recommendations for developing turbo roundabout geometric design guidelines for Queensland roundabouts.

Acknowledgements

I would like to acknowledge Dr Soma Somasundaraswaran for his support throughout this project.

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Leadership and The Development of Local Government Engineering Managers

School of Civil Engineering and Surveying

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Bachelor of Engineering
Honours - Civil Engineering

Supervisors: Dr Steven Goh, USQ

Mr Brad Salton, Group Manager, City Infrastructure Group Redland City Council

Keywords: Leadership, Local Government, Managers

1. Introduction

In theory engineers should make good managers. They are taught a lot the skills that good managers should have. They are very analytical, good problem solvers, results focused and excellent with numbers, the very essence of the profession possesses many of the skills required to be a good manager. Being a good engineering manager, however, does not automatically translate into being a good leader. If local government engineers do not develop basic leadership skills, they will ultimately be ineffective engineering managers. 'If you want to become a good manager, whether it is engineering or in some other trade, you need to stop managing and start leading. Good leaders are responsible decision makers, provide clear purpose, vision and goals, have some wonderful qualities like relationship building and effective listening' (Hall, J 2015, sec 2, para 1). To be successful in an engineering management role within local government an engineer will need to combine their technical skillset with the essential attributes of leadership.

2. Background

Most Engineers in local government jobs are not ideal candidates for management roles, and they don't necessarily even possess the skillset that makes someone a great leader. This is usually because Engineers reason in terms of numbers, processes and problems and not in terms of people. The leadership mindset versus the mindset and skills that makes a person a great engineer is vastly different. It is rare if the best Engineer in the office is also the best leader or manager. If engineering managers want to become engineering leaders, they must engage in training and personal development to build the skills that are required. A summary of the 9 main attributes of effective engineering leaders is in figure 1.

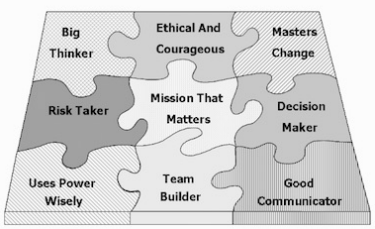

Figure 1. 9 Attributes of Effective Engineering Leaders

3. Methodology

- Conduct a literature review on the theory of leadership and the primary attributes of successful leaders;
- Conduct a questionnaire of Engineers in senior local government engineering positions;
- Undertake MBTI personality tests with a comparative analysis of findings;
- Apply on a suitable leadership instrument along with the MBTI test; and
- Make recommendations for the application of the leadership theory for Engineers based on the typical personality profile on an Engineer.

4. Key Outcomes

Make recommendations for the application of the leadership theory for local government Engineers based on the typical personality profile on an Engineer.

5. Further Work

If time persists conduct a comparison of the training types, providers or programs that currently exist which help develop the leadership skills of engineers. Assuming there is sufficient data review the findings to determine the effectiveness of the training provided in improving and developing leadership skills for engineers.

6. Conclusions

There is a core set of leadership skills and attributes which are required of senior local government engineering managers if they want to be effective leaders. Training and leadership development programs should be tailored towards engineers to ensure the growth of senior engineers into effective engineering leaders.

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Integration of Trimble V10 Imaging Rover on terrestrial surveys

School of Civil Engineering and Surveying

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Bachelor of Spatial Science Honours (Surveying)

Supervisors: Dr Zhenyu Zhang, USQ

Keywords: V10 Imaging Rover, Modelling, Integration.

1. Introduction

Conventional survey equipment has been a combination of a total station and Global Positioning System (GPS) receiver equipment. Technological advancements have seen the introduction of scanners, unmanned aerial vehicles, drones and a variety of ground-based imaging instruments. The ground-based Trimble V10 Imaging Rover has the capability of performing most everyday tasks with minimal time spent on the field. The full capability of this equipment has not been fully tested hence the need for my research project.

2. Background

This project seeks to assess the usability of the Trimble V10 Imaging Rover on common survey tasks namely; volume determination, topographic survey and asset recording. How much saving can this piece of equipment bring in? What are the achievable results?

3. Methodology

Two suitable test sites were identified for survey works. Site A was selected to satisfy the topographic and asset mapping needs. It is a typical road intersection with kerbing, services and associated road furniture. Site B was chosen for its suitability for volume estimation. It is a large earthworks bund with minimal vegetation.

Two surveys were done on each site; one using conventional equipment only and the other with the integration of the Trimble V10 Imaging Rover. See Figure 1 for selected Site A location example.

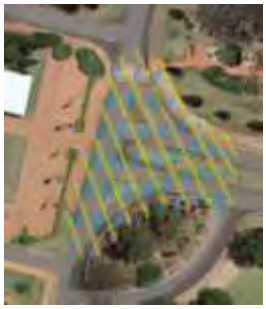

Figure 1 – Site A with Imaging Stations

4. Key Outcomes

The integration of the Trimble V 10 Imaging Rover eliminates the likelihood of missed data on the part of the surveying team.This however comes with the need for a larger amount of processing time. Experienced surveyors may find very little gains on this equipment on the tested surveyed tasks. Unquantifiable gains like safety, trueness of models at time of survey cannot be undermined.

5. Further Work

Detailed analysis of resultant models still to be conducted. Of interest will be the residuals on given cross sections between the total station and Trimble Version 10 Imaging Rover's Digital Terrain Models.

6. Conclusions

Preliminary results indicate that the Trimble V10 Imaging Rover may not be the best equipment to be used for general topographic surveys as the 'extra' data collected tends to affect the image processing times.

Acknowledgements

I would like to thank my supervisor Dr Zhenyu Zhang for his guidance and Mr Luke Czaban for his ideas and technical support throughout my project works.

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The development of a systematic framework to guide the inspection, maintenance, rehabilitation and remediation process of a levee

School of Civil Engineering and Surveying

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Bachelor of Engineering (Civil Engineering) (Honours) Bachelor of Business (Management and Leadership) (BEHB).

Supervisors: Dr Jo Devine, USQ

Keywords: Levee, visual inspection, earthen embankment.

1. Introduction

Billions of dollars are spent each year on levee construction, maintenance, repair and improvement throughout the world. Rural Queensland in particular, has experienced the deterioration of engineered earthen embankment component of levees which has been attributed to prolonged drought conditions. Local councils are faced with the difficult challenge of prioritising the repair and maintenance of levees with limited budgets. This project aims to optimise current practices by developing a systematic framework to guide the inspection, maintenance, and rehabilitation process of a levee subjected to the unique climatic conditions of rural Queensland.

2. Background

This research was motivated by a real case study, where a condition assessment of the Warrego River Levee exposed significant deterioration, as illustrated in Figure 1 (O'Brien, 2016). This research expands upon international best practice to provide a framework which concentrates on the issues relevant to levees in rural Queensland.

3. Methodology

An extensive literature review of international best practice was conducted and informed by the case study experience to develop a systematic framework (CIRIA, 2013; Institute of of Public Works Engineering Australasia, 2015). The framework will be applied to a real case study to test its practicability.

Figure 1 – A typical sinkhole on the levee crest

4. Key Outcomes

This project provides a documented visual inspection program with specific focus on the earthen embankment of a levee subjected to drought conditions and provides a logical methodology for prioritising maintenance, rehabilitation and remediation works.

5. Further Work

The next stage of this project involves the visual inspection and data collection process of the case study to review and analyse the ongoing condition.

6. Conclusions

This project presents a systematic framework for the inspection, maintenance, rehabilitation and remediation process specifically for a levee in rural Queensland.

Acknowledgements

I would like to express my sincere gratitude and appreciation to Dr Jo Devine for her continual support and guidance of my dissertation. This would not have been possible without her involvement.

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Identifying flowering vegetation using multispectral satellite imagery

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours)

Supervisors: Jessica Smith, USQ

Keywords: Remote Sensing, Flowers, Multispectral

1. Introduction

Native flowers and fruits are essential dietary requirements to many native Australian animals, and vital to the Australian honey industry. The project aims to identify flowering native vegetation using inexpensive remote sensing techniques that could assist in identifying high flower yielding vegetation. Medium to high resolution multispectral satellite imagery has been used in the analysis. The imagery used in the project was obtained from open source programs such as the Landsat and Copernicus programs. Image analysis and processing was done with open source software packages QGIS and MultiSpec.

2. Background

Previous studies in this field have used more expensive remote sensing data (lidar, radar, very high resolution satellite imagery) to model flowering and yield productions of commercial crops. This project attempts to use similar methodologies to previous studies to analyse freely available satellite imagery with a lower resolution of 10m ("Copernicus", 2018) and 30m (Survey, 2018).

3. Methodology

Data obtained relating to seasonal flowering behaviours was used to generate predictive flowering maps of Macadamia and Hardwood plantations. These maps were used to formulate a hypothesis on multispectral image analysis results of the selected areas. Thematic analysis (Figure 1) and surface reflectance of vegetation over the expected flowering period was analysed using Multispec software to see if identifiable flowering events could be detected.

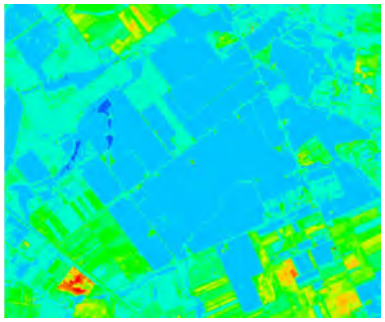

Figure 1 – Thematic image (Macadamia farm)

4. Key Outcomes

Initial methodology to generate a predictive flowering model of native flora proved too difficult as diversity mapping of plant species proved to be too broad. This resulted in the analysis of hardwood plantations being adopted to focus on large areas containing single species. Despite the refinement of the methodology MODIS, Landsat and Sentinel-2 imagery resolution proved too low to identify definable season differences caused by flowering.

5. Further Work

Results were based on hypothesised flowering events predicted from species' seasonal flowering behaviours and were unable to be collaborated through field data. It's unknown if maintained hardwood plantations experiences flowering yields comparative to non-forestry growth.

6. Conclusions

At this point the available land monitoring satellite data isn't of adequate resolution for monitoring flowering events across broad vegetation groups.

Acknowledgements

I would like to thank my supervisor Jessica Smith for her help throughout the project. I would also like to thank my peers Jacob Cormick and Joshua Egan for their contributions to the study.

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The Determination of Appropriate Intervention Levels for Road Maintenance for Local Governments

Timothy Dyball

Bachelor of Engineering (Honours) (Civil) – University of Southern Queensland

Supervisors: Dr David Thrope, USQ

Keywords: Maintenance, Defects, Intervention,

1. Introduction

With Australia covering such a large area and having a low population density in considerable parts of the country, many areas can be quite remote, which means a reliable road transport network is vital. The aim of this project it to determine the appropriate deterioration intervention level of a road at which a road authority should carry out remedial maintenance in order to maintain a reasonable standard of safety, but which also optimises the expenditure of maintenance funds that have been allocated to the local governing body.

2. Background

The objective of this project is to first identify the different types of defects that occur on Australian roads and look at and discuss the possible factors that may cause or contribute to the failure of the roads, as well as what has been identified by the asset owners as the most appropriate method to repair the defects. The project will also look at existing road maintenance management systems and the existing intervention levels that are used in local government authorities.

3. Methodology

The methodology used for this research project involves a thorough background research and literature review into road maintenance, the main causes of road deterioration and existing intervention levels. As well as this, geographic and demographic data was obtained for the area of Toowoomba and a determination and analysis of current techniques, budgets and management systems for road maintenance used was conducted. This information allowed for an assessment of the current levels of degradation on different categories of road in the local study area which provided a determination of the appropriate intervention level standards for local authorities. Figure 1 above shows typical deformation defects in flexible pavements that may require significant maintenance.

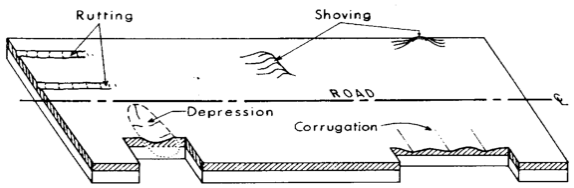

Figure 1: Deformation defects in flexible pavements

4. Key Outcomes

Once the final results have been reviewed, a conclusion can be ascertained as to whther the current intervention level set out by local governments are suitable or if there is room for improvement. This would then highlight how current intervention levels could adopt more efficient and effective techniques to better utilise recources.

5. Further Work

Still remaining on the project is a final conclusion of recommended intervention levels that could potentially be adopted with the aim to utilise resources more efficiently and effectively.

6. Conclusions

Conclusions from the project will include a detailed overview of current intervention levels and the factors that have been used to determine what should be used across the board and to be adopted by local governments.

Acknowledgements

I would like to thank Ron Ayers for providing the initial idea for the project and David Thorpe for his ongoing support through the project as direct supervisor. I would also like to thank the government departments for allowing me to access and collect the information required in this research project.

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Practical Application of Unmanned Aerial Vehicles (UAV) in obtaining 3D positional point data

Sponsor –School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours)

Major: Surveying

Supervisor: Dr Glenn Campbell, USQ

Keywords: UAV, practical applications & data capture

1. Introduction

The use of unmanned aerial vehicles (UAV's) and in particular the miniaturised version's (mini-UAV's) to undertake conventional survey tasks is rapidly changing from an idea of fantasy to a legitimate and sometimes preferable alternative. UAV technology is now used by surveyors to undertake volumetric surveys, topographical surveys and many other tasks, which were until recently limited to conventional survey techniques.

As with any rapidly emerging technology, there still remains a great deal of unknowns associated with its practical application and limitations. This study seeks to quantify whether accurate data can be obtained, the accuracy of which it is capable to do so and what factors need to be controlled or undertaken within the project design to achieve successful results.

2. Background

With all the excitement in the field of emerging UAV technology, there still exists a great deal of uncertainty about the realistic obtainable accuracies of the technology and the factors that contribute to and effect this.

3. Methodology

The study investigated three main areas associated with UAV photogrammetrical data, namely: flying height (altitude) of the aircraft, ground control point (GCP) quantity and GCP layout & orientation.

It involved the comparison of several different datasets of UAV collected 3D point data against 3D point data obtained with a conventional survey total station. The instruments used were a Trimble S5 Total Station and a Sensefly eBee UAV.

4. Key Outcomes

The individual point accuracy of each flight and different control iteration was computed, as shown in Figure 1. 120m was the optimal flying height out of the 3 altitudes test. 4 GCPs was found to be the minimum quantity required to achieve results within manufacturers specifications. The configuration of GCPs was found to have the most influence on project accuracy, with a permitter layout being preferable. Where the control was bunched, accurate values were obtained near the control points, but error quickly accumulated as the distance from the control increased.

Flight/Iteration	ΔHorizontal(E+N)	ΔElevation
Flight 1- 150m	0.029	0.060
Flight 2- 120m	0.027	0.040
Flight 3- 100m	0.028	0.049
Adjustment 1- 3 GCP's	0.050	**0.629**
Adjustment 2- 4 GCP's	0.028	0.054
Adjustment 3- 5 GCP's	0.028	0.049
Adjustment 4- 10 GCP's	0.027	0.045
Adjustment 5- Bottom Left GCP's	0.051	**0.368**
Adjustment 6- Centred GCP's	0.059	0.121
Adjustment 7- Perimeter GCP's	0.026	0.050
Manufacturer Specification	0.030	0.050

Figure 1 – Delta Values Comparison (Whole Flights/Iterations)

5. Further Work

This research was concluded in Semester 1, 2018 with a passing grade. No further work is to be undertaken.

6. Conclusions

It was found that accurate 3D data was able to be obtained by the UAV in strict testing conditions and identified that certain features represent significant limitations on the practical obtainment of such data. The minimum amount of GCP's required for good project design was identified as four and the perimeter layout was identified as the most suitable.

7. Acknowledgements

I would like to acknowledge and thank Dr Campbell for his time, support and guidance. Also Mr Joshua Brown and Mr Stephen Anthony of Ultimate Positioning Group.

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Effects of Varying Ground Water Levels on Laterally Loaded Bored Piles

Sponsor – School of Civil Engineering and Surveying

Michael Evans

Bachelor of Engineer (honours) (BENH)

Supervisors: Dr Jim Shiau, USQ

Keywords: Ground Water, Lateral Bearing Capacity, Reduction factors.

1. Introduction

Structural foundations have been instrumental in the growth of societies throughout history and has had a significant impact on the shape of modern civilization. The significance of foundations can be seen in day to day life whether it be smaller foundations for single storey housing or larger more complex foundations for high rise structures.

As the world's population continues to grow at an exponential rate so will the demand for liveable and affordable housing. As the density of populations within liveable areas continues to increase the understanding and knowledge of structural foundations is paramount.

2. Background

Despite extensive research and a long history of construction adopting the P-Y curve method of analysis for laterally loaded piles there is still a significant deal of uncertainty in the construction of piles when unexpected ground water is encountered.

3. Methodology

After extensive research it was found that each composition of soil would result in various outcomes when the presence of ground water is encountered. A Finite Element Model was developed to analysis various soil compositions such as fine grained and coarse grained soils. As part of the analysis varying ground water depths were introduced to observe the reduction in soil bearing capacity under lateral loads to potentially develop a reduction factor that can be applied on site during construction.

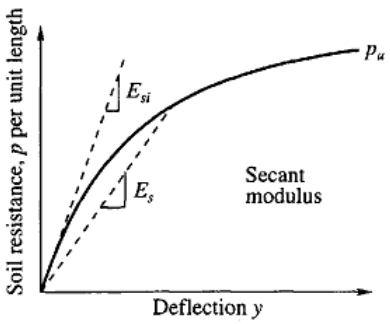

Figure 1 – P-Y Curve Plot

4. Key Outcomes

The preliminary data obtained from the finite element modelling has identified that the presence of ground water has a significant impact on the soils ability to resist lateral loads.

5. Further Work

At this stage of the project further modelling of varying soil compositions and further data will need to be collected to further investigate the effects of ground water and whether a reduction factor can be determined.

6. Conclusions

Due to the staging of this project not close to being completed it is difficult to draw any conclusions at this point. However it can be stated from preliminary modelling that as expected with the presence of ground water has a significant impact on the lateral bearing capacity of piles.

Acknowledgements

I would like to thank my supervisor Dr Jim Shiau for his guidance and support throughout this project. I would also like to thank the support team at Strand7 for their technical support throughout the modelling phase of this project.

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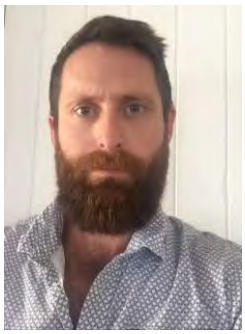
Slenderness Effect on the Behaviour of Hollow Circular Concrete Columns Reinforced with GFRP Bars

School of Civil Engineering and Surveying



Tom Fairhall

Bachelor of Engineering (Honours) Major Civil Engineering

Supervisors:

Dr Allan Manalo
Mr Omar Alajarmeh

Keywords: GFRP Bars, Hollow Circular Column, Slenderness Effect

1. Introduction

Hollow concrete columns are often used as an economical solution for piers in structures such as bridges (Lignola et al. 2011) due to their efficient cross section, high strength-mass and stiffness-mass ratios, which reduces the load conveyed to foundations. When reinforced with glass fibre reinforced polymer (GFRP) bars, this system will eliminate steel corrosion problems. GFRP bars also have electromagnetic transparency which in tidal conditions is favoured. Consequently this will reduce repair and rehabilitation costs as well as significantly increase the service life of columns. It is important however to understand on how hollow concrete columns reinforced with GFRP bars behave under loads.

2. Background

Research conducted by Mohamed et al. (2014) showed that solid concrete columns reinforced with GFRP bars are deemed slender when the slenderness ratio is 16 or higher. This is lower compared to steel reinforced columns indicating that this design parameter impacts the critical strength of the GFRP reinforced columns. In addition, the current standards relating to GFRP reinforcing ignored the contribution of the bars. This research investigates the slenderness effects of hollow circular concrete columns that are reinforced with glass fibre reinforced polymer (GFRP) bars.

3. Methodology

Four hollow concrete columns with 250 mm outside diameter, 90 mm inside diameter and with different heights (0.5 m, 1.0 m, 1.5 m, and 2.0 m) were cast and tested under eccentric compressive loads. All columns were reinforced longitudinally with 6-16 mm diameter GFRP bars and transversely with 10 mm spirals.

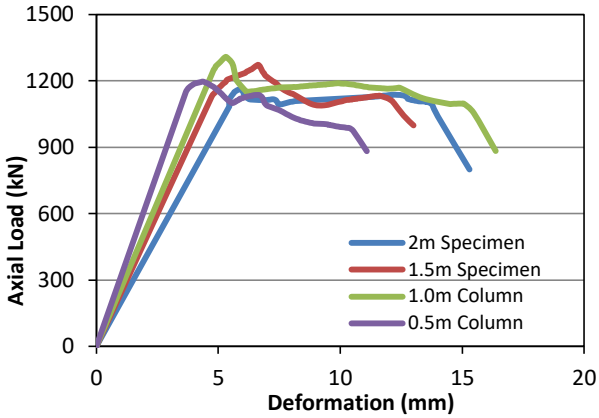


Figure 1: Comparison of load deformation of slender columns

4. Key Outcomes

From the load and deformation curve in Figure 1, it can be seen the columns behaved linear elastically up to the maximum load. Longer columns however failed at a lower load than the short columns.

5. Further Work

Further work focuses on analysing the test data evaluating the effect of slenderness ratio on the stiffness, confinement efficiency and ductility. Subsequently evaluation and comparison with existing theoretical model will be also conducted.

6. Conclusions

Preliminary analysis of the test results suggest that the slenderness ratio affects the load capacity and failure behaviour of hollow concrete columns reinforced with GFRP bars.

Acknowledgements

I would like to thank V-Rod Australia for providing the GFRP bars and the technical staff at the Centre for Future Materials at USQ for the assistance during specimen preparation and testing.

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Understanding the Performance of 3D Printed Carbon Fibre Reinforced Polymer (CFRP)

Sponsor – School of Mechanical & Electrical Engineering

Michael Finan

Bachelor of Engineering Science (Honours)

Supervisors: Dr Mainul Islam, USQ

Keywords: Composite fibre, Additive Manufacturing

1. Introduction

In the last decade, additive manufacturing techniques, such as fused deposition modelling (FDM), has gained popularity due to the ease of use, speed of printing, and low cost of machine and materials. An FDM 3D printer is capable of printing a range of thermoplastics, such as Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS) and Nylon.

Markforged has produced a material that is nylon polymer with short carbon fibre embedded in it, this strengthens the material greatly resulting in stronger prints. This material, called Carbon Fibre Reinforced Polymer (CFRP) can be combined with a technology called Continuous Carbon Fibre Filament (CCF), which is where a polymer has a carbon fibre embedded in it, both can be seen in Figure 1.

2. Background

This new additive technology is replacing subtractive technology such as CNC machines. CNC machines are computer guided mills that remove materials from a block to create the required material. This technology has been an industry staple for many years due to its capacity for intricate, repeatable designs, and ability to maintain tight tolerances, higher than a human is capable of achieving though milling alone.

3. Methodology

Testing was done with both static loadings and with dynamics loads to put the test specimen through a similar scenario to what a bicycle car will incur whilst in use.

4. Key Outcomes

The key outcomes for this project is to gain a further understanding of what the material is capable of and what it's limitations are within the manufacturing industry.

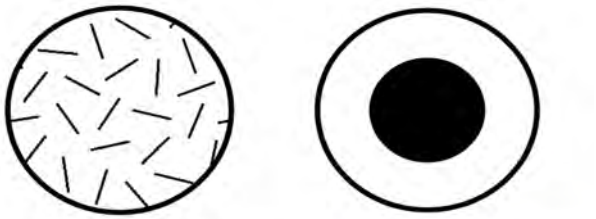

Figure 1 - Cross section of Short Fibre and continuous fibre reinforced polymer

5. Further Work

This testing looks at one specific type of part which centres around spline driven arms, there is many other types of mechanical parts that could test the viability of the material for that scenario.

6. Conclusions

From the research done, it is expected that the material will perform better than regular 3D printed polymers, however it will perform worse than the steel counterparts. This material performs better than aluminium in tensile testing and slightly worse that it in bend testing. It is expected that it will not be a replacement for aluminium in all cases but could be in places where the 3D printing technology can improve the design.

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Study on the Effects of External Parameters on the Behaviour of Expansive Soils

Faculty of Health, Engineering and Sciences

Zack Flood

Bachelor of Civil Engineering (Honors) BENH

Supervisors: Dr Buddhi Wahalathantri, Faculty of Health Engineering and Sciences, USQ.

Keywords: Expansive Soil, swelling potential, soil properties

1. Introduction

Expansive soils are subjected to increase in volume when subjected to wetting or increase in moisture content. The expansiveness of a soil, which is dependent on variables including the clay mineral type and content (Nelson et al 2015), should be determined by testing the properties of the soil before construction is initiated and by making appropriate considerations during the design phase. This project aimed at investigating the effects of load induced parameters, such as load area, intensity and other external parameters the wetting rates on expansiveness of selected soils. It looked to determine the significance of these parameters, as compared to traditional classification testing currently used for prediction of soil behaviours.

2. Background

Expansive soils may cause significant damage to low rise buildings such as dwellings and roads due to repeated action of swelling and shrinking during wet and dry periods. This project aims to build and extend existing knowledge in the civil construction practice through the analysis of test results and conclusions drawn from them.

3. Methodology

The project is entirely based on small scale laboratory experiments. The expansiveness of two soil types found in the Toowoomba region is experimentally assessed. Initially, it involved qualifying the soil types with existing industry accepted methods. Secondly, it involved observing the effect different external parameters, such as loading, wetting rates, confinement, compaction and moisture content had on the expansion potential of the soil.

4. Key Outcomes

The key outcomes so far are that external parameters which were set out in the specification such as loading case and wetting rates can have a significant effect on a the expansive capability and behaviour of soils. In addition some recognised prediction methods such as weighted plasticity index (WPI) are not always accurate predictors as can be seen below in figure 1.

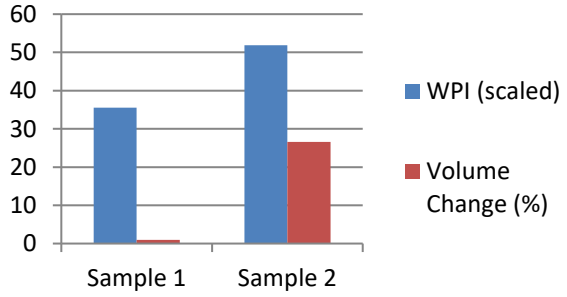

Figure 1 – WPI Indicator vs. swelling potential

5. Further Work

The further work remaining involves (1) continuing the loading pattern cases for more reliable data on the two initial soil types tested; and (2) commencing the comparative analysis on a third laboratory artificially modified soil type, which consists of a commercially available clay mineral eckalite (kaolinite) mixed with a naturally occurring soil.

6. Conclusions

Loading on the soil sample and wetting rates were found to have the most notable effect on the expansion potential of the soils, with other parameters such as compaction and confinement condition having a lesser impact.

Acknowledgements

I would like to thank my supervisor Buddhi for his guidance throughout the entire duration of the study. I would also like to thank Construction Sciences Toowoomba who enabled me to use their laboratory facilities.

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Network Management of Low Volume Local Roads in NSW

School of Civil Engineering and Surveying

Thomas Franzen

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr David Thorpe, USQ

Keywords: Low Volume Roads, Network Management, Local Road Network.

1. Introduction

This project aims to determine best practice network management strategies for Low Volume Roads (LVRs) in NSW that will ensure the safety, productivity, social equity, sustainability, and resilience of the local road network. This project looks at the current practices at Eurobodalla Shire Council (ESC) as well as those in other regions of NSW and evaluates and recommends improvements for managing both sealed and unsealed LVR.

2. Background

LVRs account for most of the worlds roads but often have insufficient funding. This is certainly the case in NSW where an estimated $408 million annual funding gap for the 145,533 kilometres of low volume local roads exists (Verity et al. 2015). This illustrates the importance of making the most efficient and effective use of every dollar spent on LVRs in NSW.

Adopting best practice principles for the network management of LVRs ensures that the limited available resources are used to provide the most beneficial outcomes. This project is important as it will help identify some of these best practices in different regions of NSW.

3. Methodology

The methodology for this project has included a literature review on the current road network management practices for both sealed and unsealed LVRs. It then involved an investigation of the current network management practices for sealed and unsealed LVRs at Eurobodalla Shire Council. Based on the findings of the preliminary investigation a survey instrument was developed to find out how other selected NSW Councils manage their LVR networks. Once these results have been obtained and analysed best practices for both sealed and unsealed LVRs will be proposed and evaluated and the findings will be documented.

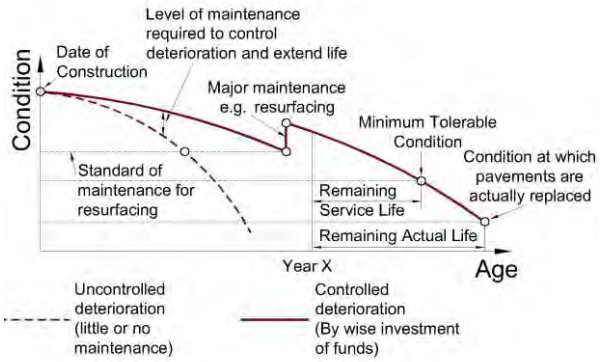

Figure 1 – Typical Road Condition Deterioration and Asset Management Strategy (Adapted from Austroads 2009)

4. Key Outcomes

The research has highlighed the importance of adopting best practice principles for managing LVR networks. It has been found that the methods adopted for managing higher volume roads cannot be universally transferred to LVRs as this would not represent an efficient use of limited resources. The research has shown that strategic maintenace and renewal strategies can greately improve the return on investment in extending the overall life of LVR assets compared to allowing uncontrolled deterioation. The effect of such strategies are highligted in Figure 1.

5. Further Work

Currently the survey questionnaire is undergoing USQ Ethics Committee Review. This has been quite a rigorous process to ensure the integrity of the research. As soon as this is approved the surveys will be sent out and further analysis will be able to be undertaken.

6. Conclusions

In summary, this research confirms that adopting best practice network management strategies can increase the efficiency, safety, productivity, social equity, sustainability, and resilience of the LVR network.

Acknowledgements

I would like to thank my supervisor Dr David Thorpe as well as Mr Rob Burke from ESC, together their contributions and advice have been invaluable.

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Testing and investigating the angular accuracy and efficiency of the Trimble SX10 camera pointing system

School of Civil Engineering and Surveying

Beau Fredericks

Bachelor of Spatial Science

(Honours) (Surveying)

Supervisors: Dr Glenn Campbell, USQ

Keywords: SX10, Surveying, Camera Pointing System

1. Introduction

Total Stations (TSs) are instruments that evolved from theodolites. They are used by professional surveyors for many measurement tasks today. With advancements in technology, Scanning (or Hybrid) Total Stations (STSs) are a combination device that have become available to surveyors. STSs add to TSs the ability to do 3D laser scanning.

Although STS instruments don't have the effective scanning abilities of stand-alone 3D scanners, Trimble's latest version of an STS, the SX10, closes the gap significantly. The SX10 has a much higher scanning rate than previous STSs. This makes it an effective scanner with the benefits of also being a TS. Significant technological changes to the way it functions make this possible, so it will be valuable to test these changes.

2. Background

The technological changes in the SX10 include the removal of the telescope and the addition of a Multi-camera aiming system. With this aiming system, any manual aiming is done through a connected tablet computer which provides the view from the cameras.

The manual aiming camera system of the SX10 has not yet been tested in academic literature. Traditionally, surveyors have manually sighted targets through the built-in telescope of a TS to obtain accurate angular measurements. The inclusion of automatic target aiming to reflective targets is common-place in STSs and TSs. However as a need for manual aiming still exists, this will be the major focus of testing.

3. Methodology

The methodology is based on ISO17123-3, the International Standard setting out procedures for testing angular measurements of theodolites. The full test procedure was used for angular accuracy as a base

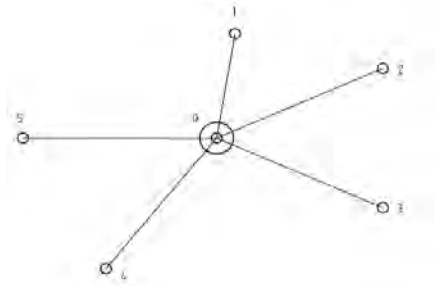

Figure 1 - Test configuration in ISO 17123-3 (ISO 17123-3 2001)

(as shown in Figure 1 above). Modified simple test procedures were used for different variables (short range, long range and vertical angles). The SX10 has been compared in all procedures to a comparable TS, the Trimble S7 which has the same angular accuracy (1") as the SX10. The S7 instrument has a telescope for aiming and both instruments feature automatic targeting.

4. Key Outcomes

The SX10 and S7 instruments have had their automatic and manual aiming methods compared through various proceedures. Differences in operating efficiencies and accuracy are expected to be identified, which may impact on choice of instrument for a range of uses.

5. Further Work

Testing in high temperatures with heat shimmer has not been done due to seasonal factors. Other variables for investigation include lighting and visual contrast conditions.

6. Conclusions

It is expected to conclude whether the technological changes to the SX10 have had an impact on the angular accuracy when manually aiming. Initial results show manually aiming with the SX10 may have a time cost.

Acknowledgements

I would like to thank UPG Solutions in Sydney for the use of an SX10 with a compatible controller, my employer Proust & Gardner Consulting Pty Ltd for their support and use of equipment as well as my family and supervisor Dr Glenn Campbell.

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Comparison of the Practical Application of ARR1987 and ARR2016 for Urban Stormwater Catchments in Bundaberg

School of Civil Engineering and Surveying

David Fulton

Bachelor of Engineering (Honours)

Supervisors: Dr Md Jahangir Alam, USQ

Keywords: ARR1987, ARR2016, Comparison.

1. Introduction

Australia's national guidelines for flood estimation are documented within a manual called Australian Rainfall and Runoff (ARR). The 2016 version of the document (ARR2016) has been released in the past couple of years which includes updates to design rainfall data, temporal patterns and climate change recommendations. The design impact associated with switching from ARR1987 to ARR2016 is still relatively unknown to the engineering industry.

This research project has undertaken a comparison of the practical application of ARR1987 and ARR2016 by applying the methodology and data included within each document to urban stormwater catchments in Bundaberg, Queensland.

2. Background

A general increase or decrease in peak discharge affects the immunity of existing stormwater infrastructure as well as critical planning instruments such as the defined flood event footprint. This is valuable information for Bundaberg Regional Council and engineering consultants.

3. Methodology

Six different sites were selected from the Bundaberg region. The catchments were broken into sub-catchments and the design inputs were determined based on the relevant manuals. The ARR1987 and ARR2016 rainfall data and temporal patterns were applied separately to each site and the peak design discharge determined in accordance with the relevant manual. The peak design discharges and critical storms (IFDs and temporal patterns) were then compared to identify any significant difference between the two manuals across the six different sites.

4. Key Outcomes

Despite IFD increases of 15-30% (ARR2016), there is no significant difference in the peak design discharge calculated using ARR1987 and ARR2016. This is primarily due to the temporal pattern structures (refer example comparison in Figure 1) and different methodology recommended as part of ARR2016.

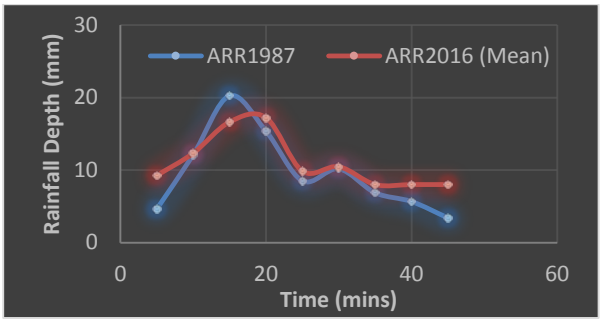

Figure 1 - Temporal Pattern Comparison

5. Further Work

Further possible work may involve increasing the number of sites to further solidify the conclusions along with a similar comparison for rural catchments and different areas with different standards and rainfall data.

6. Conclusions

Without including climate change recommendations, there is no significant difference in the peak design discharge calculated using ARR1987 and ARR2016 for urban stormwater catchments in the Bundaberg region.

Acknowledgements

I would particularly like to thank my wife for her incredible support over the past few years. I would also like to thank my supervisor, former colleagues at GHD and my current colleagues at Bundaberg Regional Council for their ideas, inspiration and supply of project data.

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Potential of Softwood Engineered Timber with Graphene

School of Civil Engineering and Surveying

Kelly Gabriel

Bachelor of Civil Engineering (Honours)

Supervisors: Prof. Karu Karunasena, USQ

Keywords: Bending; buckling; cross laminated timber; deflection; engineered timber; graphene nanoplatelets.

1. Introduction

The use of innovative materials such as graphene could provide an opportunity for low grade timber to be further utilised in engineered timber by increasing the mechanical performance and predictability.

2. Background

The intrinsic strength of graphene including an elastic modulus of 1TPa and ultimate strength of 130GPa, far exceeds that of any other material (Zaman et. al. 2011). Graphene has been successfully incorporated into polymer matrices, significantly reducing deflections and increasing buckling capacity (Song et. al. 2018). However, research investigating the potential of a graphene timber relationship is extremely limited. Sheshmani et. al. (2013) identified that the incorporation of graphene nanoparticles into wood flour polymer composites could improve the overall properties and provide a substantial reinforcing effect. Thus, the objective of this project was to investigate the bending and buckling behaviour of cross laminated timber (CLT) reinforced with graphene nanoplatelets (GPLs).

3. Methodology

CLT panels reinforced with an external GPL/epoxy layer were modelled using Strand7 finite element (FE) software. Micromechanics based on Halpin-Tsai Model and Rule of Mixtures was employed to predict the material properties of the nanocomposite layer. Empirical methods were used to validate the FE model before a detailed parametric study was conducted to investigate the effects of w.t.% GPL, GPL size and shape, thickness of nanocomposite and various boundary conditions.

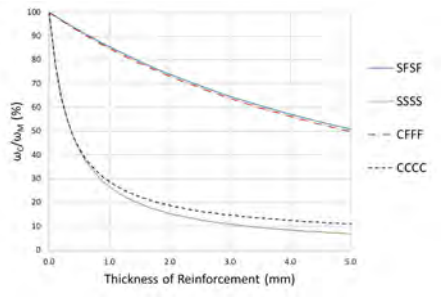

Figure 1 – Reduction of maximum deflections in response to external 1% w.t. GPL/epoxy layer on 3-layer CLT under various boundary conditions.

4. Key Outcomes

Numerical results show that an external GPL/epoxy nanocomposite layer reduces the maximum deflection and increases the critical buckling load of CLT panels. Figure 1 demonstrates the bending effect of a 1% w.t. GPL/epoxy layer on a 3-layer CLT panel. Increasing the w.t.% of GPL yielded further improvement, however, these effects were less pronounced as the number of CLT layers was increased.

5. Further Work

The bending and buckling behaviour of CLT panels reinforced with inter lamella GPL/PUR will be investigated as this application would mimic current CLT manufacturing practices.

6. Conclusions

The research highlights that the inclusion of graphene in CLT could maximise the use of low grade timber by increasing the bending and buckling performance.

Acknowledgements

This faculty sponsored project has linkage to the PhD project currently undertaken by Ms. Rebecca Cherry of Hyne Timber.

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Optimal location for a UHPQC in a distribution network for minimisation of harmonics and reactive power improvements

School of Mechanical and Electrical Engineering

Warren Gallon

Bachelor of Engineering (Honours) - Power

Supervisor: Dr Andrew Hewitt, USQ

Keywords: harmonics, power quality, voltage distortion, current distortion, THD

1. Introduction

Consideration of power quality in an electrical distribution network is an important part of the electrical design process. This ensures correct operation, efficiency and longevity of network components and connected equipment. Poor power quality can contribute to increased losses, increased thermal operating conditions, mechanical vibration and electrical stresses.

This research project investigates the use of a unified hybrid power quality conditioner (UHPQC) for improving power quality in a small distribution network. As part of this research, optimisation of the installation of the UHPQC in also considered.

2. Background

Voltage and current harmonics are sinusoidal waveforms having a frequency at integer multiples of the fundamental frequency. The inclusion of these voltage and current harmonics cause distortion to the fundamental frequency waveforms.

Modern electronics use waveform switching devices such as thyristors, diodes, silicone-controlled rectifiers (SCR) and insulted gate bipolar transistors (IGBT). These devices are commonly used in converters, inverters, switched mode power supplies (SMPS) and adjustable speed drives (ASD) and are all categorised as harmonic sources.

3. Methodology

A power quality analyser was used to measure voltage and current harmonic spectrums at specific locations within a chosen distribution network where harmonics sources were present. A simulation model was developed to replicate the measured harmonic spectrums in the distribution network along with a UHPQC filter. Figure 1 shows a distorted current waveform and the associated current harmonic spectrum.

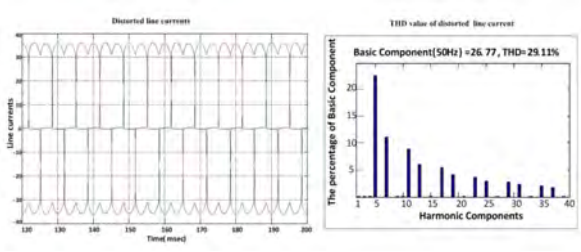

Figure 1 – Distorted Waveform and Harmonic Spectrum

The effectiveness of UHPQC filters in suppressing the propagation of harmonics throughout the network has been analysed, including an investigation of optimal placement of these devices within the distribution network.

4. Key Outcomes

A model has been developed which accurately represents the chosen network and implementation of a UHPQC filter at various nominated locations within the network. This model has been successfully used to evaluate the effectiveness and optimal location of the UHPQC filter within the distribution network.

5. Further Work

Further work would include a detailed design of the distribution network for the implementation of a UHPQC device.

6. Conclusions

Successfully developed a model that allows the evaluation and effectiveness of a UHPQC within the modelled network and determines the optimal location for the device within the network.

Acknowledgements

Thank you to my project supervisor Dr Andrew Hewitt who has provided guidance throughout all facets of this research project.

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Industrial Automation Human-Machine Interface (HMI) Design for Disabled Workers

School of Mechanical and Electrical Engineering

Adam Gibbs

Bachelor of Engineering (HONS) (Instrumentation Control and Automation Engineering)

Bachelor of Science (Computing)

Supervisor: Mrs Catherine Hills, USQ

Keywords: Industrial Automation, HMI, Disabled Persons, Assisted Workplaces

1. Introduction

This project aims to develop a HMI that enables improved interaction between disabled workers and an automated machine. The project involves observing the workers interacting with a tub sealing machine (Figure 1) using the standard HMI, developing an alternative mobile HMI and then observing the interactions with the new HMI.

2. Background

Bedford Industries is an assisted workplace that provides employment opportunities for persons with disabilities by utilising industrial automation machinery to provide contract packing services.

3. Methodology

Ethical approval by the university was required because of the target group. This involved extensive analysis of risk and data management practices.

Worker interactions with he existing machine will be observed and measured to determine areas of improvement in accordance with the ATOMS model. (Schwanke, 2005)

A mobile HMI (Android tablet) will be developed using High Performance HMI (Hollifield, 2017a) principles.

User interactions using the mobile HMI will be observed to determine if improvements have been made.

4. Key Outcomes

At the time of writing, the mobile HMI was still under development so no outcomes regarding the effectiveness of a mobile HMI have been made.

Figure 1 - Tub Sealing Machine

Progress has been made in communicating with an industrial automation controller (PLC) using an Android tablet.

5. Further Work

Continue to develop a mobile device HMI framework that can be used to assist not only disabled persons, but other groups such as persons with limited numeracy or literacy skills

6. Conclusions

At the time of writing, no conclusions have been made regarding the impact of a disabled person using a mobile device to interact with an industrial machine.

Acknowledgements

I would like to thank Jon Jones at Bedford Industries for providing the opportunity to work with their people and machinery. My supervisor Catherine Hills, has provided great support and guidance in progressing the project. Lastly I would like to thank my wife and son who have supported my studies over the last 7 years.

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Direct Volume Computation using UAV Point Cloud Data and a Known DTM

School of Civil Engineering and Surveying

Alexander Gibbs

Bachelor of Spatial Science

Supervisor: Zahra Grarineiat, USQ

Keywords: Point Cloud, Volume, Unmanned Aerial Vehicle.

1. Introduction

The continual introduction of new measurement technologies and tools in the surveying world allows for much more time efficient and higher accuracy deliverables.

The increasing popularity and accessibility of UAVs means more workplaces increasingly have the opportunity to obtain and use them, but adapting to and using the data types which they create can be challenging, especially in well established businesses.

2. Background

One of the major applications of UAVs in the survey industry is for terrain modelling, and in particular, modelling of terrain to calculate volumes of stockpiles. Conventional survey methods for volume calculation have very small data sets compared to the enormous data sets (point clouds) generated from UAVs as seen in figure 1, a small project with two shipping containers modelled with 26 Million points. The challenge is to be able make full use of these large data sets when current survey packages cannot handle such files.

3. Methodology

The simple fix to the problem was go out and buy high end software which could perform all calculations in regards to point cloud processing, but as volume calculations only were the focus, a more cost effective approach was taken. The process of a survey grade volume calculation was researched and then programming was looked at for doing the calculation. A design dataset with matching X and Y coordinates of the sampled point cloud was generated to represent the base surface and difference of Z values from the two datasets was calculated. A difference in height between both data sets for common points was then used for calculating the volume bounded by both data sets.

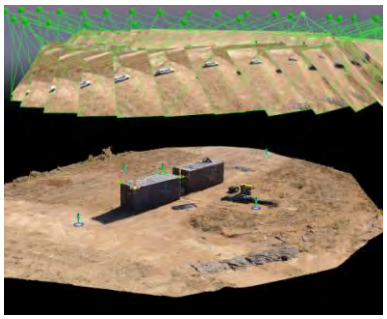

Figure 1 - Point cloud generated from UAV imagery.

4. Key Outcomes

The result of this project has generated an efficient and highly cost effective method of incorprating UAVs into the survey workflow. Without the need for expensive software, point clouds can easily be used for the accurate calculation of volumes.

5. Further Work

In addition to the calculation of the desired volume amount, some sort of graphical representation of the volume calculated would be beneficial to have as a more professional looking deliverable for a client.

6. Conclusions

The project has been a success, in that a cost effective and accurate process has been found, solving a major hurdle in incorporating the efficiencies UAVs can offer into the daily surveying workflow.

Acknowledgements

Thanks to my supervisor Zahra Grarineiat, my colleagues and boss at AJS Surveys for use of work equipment and my wife.

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Evaluation of the Irrigation Hydraulics Assessor (IHA) as a Pipeline Behaviour Estimation Tool

Sponsor – School of Civil Engineering and Surveying, and the Centre for Agricultural Engineering

Phil Ginakis

Bachelor of Civil Engineering (Honours)

Supervisors: Dr Malcolm Gillies,

Mr Michael Scobie, Centre for Agricultural Engineering

Keywords: Hydraulics, Pipelines, Agriculture

1. Introduction

This dissertation is an evaluation of the Irrigation Hydraulics Assessor (IHA), a publicly available, web-based tool developed by the Centre for Agricultural Engineering (CAE) at USQ, intended as a hydraulic analysis tool to increase efficiency in irrigation. The web-based tool allows the user to graphically plot pipeline alignments on a real-world map, and enter basic input data such as pipe alignment, fittings and flow properties; with these minimal inputs, the automated tool performs computations that estimate the pipeline pressures along the pipe (Figure 1).

2. Background

The concept for this research was proposed by CAE (NCEA, 2016), with a view to obtaining an objective assessment of the validity and necessity of the IHA tool, and an understanding of ways to improve its value. The current version of the IHA, although functional, has not undergone a robust evaluation, nor has it been bug-tested – these tasks are required to validate the tool. At the request of CEA, this dissertation aims to provide a measured and thorough evaluation of the IHA tool, for numerical accuracy, functionality, and general utility, and it identifies where the IHA is placed among similar tools while examining the value it presents.

3. Methodology

The evaluation methods employed in this project used pipeline case studies as the reference models against which to test the IHA tool. Highly accurate methods of hydraulic head loss estimation were also used to estimate losses in the case study pipelines, and a numerical comparison has been performed to compare the results, thus evaluating the numerical accuracy of the IHA estimations. A separate evaluation of the user-friendliness of the tool is also being completed.

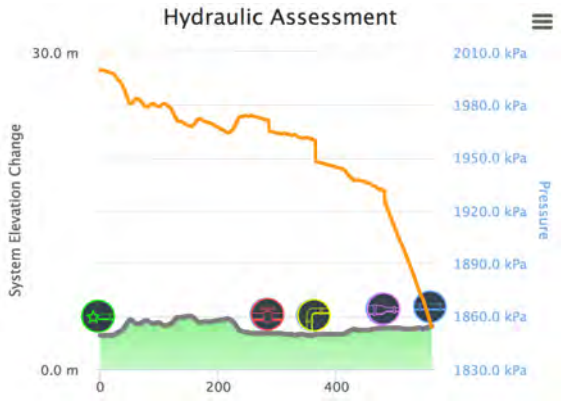

Figure 1 – Irrigation Hydraulics Assessor Sample Assessment

4. Key Outcomes

This evaluation identified many ways of producing highly accurate frictional head loss estimations which estimate losses with practically negligible errors. It also identified that the IHA tool is a unique and practical calculator, with real-world map integration not found elsewhere in similar tools. the value offered by the IHA exists, although the numerical evaluation is incomplete, thus final conclusions about the numerical accuracy of the IHA cannot be drawn.

5. Further Work

Suggested further work may relate to investigating, in specific detail, what alternative applications the IHA can be used for, and implementing alterations to the software based on the suggestions resulting from this evaluation.

6. Conclusions

Anticipated conclusions may indicate that the IHA has moderate numerical accuracy, and that the tool functionality is acceptable, but would benefit from fine-tuning prior to wide-spread public dissemination.

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Numerical Investigation on the Behaviour of Floodways During Extreme Flood Events

School of Civil Engineering and Surveying

Isaac Greene

Bachelor of Engineering (Honours) (Civil Engineering)

Supervisors: Prof Karu Karunasena

Dr Weena Lokuge

Keywords: Floodway, Strand7, Finite Element Analysis

1. Introduction

Floodways are important infrastructure utilised within a road network. This study investigates the structural adequacy of the Type 2 floodway, SD 252 as published by LVRC (2008) through a 3D finite analysis with the application of ultimate state loadings from AS 5100.2:2017 and hydrostatic fluid force.

2. Background

Over the past decade both the intensity and frequency of flood events have increased (BNHCRC, 2015). Floodways compliant with current best practises have failed as the result of being in a frequently submerged state during these events. This has created a need to structurally investigate the forces floodways undergo throughout their serviceable life. This investigation aims to assist in creating more resilient structures and regional communities.

3. Methodology

A 3D finite element representation of the Type 2 floodway was constructed in Strand7 (Fig. 1). It is one of the 4 types of floodways used in LVRC. A simplified model was developed due to the augmented models inherent complexities. The simplified model was analysed to validate material criterion, convergence controls and model response, with errors identified, analysed and omitted from the model.

Following this validation, the full model was solved for displacement, stresses and soil failure based on different loading combinations. A number of design charts relating to the type 2 floodway were then constructed based on the worst cases identified.

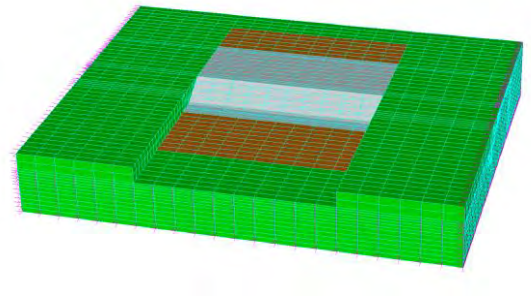

Figure 1 - 3D Finite Element Model

4. Key Outcomes

The main outcome of this research will be the development of universal design charts allowing a user to reference maximum force and moment characteristics based upon selected input parameters for structural analysis purposes.

5. Further Work

Further work includes parametric analysis of the Type 2 floodway with varying downstream batter slope angles. This is in response to the slight differences observed in scour and erosion behaviour in existing constructed floodways.

6. Conclusions

Current floodway design presents structural vulnerability for a number of AS 5100.2:2017 flood loadings. Design can however be improved by utilising the load responses from this study and incorporating them into design charts for a range of soils and parameters commonly encountered in floodway settings. The new design charts can then be referenced to determine structural adequacy and reinforcement/rock protection requirements.

Acknowledgements

I would like to sincerely thank my supervisors Dr Weena Lokuge and Prof Karu Karunasena for their invaluable input, guidance and support during the execution of this project.

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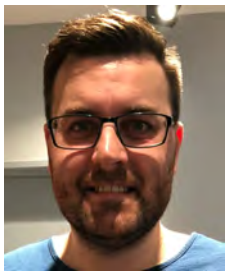
Bicycle Accident Characteristic Significance and Potential Corrective Methods

School of Civil Engineering and Surveying



Marcus Grinham

Bachelor Engineering (Honours) (Civil)

Supervisor: Mr Soma Somasundaraswaran
USQ

Keywords: Bicycle Safety, Crash Characteristics

1. Introduction

Increased environmental harm and traffic congestion caused by of our current transport mode adoptions has intensified the focus on developing sustainable transport systems. Government departments are compelled to provide renewed public access infrastructure in particular the encouragement of cycling, resulting in the necessity for improved cycling facilities and safety.

2. Background

Even with the well documented positive effects of cycling, one of the most worrying aspects is bicycle safety. Figure 1 summarises statistics from the BITRE where fatalities involving a cyclist surged from 25 in 2017 to 45 in 2018, an increase of 80%. According to the Victorian Cycling Strategy 8-28 published by the Victorian Department of Economic Development, Jobs, Transport and Resources 60% of Victorians are curious about cycling but are deterred by real or perceived safety concerns. Statistics from the Victorian State Trauma Registry (VSTR) and the Victorian Orthopaedic Trauma Outcomes Registry (VOTOR) reported by Beck et al. (2016) indicated that 69% of bicycle crashes occurred on-road locations where 44% of those crashes involved multiple vehicles.

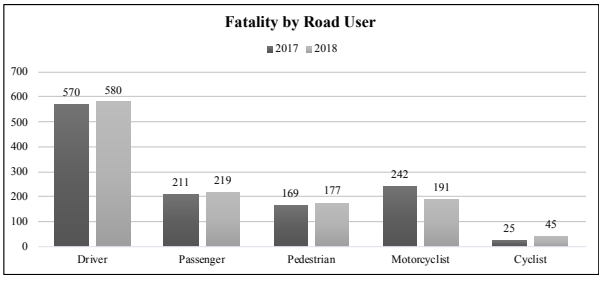


Figure 1 – Fatalities by Road User (Source: BITRE)

3. Methodology

The research paper utilises statistical analysis in particular multinomial logistic regression to investigate crash characteristic significance. The results of regression enable a general function to predict injury severity for cyclists which, in turn can be used to simulate potential remedial action effectiveness.

4. Key Outcomes

The research and analysis within this paper is intended to describe the significant underlying problems with bicycle safety within the state of Victoria. Using large datasets to critically assess the contributing factors of severe injuries for bicycle users when interacting with motor vehicles will assist in acknowledging the dangers of mixing low speed vulnerable road users with high speed vehicles.

5. Further Work

Utilisation of other statistical methods to correlate factor significance. Future analysis expanded to specific high-risk intersection data collection focusing on precise geometric/physical characteristics.

6. Conclusions

The key result this project seeks to achieve comprises recognition of crash characteristic significance to predict cyclist injury severity and devise potential solutions to mitigate injury severity and ultimately increase road safety for bicycle users.

Acknowledgements

Mr. Soma Sundaraswaran for agreeing to be my supervisor and guiding me through a difficult but fulfilling time. Mr. Glenn Dixon at Charter Keck Cramer for his ongoing support and flexibility.

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Machine Vision of Water on Roads to Detect Flood Water

Sponsor – School of Mechanical and Electrical Engineering

Xavier Gunn

Bachelor of Engineering (Honours) majoring in Electrical & Electronic Engineering and Bachelor of Business and Commerce.

Supervisors: Elizabeth McCarthy, USQ

Keywords: Flood water, image recognition, machine learning, image processing

1. Introduction

Floods are Australia's most expensive natural disaster. This project aims to use vehicle dash cam footage to detect flooding. Image processing and machine learning algorithms can be used to flood water on the road, and analyse this flood water.

2. Background

In wake of the 2011 flood, a Queensland flood commission enquiry found that improved flood detection systems are required for emergency services.

Machine learning and image processing techniques have been widely used in image recognition. Through using these techniques objects such as people can be automatically recognised. This project aims to use image recognition including those adopting machine learning principles to automatically recognise flood water on roads.

Particle image velocimetry (PIV) is a well-researched image processing technique for analysing the flow of a liquid from a video. This can be used to estimate the speed and direction of flood water.

3. Methodology

Flood footage captured from dash cams where the car is stationary will be collected. Two methods will be used to segment flood water in in image. A confusion matrix can be used as the performance metric for the segmentation and PIV.

The segmentation will be performed on individual images. The algorithms will be judged for whether they accurately segment flood water on a road in an image. The flood water that has been successfully segmented in an image will form a region in which particle image velocimetry can be used to estimate the direction of the water over multiple frames.

Figure 1 – Image segmentation of water using image erosion and dilation

4. Key Outcomes

There are two key outcomes to this project. Firstly, the segmentation of flood water in dash cam footage using machine learning and image processing algorithms (Figure 1). Secondly, the ability to estimate the direction that flood water which has been segmented in an image is flowing in using particle image velocimetry.

5. Further Work

Further work can be performed so that flood water can be detected and analysed from dash camera footage while a car is moving. This may be achievable through an object tracking algorithm such as a particle filter.

6. Conclusions

This project has achieved the segmentation of water in dash cam footage when a car is stationary, and estimate the direction the flood water is flowing in. With further work this could be implemented as part of a flood detection system.

Acknowledgements

I would like to acknowledge my supervisor, Elizabeth McCarthy, for going out of her way to guide me in my research.

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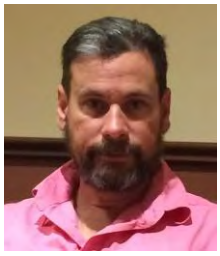
Spatial Audit and Analysis of Cycling and Pedestrian Routes in Regional NSW

School of Civil Engineering and Surveying



David Gwalter

Bachelor of Spatial Science (Hons)

Major – Surveying

Supervisors: Dr Marita Basson, USQ
Dr Michael Grosvenor, USQ

Keywords: Active Transport, Infrastructure Auditing, GPS Video Auditing

1. Introduction

The use of the transport modes of walking and cycling, "active transport", has both health and environmental benefits for the Australian community. In order to provide suitable infrastructure to support active transport it is important to understand what currently exists and whether it is fit for the purpose.

2. Background

Government policy for active transport is implemented at a local level with the development of pedestrian and bicycle plans. These plans require base line infrastructure data to be collected to enable the development of action plans for path development and maintenance. An analysis of existing plans revealed that very few had utilised surveying techniques or methods. Frackelton et al. (2013) and Dozza and Werneke (2014) have shown that the use of wheelchairs and bicycles fitted with video and GPS is beneficial to the understanding of how users use active transport routes.

3. Methodology

A suitable bicycle mounted video and GPS device was selected by comparing collected data against RTK GPS measured positions. The selected device was then used to perform a trial audit of a pedestrian/ bicycle path in the Tamworth Regional LGA. The video and GPS data was combined for viewing within a GIS application that allowed the recording of attribute information for points of interest with a geo located still image from the video (see Figure 1). The audit results were then compared to the data contained within the published bicycle and pedestrian plans.

Figure 1 – Example Image Capture with Telemetry Overlay

4. Key Outcomes

The project found that there is no standard method used for establishing the baseline data for active transport plans. It was found that a mobile phone app was a readily available audit device that could record points with an accuracy that is fit for the purpose. Initial audit data identified path quality, comfort and maintenance issues that are not discussed in the existing active transport plans.

5. Further Work

Further work that could be pursued as a result of this project includes applying the methodology to other transport studies, mobile app development and measuring path widths and grades from the video.

6. Conclusions

Auditing from the user's perspective can be a relatively simple process that can add detail not obtained by traditional auditing techniques.

Acknowledgements

I would like to thank my project supervisors Marita Basson and Michael Grosvenor for their assistance and support throughout the project. I would also like to thank my employer Peter Baxter for the loan of equipment.

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Investigating the maintenance costs and condition states of deteriorated small road structures

School of Civil Engineering and Surveying

Patient Hadonou

Bachelor of Engineering (Honours) (Civil Engineering)

Supervisor: Dr Weena Lokuge, USQ

Keywords: Culverts, floodway, cost estimation

1. Introduction

Over the past decade, various regions of Queensland have been impacted by two major flood events in 2011 and 2013. One such region was the Lockyer Valley Region (LVR). As a result, a community study by a team of researchers demonstrated that although small, road structures such as floodways and culverts are very important towards maintaining the resilience of rural communities (Lokuge 2018). The main aim of this research project is to develop a relationship between the deterioration and the associated costs of small road structures to establish a cost effective maintenance strategy.

2. Background

Prior to the floods, the maintenance of smaller road structure had been neglected. Services to culverts and floodways were provided on a need-basis. This led to two prominent issues. Firstly, inspectors took longer to identify the causes of failure due to the lack of reports regarding condition states prior to failure which delayed repairs. Secondly, a reactive approach can often mean that needs might not be recognised until a major failure has occurred and it is too late then. In Australia, there is no state or nationwide standard for the inspection and maintenance of small road structures such as floodways and small concrete culverts. In that sense, a cost estimation is a great way to truly quantify the advantages and disadvantages of a treatment.

3. Methodology

The research makes use of a quantitative approach and focuses on the assets in the LVR. Culverts and Floodway data are sourced and the maintenance needs are identified by modelling the condition states against age (fig 1). Then, a cost model is developed for the cost estimation. The final step of the methodology is the analysis.

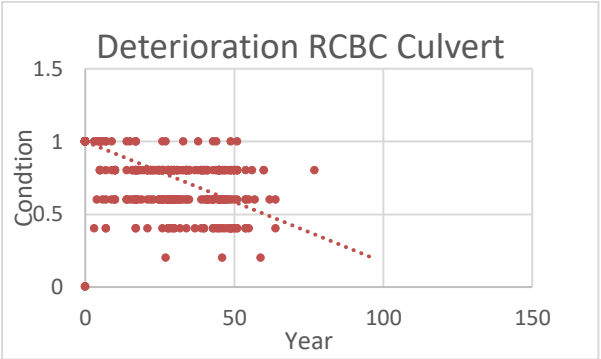

Figure 1 – Predicted Deterioration of RCBC Culverts based on LVRC Data (LVR)

4. Key Outcomes

This research allows for the identification of various links between costs and condition state. It will help regional councils to implement cost saving maintenance strategies to effectively manage their smaller road assets and establish an efficient inspection framework.

5. Further Work

Future cost analysis could focus on how much impacts various elements have on the overall cost of a structure. It could also prove beneficial to undertake a comparison of a wide range of treatment options to establish which treatments are more efficient in the long term.

6. Conclusions

This research project is still underway, but an interesting finding is that when replacement is the only treatment, the average condition of the structures decreases over the years. So, the overall network is more prone to failure during extreme flood events.

Acknowledgements

I would like to give special thanks to my supervisor Dr Weena Lokuge who guided me in each step of this research. I would also like to thank Professor Karu Karunasena who attended various meetings and provided me with some helpful insight.

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Analysis of Traffic Control Systems for Better Coordination of Traffic Signals

School of Civil Engineering and Surveying

Mark Hagan

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Soma Somasundaraswaran, USQ

Keywords: Traffic Signal Network, Coordination, Traffic Management

1. Introduction

The aim of this project is to investigate whether alternative traffic management strategies have an impact on the overall performance of a traffic signal network on a major arterial road.

Using James Street, Toowoomba, as a case study, the existing traffic conditions have been modelled using a traffic network analysis tool to determine the impact these alternate strategies would have on the network.

2. Background

Commute times in south-east Queensland have remained steady at approximately 20 minutes in recent past (DTMR, 2012). However, increasing population and density means that the daily commute will reach up to 60 minutes by 2030 which would be up to be intolerable for most residents (Passmore, 2017).

Previous studies typically focus on the traffic signal networks timing and offsets of which a lot of resources are used in designing and maintaining by road authorities. These parameters are sometimes limited by the minor legs meaning they cannot always be changed to favour one desired route.

3. Methodology

Nine signalised intersections on the route were considered for this research with the traffic data, signal phasing, timing and offsets all obtained from the Department of Transport and Main Roads (DTMR). Using TRANSYT-7F the existing network conditions were modelled and performance indicators and time-space diagram noted as illustrated in Figure 1. The alternative traffic management strategies; Dynamic Speed Limit, Restricted Right Turns, Free Left Turns and Lane Reassignment were then implemented into the existing model individually and simulated with new performance indicators output and assessed against the existing conditions.

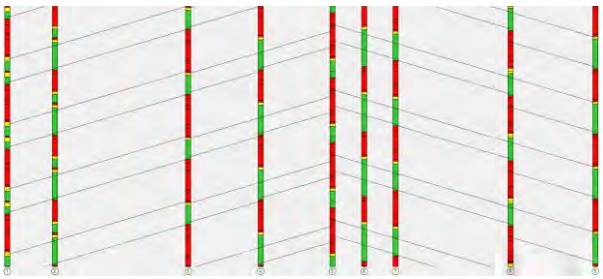

Figure 1 – Time-Space Diagram of James Street Traffic Signal Network

4. Key Outcomes

Preliminary data indicates that traffic speed has a significant impact on platooning traffic and the timing at which it arrives at the next intersection. Coordinating the traffic speed and signal timing results in a larger bandwidth and increased opportunity for traffic progression.

5. Further Work

The network performance data will be thoroughly analysed to determine a clear impact on the network as a whole. Given this analysis has only been performed on one particular system, further study could be conducted to determine if the trends are universal.

6. Conclusions

At this stage it is too early to draw any clear conclusions from the modelling data, however, it evident that traffic networks are highly sensitive to changes in speed.

Acknowledgements

I would like to thank Bill Sampson of the University of Florida as his advice has been key in developing the network model and my supervisor Dr Soma Somasundaraswaran for providing continual motivation to make progress on the project.

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Pilot plant to investigate and evaluate the potential of domestic heating using low cost solar generation as a supplemental heat source.

School of Mechanical Engineering

Matthew Harawira

Bachelor of Engineering (Honours)
Mechanical Engineering

Supervisors: Professor John Billingsley, USQ

Keywords: domestic heating, solar, thermal sink

1. Introduction

Although building shell designs have significantly improved thermal performance standards, space heating and cooling still accounts for 40% of energy use within the Australian residential energy market and 21% is used for water heating (DEWHA, 2008). In this project a pilot plant will be designed, constructed and tested to provide data to determine if a low-cost solar generator can effectively supplement this energy requirement.

2. Background

Household energy use in Australia is steadily declining but the amount spent by consumers on electricity is still on the rise (AES, 2016). Energy costs continue to drive consumption habits towards reducing usage and small scale domestic generation, typically in the form of rooftop solar and photovoltaic (PV) and this electricity is sold or stored in batteries. However with the end usage so much of this power being space conditioning and the considerable financial barriers of PV generation and storage systems, both as an upfront cost and in regards to ROI, an evaluation of an alternative was deemed necessary.

3. Methodology

A design, build and test methodology was employed to quantify the power output of a low-cost black poly-pipe collector heated by solar insolation. Water within the collector transfers heat to subsoil pipework. An Arduino microcontroller collects slab temperature and other environmental temperature data. Quantitative analysis

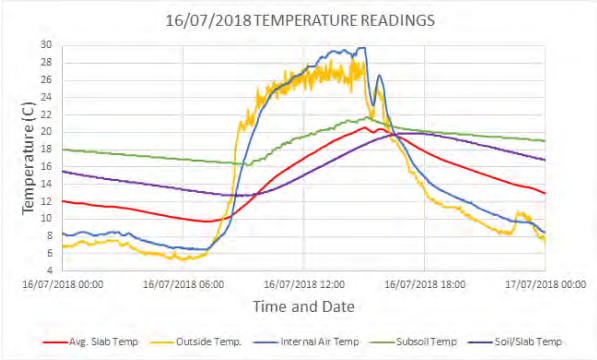

Figure 1: Average Temperature Readings

of data generated by the pilot plant forms the basis of the projects output as shown in Figure 1. This is combined with a qualitative assessment both of the local environment the test was conducted in and of published performance and cost data for PV systems in order to give the quantitative data relevance beyond the conditions the test case was conducted in and a measure to evaluate its performance against.

4. Key Outcomes

The key outcome of this project is generation of relaible data that can be used to project the viability of the system for residential use.

5. Further Work

Currently work on the project includes baseline analysis to determine heating rates of the concrete as a result of natural convection.

6. Conclusions

Preliminary analysis of data obtained shows a measurable increase of heating over baseline values.

Acknowledgements

I would like to thank Professor John Billingsley for the idea for this project and continued support throughout.

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An Instrumented Approach to the Classification of Alcoholic Beverages: combining PTR-ToF Mass Spectrometry, with Machine Learning

Sponsor – National Centre for Engineering in Agriculture

James Feleciano Herbert

Bachelor of Engineering (Honours) – Computer Systems

Supervisors: Professor Peter Brett, NCEA;

Doctor Craig Lobsey, NCEA.

Keywords: E-nose; Mass Spectrometry; Quality Control.

1. Introduction

The most common method, for the quality control of alcoholic beverages, is the human olfactory mechanism. Aside from the cost, time, and limitations to purely qualitative assessments, employing a human agent has other significant boundaries. Sensory fatigue being the most prominent of these, and ultimately, the subjectiveness of the human sense of smell (Majchrzak et al., 2018). The natural ability of the human sense of smell is unrivalled. Attempting to replicate this capacity would be an incredibly complex task, if not impossible. However, technology has developed to a point where it's use is no longer trivial, and can be of great utility.

2. Background

Mass Spectrometry ('MS') can be considered as a form of Machine Olfaction. It is a highly advanced, method of analysing substances that contain 'Volatile Organic Compounds' ('VOCs'). Compared with other methods, the accuracy, and fidelity of 'MS' produces unparalleled results. Modern 'MS' machines can detect many chemical compounds, with detection limits in the order of parts per billion. However, the number of compounds that are detected, and their complicated interactions, can make interpretation difficult. Here we evaluate the use of machine learning algorithms to cost effectively classify food samples using MS measurements.

3. Methodology

A Proton Transfer Reaction, Time of Flight, Mass Spectrometer (PTR-ToF MS), was used to detect the mass of compounds present in Beverages (see '*Figure 1*'). Principle Component Analysis was then applied to this data, in order to make interpretation more intuitive. Data was then prepared to evaluate the classification of sample types using the Random Forest Algorithm.

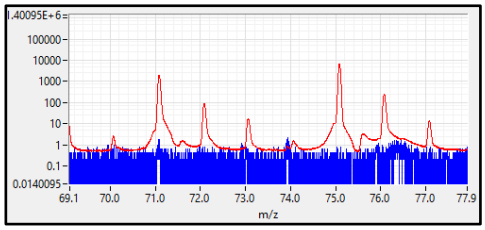

Figure 1 – A Portion of a Mass Spectrum, of an alcoholic substance; the red Peaks, show chemical compounds present in the substance.

4. Key Outcomes

The mass spectra, of the various substances, did show variability, when compared to one another. This is a positive result, as differentiation was evident between substances of similar types (e.g., beer, vs. beer), and substances of different types (e.g., beer, vs. rum).

5. Further Work

While the preliminary experimentation, and subsequent results, show great potential, a much more comprehensive experiment will be conducted. This will involve analysis on a much larger range of alcoholic beverages.

6. Conclusions

A system that can utilise the efficiency of PTR-ToF MS measurements, but also provide useful information on key sample characteristics using machine learning approaches could help overcome the limitations seen in the human agent. Additionally, it could provide efficient, and inexpensive measurements for quality, and safety control of human consumable items.

Acknowledgements

I would like to thank:- Prof. Peter Brett, and Dr. Craig Lobsey, for their time, patience, and invaluable advice, in supervision of this project. I would also like to thank Dr. Mark Dunlop, and the Department of Agriculture and Fisheries, Queensland, for assistance with the use of the Mass Spectrometer.

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Comparative evaluation of the axial behaviour of circular and square hollow concrete columns reinforced with GFRP bars

Faculty of Health, Engineering and Sciences

Terry Heslin

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Allan Manalo, USQ
Mr Omar Alajarmeh

Keywords: GFRP, Columns, Geometry.

1. Introduction

This paper compares the axial behaviour of square and circular hollow columns reinforced with Glass Fibre Reinforced Polymer (GFPR) reinforcement.

The behaviour of each column was discussed and correlated to observations from the experiment and the accuracy of the theoretical predication was analysed to determine whether the code is relevant for this area of work. This research will evaluate the effects of column geometry on the behaviour of hollow concrete columns reinforced with glass fibre reinforced polymer (GFRP) bars.

2. Background

Corrosion of steel reinforcement in concrete is a critical factor in the longevity of a structure. GFRP bars provide an alternative reinforcement which eliminates the corrosion risk in concrete. Similarly, the use of hollow sections reduces concrete material cost and weight bearing on foundations while increasing the strength and stiffness to mass ratios (Sheikh et al. 2007). It is however critical to have an understanding on the performance of this construction system under loads.

3. Methodology

Hollow square (SH1) and circular (CH1) columns with similar gross sectional area were prepared and tested under concentric compressive loading (Figure 1, left) to investigate its failure behaviour, load and deformation behaviour and strains. Similarly, solid columns (SS1 and CS1) were tested for comparison with their hollow counterparts. All columns were reinforced longitudinally with 6-16 mm diameter GFRP bars and transversely with 10 mm spirals.

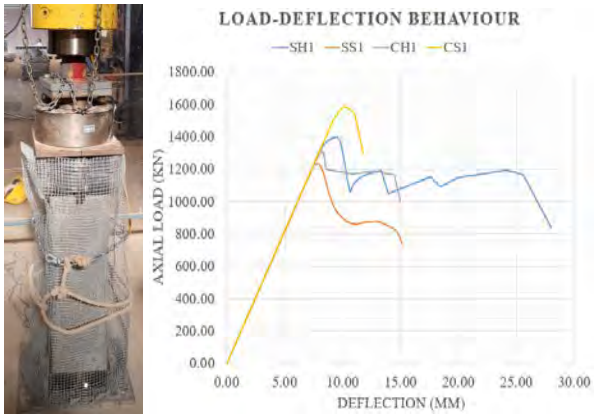

Figure 1 – Testing of columns (left) and the load and deflection behaviour (right)

4. Key Outcomes

Figure 1 (right) shows all columns behaved similarily at the initial loading, presenting a linear elastic behaviour. The solid square column did not fail where anticipated and hence presented the lowest failure load. After initial failure, both hollow columns retain their strength for an extended period in comparison to the solid columns.

5. Further Work

Theoretical evaluation of the capacity of the columns will be conducted to verify if the existing design models can predict accurately the load capacity of hollow columns reinforced with GFRP bars.

6. Conclusions

Preliminary results indicated hollow square columns present higher strength than circular whereas in the case of the solid columns, the circular cross section showed the higher failure load. The hollow sections provided ongoing strength while deflecting after failure. Further evaluation of the results will be conducted to understand the mechanism regarding this behaviour.

Acknowledgements

I would like to thank the technical staff at the Centre for Future Materials at USQ for assisting in the preparation of the test samples and also V-Rod Australia for supplying the GFRP bars.

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Home based solar power generation, storage, and localised energy grids

Sponsor – School of Mechanical and Electrical Engineering

Warren Hook

Bachelor of Engineering (Honours)

(Electrical & Electronic)

Supervisor: Associate Prof Paul Wen, USQ

Keywords: Residential solar generation, micro-grids, solar system packages.

1. Introduction

The increasing population growth and the associated energy demands places strains on the current supply network systems and the environment. Micro-grids, consisting of aggregated residential solar systems is a novel way to address these issues.

Undermining this concept is the need to determine household energy use profiles as demonstrated by Firth, Lomas, Wright, and Wall (2008); These profiles need to be matched to suitable solar system installations with sufficient reserve to contribute to a micro-grid network.

2. Background

Existing generic installation packages are designed based on government rebate offers and imposed grid export limitations. A localised micro-grid needs to consider detailed energy profile use and reserve potential, as demonstrated in Figure 1, for extend periods of reduced generation capability. In considering the analysis of energy profiles, a tool is developed to determine suitable residential packages for future proofing implementation into micro-grid networks.

3. Methodology

Spread sheet tools were developed to categorised energy profiling using categorisation methods adapted from Firth et al. (2008) for simplification into low, medium and large household energy consumers. The existing export limitations were used as an initial adjustable base for the spread sheet tool to determine suitable installation package designs. Product selections were based on a weighted rating analysis of product specifications and economic criteria. The subsequent packages were followed up with analysis of system performance and individual suitability.

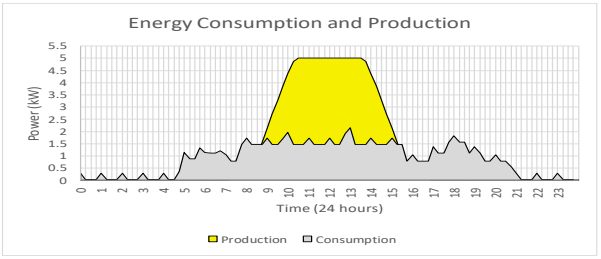

Figure 1 – Solar production overlaying energy consumption

4. Key Outcomes

With the exception of the imposed export limiation, many of the existing generic packages are useful. Simply scaling of these designs for surplus production is all that would be required for integration into micro-grid networks. The current payback period of storage batteries is prohibitive and generally exceeds their lifetime performance expectancy, however they will be an integral component of micro-grid networks.

5. Further Work

Micro-grid networks create an opportunity to test the development of an open decentralised energy market (Mengelkamp et al., 2018). The economic impact of this idea warrants investigation.

6. Conclusions

The developed tool will be useful in selecting package designs for implementing into micro grid networks. It would need significant adaptation for incorporating the economic implications of an open energy market.

Acknowledgements

This research was carried out under the principal supervision of Associate Professor Paul Wen. I would like to thank the staff of Coast Wide Solar, Peter and Charmaine Finn and David Lopez for their assistance, commercial practical knowledge and expertise.

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Identifying Rights, Obligations and Restrictions on Freehold Land in Queensland

School of Civil Engineering and Surveying

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Supervisors: Mr Shane Simmons

Keywords: Rights, Obligations, Restrictions

1. Introduction

Land forms the basis of a society's economic, social and environmental development and is a precious and limited resource. Due to sustainability and land degradation issues, governments have attempted to change the way people relate to and use the land by introducing legal rules known as Rights, Obligations and Restrictions (RORs).

These rules control a diverse range of land based activities including development, mineral, timber, heritage, environmental and water rights (Fig. 1) and affect the way in which landowners manage and use the land.

2. Background

A land administration system (LAS) provides the infrastructure for the implementation of policies and management strategies in support of sustainable development and one of its roles is the unambiguous identification and definition of RORs that exist over a parcel of land.

It has been argued that due to the dynamic nature, increasing number and complexity of RORs being created, no one could completely and easily identify RORs affecting a land parcel to any degree of certainty and that the LAS was in need of reform.

The aim of this project is to identify and undertake searches for RORs over freehold land parcels and report on any inefficiencies or impediments to that process.

3. Methodology

1. Research current literature relating to RORs and land administration systems.

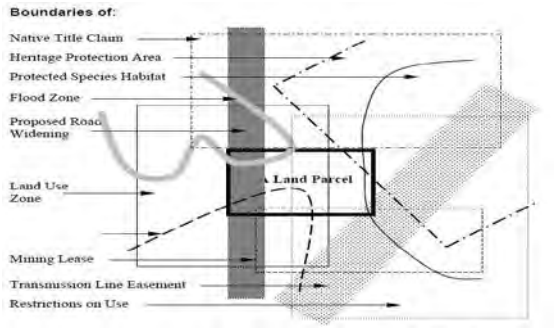

Figure 1 – Overlapping RORs on a land parcel (Williamson, Ting, 2001)

2. Identify legislation that creates RORs in Queensland.

3. Utilising Temples typology (created for use in NSW), identify how RORs are managed and recorded.

4. Conduct searches over three freehold parcels of land and identify any inefficiencies or impediments to the search process.

4. Key Outcomes

Literature review was completed with reference to status of land administration and RORs giving an insight into the problems faced by current LAS.

Property law overview was completed.

Temples typology was adapted to suit Queensland land system and the agencies which manage RORs identified.

5. Further Work

Case studies over three freehold parcels and analyse the results of the search process.

6. Conclusions

Anticipated conclusions are identifying any inefficiencies or impediments to the search process and suggesting improvements if required.

Acknowledgements

I would like to thank Shane Simmons for supervision and Dr Glenn Campbell for the research project idea.

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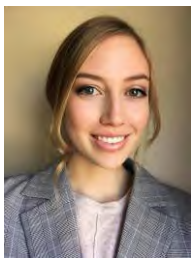
CBD revitalisation – the relationship between laneway activation and sense of place

Sponsor – School of Civil Engineering and Surveying



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(Honours)

Supervisors: Dr Marita Basson, USQ

Dr Michael Grosvenor, USQ

Keywords: CBD Revitalisation, Laneway Activation, Sense of Place

1. Introduction

In seeking to add vitality and life back into their cities, state and local governments have utilised a range of strategies to redevelop and revitalise Central Business Districts (CBD) (Woodhouse, 2011). Laneway activation has become a popular strategy to reactivate the CBD and reintroduce a sense of place in most of Australia's large cities and has also been attempted in regional cities (Urbis, 2010). This project investigates laneway activation strategies employed in a regional city and explores how it influences the sense of place within the community.

2. Background

Planning trends are increasingly focusing on revitalising CBD's as the human element over the decades has decreased due to the previous focus being on issues such as accommodating the rise in car traffic (Gehl, 2010). Laneway activation revitalises CBDs underutilised laneways with the aim of introducing vitality and a sense of place into the CBD. Laneway activation has been adopted by the regional city of Toowoomba QLD (Urbis, 2010). This project looks at how laneway activation influences sense of place in Toowoomba.

3. Methodology

The project seeks to provide a causal explanation as to how laneway activation influences sense of place in a regional community by employing qualitative and quantitative research methods. Data collection comprised of two phases. Phase one involved studying the physical characteristics of Toowoomba's activated laneways (figure 1) and ranking them to determine the most, average and least activated laneway. Phase two involved observing the behaviours of humans in the three laneways to determine the overall sense of place of the laneways using a framework derived from literature.

Figure 1 - The selected activated laneways investigated

4. Key Outcomes

The key outcomes for this project are:

- The development of a framework that has measured the behavioural indicators of sense of place in the laneways that have varying degrees of activation.
- Using this framework to measure varying degrees of sense of place observed in the three laneways.

5. Further Work

The tasks remaining in this project include analysing the results to form part of the discussion and conclusion chapters of the dissertation.

6. Conclusions

The key conclusion of this project is that laneway activation and its various physical forms contributes to the sense of place in the space in which people display through their behaviours. This suggests that laneway activation can improve the sense of place in regional cities as well as larger capital city CBD's. This project provides a foundation for further research into laneway activation and sense of place studies.

Acknowledgements

I would like to thank my project supervisors, as well as my family and friends who have supported and guided me throughout this journey.

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Conceptual Design of a Digital Meter for Power, Gas and Water Utilities

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Mechatronic Engineering)

Supervisors: Dr Steven Goh, USQ

Keywords: utility meters, digital meters

1. Introduction

Convenient access to utilities, including power, gas, and water, is an accepted part of life in many developed countries. As demand for utilities increases "electricity consumers are asking for better customer service, high accuracy in energy measurement…along with timely data delivery" (Werenga et al., 2014, p. 1). This can also be applied to gas and water utilities and is indicative of consumers who increasingly wish to be better informed about products and spending.

The aim of this project is to design a digital meter that would combine the usage data for power, gas and water utilities at a single home level, and display information useful to the consumer using accessible technology.

2. Background

Metering of public utilities has evolved dramatically from analogue electromechanical meters to advanced metering infrastructure (AMI) connected with current telecommunication technologies. Despite this, power, gas and water have remained segregated, and access to near time usage data has not become widely available.

3. Methodology

The conceptual design phase was the emphasis of this project and was largely influenced by the parameter analysis design theory (Kroll et al., 2001).

In order to gain an understanding of the design requirements of metering power, gas and water, a comprehensive needs analysis was performed, spanning performance, value, size and safety concerns, followed by a review of currently available technology. The parameter analysis was then utilised to determine key conceptual issues, such as accurately detecting utility usage and secure communication with the digital control centre, and generating designs based on these parameters.

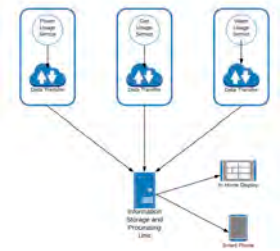

Fig 1. Flowchart of possible concept for meter

4. Key Outcomes

Initial research established the complex system and infrastructure which a consolidated meter must operate within. A concept for the design was proposed which encompassed the design requirements and available technology. The basis for this design is a central processing system which would communicate with the meters and the user displays (Fig. 1).

5. Further Work

Further work is required to investigate the feasibility of commercial use of consolidated digital meters and the ability to connect them to existing utility providers for billing purposes. There are also opportunities for the addition of features such as providing usage data for separate appliances.

6. Conclusions

The increasing consumer demand for more information and control over their utilities can be met through the addition of combined digital meters that allow access to near time data, such as the design proposed in this project.

Acknowledgements

I would like to thank my supervisor, Dr Steven Goh, for his guidance throughout this project.

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Road Safety Research at Intersections within Wagga Wagga

School of Civil Engineering and Surveying

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Supervisors: Mr Trevor Drysdale, *USQ*

Lecturer, School of Civil Engineering and Surveying, University of Southern Queensland

Keywords: Road, Safety, Intersections

1. Introduction

This projects aim was to research road safety and determine whether right-hand turn treatments should be considered as future works within the township of Wagga Wagga and if so, at which locations.

2. Background

The Sturt highway is a major east-west link through the Murray & Riverina region. It commences at the Hume highway junction in the east, travelling west for 985 kilometers until it reaches Adelaide.

In Wagga Wagga, the highway runs along the southern edge of the Central Business District where heavy Vehicles, residential and local traffic all interact. The Highway also crosses four main North-South arterial roads. Both the Highway and the Arterial roads similarly allow right hand turning movements at un-signalised intersections.

There were 33 casualty crashes that occurred on the Sturt Highway in 2016 and 45% of those occurred in the City of Wagga Wagga.

If right hand turning treatments were implemented at critical locations throughout Wagga Wagga, what impact will they have? Will they be expensive? How will they perform? These are questions that this project aims to answer.

3. Methodology

A quantitative research approach was used to formulate trends in crash data at un-signalised intersection locations. The trends identified that right-hand turning movements were a significant factor at un-signalised intersections. Costing estimates were also used to help evaluate proposed treatments. Computer programming software was used to help determine the anticipated performance of the intersection designs.

4. Key Outcomes

The project was broken into several main objectives that coincided with key tasks. Other than the revision of existing literature, some of the main objectives included;

- Collection and analyse of crash and traffic data at intersections in Wagga Wagga.
- Determining whether Right-Hand turning movements are a significant factor, and if so
- Completion of concept design(s) that incorporate intersection treatments
- Traffic modelling analysis with the use of SIDRA to determine the level of service achieved for each option.

5. Further Work

Due to the projects timeframes the proposed intersection treatments are yet to be presented to the stakeholders, Roads and Maritime Services and Wagga Wagga City Council. Future works include presenting material to these stakeholders in an attempt to persuade upgrade of existing intersections. If successful, future works would also include monitoring of the upgraded intersections and reporting on any change in safety performance and reduction of crash incidents, if any.

6. Conclusions

Un-signalised intersections within Wagga Wagga would benefit from Right hand turning treatments. These would help reduce rear-end type collisions and can typically be implemented with little costs whilst utilising existing formation widths.

7. Acknowledgements

I would like to thank the Roads and Maritime Services for assisting me to complete my studies, my Friends and Family for their support and understanding and Mr Trevor Drysdale for his guidance.

8. References

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Orthotic Prosthetics Using Active Mechanical Systems

Sponsor – School of Mechanical and Electrical Engineering

Jacob Irwin

Bachelor of Engineering (Hons) Mechatronic

Supervisors: Mr Chris Snook, USQ

Dr Albert Chong, USQ

Keywords: Gait Measurement, Gait Stability, Orthotics, KAFO.

1. Introduction

The knee-ankle-foot orthotic (KAFO) (Figure 1) is a device that is intended to help those with deficiencies in muscular strength associated with the knee joint. One of the major disadvantages of a KAFO is it lacks the ability to adequately support the person when they are walking on a downward sloping surface such as a ramp, or even in a carpark. The goal of this project was to determine if a simple hydraulic locking mechanism attached to a standard KAFO would allow the wearer to achieve additional stability while undergoing sloped or uneven surfaces gait.

2. Background

There are various methods of addressing this problem such as robotic limbs and power walkers. However, their cost is prohibitive for the average person. This project was intended to be a proof of concept and to prompt future development of low cost measures to make long term quality of life (QOL) improvements for those with lower limb disabilities that require orthotics (Halmai, 2018), who do not have access to high cost alternatives.

3. Methodology

A manually actuated locking system was developed that could be attached to the test subjects KAFO. The test subject will be asked to perform a timed walk test with and without the locking system where his gait stability ratio (GSR) (W. & E., 2003) will be calculated using high speed footage of the experiment. A pared t-test will then be used to determine if any improvements seen in the results can be contributed to the new system at a 95% confidence level.

Figure 1 – Knee-Ankle-Foot Orthotic

4. Key Outcomes

A KAFO attachment has been designed and an experiment has been developed around the test subject's needs, abilities and restrictions. A method for analysing and comparing experimental data has been developed.

5. Further Work

Depending on the results of the experiment, further work in developing a viable product based on the prototype will be required.

6. Conclusions

A cost-effective orthotics augmentation that adds to the wearer's mobility, stability and/or confidence could prove beneficial for rehabilitation regimes and the QOL of the recipient by reducing fear of falling and increasing independence (Cromwell & Newton, 2004).

Acknowledgements

I would like to thank USQ and its staff for providing adequate knowledge to conduct this project, Chris Snook for giving guidance and I would also like to thank my friends and family for supporting me throughout my studies.

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Cost Effective Polyethylene Terephthalate (PET) Object Orientation Detection System

Sponsor – School of Electrical and Electronic Engineering

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Bachelors of Electrical and Electronic Engineering (Honours)

Supervisor: Assoc. Professor John Leis (Electrical Engineering), of the School of Mechanical and Electrical Engineering, University of Southern Queensland

Keywords: Object Detection, Stereo Vision.

1. Introduction

This dissertation aimed to develop an algorithm for verifying objects in multiple orientations, in particular polyethylene terephthalate (PET) bottles during their manufacturing and filling process. This industry has an approximate market value of $620 million (ABWI, 2012). The designed detector is a stereo vision camera with a Mathworks MATLAB designed algorithm.

2. Background

As manufacturers push to become global chains that deliver resources and commodities to people, they are constantly looking for new methods to maximize profits / productivity with minimal downtime and reduction in waste while reducing operators cognitive load (Kolbeinsson, 2017). This project offers solutions for a cost-effective detector to determine when an object is in the incorrect orientation as seen in Figure 1 rather than relying on human intervention. This dissertation extends existing knowledge by applying it to a real-world issue and uses software algorithms which aligns with my discipline.

3. Methodology

First a suitable sensor detector was determined. From this a flexible mounting solution was designed and manufactured to offer easy sensor positioning. Using the mounting frame a stereo camera calibration was completed using MATLAB. An algorithm was designed and implemented to verify when a water bottle had fallen into the incorrect orientation on the consolidation conveyors as seen in Figure 1.

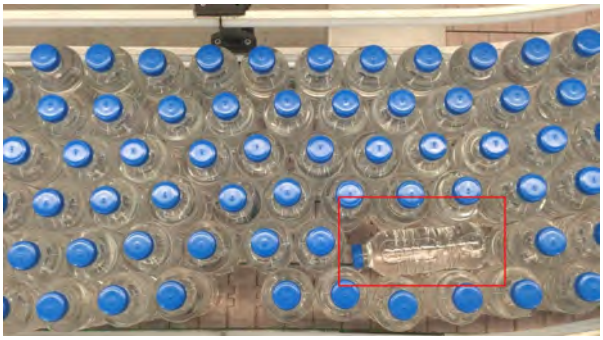

Figure 1 – Fallen Bottle that is required to be detected.

4. Key Outcomes

The primary aim is to determine if the detector is able to be reliable and sense multiple PET bottle types. From this any two cameras with the required specifications can be used with the software algorithms which makes it highly cost effective.

5. Further Work

From this an embedded solution would be the next step, this would reduce computational power while offering a final product for customers.

6. Conclusions

In testing conditions, the algorithm is able to detect incorrectly orientated bottles, however this still needs to be verified onsite at NuPure Beverages.

Acknowledgements

I would like to thank Associate Professor John Leis who has offered his knowledge and time. His background in digital signal processing has been invaluable. I also wish to thank NuPure Beverages, in particular Rob Thompson the Engineering Manager who has given me constant site access and guidance.

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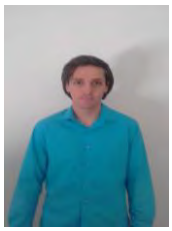
To critically evaluate and benchmark designs and manufacturing systems of modular residential housing solutions

Sponsor – School of Mechanical and Electrical Engineering



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Supervisor: Dr Steven Goh, USQ

Keywords: benchmark, modular, housing

1. Introduction

The modular home is relatively new in the residential construction sector. It differs from conventional on-site construction due to all but final utility connections being performed in a manufacturing facility (off-site). With an increasing population and urban sprawl there is a need for innovative affordable housing solutions.

2. Background

The design and construction of residential modular buildings can be seen to offer a variety of benefits for manufacturers, clients and the environment. Tanney (2014) describes the modular building as a stand-alone unit that can be joined with any number of modules to form a larger structure. These buildings are transported to site and placed in position by a crane as shown in Figure 1.

3. Methodology

Building regulations and standards are used to perform a quantitative comparison for design and construction. Each phase of the building process was identified. A quantitative method was developed to evaluate each of the processes throughout any project. Sites were visited to gain data which would be subsequently analysed to determine the level of conformance to which the works were performed.

4. Key Outcomes

The objective of the project is to determine to what level the industry is performing routine design and construction tasks with respect to the appropriate standards for each of the phases of a project.

Figure 1 – Module being lifted in position from transporter

Investigation of design drawings has shown confromance with AS1100 and the appropriate structural design standards. Proprietary design for connection of modules is apparent. Construction follows typical methods with many of the benefits attributed to workshop facilities and consistent environment.

5. Further Work

Discussion with companies is continuing to obtain representative data that best reflects the modular home industry. Data analysis will quantify the results.

6. Conclusions

The modular industry has adapted appropriate design and construction procedures to ensure conformance and provide a housing solution suitably fit for purpose. Improvements particularly in manufacturing systems should focus on material logistics, automation, preparation and fixturing.

Acknowledgements

I would like to thank my supervisor, Dr Steven Goh for his guidance when clarification and direction was required. I'd also like to thank all participants who provided insight, allocation of time in answering questions and granting permission to attend their design & manufacturing facility.

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DESIGN OF A MULTIFUNCTIONAL CYCLE FRAME

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Supervisors: Dr Ray Malpress, USQ

Keywords: Active transportation, Tricycle, multifunctional

1. Introduction

Liveability of a country can be defined by the measure of its environmental quality and wellbeing of its inhabitants. Greenhouse gas emissions from fossil fuel reliant transport systems and rising obesity levels are two prime factors that pose a threat to the quality of life in Australia.

2. Background

To minimize transport impacts, Australian Bureau of Statistics recommends greater utilization of public transport and maximising vehicle occupancy rates to reduce the total kilometres travelled by vehicles. Despite increasing fuel prices and congestion, this preposition is difficult to implement due to a high dependence on private cars. A practical solution is to integrate active transportation in daily travel.

This project aims to contemplate the hazardous effects of transport, in combination with the obesity epidemic in Australia by introducing a cycle design that adheres to the requirements of Australian commuters and encourages active transportation.

3. Methodology

Initially a market review was conducted to recognise the general cycling trend in Australia. The market evaluation also formed the bench mark for the design solution by identifying shortcomings in current systems. Subsequently, Literature was reviewed to understand fundamentals of frame design and establish design requirements. Based on the data collected a design concept was 3d modelled, followed by a material selection process. Lastly, the design was analysed via Finite element analysis to identify any defects.

Figure 1 – Foldable frame design

4. Key Outcomes

The design requirements emphasised on multifunctionality, safety and portability of the frame. Current products on the market were examined to produce two foldable concept designs that consist of a tricycle configuration to enhance safety and provide a convenient riding experience.

5. Further Work

The ongoing work consists of material selection and FEA analysis for the frame. However, further work entails improvement of the model by simulation via computational fluid dynamics and manufacturing a prototype to test in real life conditions.

6. Conclusions

A cycle that can incorporate elements needed in daily travel whilst being accessible to both beginner and seasoned cyclist promises a greater participation in active transportation.

Acknowledgements

I would like to acknowledge the support and advise given to me by my project supervisor Dr. Ray Malpress. I appreciate the patience shown in the early stages and the faith displayed throughout the duration of this dissertation.

Lastly, I would like to thank my family and partner Nimrah for their unwavering support that I received throughout this endeavour and my educational journey.

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Survey and Volume Calculation of Volumes of Fine Grained Materials using 'Non-Contact' Methods

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr Dev Raj Paudyal, USQ

Mr Chris Snook, School of Mechanical Engineering

Keywords: Volume, survey, non-contact

1. Introduction

This project aims to develop a method of survey that accurately measures a fine-grained material being stored in a large warehouse without coming into physical contact with the material. The survey has been developed to estimate the volume of the material being stored within the warehouse.

2. Background

The competitive nature of modern business requires entities to be able to accurately measure or quantify business assets allowing for smoother client interaction.

Current methods of survey for volume estimation include contact and non-contact methods, however, both methods require either the direct access to the material or direct line of sight from appropriate vantage points. These methods are restricted due to access and safety.

This study uses a unique method to quantify a business asset known as cement clinker. The study aims to offer a cheaper, faster and safe way to measure internally stored materials using more cost-efficient survey instrument that has been augmented and modified to capture the necessary data.

3. Methodology

A traditional survey method, known as a control traverse, was used to establish coordinates of the laser scanning stations. From these stations a newly developed scanning gimble and laser scanner was used to survey material stored in the warehouse. Figure 1 shows a model of the scanning gimble that was developed to mount the laser scanner and rotate it as it recorded points. Mathematical scripts were used to transform the data that was being recorded into point cloud data that represented the spatial surroundings of the instrument. Each station was then combined using the previously derived coordinates and rotated to match the common line of the warehouse wall.

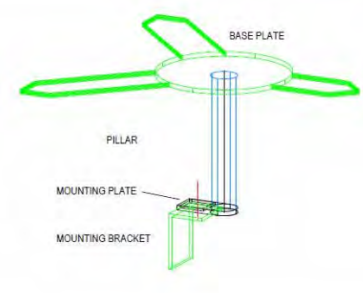

Figure 1 – Survey Gimbal

4. Key Outcomes

Survey point cloud data was generated using mathematical scripts to transform data captured by the laser scanner as it was rotated by a stepper motor. Data was used to estimate volumetric quantities.

5. Further Work

Further work includes a comparison survey on a site with much more comparability to the site chosen for the study. This site would require either direct access or direct site lines for a traditional survey to be carried out and results would need to be compared to the newly developed survey method.

6. Conclusions

An accurate, fast and safe alternative method was developed to measure the stored powdered cement clinker for the calculation of the estimated volume of material.

Acknowledgements

I would like to thank my supervisor Dev, for instructing me and always finding places for me to improve my work. Special thanks to my brother and business partner Chris Kelly for aiding me at every opportunity.

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Machine vision and data acquisition for the optimisation of Black Soldier Fly breeding

School of Engineering and Surveying

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Degree: Bachelor of Engineering (Honours)

Mechatronic major.

Supervisors: Thomas Banhazi

Andreas Helwig

Keywords: Machine vision, Image processing, Data acquisition.

1. Introduction

Machine vision increasingly impacts the world around us and the uses for the technology become more apparent as the technology becomes cheaper and more widely understood. The application of machine vision could help improve the breeding of Black Soldier Flies so that the larvae be used as a protein supplement for animal feed. Black Soldier Flies require strict conditions in order to optimise the larvae production, these conditions can be monitored using the sensors of a simple mobile phone and an image of the breeding area can determine if flies are breeding or not. Knowing the relationship between environmental conditions and breeding rate allows farmers to optimise the farm conditions to improve the throughput of edible larvae. This project seeks to use an entry level Android mobile phone to log environmental data and analyse images taken from the phones camera with the goal being to count breeding flies and log conditions for correlation.

2. Background

The contemporary and educated human strives to maintain a balanced diet which has been proven to increase the quality and the longevity of an individual's life (Chrysohoou, C. and C. Stefanadis (2013)). The origin of protein as part of that balanced diet is somewhat taken for granted by the same contemporary educated people. A vast amount of protein consumed in the general population comes in the form of animal meat. In order to rear the animals to supply that protein a great amount of feed input must be available to the farming process. Insect protein can fill this role and has environmental and societal benefits but technology to stream line this new protein source has not yet matured.

Computer vision can help to address some issues with the breeding of the Black Soldier Fly to increase throughput and efficiency hopefully improving the economics and traction of the sector.

3. Methodology

Image scenes are noisy in a sense that important information is hidden mathematically in matrices of numbers. First key features of breeding Black Soldier Flies must be identified. Once known various image processing techniques such as thresholding, dilation, erosion, area and moments can be used to define what parts of an image is noise and what are the subject of interest: Breeding BSFs en copula (engaged in mating)

4. Key Outcomes

Whilst analysing various images several key outcomes were identified. Of most interest was the fact that breeding flies can sometimes take irregular configurations rather than directly in line which each other. This proved difficult to analyse but forced a wider approach to analysis.

5. Further Work

Improving accuracy has been a challenge however some techniques are looking promising. Future work can progress the sophistication of the detection algorithms and use move novel techniques.

6. Conclusions

Machine vision applications can extract great amounts of data from an image but the value of this data comes down to how much noise you can remove. In the case of fly farming special enclosures and lighting can ensure this is more accurate. This application shows that very low cost but powerful machine vision applications can improve the economics of BSF farming.

Acknowledgements

Thomas Banhazi and Andreas Helwig for leading me to the idea and also sponsoring the project to be perused.

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AC Chopper Series Voltage Regulator for SWER Applications

Sponsor – School of Mechanical and Electrical Engineering

John Kereczko

Bachelor of Engineering (Honours) Major Electrical and Electronic Engineering

Supervisors: Dr. Les Bowtell, USQ

Keywords: AC Chopper, Buck/Boost, SWER.

1. Introduction

Single Wire Earth Return (SWER) networks are widely used as an economical way in providing electricity to rural areas. Due to the long distances SWER transmission lines cover and load growth, customers experience significant power quality issues.

This dissertation introduces an AC voltage regulator based on an AC-AC buck chopper topology. The voltage regulator compensates for large voltage sag and swell conditions by boosting or bucking the measured voltage to improve power quality.

2. Background

Traditionally line regulators are installed on the HV network to compensate for power quality issues. As customers on SWER are usually supplied by several cascading regulators, the time delay between taps can cause significant issues. To solve this, the employment of power electronic automatic voltage regulators has been introduced. However current technology used have limitations in boost and buck range, response to motor start capabilities and voltage pass through during severe sag and swell conditions.

For SWER applications, very little has been published on voltage regulation using power electronics. Although power electronic designs have been installed, limitations suggest that a more viable solution can be proposed. An efficient and cost-effective design has been implemented in this dissertation. By eliminating a DC bus, the dynamic range and reliability has been significantly increased.

3. Methodology

The methodology used for the dissertation employed the following tasks; Research, Design, Simulation, Implementation, and Testing. The design was comprised of the voltage regulator topology and control using research in circuit theory and control system techniques.

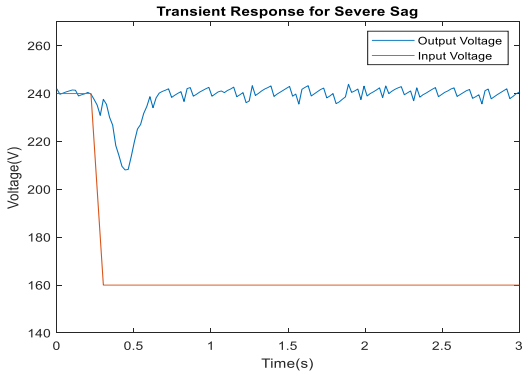

Figure 1 – Transient response for a severe sag

The design was simulated using Simulink to validate the performance requirements. The voltage regulator control circuits were implemented in hardware using a breadboard design and PLC for system control. The testing has been completed using a variable supply voltage using load conditions seen in a SWER system. Figure 1 shows the transient response for a severe sag.

4. Key Outcomes

The key outcomes achieved from this dissertations are as listed below;

1. Fast voltage regulation response during sag and swell condtions.
2. Increased dynamic range.
3. Improved response to conditions.

5. Further Work

The design has been tested using a 12 V ac supply. Further work required will be to implement the design using a 240 V ac.

6. Conclusions

An AC voltage regulator based on an AC-AC buck chopper topper topology has been designed, simulated and implemented. The results concluded that a viable solution has been determined to provide effective voltage regulation for SWER applications.

Acknowledgements

Dr. Les Bowtell for providing your experience, knowledge and guidance; and Dr. Tony Ahfock for providing the concept and project topic.

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Investigating the Accuracy of Stream Gauge Rating Curve in Flood Forecasting

School of Civil Engineering and Surveying

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Bachelor of Civil Engineering (Honours)

Supervisors: Dr Md Jahangir Alam, USQ

Keywords: Rating curve, forecasting, accuracy

1. Introduction

Rating curves show a relationship between water level and discharge in the stream and rivers. It provides a simple way to estimate the discharge in the river without having to measure manually which are time consuming, expensive and sometimes dangerous. Due to this, rating curves are one of the most widely used tools in the estimation of the flow.

This dissertation intends to investigate the accuracy of the current rating curve of the stream gauge at Gowrie Creek in Carnley, Toowoomba in forecasting extreme flooding conditions.

2. Background

The discharge estimates obtained from the rating curves are often less accurate. Major causes of the error associated with rating curve include discharge values used to produce flow rating curve are not measured directly but are estimates of real discharge (Domeneghetti et al. 2012) but the uncertainty created by using these estimated values are mostly ignored in practical use for simplicity (Herschy 2002).

This study aims to quantify the uncertainties associated with the current rating curves and study how gauge water level during extreme flooding events.

3. Methodology

Design flood for Gowrie Creek will be estimated which will then be simulated in a hydrological model using HEC-RAS and the water level and discharge relationship will be established. This relationship will be compared with the data from current rating curve and an assessment on the accuracy of rating curve will be made regarding the estimation of the large floods.

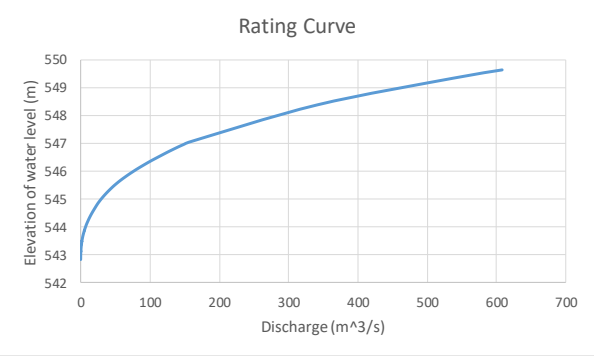

Figure 1: Plot of rating data from simulation of flow record.

4. Key Outcomes

This study aims to investigate the accuracy of the rating curve of the streamgauge at Gowrie Creek in Carnley in determining the water level during extreme flooding events. This will be done by simulating the extreme discharge conditions in the model and comparing the result with the current rating data.

5. Further Work

Moving forward from this study, it would be ideal to study the level of inundation in the Toowoomba city area during extreme flooding events.

6. Conclusions

Predicted conclusion would be that the modelled results will be very close to the current rating data with small variations. However, these variations would likely increase with increase in the extremity of the flooding.

Acknowledgements

I would like to acknowledge my supervisor, Dr Jahangir Alam for his guidance and support throughout the project. I would also like to thank DNRME hydrographer Rod Dew for providing elevation plan of the weir in Gowrie Creek.

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Applied Neural Network modelling of mobile plant equipment for use in Predictive Maintenance

School of Health, Engineering and Science

Robert Kimber

BENG - Mechatronic Engineering

Supervisors: Dr Tobias Low, USQ

Keywords: Artificial Intelligence, Predictive Maintenance, Reliability Centered Maintenance

1. Introduction

Artificial Intelligence (AI) is becoming more prevalent in our modern society as our dependency on AI capabilities increases. The reasons are apparent when we consider its competency in classifying irregular signal data or identifying patterns in complex data arrays. This study is intended to advance capability of mobile plant maintenance and improve understanding on interfacing intelligent systems with maintenance management practices.

2. Background

Strachan, SM, Stephen, B & McArthur, SDJ (2007) identified in their attempts to create predictive monitoring through vibration analysis, a heavy reliance on machine systems' operation and specification expertise and that in recent years, this expertise is diminishing. As sensor arrays installed on new equipment are becoming more extensive, reliable and accurate, there exists an opportunity in reducing this knowledge dependency through use of AI. In particular, AI's capability in classifying irregular data streams and identifying relative behaviour between multiple data streams.

3. Methodology

The mobile plant subject for the study is a commercially available vehicle, RG Holden Colorado. The first phase is collecting extensive empirical data from the vehicle, which represents the dynamic operating conditions of the vehicle. In attempts to simplify the process and reduce time requirements for this phase, the OBDII interface was utilised. The second phase is creating a characteristic model with supervised machine learning in Matlab using universal approximation to handle non linearity's.

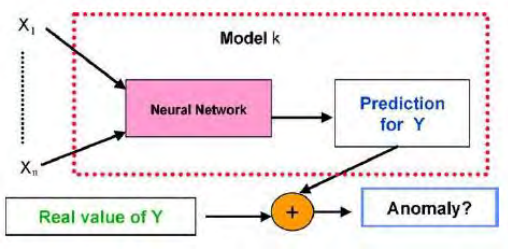

Figure 1 - Predictive Maintenance approach for Process Parameters

The last phase is validation of the characteristic model by comparing an unused dataset against the predicted dataset Figure 1.

4. Key Outcomes

This project has provided a standard approach in producing a characteristic model of measurable parameters on mobile equipment. It has identified flaws in using the OBDII communications and provided insight into the behavour of the parameters.

5. Further Work

It is identified that there are some speed constraints and unreliable parameters that exist in using an OBDII scan tool. As such, there is a valid requirement to read data directly from the CAN network.

6. Conclusions

Although AI can provide reliable predictive capabilities, it is flawed in that, in order for any maintenance event to be identified, the event must first be detectable electronically. As such AI predictive maintenance must be used in conjunction with other monitoring regimes such as oil analysis.

Acknowledgements

Dr Tobias Low for his technical support and project guidance. Hastings Deering for exposure to predictive maintenance through asset management services.

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Reducing Cascading Close Out Defects in Commercial Construction

Sponsor – School of Civil Engineering and Surveying

Charles King

Bachelor of Construction (Honours) (Construction Management)

Supervisors: Dr Vasantha Abeysekera, USQ

Keywords: Commercial construction, defect reduction

1. Introduction

This preliminary report will investigate the causes of defects being discovered during close out inspections. Close out inspections are conducted prior to hand over to ensure all previously discovered defects have been rectified to a satisfactory quality. This research project will then use these causes to adapt existing defect prevention methods to prevent close out defects.

2. Background

The problem under investigation was first discovered by the investigator during his current role as an undergraduate construction manager. Repeated inspections and approvals of recurring defects at the closing stage of these projects were causing inordinate delays, extra costs and client dissatisfaction which prompted this investigation as a participant-observer. This project is important due to the extensive risks latent defects have to all parties involved in construction projects from clients through to subcontractors.

This project extends the existing knowledge of defect prevention and management, aiming to develop existing techniques to reduce the severity and frequency of cascading close out defects.

3. Methodology

In order to understand the underlying causes of cascading defects, five large scale projects were selected as a participant-observer. In a trial project 272 cases were sourced. These are now being analysed using multiple defect-causation frameworks (Love, 2018; Wai-Kiong Chong, 2006) to develop new insights on the underlying causes. Using this prototype analysis approach, other projects will be analysed after seeking ethics approval. Having synthesised an approach, it is planned to conduct discussions with key industry/project personnel to refine the approach.

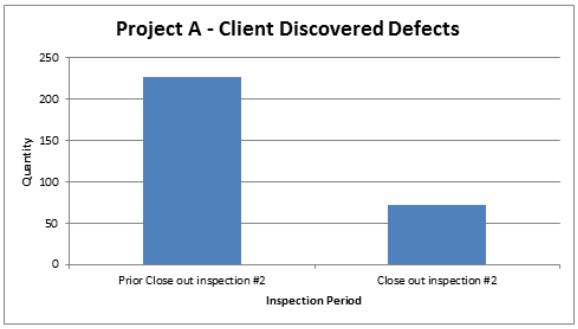

Figure 1 - Construction vs. close out defect quantities

To date, defect data from multiple projects has been analysed, displaying the high frequency of close out defects, as visible in Figure 1. The literature review revealed that this phenomenon had not been previously investigated.

3. Further Work

Time and resource limitations did not allow for interviewing of industry professionals as yet to provide potential cascading close out defect prevention methods. Further work related to this project would be further case studies of project implementing such defect prevention methodologies for further refinement.

4. Conclusions

This report highlights the key manners in which cascading close out defects are being caused in modern commercial construction, and manners of which these costly occurrences can be avoided by construction managers of future projects.

Acknowledgements

I would like to thank Dr Vasantha Abeysekera for his extensive guidance throughout the selection and development of this report.

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A Predictive Tool for Water Utilities to Gauge Electricity Expenditure in a Dynamic Energy Market

School of Mechanical and Electrical Engineering

Sponsor – Toowoomba Regional Council (TRC)

Gail Kirkpatrick

Bachelor of Engineering (Electrical & Electronic)

Supervisors: Mrs Catherine Hills, USQ

Mr Richard Hodgson, TRC

Keywords: Tariff, Water Utility, Energy

1. Introduction

In Australia energy is traded on the National Energy Market. Due to the closure of coal fired power plants and increases in fuel prices the cost of electricity has risen significantly. In addition, the concentration of supply together with commercial market manipulation, means the price of electricity can vary dramatically in a day. Viewed in the larger context of weak regulations and threats of political intervention the energy market is presently very volatile (Wood & Blowers, 2018). This creates a lot of uncertainty for businesses to plan future development and legitimise current practices.

2. Background

As water utilities are major consumers of electricity, small changes in pricing are magnified by the volume of energy consumed. To complicate matters the progressive implementation of smart meters into the market is changing the nature of tariffs. To manage costs and make informed decisions to respond to the dynamic nature of the energy market, modelling of the impact of various tariffs is essential for business.

3. Methodology

The modelling of energy consumption may be based on physical measures of the voltage and current supplying plant equipment. Cost and time made this process prohibitive. Alternative methods of calculating hydraulic power and inferring input power using efficiency values were hampered by poor quality or missing data. Instead modelling was constructed around multiple sets of historical energy consumption data aligned with volumes of pumped water, to a give specific energy consumption value for each site. The application of tariff structures to the consumption modelling can be displayed graphically. Figure 1. presents a comparison of electricity costs under Energy Qld tariffs 52A and 22L at a pump station. The modelling clearly shows the pump run time (consumption pattern) under which one tariff is more cost effective than another.

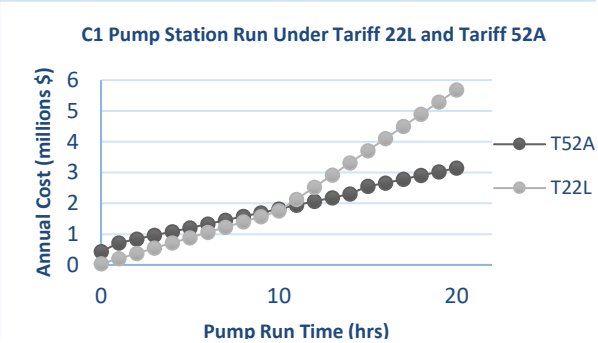

Figure 1 – Comparison of tariff 22L and 52A

4. Key Outcomes

Different tariffs support particular patterns of plant operation to reduce costs. It is not enough to reduce energy consumption to minimise costs, tariffs must be considered.

5. Further Work

Real time tariffs are increasing their infiltration into European energy markets. It is possible Australia could follow in the future. Therefore, investigation of real time tariff on water utility sites would be useful.

6. Conclusions

Tariff impact is vital to long term planning. The modelling and interpretation of tariffs provides a level of certainty in times of volatile energy markets.

Acknowledgements

I would like to all TRC WIS staff, in particular Richard Hodgson, for their generous time explaining operational processes. I would also like to thank Catherine Hills for providing much needed direction.

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Remote Livestock Monitoring Utilising IoT Technology

Sponsor – School of Mechanical and Electrical Engineering

Mac Laing

Bachelor of Engineering (Honours) (Electrical and Electronic)

Supervisors: Mrs Catherine Hills, USQ
A/Prof. Thomas Banhazi, USQ

Keywords: Livestock, RFID, IoT

1. Introduction

This project uses radio-frequency identification (RFID) and Internet of Things (IoT) technology to provide farmers with the ability to remotely monitor livestock for precise, individual identification regardless of where the farmer resides or the geographic location of the livestock. Data collected from each animal and local farming infrastructure is collated and used to display livestock inventory, whereabouts, security, feeding and watering conditions through real-time and historical reporting tools.

2. Background

Australia is among the world's largest producers of commercial livestock servicing both domestic and export markets. Farmlands which hold livestock are spread geographically throughout the entire continent, with an estimated total of 78,000 livestock farms in Australia. This vast land usage often results in farmers managing multiple holdings and not residing on or close to these properties. Taking this into account it is apparent that farmers spend a lot of energy, resources, time and money traveling to and around these remote holdings to inspect their livestock for security, health, feed and watering conditions.

3. Methodology

Key activities undertaken for this project included meeting with a variety of livestock farmers to ascertain current methods of managing remote holdings. This led to the development of a set of project requirements. A candidate property was then selected and audited to determine the technology integration approach, with factors such as data communication, electrical, environmental, operational and animal behavioural conditions considered. This formed the basis of a detailed system design, technology selection and ultimately system development activities. Electrical equipment assembly, technology programing and system testing were undertaken with product acceptance testing performed prior to site installation. Figure 1 illustrates the high level system topology.

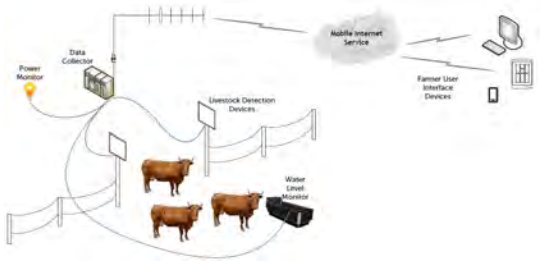

Figure 1 – System Topology Diagram

4. Key Outcomes

The developed prototype successfully achieved the desired operational tasks during product acceptance testing and is expected to perform reliably when it is deployed to site. Current livestock RFID technology was evaluated and challenged resulting in this project shifting from industry standard High Frequency devices to utilising passive Ultra High Frequency tags. Furthermore the successful integration of local farming infrastructure pushes the system towards a total farm management solution.

5. Further Work

The finalised system requires installation at the candidate farmer's property and is scheduled to take place in August 2018, however future development of the concept could see the system align with precision livestock farming type technology.

6. Conclusions

It is expected that the system will reliably provide farmers with the data and tools to remotely monitor livestock for accurate inventory management and provide farming infrastructure supervision. This will increase farming operational efficiencies, reduce operating costs and allow the farmer to be well informed.

Acknowledgements

Ross Laing; for his support and his willingness to share knowledge and experience in regards to the livestock industry. Project supervisors; for their guidance.

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Impact of Partnering on Construction Projects in Australia: Comparative Case Studies

Sponsor – School of Civil Engineering and Surveying

Student Name

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Bachelor of Construction (Management)

Supervisor: Dr Nateque Mahmood, USQ

Keywords: Partnering, construction contracts, adversarial relationships

1. Introduction

The term "adversary" is anything but uncommon, when undertaking research on the state of relationships between stakeholders in the construction industry. This stems from an engrained "perceived failure" of relationships under traditional standard form contracts (Black, et al 2000). This culture has led to the implementation of relationship-based procurement methods, one of which is termed "partnering". Partnering has been introduced to attempt to reduce lost time and money due to these adversarial relationships throughout the industry.

2. Background

This research aims to provide evidence relating to the impact that partnering has on construction contracts. With this research as well as previous research, construction companies will be able to identify whether partnering is a suitable relationship-based procurement method for them or not.

3. Methodology

This research was undertaken using a quantitative analysis of project related data of 5 traditionally procured projects and 5 projects that implemented partnering in the procurement process of the project. This data was collected via mailed surveys to construction companies, based on questions which were formulated from the literature review. There were 4 main subjects for these projects: cost, time, quality, overall project satisfaction.

4. Key Outcomes

The literature review found that adversarial relationships were still playing a major role in the construction industry, leading to expensive litigation and dispute resolution processes, which impact on the revenue growth negatively (see Table 1). There was however no comparative evidence in literature of the benefits of partnering. This research expects to prove that partnering can reduce costs, improve time-based components and quality of construction projects.

Revenue Growth

Year	Revenue $ billion	Growth %
2005-06	262.2	0.0
2006-07	300.3	14.5
2007-08	309.1	2.9
2008-09	303.7	-1.8
2009-10	325.7	7.2
2010-11	325.2	-0.2
2011-12	335.9	3.3
2012-13	349.9	4.2
2013-14	373.3	6.7
2014-15	394.1	5.6
2015-16	394.4	0.1
2016-17	373.4	-5.3
2017-18	358.3	-4.1

Table 1: Commercial and industrial construction revenue in Australia (ibisworld.com.au)

5. Further Work

Further work includes the research being carried out on a larger scale, with a wider variety of projects, taking a deeper look into project data. It would also be beneficial to follow the projects from start to completion to have more accurate data.

6. Conclusions

This project set out to carry out an in-depth literature review of partnering in the construction industry and to assess the impact partnering has on construction projects. This was achieved, however at the time of writing this abstract, the results were not finalised.

Acknowledgements

I must thank my family and friends for their unfailing support my supervisor, Dr Nateque Mahmood in his assistance through the process.

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Investigation of Modern Wireless Communication Technologies to facilitate Distribution System SCADA as part of the Intelligent Grid in South-East Queensland

Sponsor – Faculty of Health, Engineering and Sciences

Michael Leslie
BEng(Hons) – Electrical & Electronics

Supervisor: Assoc. Prof Alexander Kist, USQ

Keywords: Distribution Automation; Intelligent Grid, SCADA.

1. Introduction

In line with the Energex Network Technology Plan 2005-2025 (Energex, 2005), Energex embarked on a program of automation of remote plant (reclosers, regulators, load-break switches, etc.) throughout the network with the aims of improving reliability; reducing the severity of unplanned outages and enabling faster restoral times. The automation was made possible with the establishment of a mesh radio network known as Distribution System SCADA (DSS). Figure 1 shows a simplified representation of the DSS network and major components.

2. Background

As we move beyond the 10 year milestone since the implementation of the DSS network, it is prudent to examine the existing mesh radio network, the past, present and future drivers, and determine if any limitations exist, and where investment should be focused in order to meet the current and future business objectives.

3. Methodology

While this project focussed on the wireless communications component of the DSS network, thorough consideration was also given to other aspects impacting the effectiveness of the DSS including the geographical placement of the remote-controlled devices, and the integration with the existing Distribution Management System (DMS).

A number of key stakeholders were interviewed throughout the project to identify limitations and improvement opportunities.

A desktop survey of wireless radio systems from a variety of manufacturers was conducted to evaluate their suitability for the DSS network, with lab testing and a field trial carried out on the preferred wireless solution.

4. Key Outcomes

One of the main drivers of this project was obsolescence of the existing mesh radios. This issue has been overcome by a recent development of a replacement radio type which is currently undergoing testing to ensure backward compatibility. New software for management and configuration was required to be able to utilise these radios.

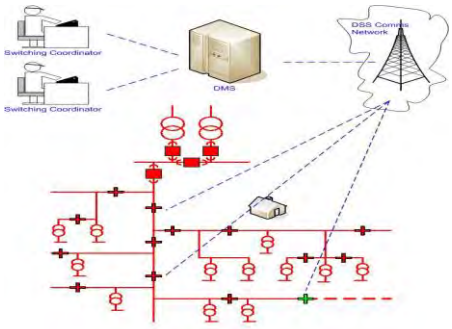

Figure 1: DSS Network Overview (Energex, 2005)

A key desirable function of the DSS system is the capability to remotely diagnose and configure the control devices. Investigations are continuing as to whether a cost-effective & secure solution can be provided to enable remote engineering management.

5. Further Work

Field testing of the new mesh radios is nearing completion, with the results yet to be finalised.

The integration and licencing of the management software is currently under investigation.

6. Conclusions

Whilst this project did not deliver anything new in terms of enhanced functionality and capacity, it has found that it is viable to defer any major capital investment in the Distribution System SCADA network until such time as the business needs drive any further change.

Acknowledgements

I would like to acknowledge and thank my project supervisor, Associate Professor Alexander Kist; Mr Rob Eckersley and Mr Peter Poulos at Energy Queensland; and Mr Mark Bell from Landis & Gyr for allowing the use of the radio technology and management software for testing.

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Evaluation of the effect of vegetation sky obstructions and multipath on AUSPOS and Trimble CenterPoint RTX Post-Processing

Sponsor – School of Civil Engineering and Surveying

Trenton Lester

Bachelor of Spatial Science (Honours) (Surveying)

Supervisor: Associate Professor Peter Gibbings, USQ

Keywords: AUSPOS, Trimble CenterPoint RTX Post-Processing, Multipath.

1. Introduction

Surveyors are often required to establish coordinates for survey control stations using data logged with Global Navigation Satellite Systems (GNSS) and processed using online post-processing services. Often these survey control stations are obstructed by vegetation which may cause errors due to multipath. It is unclear how this affects accuracy and precision and whether longer observation durations can overcome these affects.

2. Background

Various surveying standards and guidelines specify Positional Uncertainty (PU) requirements for survey mark coordination. When confronted with coordinating obstructed survey marks, the surveyor needs to be confident that the appropriate PU can be achieved.

3. Methodology

Observations were taken over three 24-hour periods on survey control stations installed with different amounts of sky obstruction. The observation files were divided into shorter duration files and submitted for online post-processing.

4. Key Outcomes

The results analysis indicates that in all situations tested, reliable and repeatable results were achieved with observations of sufficient duration. 12 hours of logging on the most obstructed station tested (see Figure 1) was sufficient to provide repeatable results within acceptable standards. A station with approx. 40% obstruction delivered repeatable results with 6 hours of logging.

Figure 1 – Vegetation Sky Obstruction

5. Further Work

Some outliers caused by multipath exist in the results and require that many more observations be conducted to provide more confidence that the stated durations will achieve accurate and precise results with every observation of that duration.

6. Conclusions

The results analysis indicates that it is possible to achieve reliable online post-processing results from GNSS observations where substantial vegetation sky obstructions exist. With usual caution and independent checks, surveyors may use these results to influence control station site selection and to indicate required observation durations in similar situations.

Acknowledgements

I would like to thank Associate Professor Peter Gibbings for his assistance and advice throughout the process of this project work. Thanks also goes to InsiteSJC and Department of Natural Resources Mines and Energy survey staff for use of equipment and offering advice and to Bundaberg Regional Council for the secure site for conducting measurements.

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Effects of Chemically Treated Recycled Water on the Setting Process and Overall Behaviour of Concrete Beams

Sponsor – School of Civil Engineering and Surveying

Andrew Lilley

Bachelor of Engineering (Honours)(Civil Engineerring)

Supervisors: Dr Weena Lokuge, USQ

Dr Sourish Banerjee, USQ

Keywords: Concrete Beams, Flexure, Recycled Water

1. Introduction

The aim of this project was to investigate the short and long-term effects that recycled water could have on reinforced concrete beams, to gauge whether using recycled water is a suitable alternative to potable water.

2. Background

Concrete production is one of the most resource intensive industries in the world, particularly when it comes to water consumption. This becomes a problem particularly in the developing world, as the most suitable source of water for concrete is potable water which is already in scarce supply in these regions. With recycled aggregate already becoming common place, there is a growing need to increase investigations into the use of non-potable and recycled water sources.

3. Methodology

To determine any noticeable or meaningful difference from the use of different water sources, initial chemical testing needs to be conducted on the control potable water and the chemically treated water to determine what is different between the two that may cause any changes to the concrete during the testing stages. After these tests have been conducted, beams are then cast, using ratios of treated to regular water to gain further analysis as to the effects the treated water may have on the properties of the concrete beams. The beams are then tested for flexural and compressive strength after periods of 28 and 56 days to see any effects over an increasing amount of time. Figure 1 from Klus, L. 2017 shows an expected look at the difference in compressive strength with varying percentage of recycled water, in this case with recycled sludge water.

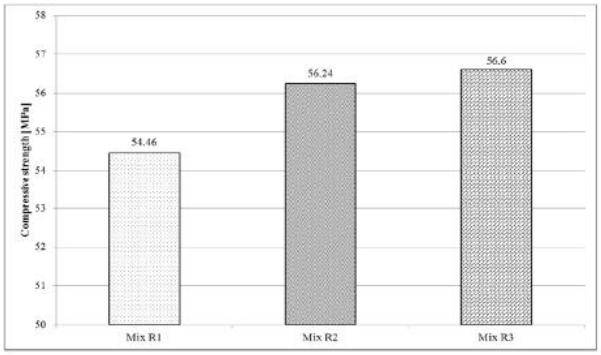

Figure 1 – 28 day compressive strength tests from Klus, L.

4. Key Outcomes

At this stage, chemical analysis testing has been conducted on both the potable water and treated water obtained from the Wetalla Wastewater Reclamation Facility. Differences in pH, hardness andd chlorine levels have been determined, through a use of either lab testing and digital probes, depending on the level of accuracy required in results. Reinforced beams have also been cast and cured, which are now waiting on the first lot to be mechanically tested.

5. Further Work

Further work at this stage is continued testing on the concrete beams for later time frames

6. Conclusions

At this point, it can be seen that using a mix of potable and non-potable sources has a small but noticeable effect on the final properties of the concrete.

Acknowledgements

The author would like to the project supervisors Weena Lokuge and Sourish Banerjee for their assistance and direction throughout the course of this project.

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Fatigue Analysis of Tower Crane Grillage Wall Bracket Connection

School of Mechanical and Electrical Engineering

Mitchell Lincoln

Bachelor of Engineering (Honours) Mechanical

Supervisor: Dr Ray Malpress, USQ

Keywords: Fatigue, Failure, Finite Element Analysis, Tower Crane.

1. Introduction

There are many instances where a tower crane needs to be positioned and installed on a structure that is inadequate for supporting its reaction forces. In these situations, a supporting structure known as a grillage (heavy framework made of timber or metal beams forming a foundation for building on difficult ground), is used to distribute forces to a location capable of supporting the reaction forces. This project aims to confirm whether the intended design of a wall bracket connection in the grillage, using chemical anchors fastened to a concrete column, for a tower crane grillage would meet its expected installation life. It is also hoped that a better understanding of fatigue life in chemical anchors will lead to safer designs which are required in high risk activities such as tower crane designs.

2. Background

A chemical anchor is a post-installed anchor that includes a steel element and a bonding compound that transmits loads from the embedded steel into a base material which is usually concrete. A wall bracket connection compromising of a series of chemical anchors, was intended to anchor a steel grillage to the support columns of a structure. A design of the original wall bracket can be seen in Figure 1.

3. Methodology

The project methodology involved researching current techniques, relevant standards, specifications, operating conditions and component information. Analysis of given tower crane data was broken down and a load path determined through to the grillage wall bracket connection. Maximum tension and shear forces in the most loaded fastener was determined to check the utilisation of the chemical anchor. Fatigue analysis was undertaken by means of finite element analysis and hand calculations to determine the fatigue life.

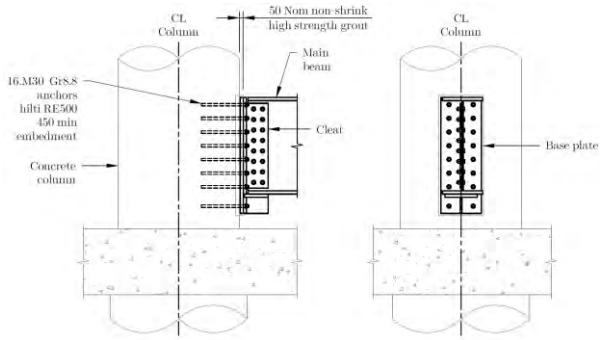

Figure 1 – Wall Bracket Original Design

4. Key Outcomes

Key information has come from standards Australia technical specification TS 101. Reaction loads and anchor forces have been determined to start the next phase of fatigue analysis.

5. Further Work

Finite element analysis is still required to determine the fatigue life of the chemical anchor use in the wall bracket connection. Research into the required edge distance of a chemical anchor installed on a round column needs to be investigated to determine the shared shear loading of the anchor group.

6. Conclusions

Although yet to be confirmed the failure mechanism of the connection seems to be that of steel failure rather than a bond of adhesive to steel or concrete. It is still yet to be determined whether the connection would meet the intended design life of the tower crane installation.

Acknowledgements

I would like to acknowledge my supervisor, Dr Ray Malpress, for his supervision, direction and generosity of time throughout the course of this project. My wife Hanna, thank you for all your patience, understanding, encouragement and support throughout this project and over the length of this degree.

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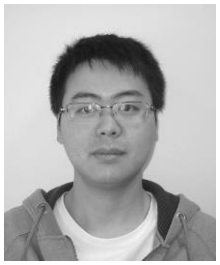
Modelling Digital Cadastral Boundary for Building Subdivisions in Victoria

Sponsor – School of Civil Engineering and Surveying



David Lu

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Supervisors: Dr Dev Raj Paudyal, USQ

Mr Andrew Busse, Beveridge Williams & Co.

Keywords: 3D Cadastral Boundary, Building Subdivision, Modelling.

1. Introduction

The current plans of building subdivisions in Victoria is based on 2D drawings. The plan includes plane views of each storey and section views of several section lines. This is a very traditional style of building plans back to 1960s in Victoria. It makes hard for users to understand the cadastral boundary inside a building and especially hard in modern complex buildings.

2. Background

Traditional land titles have their boundary model in Digital Cadastral Database. Building subdivision titles are not included in the current system. The building subdivisions will become more popular in the future due to the land price increased. Developing a model for each building can make the users easy to understand the boundary locations. Several researches have been done in Victoria and each of them has the limitation. This project is trying to find a better way to demonstrate the cadastral boundary inside a building subdivision.

3. Methodology

Two buildings have been reached in this project. The modelling process started from a simple 3-Lot subdivision. In this model, different types of cadastral boundaries are explained and shown in the 3D model. Then a more complex high-rise building has been undertaken in the modelling. The model included the building structures which are used as cadastral boundaries. The structures are only being used as the reference objects. The model is showing lots in different colours. Please see Figure 1 for an example.

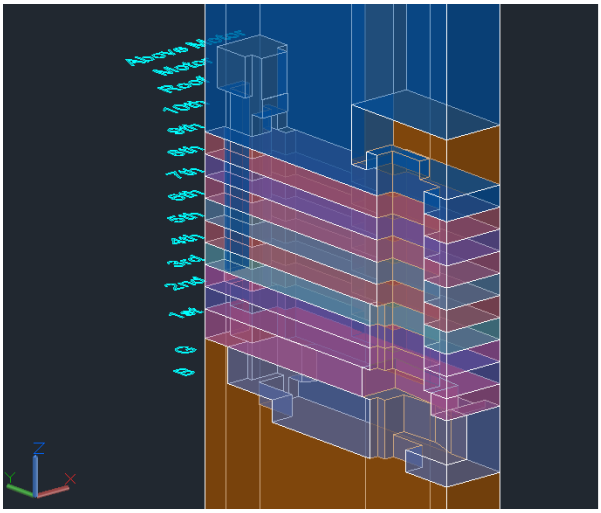

Figure 1 – Model for a multi-level building

4. Key Outcomes

It is hard to follow the cadastral boundary without any reference objects. Showing the title in dimensions is accurate but hard for the users to understand easily. The building structures can help the user to understand the model in easier way. Lots in different levels are shown in same colour and it is easy to identify the lot locations.

5. Further Work

The file size is big and hard for system to import. The lots are shown in colours and this does not work for buildings with large lot number. Time spend on each model is long, and it is not efficient to apply this method to all the buildings in Victoria.

6. Conclusions

This project applied 3D cadastral boundary model on different buildings. It is a practice in building boundary modelling. Reference objects are useful for the users to understand the boundary locations.

Acknowledgements

Thanks to Dev Raj Paudyal and Andrew Busse providing professional advices on this modelling project.

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Strength Properties of Fused Deposition Modelling Components Produced with XT-CF20 Carbon Fibre Filament

Sponsor – School of Mechanical and Electrical Engineering, Airbus Australia Pacific

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Bachelor of Engineering Honours (Mechanical Engineering)

Supervisors: Dr. Jayantha Epaarachchi

Industry: Ms Andrea House, Airbus Australia Pacific

Keywords: 3D printing, material properties, anisotropy.

1. Introduction

The role that additive manufacturing plays in the prototyping phase of design is increasing as the technology matures. 3D printers using fused deposition modelling (FDM) are becoming common as is the availability of exotic print media. However, the printer settings significantly dictate the mechanical properties of the material, meaning that it is difficult to predict the failure of components. This project aims to identify the strength of 3D printed components produced at Airbus Australia Pacific's (AAP) design office.

2. Background

AAP can 3D print a filament that contains 20% carbon fibre, which has high strength and stiffness. However, to certify the strength of the 3D printed materials and allow the production of flyable prototypes, material properties and design limits need to be established. Sung-Hoon et al. (2002) identified various printer settings that contribute to the component's strength such as print orientation, bed and nozzle temperatures and infill orientation, width and overlap. The print and infill orientation were key to a printed part's tensile strength. The aim of this project is to establish the strength of the material in common failure modes and to determine material properties for an FEA model

3. Methodology

To address this problem, FEA models of 4 different test specimens were created using a 3D orthotropic material of assumed values. These test specimens were then printed in various print and infill orientations. The test specimens were tested for tensile, compressive, flexural and bearing strength. The results of these test were used to produce design limits for the material and to create a 3D orthotropic material in FEA to analyse components of complex geometry.

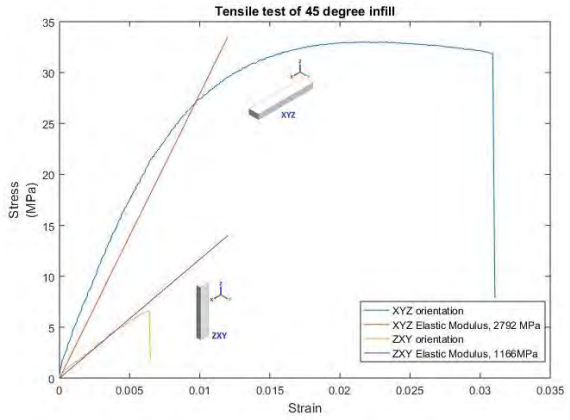

Figure 1 - Sample Diagram

4. Key Outcomes

The testing concluded that the strengths of the parts are greatly dependant on the print orientation in the first instance and infill orientation in the second. Figure 1 displays the tensile strengths of the tested specimen which show that the ZXY orientation has notably lower strength than the XYZ orientation.

5. Further Work

Future work relating to the use of 3D printed products at AAP would be to test components in order to validate the FEA model methodology. Also fatigue properties need to be investigated. Without knowledge of the fatigue properties serial production parts will not be possible.

6. Conclusions

The print orientation of the component must be carefully considered against the predicted loading conditions of the part in order to resist failure.

Acknowledgements

I would like to thank my supervisors, both academic and industry as well as the technicians in the Centre for Future Materials for their, guidance and patience.

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Spatial Modelling for Projection Mapping

School of Civil Engineering and Surveying

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Bachelor Spatial Science (Honours)

Supervisor: Dr Zhenyu Zhang, USQ

Keywords: Projection Modelling, Spatial Augmentation.

1. Introduction

Projection Mapping has long been used as a form of creative output, where an image is projected onto a non-uniform surface to which the image is mapped. Traditionally, the projected image is used to map the surface. This research project aims to utilise this creative technique for spatially accurate purposes and the virtual model will be created using various forms of spatial technology.

2. Background

Historically, Projection Mapping has been used as a creative outlet only. Through my literature review, I was unable to find any documentation, or prior research, where Projection Mapping has been used and tested for accuracy in a spatial sense.

3. Methodology

The methodology of the research project aims, firstly, to test the accuracies achievable at a small scale. During small scale testing, different control point configurations have been used and tested to determine the effect the geometry of control has on the accuracies obtainable. It also tests both how and why the accuracy of the virtual model affects the results. This will help determine the best approach to take when the project is scaled up to a much larger sized area – see figure 1.

4. Key Outcomes

- Design and implement a method, integrating spatial technology with 3D modelling.
- Design and implement proof of concept tests for Projection Mapping.
- Design and implement a method integrating Projection Mapping, and spatial modelling for locating precise positions on a structure

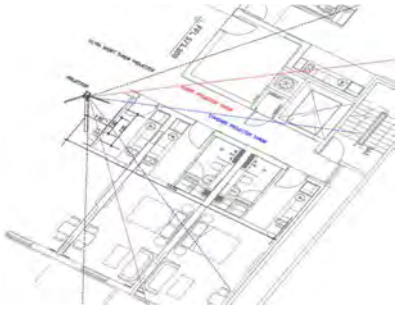

Figure 1 – Throw ratio of projectors onto floor plan

5. Further Work

Future research will include testing on a larger scale and within different environments, utilising more complex virtual models and projectors with higher specifications. Further research will also be conducted to test efficiency and accuracy when compared to conventional methods in a real-life environment.

6. Conclusions

The overarching aim of the thesis is to prove that it is feasible to use a simple data projector for accurate Survey set out. Initial testing on a small scale has shown that accuracies achievable may be as small as ± 3mm standard deviation which is generally acceptable for most applications. Further testing and refining of process will be completed to improve this figure.

Acknowledgements

I would like to thank my Supervisor, Dr Zhenyu Zhang, from the University of Southern Queensland, for his advice and guidance.

I would also like to thank my Director Michael Croft, and the ACT Geosurv team, for their support throughout the completion of this dissertation. Thanks also go to my siblings; who gave me the inspiration to use a creative approach to a technical problem.

A special mention also to my partner for the support provided over the past year to complete this dissertation.

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Monitoring and Analysis of Infiltration Losses for Hydrological Modelling

School of Civil Engineering and Surveying

Michaela Mahony

Bachelor of Engineering (Honours) (Environmental)

Supervisor: Dr Md Jahangir Alam

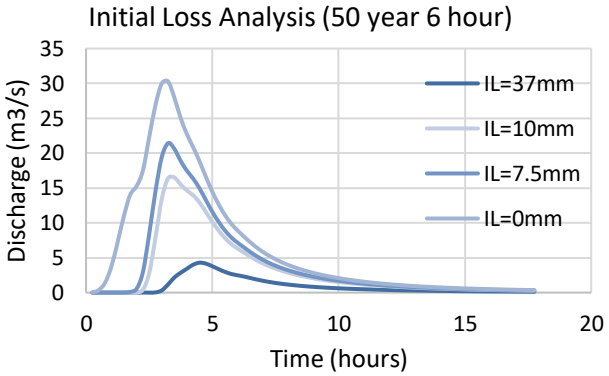

Figure 1: Initial Loss Analysis (50 year ARI, 6 hour flood)

Keywords: Infiltration Losses, Lumped Conceptual Modelling, Loss Models

1. Introduction

Traditional lumped conceptual rainfall runoff models have been a staple of hydrologic modelling for many years due to their apparent accuracy and ease of use. Whilst there is an abundance of modelling packages available, the precision of each outcome relies heavily on the model's suitability to that location. Suitable calibration and validation also play a major role in accuracy.

This project investigates Toowoomba's Gowrie Creek Catchment using several readily available lumped conceptual modelling packages to analyse the effect various input parameters have on catchment runoff. The extent of inconsistencies between models, and the limitations facing each one was also observed.

2. Background

With so many hydrological models available, it is important to recognise the benefits and limitations of each one before using them. A slight inaccuracy in the model can have a potentially huge carry on affect, therefore appropriate model and variable selection guidelines are desired to ensure the right package and data is used in every situation.

3. Methodology

RORB and WBNM were used to model design rainfall through a catchment using calibrated input parameters. Several storm durations and ARIs were explored to gather a broad range of results. A sensitivity analysis was also undertaken using a range of fraction impervious values and loss models to investigate the way inaccurate input parameters could manipulate outcomes. Figure 1 is an example of the diversity between runoff for a 50 year 6 hour flood using different loss models. The ARR (2016) was a main source of information and data throughout the duration of this investigation.

4. Key Outcomes

RORB and WBNM were expected to show differences in results due to the different underlying methodologies used by the models. The extent of the differences will open questions about the suitablility of each model. The sensisity analysis results using RORB have shown large differences in hydrograph values and shapes, clearly demostrating the effect of input values.

5. Further Work

The WBNM model is still being tested. Once this is complete, final results can be gathered and discussed to fully understand the outcomes of the investigation.

6. Conclusions

Results produced during this investigation prove the need for accurate input parameters, especially if the results will be used to design and plan future developments.

Acknowledgements

I would like to acknowledge my supervisor Jahangir Alam for giving me his support and guidance whilst completing this project.

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Achieving effective control of deaeration chemical dosing using artificial neural networks

School of Mechanical and Electrical Engineering

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Supervisors: Assoc. Prof. Paul Wen, USQ

Mr Hing Yuen Chin, North Oil Company

Keywords: Model predictive control, Artificial neural network, Dissolved oxygen

1. Introduction

Within the offshore oil and gas industry substantial amounts of treated seawater are injected back into the reservoirs to improve recovery rates. The seawater is first treated by vacuum deaeration combined with chemical scavenging to remove dissolved oxygen. The control of dissolved oxygen in the injection water is vital in preventing well piping corrosion since replacement within a single well costs millions of dollars. This project aims to achieve effective control over the dosing of the chemical scavenger by using a controller architecture based on artificial neural networks.

2. Background

The studied facility utilised manually controlled over-dosing of chemical scavenger, an effective but inefficient approach. Automatic systems using proportional-integral controllers are often used in these scenarios, however, these have limitations in handling highly non-linear processes whereas neural networks have proved effective in accurately modelling and controlling these (Hagan, Demuth, & Jesús, 2002).

3. Methodology

Matlab Neural Network Toolbox was used to generate and train a neural "Non-linear auto-regressive with exogenous input" (NARX) model using real plant data. The structure of the NARX is shown in Figure 1. Through simulation the NARX model was subsequently used to train a neural Model Predictive Controller (MPC) configured to regulate the chemical dosing rate to achieve the desired dissolved oxygen content.

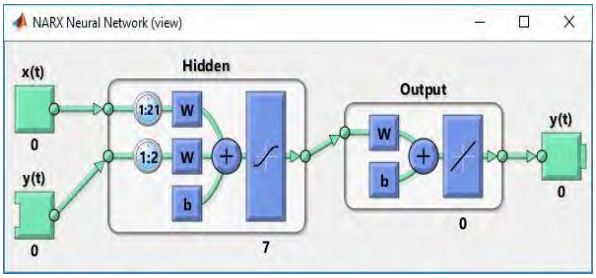

Figure 1 – A "Non-linear auto-regressive with exogenous input" (NARX) neural network

4. Key Outcomes

Seawater temperature, vacuum pressure, water and oxygen scavenger flow rates, as well as dissolved oxygen content data were used to train the neural NARX model to a mean-squared-error performance of 0.001 utilising only 7 neurons in the hidden layer. The NARX has been successfully used to generate several datasets consisting of 5000 samples each, to train the internal neural network of the MPC to good accuracy. Despite this accuracy, the actual control performance of the MPC remains unsatisfactory thus far.

5. Further Work

The MPC performance is still below standard and work continues to optimise the configuration parameters. This iterative process requires regenerating additional training datasets from the NARX model and retraining the MPC followed by re-evaluation of the performance.

6. Conclusions

The successful modelling of the plant using a neural NARX confirms the power of neural networks. Whilst many successes have been reported with neural predictive control systems, success in controlling the dissolved oxygen content remains elusive at present.

Acknowledgements

My thanks go to North Oil Company for sponsoring the project and my colleague Iain Campbell for assisting with the installation of the instrumentation.

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Hagan, M. T., Demuth, H. B., & Jesús, O. D. (2002). An introduction to the use of neural networks in control systems. *International Journal of Robust and Nonlinear Control, 12*(11), 959-985.

The Design of an Autonomous Livestock Handling and Monitoring Device

School of Mechanical and Electrical Engineering

Andrew McCowen

Bachelor of Engineering (Honours), Majoring in Mechanical Engineering

Supervisor: Tobias Low, USQ

Keywords: Machine Vision, Agriculture, Automation

1. Introduction

The development and refinement of automation and machine learning techniques have changed and continue to change the landscape of primary production – none more so than the agricultural sector. The field of Precision Agriculture (PA) deals with the use of modern technology to make long-standing agricultural processes more time efficient, resource efficient and cost effective.

2. Background

One field of agricultural which has embraced the 'age of autonomy' with noticeably less vigour is the pastoral sector. Machine vision is one very powerful tool which modern innovation has provided; yet there is a defined knowledge gap in the way it is applied to animal husbandry operations. Operations such as drenching and drafting of livestock are menial and overly time and labour intensive; machine vision could certainly aid in streamlining such processes.

3. Methodology

An extensive literature review of the field of precision agriculture was conducted, detailing the more recent advancements in that sector and highlighting the knowledge gaps. As hypothesised, there were few examples of automation and machine learning interfacing with livestock. Many of the studies detailed were either of a purely theoretical nature, or with the intent of data capture only.

Observational tests were performed, in order to capture a dataset with which to create algorithms. 'Tailhead' images of a herd of cattle were captured.

From this dataset, an image processing algorithm which extracted the size and colour of each animal was created. A system could then be designed which took the information provided by this algorithm and other inputs and actuated a mechanical device such as a drafting gate.

Using machine vision technology, McCarthy et al. (2010) proved that back length correlates to body size. The use of tailhead images is based upon this assumption.

4. Key Outcomes

The chief objective of the research conducted was to develop a device which could perform a menial animal husbandry task such as drafting or backline drenching, using a live video feed. The majority of the workload consisted of writing an image processing algorithm which could detect the colour and/or size of the animal in question. This was then used in conjunction with other sensors and mechanical devices to develop a prototype of an automated animal husbandry device.

5. Further Work

Finalisation of the proposed design is still in progress.

With present time constraints, it is unlikely that a physical prototype will be manufactured. Further work could be done on the physical construction of this device, and exactly how marketable it will be. This is very much a 'first step', with the hope that many similar devices will follow.

6. Conclusions

Machine vision is a powerful tool for making smarter, more streamlined systems. Coupled with automation, I believe it can revolutionise pastoral agriculture.

Acknowledgements

I would like to thank John Billingsley, for his assistance in the creation of my image processing algorithms; Charles McCowen, for providing the livestock used to create the dataset; and my supervisor, Tobias Low, for guiding through the process of compiling and submitting a dissertation.

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The Soil-Water Cost of Heavy Machinery Traffic on a Vertosol

School of Civil Engineering and Surveying

Rowena McGeary

Bachelor of Engineering (Hons) (Environmental)

Supervisor: Assoc. Prof. John McLean Bennett, USQ

Keywords: soil compaction, soil-water infiltration, controlled traffic farming, Vertosols

1. Introduction

This dissertation aims to determine the impact of soil compaction under heavy machinery on soil-water infiltration for a Vertosol. This will be achieved through the analysis of core samples for the change in soil water availability and infiltration dynamics based on the differences in soil-water potential with the data used to relate the cost of controlled traffic farming (CTF) to non-CTF systems in terms of soil water.

2. Background

The progression of modern agriculture has resulted in the development of larger, heavier machines that impose a greater risk of soil compaction which has been regarded as one of the largest environmental constraints brought about by conventional agriculture. Vertosols are more susceptible to compaction due to their high clay content – they hold water within their particles for a longer period of time, remaining in a plastic state and therefore compress when a load is applied. Compacted soils have less pore spaces and therefore each plant has access to a smaller volume of soil water and requires more irrigation to maintain optimal plant growth and development.

3. Methodology

Soil cores from a control soil, soil trafficked in a conventional manner and the traffic lane (representing the controlled traffic farming system) were analysed using the HYPROP unit in order to determine the soil water potential. Once the soil-water potential was determined, the HYDRUS 1D software was utilised to determine the change in soil water availability and infiltration dynamics. This data can then be utilised to relate the cost of CTF to non-CTF systems in terms of soil water.

Figure 1 – Core samples at 20-30cm depth range (L to R): control, non-CTF field, CTF traffic lane (McGeary, 2018)

4. Key Outcomes

Upon completion of this paper, the relationship between the cost of CTF and non-CTF systems in terms of soil water will be identified.

5. Further Work

This has the potential to be a relatively broad area of study, and there are opportunities for further work. Future areas of study may include; the effects of various heavy machinery types, the effects of various axle loads and the effects of different tyre/track configurations.

6. Conclusions

During the time of writing, experimental testing and analysis of the results were currently underway and therefore, no conclusions have been made at this stage. The findings from this project will enable the determination of a relationship between the cost of CTF to non-CTF systems in terms of soil-water.

Acknowledgements

I would like to thank my supervisor, Assoc. Prof. John McLean Bennett for his continued encouragement and guidance, Mr David West for his assistance and my friends and family for their love, support and patience.

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Analysis of Traffic Flow through Roundabouts for Improving Performance

School of Civil Engineering and Surveying

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Bachelor of Civil Engineering

Supervisors: Dr Soma Somasundaraswaran, USQ

Mr Adam Gwatking, RMA Engineers

Keywords: Roundabouts, Signalised Intersections

1. Introduction

Increasing population in a city usually creates traffic congestion, due to the lack of transport infrastructure facilities. To cope with traffic congestion at any intersection, upgrades take place, allowing for more volume to pass through. The current consensus in Transport Engineering is that when upgrading intersections, the natural progression is to upgrade from Unsignalised, to Roundabouts, to Signalised Intersections as the traffic volume increases (Austroads 2017). This project aims to challenge this generalised thinking by seeing whether in certain circumstances roundabouts are better for improving performance along a corridor than signalised intersections.

2. Background

This project looks at analysing the corridor along Hume Street, from Perth Street to Long Street., as seen in Figure 1. This corridor was chosen as it suffers from congestion issues, and is seen as one of the main streets in Toowoomba. This corridor consists of three roundabouts in-between James Street and Alderley Street.

3. Methodology

Modelling programs such as TRANSYT-7F and SIDRA have been instrumental in analysing the traffic flow through roundabouts. Four different scenarios were modelled, looking at the existing operating conditions, as well as some alternate operating conditions. The proposed alternate operating conditions focused on replacing one or more of the intersections with signals, to see how this affected the corridor. Each of these models incorporate a number of key parameters, such as geometric conditions, current traffic flow, and the saturation of the intersection, to estimate the degree of saturation, delay time, and queue lengths.

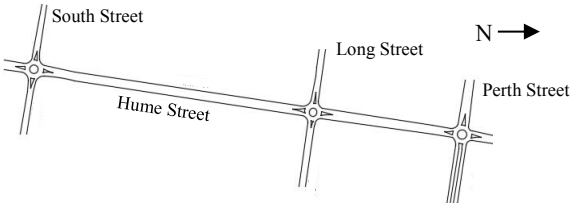

Figure 1 – Diagrammatic View of the Hume Street Corridor

4. Key Outcomes

During analysis, it was clear that each alternate operating condition would have its own benefit, and that on a whole, no one operating condition would be superior to the other. The existing conditions are expected to be more beneficial for east and westbound vehicles travelling along the feeder streets of South, Long and Perth Streets, whereas the alternate conditions are expected to gradually improve the traffic flow along Hume Street.

5. Further Work

The remainder of the analysis is yet to be complete, with each of the alternate operating conditions to be refined in order to complete analysis. Upon commencement of this project, the aim was to also analyse the flow on effects of these changes along the Geddes Street corridor. Due to time constraints, it is unlikely that this will be a part of the analysis.

6. Conclusions

Improving the performance of an intersection isn't as simple as upgrading to the larger capacity intersection. A number of different factors do into determining whether or not a type of intersection is suitable for the location. This report found that upgrading the analysed corridor from roundabouts to signals does improve flow in one direction, but inhibits flow in the other direction.

Acknowledgements

I would like to thank the following for their ongoing support and guidance throughout the duration of this project; Dr. Soma Somasundaraswaran, Mr. Adam Gwatking, and my friends and family.

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Camera-based plant sensing system for estimating crop maturity

University of Southern Queensland Faculty of Health, Engineering & Sciences

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Bachelor of Engineering (Honours)

(Agricultural Engineering)

Supervisor: Dr Alison McCarthy, USQ

Keywords: camera based plant-sensing, maturity estimation, image analysis.

1. Introduction

Improving efficiencies with irrigation, fertiliser and harvest management provides economic and environmental benefits within the industry. Vegetable crop maturity estimations are typically carried out by inspection of the crop once removed from the ground.

This project aims to develop a non-destructive camera-based plant sensing system for estimating carrot crop maturity in a variety of soil types and management practices.

2. Background

Sensing techniques are used frequently in other industries such as broadacre crops. Broadacre crops have an advantage in that the harvested section of the crop grows above ground. Remote sensing in vegetable crops would provide useful information regarding plant growth and yield and in a timely manner (Yang et al. 2008). By identifying observable vegetable crop parameters above ground that relate to crop yield below ground a model may to be produced to estimate crop maturity. Depending on the correlations found, either regression models (Liang, Kirk & Greene 2018) or machine learning models (Yamamoto, Guo, Yoshioka & Ninomiya 2014) may be adopted. It is anticipated that the outcomes produced by this project may provide an additional tool for crop management and harvest decisions resulting in reduced input resources and costs while producing optimum yields.

3. Methodology

Data collection is routinely carried out to identify crop / weather / soil parameters that relate to carrot crop yield. The data which shows a strong correlation with yield will be used to create a model to predict crop maturity / yield. RGB & bandpass filter photographs and soil moisture measurements are routinely taken from test sites within the fields (see Figure 1). Sample plants are removed from the ground and yield data is recorded. Simple algorithms are used to prepare the imagery for analysis. Correlation analysis is currently being undertaken and a final model will be developed from this.

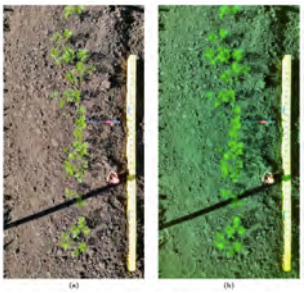

Figure 1 – Example of RGB (a) and bandpass filter (b) sensing routinely taken in the field

4. Key Outcomes

Correlations appear to exist between various observable parameters and root yield although these seem to be specific to each site. The model may require a site-specific adjustment factor to be applied to better estimate crop maturity.

5. Further Work

Data collection and correlation analysis is currently being undertaken and a suitable model will be produced from these findings. This will include regression analysis and potentially machine learning.

6. Conclusions

It is predicted that correlations exist between observable crop parameters and yield and a model can be developed to estimate crop maturity.

Acknowledgements

I would like to thank Dr Alison McCarthy for her knowledge and guidance. In addition, I would like to thank the West family for allowing data collection within their crop.

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Stair Specific Assistive Device, Refining the Home Lifestyle of Those Living with Frailty

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours) (Mechanical)

Supervisors: Mr Chris Snook

Keywords: Aid, Disability, Gait

1. Introduction

This paper analyses the gait pattern of those traversing stairs with limited mobility and compares the effects of an assistive aid on the user's gait. The effects of gait upon the joints were investigated and correlated to the pain and reduction in mobility experienced by people when traversing their stairs within their home. This research then evaluates the effect of a specifically designed aid useful for reducing unused movement while traversing and reducing the stresses placed upon the joints.

2. Background

Living independently is a critical factor used for evaluating one's quality of life. A mobility aid designed specifically for supplementing someone's mobility when traversing stairs provides an allowance for those living with a disability to live a little more independently. Doctor Elizabeth Hensor suggests that stairs are the most likely to reduce independence in statements like the following *"knee pain is most likely to first appear during weight bearing activities involving bending of the knee, such as using stairs."* (Hensor EMA et. al., 2015).

3. Methodology

A Pilot Study was conducted initially to determine the feasibility of designing an assistive device. This was to determine that any current aids don't already fulfil the purpose that the designed aid was aiming to fulfil. Following this a basic gait analysis was conducted using Kinovea, to determine the typical gait of someone using stairs. This allowed the determination of specific angles throughout the gait cycle as seen in Figure 1. Finally, the design was modelled and simulated within a 3D CAD program to identify how it performs and reduces stresses.

Figure 1 – Kinovea showing key angles and motion paths

4. Key Outcomes

Within the research conducted it has been identified that the effects of stairs on the body increase the average peak loading on the knee by approximately 70% more than the act of standard walking which places the equivalent of approximately 3 times the body weight of the walker on the knee.

5. Further Work

Theoretical evaluation of the assistive aid will be conducted to verify how much the assistive aid can relieve the knee of this mechanical loading and any other load bearing joints.

6. Conclusions

Preliminary tests within the pilot study have shown a slight decrease in the forces while traversing stairs. Therefore, it is expected that the final tests will support the aim of the project in reducing these forces significantly.

Acknowledgements

I would like to thank my supervisor Mr Chris Snook for his advice throughout the duration of the project Mrs Georgia Smith and my family for their continuing support.

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The Need for Real-Time Progress Reporting in Relation to Time, Cost and Quality

School of Civil Engineering and Surveying

Riley Mellor

Degree: Bachelor of Construction majoring in Management

Supervisors: Dr Vasantha Abeysekera, USQ

Keywords: Real time progress reporting, cloud-based programs, Project reporting

l. Introduction

This dissertation investigates and analyses the process of real time progress reporting in construction and how it can impact key construction process in relation to time, cost and quality of a construction project.

The report endeavours to both investigate the importance of implementing real time progress reporting and also how a method of real time progress reporting can be successfully implemented in different forms of the construction industry to bridge the gap and potentially solve problems outlined in the report.

2. Background

Monthly reporting is a key part of determining if a project is on or off track with regards to time, cost and quality. Which is why it is important that the information used is as accurate as it can be, otherwise the re- porting will reflect an unreal representation of the progress of the project.

There are currently multiple programs in the construction industry which aims to capture real time progress reporting to streamline monthly reporting to make it more accurate and less time-consuming. However, there are a few flaws in current methods of real time progress reporting such as transferring information from site and also verifying that information. When the required data is not captured accurately or completely, extra communication is needed between the site office and field personnel (Thorpe and Mead 2001). This can be a time consuming task, which is one of the multiple problems the research project tries to eliminate regarding real time progress reporting.

3. Methodology

The methodology employed is to address the problems outlined in the report by implementing a method to help enable better and easy management of the projects progress to assist in the monthly progress re- ports such as the cash flow, forecasting (time and cost) and progress claims (subcontractor and client). The implemented method aims to streamline productivity and create more accurate reporting through real data which reflects what is happening on site in real time.

The aim is to solve the issues raised in the report by creating a more accurate method/system of real time progress reporting through a trade specific scope data diary entry which is updated by site staff.

This scope specific diary entry data will be capable of being imported to cloud-based programs such as shared computer files, so the information can be shared with project team members. In particular this method will be implemented into the current construction company I work at to improve the way we conduct our monthly reporting.

4. Key Outcomes

The desired outcome for this research project is that there will be an implemented method that captures the progress of a construction project in real time. Allowing project team members to access the uploaded information at any time, to assist in creating an accurate monthly project report which is a true re- flection of what is happening on site in real time. This will mean the task of creating monthly project reports will be streamlined, reducing resources and also time it takes to conduct the reports which will help enhance the productivity within the industry for the future.

5. Further Work

Time and resources restrict the level of quality and depth which can be implemented to develop this program. Therefore, future work will involve refining the system in more detail while also making it compatible to be uploaded into any cloud-based software's which construction companies use to manage their projects.

6. Conclusions

The main benefits of implementing a system provides accurate real time progress of a construction project is the benefits it will have in regards to controlling the time, cost and quality of a project. While also making management tasks such as monthly project reports a quicker and more accurate task.

Acknowledgement

I would like to acknowledge my current employers who have allowed me to test the proposed method on real world construction projects.

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A Sustainable Focus on Rural Town Main Streets & Highway Initiatives

Sponsor – School of Civil Engineering and Surveying

Grant Minchev

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr David Thorpe, USQ
Mr Greg Klein, AECOM

Keywords: main street highway, dual purpose highway, sustainable streets

1. Introduction

Highways often pass through the heart of small towns in rural areas, and road corridor developments may prioritise through traffic over local access. Some of these roads may be constrained, hard to change or wide and over designed for their function. These roads often are dual purpose being a highway as the main street.

2. Background

This research was prepared to determine a better understanding of how to balance the conflicting desired outcomes of "high street highways" to achieve a sustainable outcome. Towns that are located on a highway with existing commercial development and public realm within the corridor fall into a unique category of design scenario. Therefore, the need to research to give guidance to organisations, local governments and road authorities for a better understanding approach is seen to be significant.

3. Methodology

Review of main street and highway requirements, issues and their dual-purpose function. Review and research of case studies and guidelines both nationally and internationally. Analysis of identified common issues, relating to high street highways and critically evaluate these against a case. Therefore, a qualitative analysis to reveal why some of these issues are difficult to solve sustainably through an industry case scenario at the early phases of development.

Figure 1 – Main Street Highway Case, Sarina Town

4. Key Outcomes

At this stage, there are similarities between the case study town selected, Sarina (QLD) and the common issues identified in the review phase. Unsurprisingly the dominant use of the space is vehicles via the road area, creating highly unbalance sustainability pillars.

5. Further Work

A qualitative approach identifies broader issues to inform authorities and local governments of a baseline of approaching main street highways. Further quantitative research could focus on smaller aspects of variables.

6. Conclusions

The results are expected to support baseline knowledge and identification of common issues, providing the industry with better guidance when assessing and designing main street highways in a sustainable manner.

Acknowledgements

Dr David Thorpe (USQ) and industry supervisor for their suggested project topic, support and guidance on this topic has been fundamental.

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Exoskeleton Arm Control system:

Design, Construct and Evaluate

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Hons) in Mechatronics

Supervisors: Prof John Billingsley, USQ

Keywords: Exo-Skeleton, Strength Augmentation

1. Introduction

This project aimed to design, construct and test a unique exoskeleton design that is robust and repairable, and suitable for use in the construction field.

The prototype arm that has been produced is designed as only part of a full body exoskeleton, which will significantly reduce the physical strain that is placed on a worker's body during typical tasks performed on a construction site.

2. Background

While there are several exo-skeleton designs available on the market, very few of them provide a full body version, and if they do the cost is prohibitive (Sankai, 2007) and the designs cannot withstand the abuse that a typical tradies tool would sustain. Repairs also require replacement of expensive components, not off the shelf items. This project aims to address these faults.

3. Methodology

Firstly, research was undertaken to identify what alternatives were available on the market, and there were a few options, but nothing that ticked all the boxes.

Then a design was formulated using off the shelf components, refer to Figure 1, and numerous refinements and changes were made to accommodate a maximum range of motion.

The bracelet sensor system was particularly difficult to refine, and numerous attempts were made to achieve a functioning design.

The control system, while basic, depends on the bracelet, so with each change at the wrist, the programming needs revision. High level control systems (Anam & Al-Jumaily, 2012) were not considered, just an arm following device with safety limits..

Final stage will be testing, having an operator perform tasks to gauge the viability of the design.

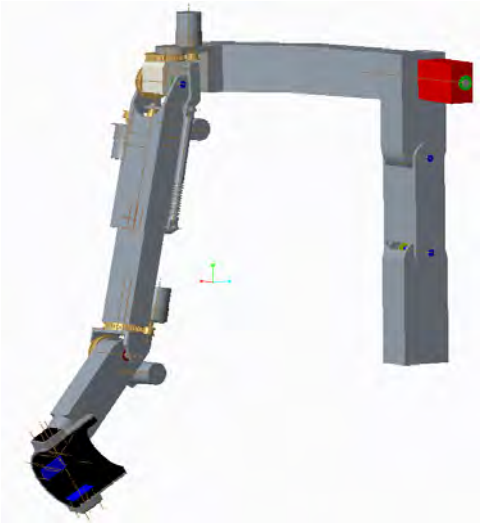

Figure 1 PTC Creo model of prototype Exo-skeleton Arm

4. Key Outcomes

A Design has been developed, and proposed testing has been specified. The prototype arm is partially constructed, and the control system has been outlined and partly programmed. Work is continuing.

5. Further Work

The rest of the exoskeleton was not designed as part of this project, that is still to be done.

Numerous refinements could be made to this design.

6. Conclusions

This was a very ambitious project to undertake in an expanding field. The result remains to be seen, but at this stage the project will not meet all of the desired outcomes.

Acknowledgements

Many thanks to my supervisor, Prof J. Billingsley.

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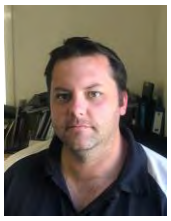
Electron tube performance monitoring via remote means

Sponsor – School of Mechanical and Electrical Engineering

Adam Murray



Bachelor of Engineering (Honours) – Electrical and Electronic Engineering

Supervisor: Dr Andrew Maxwell, USQ

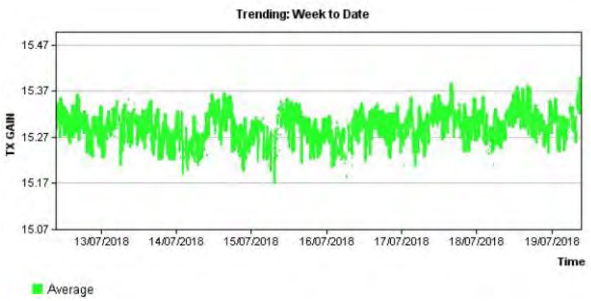


Figure 1 – Logged data for Electron tube gain

Keywords: Electron Tube, Performance analysis, RF

1. Introduction

Whilst the use of Electron tubes has been greatly superseded by solid-state semiconductor devices, there are still specialist applications where they are very much in use today. One such application is the field of high power RF transmission. As electron tube devices have a finite lifespan, this project focused on how to monitor Electron Tubes operating conditions to better understand their performance, and to better predict when they will reach the end of their useful life.

2. Background

As many high-power FM broadcast transmitters employ Electron tubes in the final output stage, this presents an ongoing cost for replacement tubes and subsequent labour. Increased connectivity to remote transmitter site locations has resulted in improved visibility in real-time of a company's assets. Increased monitoring will allow a company to better plan Electron Tube replacements based on performance instead of interval-based replacement reducing overall maintenance costs. Further to this, improved performance analysis will assist in predicting failures.

3. Methodology

To determine the best way to monitor an Electron Tubes performance, it was first necessary to analyse typical methods of tube failure. The next step was to determine the best way to measure these changes over an Electron tubes' life-cycle to determine a historical baseline of what changes to expect. Historical records were then analysed to develop an understanding of Electron Tube performance. A measurement system was then developed to facilitate capture of the Electron tubes performance in real time (Figure 1 shows a real time example of gain fluctuations over time).

4. Key Outcomes

The designed measurement system monitors all key metrics of Electron tube performance. This data will be analysed over time with a view to extending the next maintenance interval based on Electron tubes performance. This measurement and prediction system will give better insight into the typical variations in performance of an Electron tube over its life.

5. Further Work

After analysing the performance of multiple tubes over time, a better model for typical changes in performance and life expectation will be developed. After logging the deterioration of several Electron tubes, an understanding will be gained on typical remaining useful life based on current performance indications.

6. Conclusions

The system implemented real-time monitoring of Electron Tube performance to predict and monitor useful lifespan. This then ensures greater lifecycle monitoring through increased utilisation of existing in-operation tubes reducing costs of replacement, and helping to prevent outages due to tube failure.

Acknowledgements

I would like to thank the NMS team at Broadcast Australia, and Dr Andrew Maxwell for their support during this project.

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Safety Benefits of Narrow Median Wire Rope Safety Barriers on Rural Highways

School of Civil Engineering and Surveying

Joseph Nash

Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Jo Devine, USQ

Keywords: Narrow Median Wire Rope Safety Barrier (NMWRSB), Rural road safety, Empirical Bayes

1. Introduction

Cross-centreline crashes are one of the most severe crash types that can occur on the Australian road network. Roads and Maritime Services (RMS) have identified the need for road safety improvements on rural roads since two-thirds of fatalities in NSW occur in these locations. NMWRSB, as seen in Figure 1, have been identified as a road safety treatment for undivided rural roads in areas experiencing higher volumes of traffic. Its function is to not only separate traffic but also reduce the severity of cross-centreline crashes.

2. Background

In 2007 and 2015 the Roads and Traffic Authority, now RMS, implemented NMWRSB on sections of the Pacific and New England Highway respectively. At the time of the Pacific Highway treatments little had been done in NSW to separate traffic on high speed undivided roads and as a result the implementation of NMWRSB was a relatively new initiative. NMWRSB studies for the Pacific Highway in 2009 indicated that result reliability for the effectiveness of treatment could be improved by analysing additional years of data. This research also aims to evaluate the effectiveness of treatment for the New England Highway NMWRSB sites since no formal study has yet been undertaken.

3. Methodology

A method for determining the safety improvements a treatment has on a section of road is to compare the crash frequency before and after a treatment has been implemented. The reviewed literature has indicated that the most suitable statistical analysis method is the Empirical Bayes (EB) method since it is able to account for treatment, exposure, trend and random effects (Hauer, 1997).

Figure 1 – Narrow Median Wire Rope Safety Barrier (McTiernan, Thoresen & McDonald, 2009)

4. Key Outcomes

This research aims to quanitfy the safety benefits of NMWRSB by identifying crash reduction percentages and undertaking a cost-benefit analysis. The EB analysis requires crash data, segment lengths and AADT for both comparison and treatment sites. This data develops safety performance functions (SPF) in statistical software packages. Using the SPFs and other EB formulae the crash reduction is calculated. Results indicate that whilst incidence of crashes have increased the severity of crash types has been reduced. This trend of results is consistent with reviewed literature.

5. Further Work

This study will be completed with the compilation of results and completion of a cost benefit analysis.

6. Conclusions

Expectations are that the results will build on the existing knowledge of NMWRSB and its effectiveness at reducing the severity of crashes to save lives.

Acknowledgements

Gratitude goes to my supervisor, Dr Jo Devine for her guidance throughout the year and the individuals at the Roads and Maritime Services whom have given their time and knowledge to help me with my research.

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Shunt Reactor Switching Transient Analysis

Sponsor – School of Mechanical and Electrical Engineering

Patrick Nolan

Bachelor of Engineering (Honours) - Power

Supervisors: Dr Andrew Hewitt, USQ

Assoc. Prof. Tony Ahfock, USQ

Keywords: CB (Circuit Breaker), TRV (Transient Recovery Voltage), current chopping.

1. Introduction

Shunt reactors are found in electrical energy networks and are used to reduce steady-state voltage levels by absorbing reactive power. As the demand for voltage regulation changes a CB is often used to operationally switch a shunt reactor in and out of service. When a CB is used to de-energise the highly inductive shunt reactor load current, significant stress may be placed on the CB due to the TRV that appears across the CB contacts. The primary focus of this project is to investigate CB switching phenomenon associated with the de-energisation of a shunt reactor. The aim is to provide an improved understanding of three-phase shunt reactor switching and identify key factors that influence the TRV during the first-pole-to-clear.

2. Background

The TRV is a major concern for both the CB and other electrical equipment located nearby due to prematurely aging and possible catastrophic failures. An improved understand of the shunt reactor switching phenomenon will lead to designs and testing outcomes better suited to the various network conditions. This project will reference Australian standards for switching of shunt reactors using CB's and further develop the knowledge of element sensitivity for design purposes.

3. Methodology

A Simulink software model has been developed to investigate specific conditions that affect the TRV. Simulink software blocks are used to represent realistic network elements and system parameters that can be used to analyse the shunt reactor switching response.

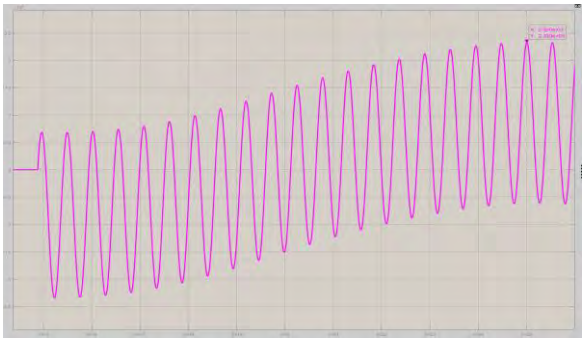

Figure 1 – TRV on First-Pole-to-Clear (4A Current Chopping)

4. Key Outcomes

A shunt reactor switching model has been developed in Simulink and transient analysis has begun with an example of a modelled TRV in Figure 1. The first-pole-to-clear model has identified a number of key elements that significantly affect the TRV. The TRV response under various scenarios has been assessed based on the Australian standards for CB capabilities. The results obtained could be used by electrical network designers to help identify unfavourable conditions of shunt reactor installations.

5. Further Work

Investigation of the element sensitivity is not fully completed and hence the results are not finalised. The remaining tasks include, TRV analysis of control measures and verification of results using an analytical solution. The analytical model will be used to validate the Simulink model and investigate the TRV behaviour.

6. Conclusions

Through an improved understanding of the complex reactor switching phenomenon, designers will be able to better interpret and apply relevant standards. The results provide an improved understanding of the hazards relating to shunt reactor switching and the best options for implementing suitable control measures.

Acknowledgements

Dr Andrew Hewitt has been supportive throughout my research and I am grateful for his input. A special thankyou to my family for their patience and tolerance.

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Impact of Harmonics from 12-pulse Converter-Fed DC Drives

Glencore – Mount Isa Copper Operations (MICO)

Mike Nyakureba

BENH-Power Engineering

Supervisors: Dr Tony Ahfock, USQ

Mr Peter Ferguson, MIM

Keywords: Sequential Mode, Power Quality Analyser (PQA), Total Harmonic Distortion (THD)

1. Introduction

The intent of this project is to analyse the harmonics from a 12-pulse ac-dc converter, determine the impact on transformers , check for power quality issues on the Mt Isa Mines (MIM) underground network then to recommend mitigation measures.

This also involves establishing whether the overheating of the transformers can be attributed to the harmonics and to check whether transformer specifications are adequate.

2. Background

The DGA results for MIM transformers at 19Z62 and 19B M62 have over the years been indicating the problems associated with over-heating on all of them. These transformers feed the Enterprise Mine network and the sequential mode twelve-pulse ac-dc converter for 19B M62 winder.

The twelve-pulse ac-dc converter has been operating without a harmonic filter since 2011 when the previous filter failed. This study aims to show whether there is a link between the harmonics and the over-heating issue.

3. Methodology

To determine the harmonic content and waveform distortion, a PQA was set up at four suitably selected locations to record the required measurands on the on the circuit feeding the twelve-pulse DC converter. A model of the twelve-pulse converter was built, and simulation was done using MATLAB Simulink software to correlate the outcomes from the PQA and the simulation. The harmonic spectrum obtained from the measurements taken on the LV side of the winder transformer is shown in Figure 1.

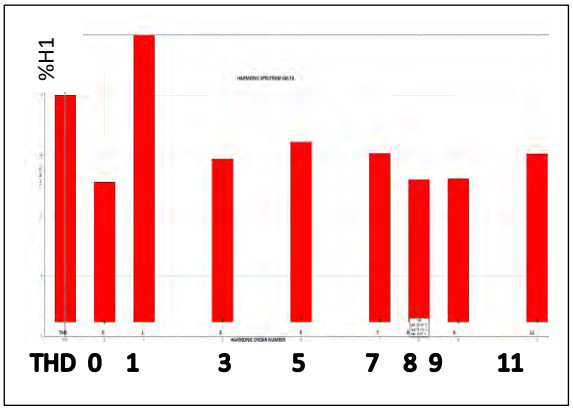

Figure 1 – Current Harmonics Spectrum from Winder Armature Transformer-LV Star side

4. Key Outcomes

The results of the study indicated a significant amout of THD for the current , the presence of 5^{th} and 7^{th} harmonics and a DC component in the harmonic content.These 5^{th} and 7^{th} harmonics are unique as a twelve-pulse should eliminate these harmonics.There was also low frequency oscillation of the current waveforms observed in the measurements taken using a Fluke PQA and the analysed in Power Log Software.

5. Further Work

There is additional work required to determine the cause of the low frequency current oscillation and the ripple content of the converter DC output which could not be carried out due to safety concerns.

6. Conclusions

The results of the indicated that there is a high current THD, 50% on average which is above the 25% limit of the manufacturer and the IEEE Std. 519. There is the need to correctly specify transformers depending on the usage including k-factor and install the harmonic filter.

Acknowledgements

I would like to thank Peter Ferguson, MIM for great assistance and allowing the project to be undertaken. I would also extent my heartfelt thanks to Dr Tony Ahfock for the insightful help in fulfilling this project.

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Optimising Rural SWER Distribution Systems in Queensland

Sponsor – Ergon Energy/ Energy Queensland

Benjamin O'Brien

Bachelor of Engineering (Honours)
(Electrical and Electronic Engineering)

Supervisors: Mr Andreas Helwig, USQ
Mr David Sheppard, Ergon Energy

Keywords: Single Wire Earth Return, Distribution System, Grid Utility Support Systems

1. Introduction

Rural electricity supply has always had its challenges especially in remote areas of Queensland due to low customer density. This issue is managed by single wire earth return (SWER) system. The supply of rural electricity is becoming difficult with the current aging SWER network. Currently, Energy Queensland looks after 64,000 km of SWER in its electricity network. In recent years the demand on the SWER system has continually increased due to irrigation, on-farm automation and rural life-style domestic demand increases. The centralised Grid Utility Support System (GUSS) has been introduced to support the unpredictable demands on the SWER network. The GUSS is a 25 kVA power output, with 100kWh battery storage system put into a form of network peak demand support through storage of energy at low demand time for later release as needed.

This research project investigates decentralising the GUSS with a distributed energy storage system strategically placed as a cost effectively solution to support future SWER peak demand and extend the operational usefulness of SWER networks.

2. Background

Ergon are aware that the current SWER network will not be sufficient for future growth in peak demand in isolated parts of Queensland. There is a need to determine the best possible options available to support the current SWER networks. This project investigates potential advances in the use of GUSS systems as a way of improving the SWER systems performance.

3. Methodology

The research centres on load flow modelling and developing business case scenarios for renewable energy and battery storage. Modelling for the SWER system includes four scenarios i.e. the current centralised GUSS, decentralised GUSS, and microgrid systems. Business case studies for these scenarios include three different types of ownership of the assets. These are Ergon ownership, Private ownership and combination of Ergon and Private ownership

Figure 1 – Centralised Grid Utility Support System (GUSS), Ergon Energy (2018)

4. Key Outcomes

A business model and case study that will determine whether the current SWER with centralised GUSS should be replaced or broken up into microgrids with decentralised GUSS.

Highlighting the importance of research and development in the area of energy storage technology will play a vital role for the future of energy supply to isolated areas in Queensland.

5. Further Work

Further work would include developing another model of the SWER system with alternative software packages to compare and help validate results.

6. Conclusions

In summary, the project outcomes have been positive after modelling revealed improvements in voltage stability across the SWER network with the inclusion of decentralised GUSS but there is a need for further research done in this area.

7. Acknowledgements

I would like to thank my thesis supervisor Andreas Helwig for his continuous expert guidance, patience and support over the past 12 months. I would like to give special mention to David Shephard (Ergon Energy Regional Asset Manager, Southern – Retired) for his help in getting this project off the ground and for sharing his extensive knowledge throughout the duration of this project. Finally, thank you to Ergon Energy for sponsoring this project and giving me the opportunity to learn from such a highly skilled and talented team – Scott Marsh and Ben McIntyre.

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Evaluation of UAV vs Conventional Surveying methods in locating Waste Material at a Landfill Site

School of Civil Engineering and Surveying

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Bachelor of Spatial Science

(Honours)

Supervisors: Dr Xiaoye Liu, USQ

Keywords: UAV, Surveying, Landfill

1. Introduction

Landfill sites are continually monitored by surveying companies for quality control and volume calculations on waste material. Most companies use conventional surveying methods to locate the active cells which can take quite a considerable amount of time. The use of newer technology in the surveying industry must be tested where possible. Therefore the use of UAVs in monitoring Landfill sites will be tested and compared to conventional methods to see if it is an option for the future.

2. Background

This project is important in investigating the advantages of using a UAV system for certain surveying applications. It extends the existing knowledge of UAV applications to the landfill sector and evaluates its usefulness in monitoring the active cells. The information from this dissertation will help future surveyors make informed decisions on where a UAV system can be used to save time and maintain accuracy requirements.

3. Methodology

The project included surveying of a landfill site first using the total station then secondly using the UAV system. Each of the separate surveys covered the same outlined area of landfill and ground control. The data for each of the methods were then processed and generated DTMs were compared to a base digital terrain model for volume calculations. Each of the processes were also timed for comparisons to be made in efficiency.

4. Key Outcomes

The key outcomes of the project include:

- UAV can be used for mapping of Landfill sites within accuracies of conventional surveying techniques.
- UAV surveying is much safer and efficient to use.
- Volumes from the UAV data were very close to the conventional surveying volume.

  (See Table 1.0)

These outcomes were achieved by comparing the data and procedures of the two techniques.

	Volume (m^3) above Base DTM
2018 S6	254,510.40
80m UAV	254,625.50
110m UAV	254,711.50

Table 1.0 – Volumes above Base DTM Comparison

5. Further Work

Students can do further work with the use of UAV on different sites of varying grade and size. More work can also be done to assess whether the flying height of the UAV affects the accuracy of the data and further volume calculations and comparisons.

6. Conclusions

The project has found that the use of the UAV is more accurate in locating waste material than the conventional surveying technique and is very efficient.

Acknowledgements

I would like to thank my supervisor Dr Xiaoye Liu for her support throughout the year. I would also like to thank John Mangan from Moira Shire Council for allowing this project to occur along with Steve Collins and my employers at North East Survey Design.

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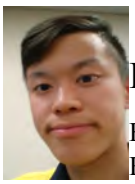
Design and Refinement of a Trailer Mounted Crane

School of Mechanical and Electrical Engineering – University of Southern Queensland



Benjamin Oon

Bachelor of Mechanical Engineering Honours

Supervisor: Dr Jayantha Epaarachchi, USQ

Keywords: Crane, Design, FEA

1. Introduction

This project was initiated to assist a friend of mine who owns a metal fabrication business. He wishes to be able to manufacture low cost, low maintenance crane to be mounted onto his delivery trailer. The purpose of this crane is to allow him to deliver the products he fabricates to clients.

I will attempt to design a crane for my friend, and refine this design further to ensure that the optimum result is achieved. This is a design project which will allow my friend, and also others to be able to manufacture their own low cost, low maintenance cranes to increase and expand business profitability.

2. Background

This project will allow my client to have a custom crane designed that complies with the relevant Australian Standards as well as meeting the specifications he wishes to have. This project will further my knowledge into Australian Standards and manufacturing processes, as well provide me with practice in using cutting edge finite element analysis (FEA) software. This will help me in my mechanical discipline by providing me with experience in the research and design field.

3. Methodology

The methodology I have used in this project is more quantitative, with numerical methods employed in the FEA and early stage planning. To achieve the desired outcome, I have employed research into existing literature, standards, regulations, and crane designs, conducted preliminary calculations as well as evaluating initial designs, modelling in 3D and FEA, as well as data comparison and analysis.

Figure 1 shows the FEA results of a proposed design for the crane. The model has been loaded with 500kg at the tip of the jib to simulate working conditions. The colours represent the displacement experienced by the jib.

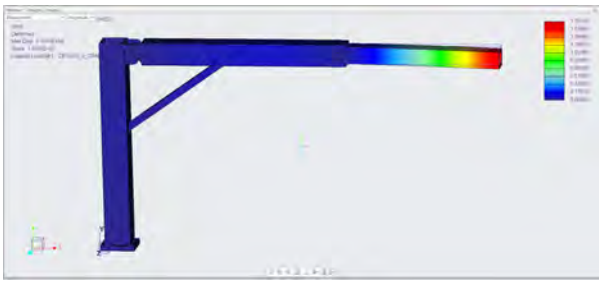


Figure 1 – Screenshot showing 3D model in FEA software, the colours represent displacement and stress

4. Key Outcomes

So far, I have reviewed all the relevant Standards and legislation regarding this prooject. Based on these documents, I am able to design a crane which will remain legal to use in the country and complies with all safety requirements mandated by the government. Basic designs, calculations and initial FEA have been completed.

5. Further Work

Further analysis using FEA and other supporting software will be used to further evaluate different crane designs as I progress further along with this project. I will have to come up with a criteria to determine when the design has been suitably refined. Following the design, if time permits I will draw up full technical drawings to be sent to my friend, ready for manufacture.

6. Conclusions

So far the key outcome of my project is having 3 initial designs to be compared and having completed a review of relevant standards and legislation.

Acknowledgements

I would like to thank my supervisor Dr Jay for his guidance, my friend Andrew House for providing me with this project and some advice, and for anyone else who has provided me with information or ideas throughout this project.

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Effect of Compressive Strength on the Behaviour of GFRP Reinforced Hollow Concrete Columns

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Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Allan Manalo
Mr Omar Alajarmeh

Keywords: GFRP, Compressive Strength, Columns.

1. Introduction

Concrete compressive strength is an important factor in the design of concrete columns and structures. This research aims to experimentally investigate the effect of change in the concrete compressive strength on the behaviour of hollow concrete columns reinforced with Glass Fibre Reinforced Polymer (GFRP) bars and spirals when subjected to axial compressive loading.

2. Background

Hollow concrete columns are desirable in construction due to their high strength-to-mass ratio (Lignola, Nardone, Prota, De Luca, & Nanni, 2010). Due to limited concrete cover however, steel reinforcement is prone to corrosion, leading to loss of strength in structures. To solve this issue, GFRP reinforcement is proposed as an alternative to steel internal reinforcement. However, it is important to have a detailed understanding on how different design parameters such as concrete compressive strength affects the overall behaviour of hollow concrete columns reinforced with GFRP bars.

3. Methodology

This research was conducted experimentally through the compressive testing of four (4) hollow concrete columns of 1m height, 250mm outer diameter and 90mm inner diameter. Columns with compressive strengths ranging from 21.2 to 44.0 MPa were tested as shown in Figure 1 (left). All columns were reinforced longitudinally with 6-16 mm diameter GFRP bars and transversely with 10 mm spirals spaced at 100 mm on centres.

4. Key Outcomes

All hollow columns failed due to spalling of the concrete cover, with secondary failure occurring in the transverse spiral reinforcement. The 44.0 MPa column sustained the highest load at failure of 1880 kN, while the column with the lowest concrete compresive strength of 21.2 MPa sustained the lowest failure load of 916 kN, as shown in Figure 1 (right). The increase in concrete compressive strength also resulted in increase in axial stiffness of the column.

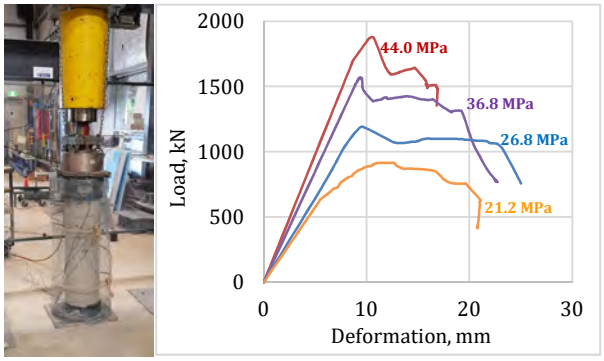

Figure 1 – Column test (left) and load-deflection curve (right)

5. Further Work

Further work includes analysing the test parameters, including the effect of compressive strength on the stiffness, ductility, and confinement efficiency of the hollow concrete columns. Subsequently evaluation and comparison with existing theoretical models will be also conducted.

6. Conclusions

Initial analysis of the test results indicates that change in compressive strength affects the load capacity and failure mode of GFRP reinforced hollow concrete columns. An increase in concrete compressive strength (f'_c) was associated with an increase in failure load and axial stiffness.

Acknowledgements

I would like to thank the technical staff at the Centre for Future Materials for their assistance in the experimental component of this research. Additionally, I would like to thank V-Rod Australia for supplying the GFRP bars.

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Cryogenic Temperature Measurement for LNG Loading

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Hons) Electrical and Electronic

Supervisor: Catherine Hills, USQ

Keywords: Instrumentation, Natural Gas, Hydrocarbons

1. Introduction

Chevron's recently operational Gorgon Gas plant on Barrow Island loads hundreds of LNG ships per year each averaging around 180m3. The LNG is pumped from the storage tanks and onto the ships through the LNG loading arms. When there is no ship being loaded through the loading arms they heat up to ambient temperature which can be more than 50˚C. To initiate loading the operator must manually introduce LNG into the arm via a hand control valve ensuring that they do it slow enough for the boil off gas to cool the arm as it is filled. If the arm is cooled down too fast there can be thermal shock and differential cooling resulting in split seals and hydrocarbon leaks. Currently there is limited temperature measurement along the arms, so the operator does not have an accurate idea of what the cooling profile is. This paper explores the development of a cryogenic temperature measurement system that is non-intrusive to the current process and an installation which is hazardous area rated to assist operations personnel to safely and efficiently cool down an LNG loading arm during ship loading.

2. Background

Natural gas liquefaction is a proven development concept which allows gas resources to be monetised by connecting the supply with markets in a flexible manner. The key to the LNG value chain is transport of the high energy density fuel to markets by a dedicated fleet of ships. The safe and efficient loading of these ships is crucial to the success of the business. This project is important in developing a post construction solution to an operational safety risk and process optimisation.

3. Methodology

Temperature data was gathered from two marine loading arms during the cool down of the vessel 'LNG Barka'. This data was used to develop a temperature profile of the arm during cooldown and identify areas which could be optimised to save time during cooldown. Current sensor technologies were researched and assessed for site compliance and measurement accuracies. A major aspect of this assessment was the hazardous area rating, non-intrusive installation and site integration.

Figure 1: Transmitter and Wireless Gateway

4. Key Outcomes

Temperature profile data was successfully taken across multiple arms during a load this helped to build the scope for selection of measurement system, site requirements and Australian stardards were assessed to ensure compliance. It was interesting to discover that there would be limited options for measurement due to hazardous area zoning and that only few manufacturers attained such accreditations. The dynamic movement of the loading arm also posed a challenge overcome.

5. Further Work

Remaining project tasks include the purchase of hardware, construction and implementation on site. Restrictions due to budget and delays for approvals to implement through the engineering management of change process meant the purchase and installation were not viable in the given time frame.

6. Conclusions

The key conclusion for this project is that the problem could be solved by the implementation of hazardous area rated temperature instruments utilising a WirelessHART mesh network communications (Figure1).

Acknowledgements

I would like to thank my supervisor Catherine Hills for her constructive feedback and guidance throughout this project.

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Soil Physical and Chemical Properties as Effected by Long Term Land Application of Paunch

Sponsors – Oakey Beef Exports Pty. Ltd. & National Centre for Engineering in Agriculture (NCEA)

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Bachelor of Environmental Engineering (Honours)

Supervisors: Dr Dio Antille (NCEA)

A/Prof. Bernadette McCabe (NCEA)

Keywords: Paunch, soil quality, fertiliser

1. Introduction

The red meat processing industry results in a significant number of different by-products and animal wastes. One of these by-products is paunch; the stomach contents of the animal after slaughter. Currently, many abattoirs are investigating methods of recycling and utilising paunch waste as a useful and profitable material (Bridle & Hickney 2013).

This project aims to address the knowledge gap regarding the physical and chemical effects of adding paunch to soils. It will do so by quantitatively investigating key soil quality indicators and determining the overall net effect of long term paunch application.

2. Background

The main use of paunch is currently as a product for domestic gardens where the paunch is mixed with other bulking agents and sold as either bulk soil conditioner or bagged compost (McCabe et.al 2016). Paunch contains a high level of organic matter and other nutrients essential for plant growth. Some abattoirs compost paunch on site and apply it directly to agricultural land, however little is understood about optimal application rates, composting periods or the quantifiable benefits of applying paunch to the soil (McCabe et.al 2016).

3. Methodology

In order to address the knowledge gap, soil quality indicators including soil bulk density, moisture content, aggregate stability, soil hardness, saturated hydraulic conductivity, salinity (EC), soil organic matter, pH and texture will be determined. Collected via a soil corer, the samples are tested down the soil profile in 20cm increments up to 80cm. Four sites owned and managed by Oakey Beef Exports Pty. Ltd. were chosen for the comparison. Site 1 and site 2 had paunch applied for 3-5 years, site 3 for 20+ years and site 4 is a control site which has not had paunch applied. Please see Fig. 1.

Figure 1 – Test site locations, Oakey QLD (Google Earth, 2018)

4. Key Outcomes

Thus far, samples from all sites have been collected and much of the analyses have been completed. Data analysis is currently underway to investigate soil health and therefore the overall effect paunch has on soils.

5. Further Work

Soil chemical tests are yet to be completed in order to fulfil the objectives of this project. Once complete, further work should be conducted to optimise application rates and methods of paunch application.

6. Conclusions

The limited amount of knowledge currently available on the effects of long term paunch application justifies the need for this project. If found to successfully improve soil quality and health farmers will gain access to an affordable soil amendment and abattoirs will be able to create a further income source.

Acknowledgements

I would like to thank Oakey Beef Exports Pty. Ltd. and NCEA staff. I would also like to thank my supervisors Dr Dio Antille and A/Prof. Bernadette McCabe.

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Long-term Flexural Performance of Epoxy-coated GFRP Composite Laminates

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Bachelor of Engineering (Honours) (Civil)

Supervisors: Assoc Prof Allan Manalo,

Ms Mojdeh Mehrinejad

Keywords: GFRP laminates, flexural durability, epoxy-coating

1. Introduction

The use of fibre-reinforced polymer composites has risen in popularity for civil infrastructure. Among them, the glass fibre-reinforced polymers (GFRP) have gained mainstream acceptance due to its low production cost, high strength and stiffness to weight ratios, high corrosive resistance and low density compared to conventional steel or aluminium.

2. Background

In civil engineering application, GFRP composites are exposed to high moisture and temperature (Manalo et al, 2017). On the other hand, epoxy resin is known to possess superior mechanical properties and durability characteristics. The focus of this comparative research is to better understand the significance of coating GFRP with epoxy in enhancing its long-term flexural behaviour under these accelerated environmental conditions.

3. Methodology

An extensive experimental program was implemented to evaluate the long-term flexural performance of epoxy-coated GFRP composites, which can be divided into the following:

- ***Specimen preparation:*** A total of 54 GFRP coupons were cut longitudinally and transversely to the desired dimensions. Half of the sample size were then covered with an epoxy resin mix.
- ***Conditioning:*** GFRP samples were placed for 1000, 2000 and 3000 hrs in an environmental chamber and exposed to an RH of 98% and temperature of 60°C.
- ***Flexural test:*** Three-point static bending test was implemented following the ASTM D790 to evaluate the flexural property of coated and non-epoxy coated GFRP composite specimens.

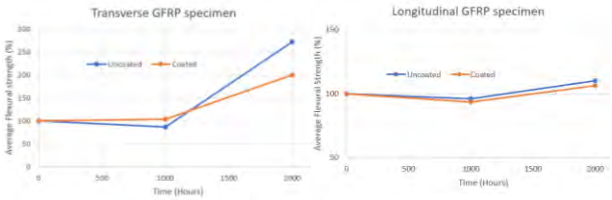

Figure 1 – Average strength for coated and non-epoxy coated GFRP specimens at 0, 1000 and 2000hrs. (right – longitudinal, and left – transverse GFRP laminates)

4. Key Outcomes

Figure 1 illustrates that epoxy-coated transversely cut GFRP specimens retained better properties than the longitudinally cut GFRP specimens. This is due to the fact that it is governed by the resin matrix instead of the individual glass fibres. After 2000 hours, non-epoxy coated GFRP laminates underwent a 'curing' stage due to the heat which temporarily improved the resin matrix bonds within the GFRP laminate.

5. Further Work

Microscopic observation still needs to be conducted to determine the types of failure exhibited by the GFRP composite samples. A prediction model will also be generated based on all test results. In addition, further study can be done on the characteristics of epoxy coated composites under long-term UV ray exposure.

6. Conclusions

The following are the main findings from the results of the preliminary exposure test and mechanical testing:

- Transverse: epoxy-coated GFRP laminates retained their properties by up to 200% while uncoated retained 270% after 2000 hours exposure test.
- Longitudinal: non-epoxy coated GFRP laminates retained 110% whilst epoxy-coated GFRP only retained 106% after 2000 hours of exposure.

Acknowledgements

I would like to thank my supervisory team for their patience, constructive feedbacks, guidance and assistance throughout this project.

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Terrestrial Laser Scanners and its applications for pavement conformance in accordance to Roads and Maritime Services QA Specifications G71 – Construction Surveys

School of Civil Engineering and Surveying

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Bachelor of Spatial Science (Honours) (Major in Surveying)

Supervisor: Dr. Zhenyu Zhang, USQ

Keywords: Terrestrial Laser Scanner, Pavement, Conformance.

1. Introduction

This dissertation investigates the use of terrestrial laser scanners (TLS) for its use on pavement conformances and if they comply with Roads and Maritimes Services (RMS) Quality Assurance Specifications G71 – Construction Surveys (G71).

2. Background

The significance of this study is to test various TLS, performing several construction activities, to ascertain if they comply with current government specification. TLS will be used to conduct pavement conformances and tested against orders of accuracies defined in G71.

3. Methodology

A stretch of road was assessed and chosen to perform all field work. Once chosen, a total station was used to survey the surface to create a control sample, utilising a grid system. Two TLS and two multi-stations were then used to scan the same surface and a pavement conformance report was adopted to test the scanned surfaces against the control for any variances in the delta heights.

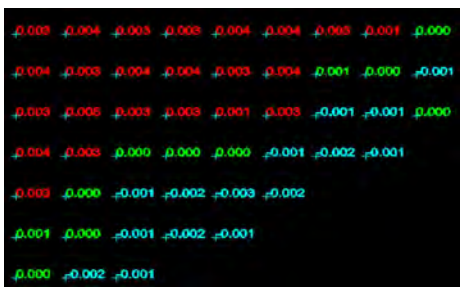

Figure 1: sample pavement conformance grid system

4. Key Outcomes

The results shown in the pavement conformance reports demonstrated strong evidence that all insturments tested meet all tolerances specified in G71.

5. Further Work

Trialling additional TLS to obtain a wider testing sample to build a stronger case to the research.

6. Conclusions

By testing the TLS against the Total stations, the results show that a TLS can meet the tolerances specific in G71 and are a viable tool for surveyors and conforming road pavements.

Acknowledgements

I would like to thank Dr. Zhenyu Zhang for his knowledge and guidance. I would like to thank Joshua Brown (UPG Solutions) for allowing the use of the Trimble SX10 and TX6 in this dissertation. Paul Connolly (RMS) to allowing the use of the Leica C10 and MS60.

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Guardian Angel: Reactive Wearables and Clothing

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours)
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Supervisors: Dr Andrew Maxwell, USQ

Keywords: Wearable Technology, Smart Clothing, Integrated Textiles, Lone Worker Safety.

1. Introduction

Workers operating in isolated or remote locations away from the public and without co-workers and/or constant supervision are at an increased risk from situational or environmental hazards with the potential to sustain serious and fatal injuries. With the recent popularisation of wearable technology and the ability for a wearable device to actively and intelligently monitor the status of a worker, it has become a growing interest for businesses to adopt this technology for the purposes of monitoring and improving the safety of its lone workers.

2. Background

Wearable technology has the inherent advantage of being able to offer continuous monitoring of physiological and environmental parameters and can provide real-time feedback on the current conditions of the worker and their environment. According to the preliminary work health and safety statistics published by Safe Work Australia (2018), it has been estimated that there were 187 work-related fatalities reported in 2017. In 2016, the number of reported fatalities was 182. Wearable technology has the advantage of being able to automatically assess the status of the worker and intelligently react to situations where the worker has become injured and is unable to contact for support.

3. Methodology

Much of the research conducted in this project has been based around the design and development of a physical prototype following a comprehensive literature review and detailed requirements analysis. The design can be broken into two key areas. The first is the hardware electronics design which includes the selection of a suitable microprocessor, power supply, physiological and environmental sensors, and the integration of these components into simple clothing or textiles. The second key area is the software implementation which is responsible for the collection and analysis of the data from the sensors as well as the activity classification which forms the basis of the decision support platform. Figure 1 above shows the high-level data flow diagram of the software implementation.

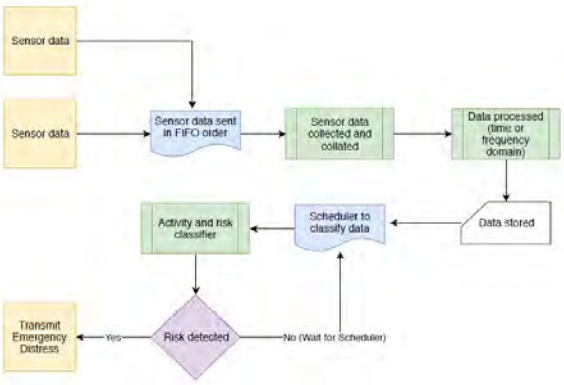

Figure 1 – A high-level software data flow diagram showing how the data will be collected, processed, and then analysed.

4. Key Outcomes

The primary outcome of this project is to explore and assess the feasibility and practicality of using wearable technology for the purposes of monitoring and improving the safety of lone workers. The outcome of the prototype design is to collect heart rate and accelerometer data from sensors integrated into simple clothing and then analyse this data as part of a classification system used to assess the safety status.

5. Further Work

Given the time constraints of the project, only a basic analysis has been performed into the sensor selection and activity and safety classification modelling. There is an opportunity therefore for further research to be conducted into optimising the sensor selection and comparing other alternative classification algorithms.

6. Conclusions

Wearable technology can be used to improve safety through unobtrusive monitoring using integrated textiles that is both practical and comfortable for lone workers.

Acknowledgements

I would like to thank my supervisor Dr Andrew Maxwell for his assistance and to my family for their continued patience and support.

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Wind power study for mining and rail solar communications sites in the Pilbara, Western Australia

Sponsor – School of Mechanical and Electrical Engineering

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Supervisor: Mr Andreas Helwig, Senior Lecturer (Electro-Mechanical Engineering) of the School of Mechanical and Electrical Engineering, University of Southern Queensland

Keywords: Wind, Solar, Batteries.

1. Introduction

There are many remote solar communications sites like those in figure 1 that support mining and rail operations in the Pilbara region, Western Australia. The reliance on reliable communications is increasing with the move to fully automated haul trucks, drill rigs and locomotives. This communications infrastructure often has no connection to mains power and relies entirely on solar PV generation with battery storage. Power failures are common at sites in extended periods of heavy cloud cover. These power failures can cause major interruptions to the mining and rail operation.

2. Background

There is a perceived problem that is solar power alone is not always enough to maintain sufficient charge for the batteries to power these sites 24 hours a day, 7 days a week.

3. Methodology

- Conduct a literature review.
- Measure and analyse available wind resources.
- Model and compare wind and PV generation.
- Determine the best power solution for off grid mining and rail communications infrastructure.

4. Key Outcomes

Determine if the addition of wind generation will reduce site power failures and investigate if the wind turbulance created by a passing locomotive can generate a useable amount of electricty for charging solar site battery banks.

Figure 1 – Typical Pilbara Rail communications site (Rio Tinto KP170 | Jayde Potts, 2017)

5. Further Work

It is unlikely the full cost of maintaining wind turbines will be understood by the end of this research project.

6. Conclusions

There is sufficient wind resource to generate a useable amount of electricity which may extend the battery backup time in periods of reduced solar capacity. However a healthy battery bank sized correctly should be able to maintain sufficient charge to the batteries throughout heavy cloud periods.

Acknowledgements

I would like to thank my USQ supervisor Mr Andreas Helwig for reviewing my work and his constructive feedback. Mr Robin VanStaden, Principal Advisor, Rio Tinto for giving me the idea for this project and assisting with time and resources. Greg Greber, Technical Advisor, Rio Tinto (retired), Rob Howes, Communications Engineer, Titan and Nicolas de Sancha, Engineering Manager, Bitlab for providing me with valuable technical support throughout the project.

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Development of an Asphalt Pavement Quality System

School of Civil Engineering and Surveying

Jay Power

Bachelor of Construction Management

Supervisor: Nateque Mahood, USQ

Keywords: Asset Management, Quality, Asphalt

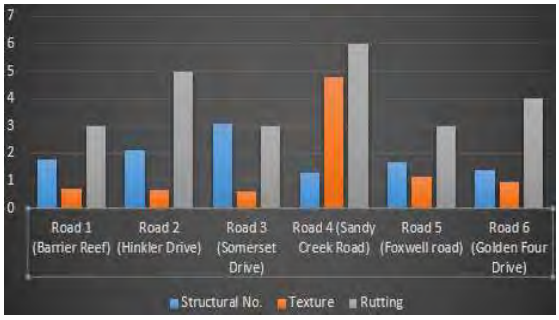

Fig 1: Pavement Case study – Results of Field Tests

1. Introduction

The Development of the Asphalt pavement quality system is a requirement of the City of Gold Coast council to improve the implementation of the quality standards that are required within the Asphalt construction division. There is currently a Quality system in place within the City Assets branch although with the amount of non-conforming pavement works that have been performed, along with numerous cases of early fatigue and failure there is a need for a redevelopment of the quality system is required to help resolve the issues found throughout this study. As an implementation project there has been an analysis of the current quality system along with a procedure manual and standard specification as part of the Councils Land Development Guidelines which majority of the works performed are to comply with these guidelines.

2. Background

The City of Gold coast have a large amount of Asphalt resurfacing and sealed roads spanning the length and width of the Gold coast region with approximately 3320 kilometres of sealed roads with the remainder of unsealed roads to take care of in the program each year. Every new project within each yearly program adds to the current network, making the process of maintenance and re-sealing a challenge to be performed with a slightly increased budget allowances. This is a challenge that most local government organisations face on a yearly basis with the task of evaluating the requirements along with prioritising the defects accordingly to assign a program of works that best fits the needs of the local network and also meeting the need of the community.

3. Methodology

The objective of this research is to formalise the Quality Assurance process to aid in the decision making process all the way through to the placement and construction of the product with the inclusion of the maintenance processes required. The Quality assurance is a way of preventing any defects to the process with a system designed to deliver solutions to mitigate any of the known factors of failures in the Asphalt pavement process. The PaveMax Quality System will help to remove these by utilising the whole of life cycle cost model, revised specifications, process charts and integrated problem resolutions with a detailed explanation of the asset failures that have been monitored in the case study (Figure 1).

4. Key Outcomes

There has been a number of roads analysed throughout this study with has shown the shortfalls in the quality assurance around the placment and construction phase. To mitigate this there has been a complete restructure of the process proceedure with inclusion that implement hold point where nessisary and a structure that will categorise different road constructions into levels of inspections required.

5. Further Work

The implementation of the Quality system will be introduced into the Asset management process and will be an integral part of the pre-planning process.

6. Conclusions

This study will aim to formalise the whole of life costing within the asset management section. This tool and associated structured process will make sure a lot more accountability will be placed on the inspectors to ensure that council receives a quality product that will endure the design life appointed.

Acknowledgements

I would like to thank the City of Gold coast for the ongoing support through this process. Nateque Mahood for supervising me through this subject with support when required and most of all my wife Lynne for the ongoing reassurance and support which helped to keep me motivated throughout the whole course.

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Model an Inverter with demand response capability aligned with the framework detailed in AS 4755.1:2017 using DigSILENT PowerFactory software

Faculty of Health, Engineering & Sciences

Asis Ram

Bachelor of Engineering Honours

Supervisors: Dr Andrew Hewitt, USQ

Mr Phil Hanson, Energy Queensland Ltd

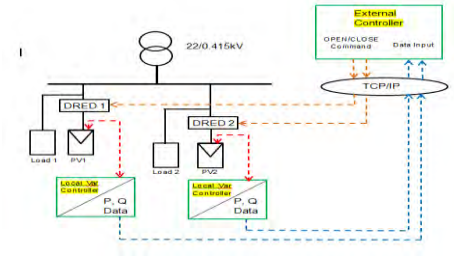

Figure 1 schematic diagram of proposed model

Keywords: Photovoltaic, Inverter, PowerFactory

1. Introduction

Our governments are under pressure to solve the energy crisis of today and into the future by investing in cleaner sources of energy. Distributed Generation (DG), particularly Photovoltaic (PV) systems, provide a means of mitigating these challenges by generating electricity directly from sunlight [2]. In 2015, the Australian Government settled on reforms to the Renewable Energy Target (RET) by setting the target for large-scale generation of 33,000 GWhr by the year 2020. This would result in about 23.5 per cent of Australia's electricity generation coming from renewable sources by 2020 [3].

2. Background

Studies have shown that the presence of DG can cause undesirable voltage rise in low voltage (LV) networks [1]. Implementation of voltage rise mitigation on LV networks, which is transferred back to HV feeder networks via distribution transformers, is more important than ever.

3. Methodology

A basic inverter control model is presented. Initially, the model simulates the network with the PV inverters performing local voltage control. Under this arrangement, the inverter acts in isolation to control the connection point voltage by reactive power injection/ absorption. The control system is then augmented through the use of a remote control device located at the supplier substation, as shown in Fig. 1.

4. Key Outcomes

A PowerFactory model has been developed to simulate the practical integration of PV injection systems into a low voltage distribution network. This model allows for steady state simulation of the network for varying load and generation profiles. It also provides insight into the system stability when the integrated PV inverters operate to locally control the network voltage.

5. Further Work

The external controller model has been designed which accepts data from the PV inverters and the panels. Once the local controller voltages are outside the regulated limits, the external central controller will issue commands to the Demand Response Enabled Inverters (DRED). The integration of the external and local controllers is still under development.

6. Conclusions

It has been shown by the PowerFactory model that rise of voltages at the customers PV inverters can be controlled within statutory limits when inverters act in isolation using reactive power control.

Acknowledgements

I would like to thank Energy Queensland for providing the research topic, and Mr. Phil Hanson for guidance in the use of PowerFactory. Dr, Andrew Hewitt has provided guidance and the idea of local voltage control.

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PRACTICAL APPLICATIONS OF LOW COST WATER LEVEL GAUGES IN FLOOD EARLY WARNING SYSTEMS

Water Modelling Solutions

Mitchell Redenbach

Bachelor of Engineering Honours (Civil) (BENH)

Supervisors: Ms Justine Baillie, USQ
Wendy Carlisle, Water Modelling Solutions Pty Ltd

Keywords: Flood Early Warning System, Hydraulics, Hydrology

1. Introduction

Flood forecasting provides valuable insight into potential flooding events yet weather systems have the potential to change without warning. This research project evaluates the possibility of designing a Flood Early Warning System using only empirical evidence, that is water level, with the key objective of minimizing incorrect flood predications.The flood warning system has been designed for Jondaryan and Oakey.

2. Background

This research further addresses a clear gap in the literature regarding the high-cost associated with designing a flood warning system by utilizing an inexpensive gauge to evaluate the implications and the possibility of create a cheap, affordable and accurate Flood Early Warning System (FEWS). The literature has shown a system such as this is only applicable to creek flooding and would not be applicable to areas prone to flash flooding (Hardy et al, 2016).

3. Methodology

The flood warning system is a combination of a General Electric pressure transducer coupled with an AEGIS data logger to store and send data. The gauge has been tested in numerous scenarios including stationary water height, simulated slow onset creek flooding and fast onset creek flooding. The Jondaryan XP-Rafts hydrologic model has been validated against the Regional Flood Frequency Analysis online tool as well as the 2013 GHD flood study commissioned by Toowoomba Regional Council. The Jondaryan hydraulic model has been developed from scratch and calibrated to the same 2013 GHD flood study.

4. Key Outcomes

Results from the gauge testing and 2D hydraulic models show that it is possible and practical to create a FEWS with a low cost gauge. Table 1 shows the gauge was tested to be accurate within 2cm and have a response to the triggering level of 2 minutes. The hydraulic model provided an accurate representation of creek flooding and allowed water level analysis to correspond upstream heights with downstream breaches. It has been discovered that this FEWS would only be applicable to towns where there is one main body of water passing through with a long narrow catchment.

Table 1.

Actual Height (mm)	Gauge Height (mm)	Difference (mm)
750	730	-20
1000	980	-20
1250	1230	-20
1500	1482.5	-17.5
1750	1730	-20

5. Further Work

Additional gauge works includes installing a test site to monitor how the gauge responds to infield scenarios. This is unlikely to be completed for this research project due to the creeks being seasonal.

6. Conclusions

It is possible and practical to install low cost FEWS's based solely off water levels. This would provide an accurate warning of flooding while reducing the spread of misinformation which leads to complacency.

Acknowledgements

Wendy Carlisle and Blake Boulton, Water Modelling Solutions Pty Ltd
Justine Baillie, Project Supervisor, USQ

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How to Represent a 3D Cadastre in the NT

Sponsor – Northern Territory Government, Department of Infrastructure, Planning and Logistics

Dan Reimers

Bachelor of Spatial Science (Honours) Surveying major

Supervisors: Chris McAlister, USQ

Keywords: 3D Cadastres, Data Models, complex multi-storey developments.

1. Introduction

Traditionally, when people purchase property there is a need to know where and how much land they have purchased. This knowledge comes in the form of a 2D cadastral survey plan. However, in more recent times, as technology advances and population densities increase, multi-storey developments are becoming more and more common and when people purchase these types of properties (or parts of these properties) the traditional 2D cadastral survey plan is not adequately defining all the Rights, Restrictions and Responsibilities involved with each parcel. This thesis is a research project that will define a 3D cadastral system, outline the benefits of such system and advise the NT Government of possible pathways forward to achieving a true 3D Cadastral system.

2. Background

Rajabifard (2014) states "*it is no longer just about land; it can be expected that in the future, the majority of lots created will be associated with vertical developments".* Figure 1 shows an example of the current 2D digital cadastral database and it will be shown in this thesis how this system is inadequate for complex multi-storey developments.

3. Methodology

A process was developed of firstly explaining the current 2D system and showing how this system is inadequate. Research was then used to explain a true 3D cadastral system and how such a system could benefit the NT. The final chapter of the thesis advises the NT Government on the best way forward to achieve a true 3D system, taking into account a number of different factors.

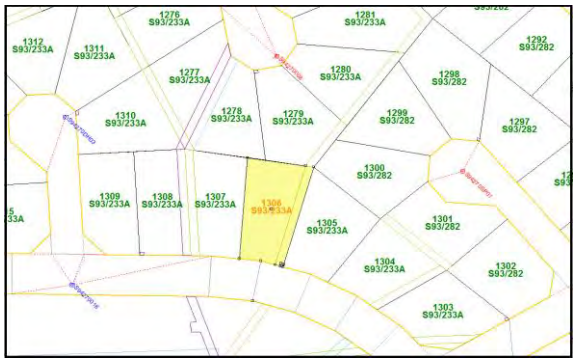

Figure 1 – Current 2D Digital Cadastral Fabric of parcels

4. Key Outcomes

This thesis defines a true 3D cadastral system, in terms of Characteristics, Requirements, Benefits and Issues. There is a focus on the Northern Territory as key improvements and opportunites are outlined and the major outcome of this project is providing advice to the NT Government on the best pathway forward to achieve a 3D cadastral system for the NT.

5. Further Work

More testing of other 3D cadastral programs is needed to find strengths and weaknesses of each application.

6. Conclusions

It is now clear that the land registration system needs to incorporate heights to be a true 3D system and properly define the RRR's involved with complex multi-storey developments. This thesis has provided advice to the NT Government on how such a system can be achieved.

Acknowledgements

The Author would like to thank his employer, the Northern Territory Government for the provided support and assistance, in particular the former and also the current Surveyor-General of the NT.

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A study of the accuracy of oblique image capture in UAV Photogrammetry compared to vertical image capture

Sponsor – School of Civil Engineering and Surveying, USQ

Andrew Roberts

Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr Kithsiri Perera, USQ

Keywords: Oblique, Accuracy, UAV.

1. Introduction

Oblique angle photogrammetry has the potential to capture near vertical survey data which vertical (nadir) image capture may have missed (Fenney, 2016). Studies have identified the accuracy benefits of utilising both vertical and oblique image capture (Chiabrando, Lingua, Maschio, & Teppati Losè, 2017). Studies into the effect of varying the angle of oblique image capture on Digital Elevation Model (D.E.M) accuracy are limited.

2. Background

This project is important as it investigates which oblique image capture angle results in a more accurate digital elevation model where abrupt vertical surfaces are present. The project extends the knowledge and practice of UAV photogrammetry in Surveying by quantifying errors relative to the distance from abrupt vertical surfaces.

3. Methodology

In this study, multiple UAV photogrammetry missions of cubic targets located on a netball court were undertaken at 30m above ground level, slow speed (0.81m/s) and high overlap (90%). Each mission was undertaken at either 80°, 70° or 60° image capture angle. Check points were measured at 100mm increments radiating out one metre from the edge of the cubic target utilising a total station. Twenty ground control points evenly spaced around the site were also measured by total station. Each mission's images were reduced using Agisoft Photoscan set to the highest accuracy setting allowable with available computational power. A digital elevation model (D.E.M) was created for each angular mission and exported to Virtual Surveyor software for analysis of checkpoints. The X and Y coordinates of checkpoints were inputted into Virtual Surveyor and the resulting D.E.M Z values for those points were exported and compared to the known surveyed Z values. The resulting error in Z values for each angle were graphed as can be seen in figure 1.

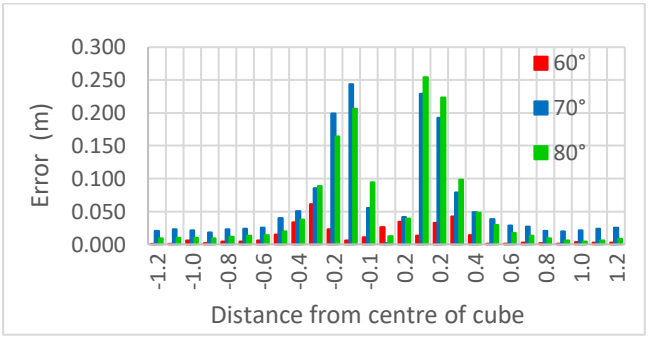

Figure 1: Error in Z value relative to distance from centre of cube 60°, 70° and 80° image capture

4. Key Outcomes

One key outcome is that 60° oblique angle image capture produced the D.E.M with the highest accuracy at a height of 30m above ground level. A second key outcome is that high accuracy D.E.M's are achievable with a consumer grade UAV.

5. Further Work

Undertake further UAV photogrammetry missions at a flight altitude of 10 metres AGL to confirm the test results of 30m AGL.

6. Conclusions

60° oblique image capture provide a more accurate representation of a topographical surface with abrupt changes in elevation, when compared with 70° (oblique) and 80° (Nadir) image capture.

Acknowledgements

I would like to thank Dr Kithsiri Perera for being my Supervisor for this project after Dr Chong's withdrawal due to illness.

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A Sustainable Approach to Single Lot Residential Stormwater Disposal

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Supervised by:

Mrs Justine Ballie, USQ.

Keywords: Infiltration; Hydrological; Urban stormwater; Kinematic wave equation.

1. Introduction

The impacts of increased impervious or "hard-stand" areas due to urbanisation are numerous and broad ranging. The increase in impervious areas results in

> *"…changes in the characteristics of the surface runoff hydrograph, increasing stormwater runoff volumes and peak flows."*
>
> (Barbosa et al. 2012)

This research project focussed on quantifying the hydrological alterations related to a single residential development, to determine the magnitude of the impact and identify more sustainable management practices that could be implemented at such a scale.

2. Background

Stormwater management is vital to protect and enhance development and ensure the health and safety of the public. Older drainage-efficiency philosophies generally gave no thought to other components of the hydrological cycle. Since the mid-1980s approaches have been aimed at improving environmental, social and economic outcomes, yet little documentation exists quantifying alterations associated with a residential lot.

3. Methodology

This project developed numerous one-dimensional models, based on the Kinematic Wave Equations, to determine pre/post development peak discharge and infiltration from a typical residential site. Following verification of a 'base' model, eleven models were adapted to a storm duration, ranging from five minutes to two days. Each model can alter the design storm event from a 12EY (exceedances per year) to a 1%AEP (annual exceedance probability) storm. Additionally, the models cover three different soil types and three different topographical (planar) configurations – slope.

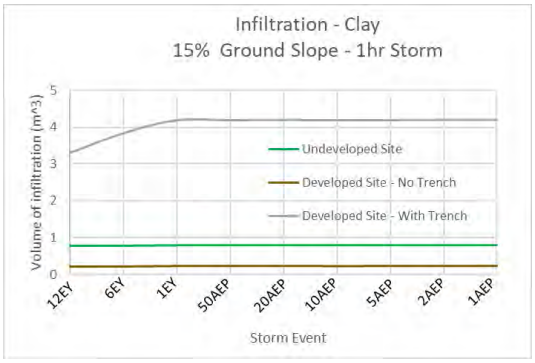

Figure 1 – Infiltrated volume

4. Key Outcomes

The reduction in infiltration for sand, gravelly clay and clay sites without forced infiltration was 60-80% in the developed state. As expected the largest variations were observed for clay soils with an increase of 400-560% for durations up to 2 hours. Longer, larger magnitude storms returned the smallest fluctuations in the order of 40-200% increases.

Regardless of the design storm, there is a minimum three-fold increase (up to 425%) in the infiltrated volume when an absorption trench is used on clay sites with a 15% slope (refer to Figure 1). Conversely, where direct discharge is employed, infiltration is reduced by 72% to less than 0.25m^3, for a one-hour storm event.

5. Further Work

The remaining work required is to optimise the disposal approach, dependent on the soil type, to best reflect the pre-developed water balance for a single residential site.

6. Conclusions

By utilising a combination of options including: detention; infiltration and; direct discharge, stormwater disposal for single residential development lots can be more sustainable than many current practices achieve.

Acknowledgements

Thank you to my supervisor, Mrs Justine Baillie, for all your support and guidance and to my partner Candice Keane for all your support, understanding and patience.

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Energy Efficiency through Home Automation

School of Mechanical and Electrical Engineering

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Bachelor of Engineering Honours
(Power Engineering)

Supervisors: Dr Les Bowtell, USQ
Mrs Catherine Hills, USQ

Keywords: Energy Efficiency, Home Automation, Control System

1. Introduction

Domestic energy consumption is the largest concern amongst electricity consumers with 81% of Australians being concerned by power price increases (Ibrahim,2017). Some consumers go to great lengths to reduce their quarterly electricity bills by finding cheap and effective energy saving measures. Employing energy saving measures is not a new concept but opportunity presents itself to reduce the home energy bill with the rise of automation being installed in domestic installation.

This project targets the 10 to 30% of the average domestic energy bill which is consumed by "standby power" used by appliances not turned off at the outlet and the ineffective use of appliances (Australian Government,2013). The design and implementation of a cost effective electrical control system was completed with the aim of determining the feasibility of such an installation for reducing domestic energy consumption.

2. Methodology

After selection of a domestic installation, electrical loads, load usages and electrical circuits were identified with selection of key domestic circuity for control chosen. A weekly consumer "load profile" was produced where load control would switch on and off as required through electrical control. An electrical control system was then designed as per AS3000:2007 (Standards Australia, 2007), including appropriate electrical switchgear, a programmable logic controller (PLC) and human machine interface (HMI) as shown in figure 1. Both the PLC and HMI were programmed and commissioned as per consumer load profile with manual parameter setting (on/off time adjustment) and manual circuity bypass added.

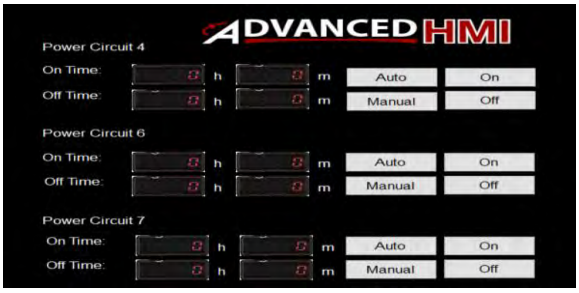

Figure 1 – Human Machine Interface Design

3. Key Outcomes

This investigation intends to quantify potential energy savings for a domestic consumer using a load profile based electrical control system. This investigation will be undertaken within Energy Audits AS/NZS 3598.1-2014 (Standards Australia,2014) and will investigate the feasibilty of the design and identify its "payback period". A design that is cost effective, saves 10-15% energy consumption of controlled loads compared to non-controlled, easily manipulated by the consumer and be free of any safety concerns will be considered a successful design.

4. Further Work

Assuming the project design produces viable results, production of a generic design will be produced that could be used on other domestic consumers. Testing on a wide range of consumers will ensure the product will be viable in a mass market. Furthermore, development of a portable HMI system, possibly accessible via a smart phone for increased ease of use.

5. Conclusions

Predicted results upon initial testing show that there is potential to save the expected 10-15% of energy consumption and be viable as a control method. Whilst ease of use by a consumer needs to be refined, there is potential for the design being open to a mass market.

Acknowledgements

I would like to thank both project supervisors, Dr Les Bowtell and Mrs Catherine Hills as they were a great resource in idea generation, and project design.

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Investigation of the quantity of error caused by vegetation coverage with UAV

School of Civil Engineering and Surveying

Nathan Rudd

Batchelor of Spatial Science Honours (Surveying)

Supervisors: Jessica Smith, USQ

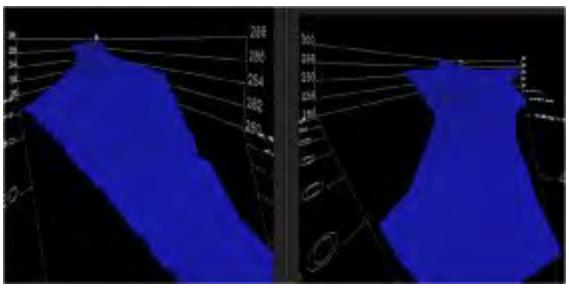

Figure 1 - Digital Terrain Models

Keywords: UAV, Vegetation, Error

1. Introduction

Unmanned Aerial Vehicles (UAV) are rapidly becoming more popular in the surveying industry. They are utilized to provide mapping information in support of development. Prior studies have aimed to verify the accuracy of the spatial data collected by a UAV. The results of these studies frequently highlight vegetation as a limitation of the research.

2. Background

Currently when collecting spatial data with a UAV to generate a DTM (Digital Terrain Model), irregularities or false heights that do not represent the actual terrain occur. Vegetation appears in the model as the ground and must be removed. This is not a problem for stand alone vegetation, the problem occurs when a model of a greenfield site is required and the grass/vegetation is high.

3. Methodology

A site was selected that is subject to a development application. The site has undulating and flat topography for a broad study area. The site was surveyed using traditional methods to determine the true ground levels and the top of existing vegetation on the site. The UAV was flown over the subject site to capture the terrain. The data was processed to generate a DTM. Figure 1 (above) displays the DTM generated by the UAV (Left) and traditional survey methods (Right). The models were compared to determine if the UAV can model a surface correctly that has vegetation.

4. Key Outcomes

This paper has researched background information on the UAV used in this study, the operational requirments and the expected accuracy outcomes. The paper has also reviewed the applications and use for UAV within the survey industry. For a conclusive answer to the problem the surfaces created with the UAV and the traditional survey method were compared using an Isopach. The isopach of the UAV followed closely to that of the vegetation surface measured with the total station.

5. Further Work

Finding a suitable method to create a correction for the UAV to model the true ground level accurately.

6. Conclusions

This project has conclusively found that the visible surface of vegetation is measured by the UAV. Any vegetation coverage over the ground will create an error above the true elevation of the ground virtually the same as the height of the vegetation.

Acknowledgements

I would like to thank the following people and companies for their support in completing this dissertation:

My supervisor Jessica Smith for guidance throughout the project period.

James McLellan from Peak Survey & Developments for taking the time to fly the drone for this project.

My employer North East Survey Design for allowing access to the surveying equipment and software required to complete this study.

Some helpful references to assess UAV accuracy for this study were Wang (2014) and Siebert (2014)

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Wave Gauge: Characterising Vessel Movements and their Erosive Components

School of Civil Engineering and Surveying

Brendan Ryan

Bachelor of Engineering (Honours) (Environmental)

Supervisors: Justine Baillie, USQ

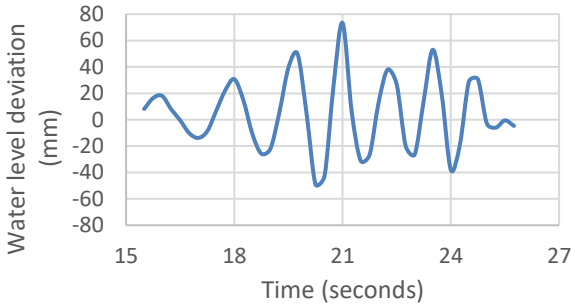

Figure 1 – Gauged wave profile

Keywords: Prototype, Riverbank erosion, Vessel wake

1. Introduction

Riverbank erosion causes the loss of valuable agricultural land, damage to infrastructure, increased sediment load, riparian vegetation loss and decreases in bank stability (Abernethy & Rutherfurd, 1999). It is suggested that vessel waves can accelerate the rate of riverbank erosion and therefore, require assessment when managing river health.

The research involves the development and testing of a Prototype Wave Gauge. This will record vessel waves to produce an output which categorises individual vessel movements and lists their respective erosive components.

2. Background

In 2017, the Murray Darling Basin Authority proposed a controversial ban on wake enhancing vessels within 49 km stretch of the Murray River, downstream of Corowa, NSW. The vessel movement data supporting the ban was collected visually on two weekends throughout the peak season. It was identified that there was a lack of strong data that specifically linked vessel usage to riverbank erosion. Thus, it was suggested that future management decisions could be better made with the use of a gauging tool that autonomously collects vessel movement data.

3. Methodology

Following extensive prototype development, the methodology was developed to critically analyse the performance and applicability of the Wave Gauge and its associated Processing Tool. Three vessels with contrasting type, length, power and weight were used throughout the research where variables such as speed, sailing line and direction were tested. A data output will list each vessel movement within the given time-period and detail its respective time of occurrence, maximum wave height, maximum period, maximum energy and its erosive score.

4. Key Outcomes

In the development of the Prototype Wave Gauge, several design options were investigated. Suprisingly, using an ultrasonic sensor for gauging the wave profiles was found to be suitable which had not been identified in any previous research.

5. Further Work

The Wave Gauge's ability to differentiate vessel types and speeds could be enhanced with more extensive testing of different vessel types. Further work could involve the development of a commercially viable wave gauging tool; this would have greater sensor accuracy, more advanced processing software and the ability for remote connection.

6. Conclusions

The Wave Gauge has been found to successfully measure vessel waves as seen in Figure 1. It produces an output that categorises the vessel movements, listing their respective erosive components.

Acknowledgements

Justine Baillie has been an exceptional help throughout the course of the project, her knowledgeable guidance has been greatly appreciated. Nicholas Marks was also a fantastic help with developing the Wave Gauge.

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Feasibility of Developing a Licensing Scheme for Fijian Contractors and Sub-Contractors

Faculty of Heath and Engineering Sciences

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Bachelor in Civil Engineering

Supervisors: Dr Vasantha Abeysekera

Keywords: *Licensing, Workmanship, Contractors*

1. Introduction

This paper researches on the feasibility of licensing Fijian contractors and sub-contractors. This project is important to ensure that contractors and sub-contractors involved in the construction boom are well equipped with managerial competence as well as skilful craftsmen. It builds on previous research conducted in developed countries and extracts information in line with Fiji's suitability.

2. Background

Fiji is a developing nation, with a strong growing construction industry. A strong construction industry is beneficial for national economic development.

A number of complaints have been raised associated with poor quality of workmanship, inferior quality materials and delayed project delivery by a number of contractors and clients in the local market. Gimmicks of some unscrupulous building contractors (Aguilar, 2017) continues to be a concern for the building sector.

There is no signal entity with the expertise to receive these complaints and provide mitigating solutions. There is also no policing on the level of craftsmanship that a person has and his ability to carry out works. This is an implementation project that aims to establish the feasibility of setting up a licensing scheme with respect to scope, form, structure and craftsmanship.

3. Methodology

Newspaper articles were collected to identify the key concerns facing the Construction Industry in Fiji. A literature review was undertaken to ascertain the existing licensing schemes. A review of how construction industry issues are addressed in developing countries was also carried out. The literature review raised a number of questions on how solutions that have been adopted abroad can be adapted to suit Fiji's work culture. It is important to find answers to these questions in order to provide a structured response to the issues facing the construction industry. These questions will be used to collect data from the industry professionals and workers. These data will be analysed to help draw conclusions for this paper.

4. Key Outcomes

Literature review identified that licensing schemes currently co-exist in the construction industry, however they are implemented by separate statutory bodies.

This study hopes to find credible data that will assist with the construction industry issues in Fiji. The key outcomes will be well documented subsequent to collection of data by questionnaires and personal interviews. This survey is critical in identifying the feasibility of this licensing scheme.

5. Further Work

A possible future study can be undertaken to research on the establishing a Fijian Construction Board to regulate all craftsmen, contractors and sub-contractors. Additional research on the level of training and accreditation provided by local institutions will also need to take place.

6. Conclusions

Hopefully, this study will conclude on the feasibility with respect to its suitability, acceptability, and implementability of this licensing scheme.

7. Acknowledgements

I would like to thank my supervisor Dr Vasantha Abeyesekera in helping me understand and analyse issues from different viewpoints. His experience and research papers has provided a good insight in my research work.

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Automating Processes for Cross-checking Plans and Invert Levels for Laying Drainage Mains on Grade

School of Civil Engineering and Surveying

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Bachelor of Spatial Science
(Surveying) Honours

Supervisor: Professor Kevin McDougall, USQ

Keywords: Automation, drainage calculations, mobile app creation and development.

1. Introduction

Drainage relates to water, sewer and stormwater infrastructure which is constructed as an asset for local water board authorities and local governments during land development. There are many different types of drainage pipe mains and in this research project gravity mains are the primary focus.

The aim of this project is to automate manual grade calculations by creating an Excel spreadsheet and mobile app which will minimise human error and result in increased company efficiency and improved quality assurance measures.

2. Background

Research into currently available software and mobile apps for drainage revealed a gap in functionality related to the calculations and checks made before and during construction. To ensure the quality of completed works, checks must be undertaken to ensure the work is within specified constructed tolerances as set out in the relevant standard or code.

3. Methodology

To help achieve the project objectives for this research an Excel spreadsheet was created through a design, build and evaluate process. Using this spreadsheet a mobile app was created by utilising a web based app creation program.

Figure 1 illustrates an example of the mobile app created.

4. Key Outcomes

Development of design and testing of an application for drainage calculations and identify potential limitations or further advancements in functionality.

Figure 1 – Mobile App for Drainage Calculations

5. Further Work

The design, building and evaluating process for the app is continuing to achieve a user-friendly app which will contribute to helping generate current and future improvements in the drainage industry.

6. Conclusions

Automation is achievable in relation to calculations and can have a positive impact on company efficiency and quality assurance which gives confidence to the users. If successful, the outcome of this research will fill a gap in functionality identified in currently available drainage apps and programs.

Acknowledgements

Thanks to Sagar Aher in which the idea to create an app and research into this area came from and Sands Civil Group for their input and support. Thanks to Kevin McDougall for his help, guidance and supervision.

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RSPEC and Pavement conformance analysis using a photogrammetric mapping system from a UAV

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Benjamin Sansom

Bachelor of Spatial Science (Surveying)

Supervisors: Zahra Gharineiat

Keywords: Photogrammetry, UAV, Conformance

1. Introduction

Technology in the field of surveying is constantly evolving. This evolution in surveying practices requires us to keep up to date with the new technological advancements' capabilities, limitations and ease of use. From EDM, to GPS and now to close range photogrammetry this dissertation looks to determine if we can use photogrammetry to undertake an RSPEC survey and develop the research further to gain an understanding of the accuracies involved and whether it is suitable for use in pavement conformance. This dissertation will also analyse if these accuracies are met in a time and cost effective manner.

2. Background

If successful in the capabilities of the UAV via photogrammetry this surveying technology could be included in the kit bag of a professional surveyor. Instead of having to walk with a staff and measure points with a total station, a UAV can fly a job site for you and via orthorectification programs produce point clouds accurate enough this could be a real advantage in certain surveying applications.

3. Methodology

It was decided to undertake my own research in the field. Testing was done, by undertaking a survey via traditional survey methods and then flying the same site with a drone using GCP's installed on the same datum as the traditional survey. Both methods were then compared against one another for accuracy comparison by comparing the point cloud surface generated from the UAV flight in Pix4d to the traditional method. By flying the site at 50m above surface level and 30m above surface level we can also determine if our flying height will affect our comparison.

Figure 1 – Flying the UAV onsite

4. Key Outcomes

Expectations are to get within the quoted accuracies of beween 0-50mm. I am hoping the research determines highers accuraies to be used in other survey applications. The most surprising outcome of the research was the ease of use of the drone flight programs and the accuracy of the drone flight photogrammetry point cloud. Aside from a coouple of outliers the point cloud surface was very close to the traditional survey method. The results are similar to those that are expected to be achieved from a GPS survey. The report needs further analysis and finalising as well as proper conclusions and findings taking confidence levels into account

5. Conclusions

Having undertaken a brief analysis of the findings I can conclude that the drone can replace certain surveying techniques but not all of them. Depending on the job requirements and the accuracies required this can replace traditional survey methods. Any survey that can be completed via GPS can be completed via UAV

Acknowledgements

I would firstly like to thank my supervisor Zahra who helped me get over the line with the acceptance for this project. And secondly the team at Veris for allowing me access to the drone and processing programs.

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Use of Monitoring Dynamic Performances for Structural Health Monitoring of Concrete Structures

School of Civil Engineering and Surveying

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Bachelor of Engineering (Civil) (Honours)

Supervisor: Dr Jayantha Epaarachchi, USQ

Keywords: Structural Health Monitoring; Concrete Testing; Vibration.

1. Introduction

Civil infrastructure has been built using concrete for more than 100 yrs. During their operational life time damage can occur due to natural disasters, and overloading. Some of the damage within the structures are hidden killers and infrastructure can fail without any prior warning. This proposal intends to study the damage condition using dynamic/structural response of the structure under operational situation at laboratory level. The change of; natural vibration frequency, amplitude of vibration, and damping will be used as indexes of health of the structure. Finally, the structures will be tested for strength.

2. Background

Structural health monitoring (SHM) can be applied to most infrastructure. The need for this monitoring is essential to ensure the structural stability, safety and reliability. It can also lead to reduced maintenance and early knowledge of damage, allowing early repair of issues. Currently, SHM equipment and techniques is used mainly on larger structures in urban areas.

3. Methodology

In order to complete the project, quantitative results had to be obtained from experimental methodologies. Three tests were completed on two concrete beams fabricated in the initial stages of the project. One beam was used as a control specimen another was created to simulate a common problem in concrete bridges (corrosion in steel reinforcement). The two beams are shown in Figure 1. The first test conducted was using three point bending to test the bending and strength of each beam. The next test was vibration testing and accelerometers were used on various points along the beam to calculate accelerator and damping. The final test was to test each beams strength.

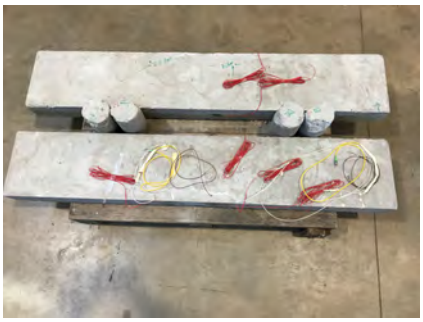

Figure 1 - Concrete Beam Specimens

4. Key Outcomes

Following the methodology, two reinforced concrete beams were created in the laboratory. The first testing, three-point bending, has been completed and results found both beams have similar deflection.

5. Further Work

The final two experimental tasks remain to be completed, and data collected is yet to be analysed. The Fiber Optic Sensor was found to be not working in the first experiment, leaving this aspect inconclusive as data from this sensor cannot be collected.

6. Conclusions

Optimistically, the project will conclude by identifying a particular SHM technique and methodology that can be economically implemented and used in civil infrastructural health monitoring techniques. It will also demonstrate the effects of weathering on concrete structures.

Acknowledgements

My supervisor Dr Jayantha Epaarachchi, USQ, has been instrumental during the project lifespan. I would also like to acknowledge my previous supervisor John C. Moore, University of New England, who developed a project using SHM techniques on a regional concrete bridge, and knowledge which the project is building on.

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An investigation into an alternative on-site stormwater detention structure to increase capacity and reduce spatial footprint and economic impact

Sponsor – J.A.K. Civil Pty. Ltd., MJB Industries, University of Southern Queensland

Cameron Scott

Bachelor of Engineering (With Honors) – Civil Engineering Major

Supervisors: Dr Jahangir Alam, USQ

Mr Philip Kemp, J.A.K. Civil

Mr Aaron Hovey, J.A.K. Civil

Keywords: Residential, Stormwater, Detention Structure, Seepage, Spatial Footprint, Economic Impact.

1. Introduction

As typical residential lots become smaller, so too does the available space for on-site stormwater management. The currently available on-site stormwater detention systems do not utilise minimal available space and can vary heavily in strength and cost.

The proposal will investigate currently available structures and establish their benefits and drawbacks. Using this information, a design for an alternative on-site detention structure will be presented, which increases capacity, reduces spatial footprint and minimises economic impact.

2. Background

As available space on residential lots becomes smaller, it is important to utilise as much spatial footprint as possible. In areas where on-site stormwater management is required, the use of a product with minimal spatial footprint and economic impact is very important.

3. Methodology

Literature Review was completed to gain knowledge in the field of on-site detention structures and enhance methodology. Experimentation of 3 currently acceptable on-site detention structures occurred to establish benefits and drawbacks in cost, seepage, strength and spatial footprint. A prototype was designed for an on-site detention structure which utilises the benefits and eliminates the drawbacks of currently available structures. Comparison of this prototype to currently available structures then occurred.

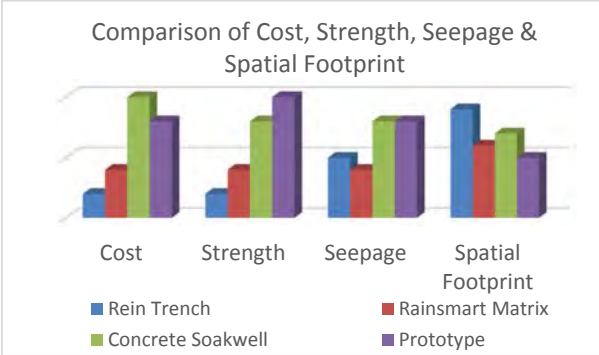

Figure 1 – Comparison of Cost, Strength, Seepage & Spatial Footprint of On-Site Detention Structures

4. Key Outcomes

The strength and seepage results from experimentation gave insight into the capabilities of currently available structures. Storm modelling helped to confirm validity of currently acceptable on-site storage volumes. The design of a new on-site system has widespread advantages, which may extend beyond residential applications in the future.

5. Further Work

Final submission. The manufacturing of this design will not be able to occur, so field testing on this prototype will not be possible. In the future, manufacturing and distribution of this new design would be ideal to confirm theoretical testing.

6. Conclusions

Variance in available Stormwater Detention Structures is quite limited, so the development of a new product is important for this market.

Acknowledgements

My supervisor Dr. Jahangir Alam, my industry supervisors who helped greatly with resources. I'd also like to thank my loving wife Carolyn for dealing with the wild mood swings throughout.

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Reduction of transient pressures witnessed by spillway drainage systems through use of attenuating devices utilising the comparison of Computational Fluid Dynamics (CFD) vs. Physical Hydraulic Model (PHM) data

Sponsor – SunWater Limited

Christopher Salvatore Scuderi

Degree – Bachelor of Engineering (Honours) (Civil)

Supervisors: Dr Malcolm Gillies, USQ

Mr David Ryan, SunWater

Keywords: Transient Pressures, Computational Fluid Dynamics (CFD), Physical Hydraulic Model (PHM)

1. Introduction

Modern technology such as Computational Fluid Fairbairn Dynamics (CFD) modelling was used together transient pressures identified in the spillway chute at with Physical Hydraulic Modelling (PHM) to design for the Dam. CFD may still considered by some practitioners as an unlikely substitute for Physical Hydraulic Modelling (PHM). It is suggested in this paper that the use of CFD in conjunction with PHM modelling can provide designers with convincing evidence that CFD has a rightful place in the hydraulic design of spillways.

2. Background

Construction of Fairbairn Dam commenced in 1968 and was deemed operational by the honourable J. Bjelke-Petersen in December 1972. CFD was used to further understand how transient pressures are affecting the under-drainage system of Fairbairn Dam.

For Fairbairn Dam, a sufficiently fine mesh resolution was required, operators or from other professions within the so that the CFD program could adequately model the area. The CFD 3-D model featured a variable cell size ranging from 50 mm to 2.0 m and comprised over 17 million cells. Discussion on the CFD model will provide the attendees with the understanding of both the complexity of the model and how useful such a model can be in understanding the characteristics of the spillway flow.

3. Methodology

The model was developed using Siemens Star CCM+ CFD modelling software. The software is a fully featured

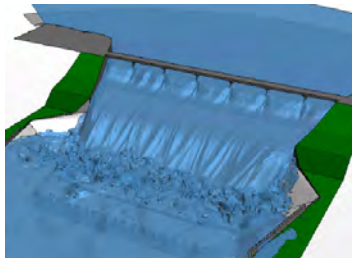

Figure 1 – Aerial image of Fairbairn Dam CFD simulation. (Image Provided Courtesy of SunWater Limited, September, 2016)

CFD modelling package with the ability to simulate multiphase flows and is used worldwide by commercial and research organisations. This software has been used for similar applications not only within Australia but worldwide. The software employs flow boundary conditions for inlet and set tail water conditions for outlet control. A non-slip shear wall condition was applied on all solid surfaces to simulate the effects of wall roughness. A combination of literature reviews and case studies of similar dams was used to measure transient pressures within the spillway channel. The data from CFD was then compared to the results of the PHM.

4. Key Outcomes

Option 5 - V07 has reduced the transient pressures within the dissipater blocks from 8.28m Head (81.2kPa) & 3.6m head (35.2 kPa) to 0.94m head (9.3kPa). CFD model has produced similar pressure transducer results as the PHM model at a fraction of the cost and results can be delivered within a month in comparison to 6 months constructing a PHM.

5. Further Work

Place pressure transducers into a larger scale 1:20 PHM or the underdrainage system of the dam to compare and compare with CFD data.

6. Conclusions

CFD has significant benefits in that in some cases, modification of the model profile can be undertaken relatively easily compared with PHM. CFD Modelling has evolved in recent years and can be used in conjunction with PHM.

Acknowledgements

I would like to firstly thank my family who have loved and supported me through my journey. Thanks to David Ryan and James Apostolidis for keeping me on track and mentoring me each day. Last but not least my fiancé Maria for her love and support and understanding.

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Assessing land use/cover changes in the coastal environment of Yeppoon, Queensland, through the analysis of multi-temporal remote sensing imagery and GIS

University of Southern Queensland

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Thomas Searl

Bachelor of Spatial Science (Honors)

Supervisors: Prof. Armando A. Apan, USQ

Keywords: Coastal Environment, Remote Sensing, Monitoring

1. Introduction

There are many challenges that our coastal environments are facing. As such there is a need to implement accurate and effective monitoring measures that provide data for analysis giving information necessary to put in place strategies to mitigate and restrain these effects (Zhang, 2010).

Remote sensing techniques, such as Multitemporal Imagery provides a greater understanding of the effects of land use and change. The analysis of single scene through different time periods provides an enhanced ability to accurately identify land features, significant information about how our world is changing, and unique insight into the relationship between environment and the impacts of human activity (Sk.sagepub.com, 2017). Whilst this technology has been used widely in areas other than coastal environments, evaluating the effectiveness on such sites will provide necessary data that has been previously missing.

2. Background

The land use and cover is one of the most important drives of environmental change on all spatial and temporal scales. It contributes significantly to the earth atmospheric interactions, forest fragmentation and biodiversity loss. It has become one of the major issues for environmental change monitoring and natural resource management (Dewan,2008).

3. Methodology

Two site within the coastal environment of Yeppoon were selected. The two site (Lammermoor and Mulambin) were chosen because of their geo-graphic location and the land use change within these environments. High-resolution imagery of the two sites was obtained from the Livingstone Shire Council form 2010, 2014 and 2017. The imagery was then digitized using the ArcGIS software and each site was compared through these dates.

4. Key Outcomes

After analysing the data, it is clear that multi-temporal imagery with the use of high resolution imagery is an effective way to monitor land use/change.

5. Further Work

Further investigation into the methodology and results of this dissertation needs to be finalised, although it is clear through the analysis of the current data that the methodology is able to support the requested desired outcomes of this dissertation.

6. Conclusions

The use of multitemporal imagery has been able to identify the land use/change and detail the nature, direction, extent and impacts of land use change in the coastal environment of Yeppoon

Acknowledgements

I would like to thank Livingstone shire council for suppling the high-resolution imagery and the assistance from their GIS staff. I would like to thank Professor Armando Apan at USQ for his support, guidance and encouragement throughout the dissertation. Finally, I would like to thank my family and friends for their support and tolerance during the completion of this report.

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Identification of Kangaroos using Machine Vision

School of Mechanical and Electrical Engineering

Laura Sehmish-Lahey

Bachelor of Engineering (Hon)

Supervisors:

Dr Tobias Low, USQ School of MEE

Dr Cheryl McCarthy, Centre for Agricultural Engineering

Keywords: machine vision; kangaroos; regions of interest (ROIs); background subtraction; convex hulls;

1. Introduction

The aim of this project was to create a system that will identify kangaroos as they cross a boundary and record data relation to their movements. This was done through the use of a motion-activated infrared-enabled camera and a machine vision algorithm which analysed the visible light and infrared footage.

2. Background

According to Gong et al. (2009), every year in Australia more than $743.5 million is lost due to the impact of pest species in agriculture. To reduce degradation of land from these animals, farmers often implement animal control methods. This project will provide farmers a way to monitor the movement of target species and thus allow them to determine the effectiveness of any animal control methods they have in place. Currently the effectiveness of any such control methods can only be monitored visually by the farmers and this is not very accurate. Similar projects such as Dunn et al. (2003) have focused on the identification of domesticated animals, and others such as Cohen et al. (2011) have focused on small endangered animals. No such project has been found to analyse large undomesticated animals for this purpose.

3. Methodology

To effectively create a machine vision algorithm to recognise target species, a camera had to be chosen that could provide clear, useable footage during varying light conditions. A high traffic location on a property boundary was selected for the data collection and using this data the algorithm was created. The algorithm was based on background subtraction and the creation of ROI's around the target animals using convex hulls, as shown in Figure 1. These ROI's were counted as they pass a threshold. The accuracy of the algorithm was calculated based on the number of incorrect positive animal identifications on various pieces of footage.

4. Key Outcomes

A generic foreground detection algorithm has been created to detect and count the number animals crossing the boundary. This algorithm is currently being modified to increase its accuracy in counting kangaroos and reduce the likelihood of an incorrect identification. The algorithm has been designed to work with varying backgrounds which means the project will be more robust in multiple possible camera locations, and this will increase is usefulness.

Figure 1 – Screen shot of Animal Counting Algorithm

5. Further Work

Future work involves collecting footage of humans and dogs passing across the threshold. This will allow the algorithm to be tested to determine how well it differentiated Kangaroos from other animals crossing the boundary. If successful, this project could be used in conjunction with an automated one-way gate to stem the flow of target animals into a property.

6. Conclusions

The conclusion of this project so far is that a machine vision algorithm based on video imagery from an outdoor camera can monitor kangaroos crossing a boundary. This will be useful to farmers, but further work would be required to distinguish other species of interest.

Acknowledgements

The author would like to thank the project supervisors, Tobias Low and Cheryl McCarthy, for their assistance throughout this project. Additionally, Greg Lahey for the use of his property for data collection.

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Investigation of the Effects of Encapsulated Phase Change Material on Basic Solar Disinfection Rainwater Treatment

Faculty of Health, Engineering and Sciences

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Bachelor of Engineering (Honours) (Mechanical)

Supervisors: Dr Andrew Wandel, USQ

Keywords: Solar disinfection (SODIS); drinking water; anti-bacterial treatment; phase change material (PCM); thermal energy storage; temperature control.

1. Introduction

Populated areas suffering from drinkable water shortage often use solar water disinfection (SODIS) of rainwater. It is a low-cost and relatively effective way to purify rainwater, and Australian climate appears suitable for SODIS implementation. The main objective of the project is to combine SODIS and a simple and safe method of temperature control using phase change material (PCM) to improve SODIS treatment.

2. Background

The basic SODIS method is less effective under poor weather conditions, and it is difficult to estimate whether the water reached the temperature sufficient for anti-bacterial treatment. An encapsulated PCM can be used to possibly improve SODIS treatment and to produce an affordable visual indicator.

3. Methodology

The research was based upon an extensive Literature Review on the following: background information related to SODIS rainwater treatment, drinking water quality standards and available PCM. The PCM capsules and indicators were designed and tested on a range of water samples in comparison with the basic SODIS treatment. All relevant temperature and weather data were recorded and analysed. A series of tests on a few samples were conducted at the Mackay Water and Waste Management Laboratory to analyse the microbial qualities and validate SODIS treatment. The designed phase change capsules and SODIS indicators were critically evaluated in terms of performance and affordability for future use in household conditions.

4. Key Outcomes

The experiments confirmed that SODIS treatment does not affect chemical and physical properties of water. It was discovered that none of the samples reached the temperature high enough to eliminate the bacteria and bring rainwater up to drinkable standards (Figure 1).

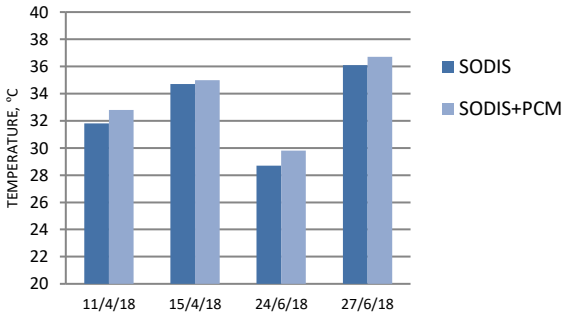

Figure 1 – Comparison of Daily Sample Average Temperature

The relationship between daily solar exposure and the temperature at the field SODIS station was reviewed to identify the reason for that, suggesting that SODIS may be a seasonal treatment. The significant achievement is the performance of SODIS indicators, with some minor drawbacks. Also, PCM capsules do affect the water temperature, keeping the samples 0.1 – 1.2ºC warmer than those subject to regular SODIS treatment. This means the proposed system has a positive effect on the basic SODIS treatment.

5. Further Work

The importance and value of such a subtle temperature difference brought by the PCM capsules are yet to be addressed. The scarcity of resources prevented a full set of SODIS tests and Laboratory examinations planned. It is highly recommended to continue the research and conduct a set of SODIS tests during the summer, when the highest atmospheric temperatures are observed.

6. Conclusions

This project incorporated and applied the knowledge of SODIS treatment and PCM properties to deliver valuable data obtained in climate and weather conditions unique to Queensland. Pending further research, this data can be regarded as ground for extended implementation of PCM capsules for SODIS treatment.

Acknowledgements

The author would like to thank Dr. Andrew Wandel, the Supervisor of the project, for his time and guidance and the author's family for the ongoing support.

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Shear strength properties of non-corrosive reinforcement elements (fibreglass bolts)

Sponsor – AROA and MINOVA
School of Civil Engineering and Surveying, Faculty of health, Engineering and Sciences
University of Southern Queensland

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BACHELOR OF ENGINEERING (HONOURS)

Supervisors: Dr Ali Mirzaghorbanali
Prof Naj Aziz
Mr. Peter Gregor

Keywords: Shear Strength, Fibreglass, Non-corrosive reinforcement.

1. Introduction

This paper investigates the shear strength properties of the fibreglass bolt and relates these properties as an environmental friendly product to use at the workplace. A series of double shear tests was conducted to examine the shear strength of the different fibreglass bolts within the constant stratum of 20 MPa Uniaxial Compressive Strength (UCS). Two different fibreglass bolts were used to determine the mechanical properties, 20 tonnes and 30 tonnes respectively.

2. Background

Fiberglass is a glass reinforced plastic composite and its properties results in positive outcomes for underground tunnels, mining and high buildings. This study focusses on the shear failure mechanism of fibreglass rock bolts that is incorporated in civil applications and environmental concerns. The properties like long duration, non-corrosive and flexible in mechanical strength assist in the advancement of fibreglass in civil engineering applications as well as the demand for lightweight, modular bridges and for emergency purposes. Moreover, the elongated strain to failure practically gives enough time to alert before failure takes place, which ensures the health and safety of public.

3. Methodology

To find the shear strength of the fibreglass a modified equipment, previously designed by Aziz et al. (2016) was used for the construction of stratum. Double shear testing methodology is designed to investigate the relationship between shear strength and host USC by encapsulating the rock bolts in the rock strength of 20MPa. The pretension values for fibreglass of 0 and 10 kN were selected for this project.

4. Key Outcomes

The test resulted in the shear load versus shear displacement graph of the fibreglass bolt with 20MPa of concrete strength as shown in Figure 1. Shear load monotonically increased after elastic stage, reaching to peak shear value of 180 kN in shear displacement of 17 mm after which the sample failed. Pre-tension value showed an increasing trend with increase in shear displacement achieving the peak value in the same shear displacement as the shear load. After testing, the sample was carefully dismantled to investigate the quality of grouting and encapsulation, which showed the high-quality encapsulation.

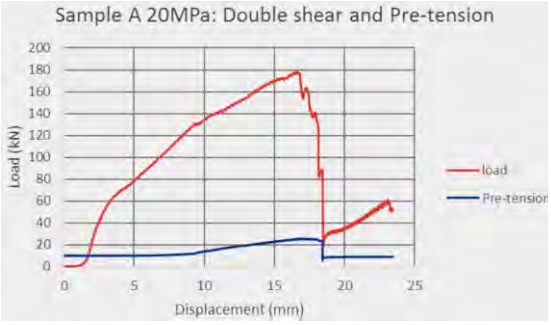

Fig. 1 – Double shear testing results

5. Further Work

There are more experiments to conduct for other prepared samples. The results obtained with these samples will be incorporated in comparing the data.

6. Conclusions

The results from the test show that fibreglass can be an alternative solution for steel reinforcement. As a result, the properties of fibreglass rock bolts lead to customisable performance and increase the use in mining and civil projects where environmental issues such as corrosion, health and safety are conspicuous concerns.

7. Acknowledgements

I would like to thank my supervisors, Dr Ali Mirzaghorbanali, Prof Naj Aziz and Mr. Peter Gregor for their assistance.

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Studying Scour Behaviour around Culverts Using a Validated Numerical Model

School of Civil Engineering and Surveying

Bradley Sheriff

Bachelor of Engineering

(Honours) (Civil)

Supervisor: Dr Buddhi Wahalathantri, USQ

Keywords: Scour, culvert, numerical modelling

1. Introduction

One of the most prevalent damage mechanisms affecting waterway crossings is scour. Scour is the erosion of a waterway channel bed and banks due to the hydrostatic forces of the water flowing in the channel.

This project aims to develop a validated and accurate numerical model using ANSYS Fluent software to study the effects of scour around culverts. The project will also assess the modelling capabilities and limitations of the software for the use of culvert scour modelling

2. Background

Extensive damage to bridges, culverts and floodways during recent major flood events has been reported all across the Australia resulting in huge repair and replacement costs for road authorities in Australia. Wahalathantri et al. (2015) reported that scour is one of the major failure mechanisms in culverts and floodways.

Scour is a complex failure mechanism that requires the understanding of local characteristics of waterways such as hydraulic and soil properties. However, only a limited number of local research has been conducted in this area. Therefore, comprehensive local research should be undertaken to assess the scour estimation methods and their applicability to local conditions. This requires both numerical and experimental based studies.

3. Methodology

A series of laboratory experiments were conducted to experimentally measure the scour around a small scale culvert model at different flow rates, bed slopes and blockages (See Figure 1). The same model was simulated using the ANSYS Fluent software package. This research assesses the effect of different flow characteristics on scour profile and examines the correlation between experimental and numerical data.

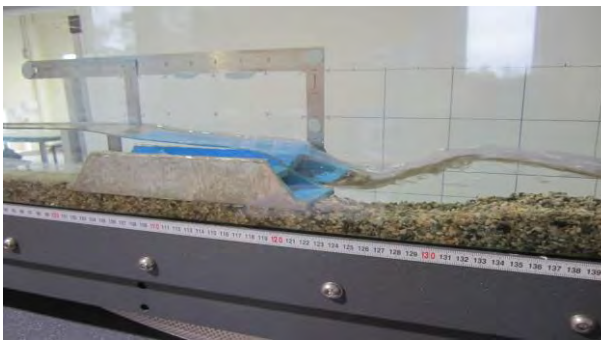

Figure 1 – Scour in Scaled Culvert Laboratory Model

4. Key Outcomes

The laboratory work has shown that scour profiles are more elongated with the maximum depth occurring further downstream for unblocked culverts. Blocked culverts result in a deeper scour closer to the culvert end. Current findings indicate that the ANSYS Fluent software does not accurately represent the effect of friction loss due to bed roughness.

5. Further Work

Further research is required to determine the suitability of ANSYS Fluent software to accurately model the effects of wall and bed friction in an open channel culvert scenario. Further research could also study the effect of different types of cohesive and non-cohesive bed materials as well as developing 3D models.

6. Conclusions

This study has found that further studies are required to simulate scour in virtual environment using ANSYS Fluent software package.

Acknowledgements

I would like to acknowledge my supervisor, Dr Buddhi Wahalathantri for his guidance and support throughout the project.

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DTM Accuracy Comparison Between Onboard RTK-GNSS UAV Versus Low Cost Quadcopter UAV At Different Geomorphological Sites: A Malaysian Approach

School of Civil Engineering and Surveying

Shu Ji Linn
Bachelor of Spatial Science (Honours) (Surveying)

Supervisor: Prof. Armando Apan, USQ

Keywords: Real Time Kinetic, Unmanned Aerial Vehicle, Photogrammetry, Mavic Pro.

1. Introduction

This dissertation aims to determine the optimum flight configuration for a low-cost multirotor to obtain the most accurate DEM results. This report will look at comparing accuracy between the low-cost quadcopter which is DJI Mavic Pro to the higher cost On-board RTK GNSS Fixed Wing UAV, Topcon Sirius Pro. This paper explores the effects of combined image acquisition mode, such as double grid mission mode to improve positional accuracy.

2. Background

Currently, Malaysian surveyors are reluctant to venture into aerial photogrammetry due to the misconception of excessive costs to purchase Unmanned Aerial Vehicles, Cameras and complex Image processing software. Total stations and GNSS are classified by the local authorities as the legal surveying instrument to define cadastral boundaries (JUPEM, 2012). Therefore, most surveying work were carried out using either total station or GNSS due to its reliability and accuracy.

3. Methodology

For this experiment, three cases will be carried out considering different terrain. Each case will be tested at flight altitudes of 60m and three different numbers of Ground Control Points (i.e., 5, 15, 25). Agisoft Photoscan was used in orthorectifying the aerial images captured by both models of UAV. The point clouds were generated and exported into Global Mapper.

Key Outcomes

To determine the optimum flight configuration for low cost multirotor to obtain the most accurate DEM results. Also, to explore the effects of combine image acquisition mode such as double grid mission to improve positional accuracy.

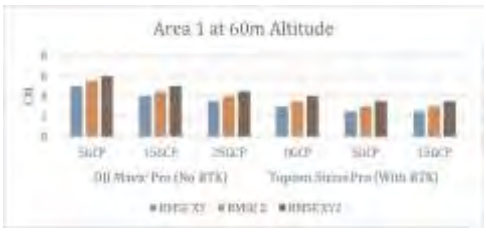

Figure 1: Accuracy assessment of an RTK flight and a non-RTK one, with different number of GCPs.

4. Further Work

Random distribution point to point and linear comparison will be conducted as a hypsometric expression of the difference between the two surfaces.

5. Conclusions

DJI Mavic Pro has high positional accuracy comparable to Topcon Sirius Pro with a difference of only 5mm with the optimal flight configuration of 25 GCPs and flight height of 60m.

Acknowledgements

I would like to express my sincere gratitude to Professor Armando Apan for his guidance and constructive advises in completing this project

Reference

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Challenges in Project Management of Infrastructure Projects in Fiji

School of Civil Engineering and Surveying

Hardeep Singh

Bachelor of Engineering (Honours) Civil

Supervisor: Dr Nateque Mahmood

Keywords: Project planning, Project Implementation and Project delays

1. Introduction

Infrastructure is the link to economic growth of any nation. There are no concrete numbers on the percentage of projects that's has failed in Fiji, but from experience it is very rare that projects are completed on time and within budget. This research will identify the factors that influence the project management of infrastructure projects in Fiji. The purpose of this thesis is to contribute to the existing knowledge of Infrastructure Project Management in developing countries like Fiji. It is an attempt to test the rationality and correctness of the day-to-day challenges faced by Project Mangers in Fiji and thereby propose necessary changes in present ideas or additional issues that need consideration in future.

2. Background

There is currently no specific study of project management in Fiji. However, there have been many studies regarding the planning and implementation of projects in developing countries such as, Aibinu et. Al (2002) the effects of construction delays on project delivery in Nigerian construction industry and many more. This presents opportunity to fill the gap in the current body of knowledge to ensure that it meets the academic demands and well as greater benefit to this region.

3. Methodology

In this research, a case study methodology is adopted. The case study research is a qualitative approach in which the investigator explores multiple cases through data collection involving multiple sources of information, such as literature review of previous research, project documentation, reports, and interviews. The in-depth review of existing literature, project documentation (considered both on-going and completed projects in Fiji), and industry reports are undertaken to achieve the project objectives of determining the challenges in project management of infrastructure projects in Fiji. The information gathered from thesis sources are used to develop a comprehensive semi-structured questionnaire for interviewing a number of relevant key personnel involved in infrastructure projects in Fiji. . The interviews are designed to obtain professionals' views and experiences with respect to challenges of project management of infrastructure projects in Fiji. Using the information gathered from these interviews, strategies are developed for minimizing the challenges in project management in Fiji. Groups included in the research were engineering, government departments and construction companies.

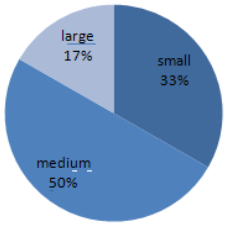

Figure 1 Illustration of groups included in the interviews, as per their size

4. Key Outcomes

The majority of the case studies that were reviewed during the project confirms that despite a tenfold increase in the project investment, international funding institutions and ministries of less developed countries like Fiji still report serious problems in project management. Many are due to poor planning, cost overrun, constructability, environmental effects, and requirements of land acquisition. The expected outcome of the interview will be that project managers face unexpected obstacles in managing time, money, scope and people on a daily basis. Furthermore, effective communication to everyone involved in the project is crucial to its successful completion.

5. Further Work

It is believed that this study has given insight of the challenges in project management of infrastructure projects in Fiji. However, there are other areas that could be improved and studied in more details. It is recommended that a practical guide for the Project Management in Fiji and the implementation of Project Management Methods in Fiji and its practices to be studied. Finally, it is hoped that this study will beneficial to all parties involved in construction industries and would stand as a good foundation for future research

6. Conclusions

The project outlines a commitment at national level too. Improve project management services in Fiji which will positively contribute to the ongoing social and economic developments.

Acknowledgements

Acknowledgement goes to course supervisor who has constantly assisted throughout the project by giving feedbacks and guidance.

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Comparative study on precast concrete and cast in-situ reinforced concrete panels for building construction in Queensland

School of Civil Engineering and Surveying

Prince Singla

Bachelor of Engineering (Honours) (Civil)

Supervisor: Dr Allan Manalo, USQ

Keywords: Precast, In-situ cast, comparative study.

1. Introduction

This project aims to identify the difference between precast and in-situ reinforced concreting methods in Queensland focusing on the manpower and time-frame required for each technique. The results of this research will provide useful information to the construction industry in adopting a better construction method that will save time, energy and affordability.

2. Background

The construction industry consumes about 40% of the total global energy and produces 50% of the global waste. Precast panels and in-situ casting are the two mostly adopted methods for concrete construction, wherein both methods have advantages and disadvantages. Thus, a systematic investigation is needed to come up with an optimum solution (Blismas & Wakefield, 2009) in adopting each method.

3. Methodology

To achieve the project objectives, this project conducted into two stages:

Stage 1: Research in-situ concrete casting technique.

Stage 2: Research precast concrete casting technique.

Data for both stages are gathered from visiting actual construction sites in Queensland. Figures 1 and 2 provide a comparison of seven stages of construction starting from the building walls to formwork removal.

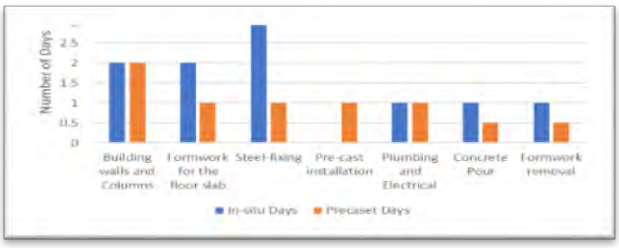

Figure 1: Comparison of days for floor cycle

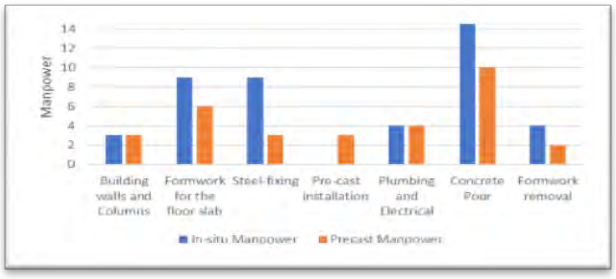

Figure 2: Comparison of manpower for floor cycle

4. Key Outcomes

Construction with precast panel has the following advantages as refered in Figure 1 and 2:

- 35% quicker and requires 34% lesser manpower than in-situ casting due to the lesser time required for formwork erection and removal, steel fixing and concrete pour.

The disadvantage with precast construction

- More concrete waste than in-situ casting since the leftover concrete in the factory is sent to landfill.

5. Further Work

The data and observations from this study are gathered from site visits to one construction project. Gathering more data is recommended as a further work to verify the findings from this study. A more detailed analysis can be also implemented to determine the most optimal construction method for reinforced concrete panels.

6. Conclusions

Precast construction requires lesser time and manpower in manufacturing concrete panels than in-situ casting. The formwork erection and removal, steel fixing and concrete pour were identified as the activities that are significantly different between two methods. With proper planning and estimating, concrete waste can be minimised for precast construction.

Acknowledgements

I would like to thank David Raetz, Design Manager, Precast Concrete Productions for providing site access to their projects to gather data for my research.

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An Objective Criteria for the Determination of Non-Tidal Riparian Boundaries in NSW

School of Civil Engineering and Surveying

Lachlan Smith

Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Dr Glenn Campbell, USQ

Keywords: non-tidal riparian boundaries, doctrine of accretion and erosion, watercourse morphology, gradual and imperceptible

1. Introduction

Currently in New South Wales (NSW) there is a practical confusion within the surveying profession and land owners regarding the determination and legal understanding of defining non-tidal boundaries. The aim of this project is to substantiate whether there is a viable alternative to the common law understanding of non-tidal riparian boundaries in NSW.

Figure 1 - Example of an irregular riparian boundary definition. Source: Six Maps, 2018

2. Background

There is a practical limitation in the amount of literature available for the surveying profession in this field. The importance of this research is for surveyors and the general public interest in regards to potential issues in the future.

The legal framework for riparian boundaries has been adopted from English settlement and it was also observed in Southern Centre of Theosophy Inc v South Australia (1978) 19 SASR 389 that the doctrine "*may be traced to Roman Civil Law*". The climate and geographical characteristics of Australia are varying and vastly different from England. If the doctrine has been adopted from England and the climatic conditions are quite different from NSW, the question must be asked is this a viable long term adoption of this doctrine?

3. Methodology

Research findings regarding common and statutory law, survey standards, legislation and non-tidal watercourse morphology were the basis of addressing this problem. Three non-tidal riparian boundary surveys which have watercourses of varying characteristics were used as case studies. Results and research findings will provide the foundation to develop an objective criteria/proposal.

4. Key Outcomes

There are two difficulties in defining non-tidal NSW waterways. One is the modified nature means natural flows of these waterways traditionally are very unlikely. The second, is that gradual and imperceptible as per the definition of the doctrine is also very unlikely of occurring due to the Australian rainfall patterns. The challenge is to determine which scenario is less damaging and more practical.

In a situation where loss of land due to stream activity occurs it is important to note that the NSW Constitution makes no reference to "just terms" compensation for the acquisition of land. However, Parliament could revoke the exisiting or pass a new Act to allow land to be acquired without compensation.

5. Further Work

Further work involves analysis of results from case studies and the development of an alternative object criteria. Research into the barriers and cost implications of altering the legal framework must be undertaken before any legislative change can be made.

6. Conclusions

This research has created awareness for problems that will be faced in the future regarding land ownership. The industry needs to determine if the current practices and legal understanding will still be viable in years to come.

Acknowledgements

I would like to thank Glenn Campbell for the guidance during the project, as well as Mitchel Hanlon for equipment use and on-going professional support.

References

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Design of a Smart Parking System for a Regional University Car Park

Sponsor – School of Mechanical and Electrical Engineering

Michael Smith

BENH Mechatronics Engineering

Supervisors: Dr Steven Goh, USQ

Keywords: Smart Parking System, System Design, Regional University

1. Introduction

Smart Parking Systems are systems implemented to improve the process of finding a parking space in a car park, so that parking can be used more efficiently. The design of these systems involves selecting suitable technology that achieves the goals of the parking system. Systems can be designed with the chosen technology using a new product development model. This project will outline the design process and considerations for a smart parking system at a regional university (USQ Toowoomba Campus).

2. Background

This project will provide useful information to researchers who intend to conduct research with smart parking systems in a similar context. While research has been carried out in areas such as sensor networks and feasibility analysis, there has not been much research into the system design. Regional university car parks in particular provide unique challenges that are not encountered in purpose-built car parks, and this project aims to address these problems and provide an optimal design.

3. Methodology

The methodology used for this project is adapted from a new product development model. The design process of any project has defined stages that contribute towards an end goal. This project will utilise the first 4 stages of the new product development model outlined by Booz, Allen, and Hamilton; Objectives, idea generation, screening, and business analysis. This will result in a single design which will then be evaluated against the original objectives. Figure 1 shows the capacity of the entire car park at 10 am, demonstrating the need for this project.

Capacity	Monday		Tuesday		Wednesday		Thursday		Friday	
10:00 am	Gen.	Met.	Gen.	Met.	Gen.	Met.	Gen.	Met.	Gen.	Met.
January	55%	12%	61%	18%	67%	21%	58%	14%	ND	ND
March	88%	52%	90%	62%	85%	64%	86%	59%	66%	42%
April	76%	36%	8%	19%	80%	79%	79%	62%	64%	47%
May	77%	44%	82%	48%	85%	53%	79%	52%	80%	73%
June	65%	52%	59%	52%	64%	47%	62%	47%	64%	47%
July	78%	55%	91%	59%	88%	64%	81%	47%	62%	29%
August	77%	48%	83%	56%	70%	29%	70%	47%	57%	33%
Septembe	81%	68%	50%	12%	59%	52%	85%	53%	80%	73%
October	65%	52%	70%	47%	91%	59%	70%	47%	64%	47%

Figure 1 – 10 am parking capacity for USQ

4. Key Outcomes

Using parking data and background information, a set of criteria and objectives relating to the smart parking system design were obtained, relevant to this application. The most significant outcome of this project that has been achieved so far is the smart parking system technology comparison. This is an important step in achieving the other goals of this project, as it relates the system objectives to the design of the system.

5. Further Work

The system designs need to be specified so that screening can narrow this down to one design. Following that, a business analysis and evaluation of the best design will be carried out. Outside of this project, there is still work to be done regarding the software design of these systems.

6. Conclusions

This project will determine the most appropriate design for the car park at USQ Toowoomba Campus. This will provide insights on the challenges associated with this application and how they can be overcome.

Acknowledgements

The author would like to thank Dr Steven Goh, for his patience and insights on how to approach this project.

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The Role of Distributed Battery Storage to Augment & Support the Network during Peak Demand

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Nicholas Stack

Bachelor of Engineering (Honours)

Major Electrical & Electronic Engineering

Supervisors: Dr. Les Bowtell, Mr Andreas Helwig

Keywords: Batteries, Distribution, Network

1. Introduction

In the society that we have formed over hundreds of years, we are at a period in time where the generation, transmission and distribution of electricity has become a necessity within all facets of our existence. As our population continues to expand, we endeavour to keep the expansion of our networks in line with this growth.

This project explores the use of batteries banks connected to residential fed distribution transformers, in order to shift load from the peak time slot, to the off-peak time slot in an attempt for added efficiencies and lifespans of existing equipment, as well as cost savings to consumers.

2. Background

As there is a wide variety of batteries, understanding the specific uses that can improve efficiencies in a large scale network is required for the current ageing systems. Power prices have been a current point of discussion in the media and all avenues to alleviate these household pressures is advantageous for all.

3. Methodology

The methods used was analysing the computer generated loads of 200kVA, 315kVA and 500kVA transformers at 80% loading. Battery sizing was determined to offset 25% of the power output during peak time (4pm-8pm weekdays) in order to align with real world Energex data of residential transformers. As well as battery sizing, the charging regime and capital/ongoing costs are also calculated.

4. Key Outcomes

It has been determined that the current limitations in energy and costings for batteries are well above where they need to be in oder to offset portions of loads on a distribution level (Figure 1). For the voltage levels of appropriate inverters capable of a level of stability in the nextwork, battery quantities are excessive and limination of appropriate space at transformers hinders and efficient solution.

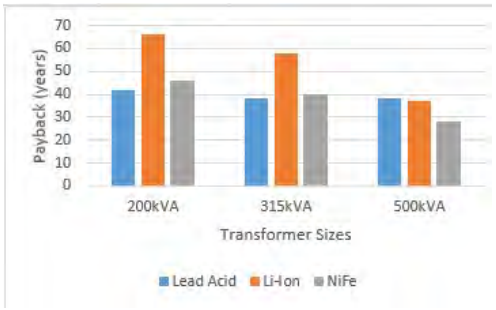

Figure 1 - Sample Diagram

5. Further Work

An in-depth analysis of current technology, as well as where technology needs to be from both energy requirements, and costings.

6. Conclusions

This project has enabled an understanding of current battery limitations in a distribution sense. As batteries are becoming more prevalent, to understand another area that they can/cannot work is imperative for the continuing improvements to this technology.

Acknowledgements

My supervisors Les and Andreas have provided invaluable insight into this project and have assisted greatly throughout this process. The research provided from Andreas Poullikkas, The Rainbow Power Company and Energex have all played a major role in shaping this project the way it is.

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Potential for Energy Generation using Pumped Storage Hydropower in the Toowoomba Water Supply

School of Civil Engineering and Surveying

Madison Stahlhut

Bachelor of Engineering (Honours) – Civil and Bachelor of Business and Commerce – Management and Leadership

Supervisor: Justine Baillie, USQ

Keywords: Hydropower, Toowoomba, feasibility

1. Introduction

Pumped storage hydropower (PSH) is a type of renewable energy and a form of hydroelectricity which enables the storage of potential energy in the form of water. Water is stored in an upper reservoir, and during peak energy demand periods, is released to a lower reservoir via a turbine. When demand is reduced, the water is pumped from the lower reservoir back to the upper reservoir storage for the process to be repeated (Mays 2011). Figure 1 shows how a typical system operates.

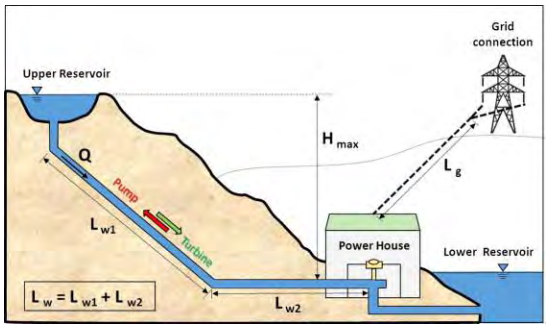

Fig. 1: Typical PSH scheme (Kucukali 2014).

This project investigates the feasibility factors of PSH, in order to provide an indication of whether a scheme is feasible in the Toowoomba region.

2. Background

Australia is currently experiencing an 'electricity crisis' according to many industry leading experts and politicians (Dayman 2017). The stability of the system, as well as increasing demand and subsequent prices are emerging issues in the national spotlight. There is also growing awareness of the need for the use of renewable energy sources to be increased. Trends in worldwide show that providing affordable, stable and reliable baseload power is done so by supplying a market with varied sources, including renewables. PSH allows for the introduction of renewable energy sources to augment existing electricity grids during peak demand periods. This potentially alleviates the issues being experienced, whilst also preparing for the increasing use of renewables in the future. The Toowoomba region provides a possible location for a PSH system to be implemented due to the locality of two of the water supply dams, however the feasibility of such a scheme at the location is unknown.

3. Methodology

The project utilises the site features found in literature which make successful schemes, in order to assess the location in the Toowoomba region, and determine possible configurations to be constructed. For each configuration the potential generation was determined using the elevation difference between release points and flow in the pipeline, which is dependant on the upper reservoir size, and the operating time. Economic factors are then considered for each of the sites, based on existing pumped storage systems. These factors include capital costs, operating costs and revenue.

4. Key Outcomes

Three configurations have been determined which are considered to be feasible based on the methodology. It is interesting that the location being investigated does not provide the traditional terrain suited for PSH, resutling in three unique configurations, not typically seen in existing schemes.

5. Further Work

The economic feasibility still needs to be assessed, in order to provide an overall picture of the feasibility of PSH in the Toowoomba region.

6. Conclusions

The key conclusions include that there is potential for pumped storage hydropower in the Toowoomba water supply, however it may not be economically feasible, based on the potential generation.

Acknowledgements

I would like to thank my supervisor, Justine Baillie from USQ, who has been instrumental in the development of this project, and Toowoomba Regional Council for providing some key data used for analysis.

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Investigation into Peak Wet Weather Flow design guidelines for sewerage networks in the Byron Shire, NSW

Faculty of Health, Engineering and Sciences

Jason Stanley

Environmental Engineering

Supervisors: Dr Vasanthadevi Aravinthan, USQ

Keywords: Inflow, Infiltration, Peak Wet Weather

1. Introduction

Mullumbimby is a scenic town of approximately 3600 residents located within the Byron Shire Local Government Area on the New South Wales north coast. The town is located within the Brunswick Valley and as such has a unique combination of high intensity rainfall, silty clay soils and a high ground water table. The combination of these elements result in flat graded, deep sewers mains remaining under high hydrostatic head for a long period of time after large rainfall events.

All sewerage systems receive some degree of Inflow and Infiltration (I/I) derived from rainfall however the township of Mullumbimby experiences significantly high I/I during rainfall events, up to 20 times that of Average Dry Weather Flow. This research project uses current Peak Wet Weather Flow (PWWF) analysis to identify areas worst affected by I/I to allow better planning of the towns maintenance and capital works program.

2. Background

The Mullumbimby sewerage network was constructed in 1964 and since that time, the PWWF design requirements for sewerage network have significantly increased. The local water utility has encounter legacy issues associated with this under-design since it was commissioned. As such, the validity of current day PWWF design aspects has been researched against current day dry weather and wet weather events.

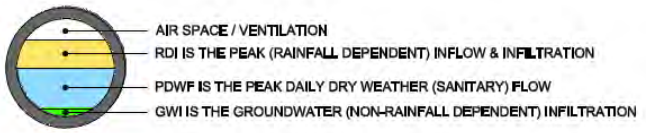

Figure 1 – PWWF components (WSAA, 2014)

3. Methodology

The Mullumbimby sewerage network contains 13 sewage pumping stations with gravity sewerage. Supervisory Control and Data Acquisition (SCADA) monitors and operates each of these pump stations. , as part of this project, SCADA has been upgraded to allow for derived inflows and outflows for each catchment. This derived flow can be compared against predicted PWWF during rainfall events.

4. Key Outcomes

Data from Rainfall events in August, 2018 were successfully captured and analysis of these events has identified areas where I/I is relatively high. It has also allowed for identification of whether the flow is due to inflow or infiltration which affects the types of mitigation measures required.

5. Further Work

Further flow monitoring is currently underway to allow for further calibration of derived flow during future rainfall events. Pilot projects implementing Water Sensitive Urban Design (WSUD) and Low Pressure Sewerage (LPS) systems are currently being designed.

6. Conclusions

The current PWWF design guidelines from WSAA have proven to achieve a reasonable level of accuracy for the expected PWWF and ADWF for Mullumbimby.

Acknowledgements

I would like to express my gratitude to those who have provided me assistance to finish this research project. Thank you Byron Shire Council for providing required resources to undertake and complete this project.

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Developing a Maintenance Framework for Culverts

School of Civil Engineering and Surveying

Michael Stanton
Bachelor of Engineering (Honours)

Supervisors: Dr. Weena Lokuge, USQ
Prof. Karu Karunasena, USQ

Figure 1 RCP (LVRC)

Keywords: culvert, maintenance, asset management.

1. Introduction

Culvert maintenance is vital to the continual operation of road and rail transport. Traditional culvert maintenance only considers the asset as a whole. This report endeavours to identify and assess key components of culverts individually. The rational of this is that it is often easier and more cost efficient to repair/replace a section of a culvert than to replace the cluvert as a whole.

With the assistance of the Lockyer Valley Regional Council (LVRC), this research assesses the inspection data of a large number of culverts and provides the framework for a culvert maintenance strategy with the assistance of images for condition ratings.

2. Background

The most efficient way to maximise the cost/life of an asset is through proper maintenance. De Sitter's Law of Fives states that for each dollar spent at stage 1 is equivalent to saving $5 at stage 2, $25 at stage 3 or $125 at stage 4 (Vanier 2014).

The International Infrastructure Maintenance Manual (IIMM)(IPWEA 2015) is widely used throughout Australia and the world as the base for road based asset management. This research utilises the theory behind IIMM and implements images sourced from LVRC on structures with preclassified condition ratings.

3. Methodology

Initial research was undertaken into the causes and indicators of culvert deterioration. Then a comprehensive investigation was undertaken into previous and current asset management including culverts and bridges. Then data from LVRC was collected, assessed and organised. This data was used to identify reinforced concrete pipe culverts (RCP) (Figure 1) and reinforced concrete box culverts (RCBC) with current and previous condition rating. Images for the above culverts were assessed and condition ratings were given to assist future inspectors in determining the condition rating for elements of culverts. Finally, an inspection framework was created to assist with future culvert inspections.

4. Key Outcomes

The key outcome for this project was contribution to the existing inspection guide for culverts featuring culvert elements and a visual guide. This is unique as previous culvert inspections often reported the asset as a unit and the implantation of an image guide limits the confusion that can arise when assessing structures.

5. Further Work

Further work could be undertaken to have more detailed images taken with reference points within the image so as to minimise any confusion as to size of cracks or areas affected.

6. Conclusion

As culverts are inspected rarely (often every four (4) years or after a major event) it is important that when inspections are undertaken that they are done as comprehensively as possible with little room for error.

Acknowledgements

I would like to thank the following people and organisations for their assistance and encouragement. Mrs Tammy Stanton, Dr. Weena Lokuge, Prof. Karu Karunasena, Mr Mathew Burdett (LVRC).

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An Assessment of Elsholz Redirective Concrete kerb on Road Safety

School of Civil Engineering and Surveying

Simon Steel

Bachelor of Engineering (Honours),

Major Civil Engineering

Supervisors: Mr Trevor Drysdale, USQ

Keywords: Elsholz, Barrier kerb, Redirective kerb

1. Introduction

Elsholz kerb (figure 1) is a low profile concrete kerb included in the Roads and Maritime Services Standard Drawings with protruding edges which cause a vehicle to redirect back into the travel lane when impacted.

Elsholz is a low profile rigid system, reducing its impact on site distance and fitting in narrow medians without any deflection required. Elsholz is also aesthetically pleasing, and can be integrated into urban designs easily and in a neat and tidy fashion.

2. Background

Elsholz was developed in the 1960s in West Germany as a barrier kerb, however has not been extensively tested and researched in the same manner as other more modern road safety systems. No record of Elsholz being tested against Australian standards or NCHRP 350 has been identified. Due to this lack of information, I took the opportunity to investigate the real world performance of Elsholz kerb and research its development history.

3. Methodology

The methodology of this project was based on real world crash data, available through the NSW Crashlink data base, and selection of known Elsholz sites. 30 potential sites in the Newcastle, Central Coast and Sydney regions where identified and investigated, narrowing down to 9 sites suitable for further analysis.

Crash data prior to and post the Elsholz installation was collected, and analysed along with detailed site inspections, in order to determine the performance of the Elsholz. A cost benefit analysis was also conducted on each site.

4. Key Outcomes

Key outcomes of this project vary between the sites. Overall, the crash data has shown the Elsholz has had a positive impact on the safety of the road, with a reduction in head on collisions when installed in the median and off road impacts when installed in the shoulder

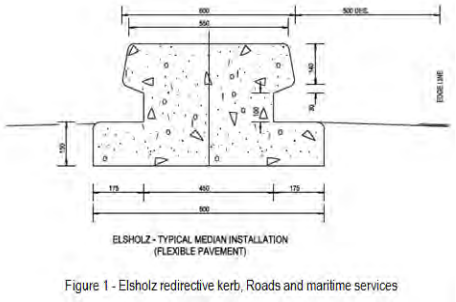

Figure 1 - Elsholz redirective kerb, Roads and maritime services

Figure 1 – Elsholz kerb

5. Further Work

The analysis of sites needs to be completed, following which the dissertation will be completed and finalised. Further research on the subject could involve a review of the sites and several others installed in the Hunter region recently at a later time, when more data has accumulated. Crash testing of Elsholz as per Australian Standard 3845 and NCHRP report 350 would also be recommended.

6. Conclusions

Elsholz has a positive impact on the safety of a road, and doesn't appear to pose a significant increase in risk to drivers. Further research, investigation and testing required before any changes to Road Design practice in regards to Elsholz are made.

Acknowledgements

I would like to acknowledge the assistance of my supervisor for his advice, reviewing my work and preparing my dissertation, my colleagues at Roads and Maritime Services for their support of my project and identifying Elsholz sites and my friends and family for their ongoing support throughout my project and degree.

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Virtual Learning Environment for Emergent Behaviour AI and Transference into Real-World Application

University of Southern Queensland
Faculty of Health, Engineering and Sciences

Benjamin Steggles

Bachelor of Engineering
(Mechatronics)

Supervisors: Dr Tobias Low, USQ

Keywords: Robotics, Artificial Intelligence, quadruped

1. Introduction

The development of artificial (AI) within the robotic world has been becoming more prolific within the academic environment and these techniques will soon be developed for use within the industrial world. As such an understanding of the complexities between simulated and physical-world (PW) trained AI is a necessity. This project looks to compare AI that is trained in the simulation to that which is trained in the PW to determine if it is a predicter of future outcomes of a PW trained AI.

2. Background

There are multiple methods for AI implementation in robotic locomotion. Majority of these methods are either applied solely in the simulated or PW. The AIBO robot was designed specifically for AI implementation and has been used often including Kohle (2004) when used to develop gait algorithms for Robo-soccer competitions.

3. Methodology

The simulated environment is developed using Mujoco which was developed by Todorov, Erez, & Tassa (2012). For the AI, Tensorflow, developed by Abadi & Co. (2016), is used to develop a convoluted neural network (CNN) which is then optimized using proximal policy optimization (PPO) program written by Coady (2017). The physical and simulated environments are identical, a quadrupedal robot is set to operate within a field with an external camera over the top of the field to help define its state. The state is fed to the CNN to define the actions for the robot. The robot policy is trained adjacent to the simulation and the difference in the rewards is analysed.

4. Key Outcomes

Unfortunately outcomes have not yet been determined as testing has not started. Expected results are shown in Figure 1. This reward plot shows the return for the robot in a simulation. It's expected that running the policy from episode 30k in the simulation and the robot adjacent to 50k a divergence of rewards will occur.

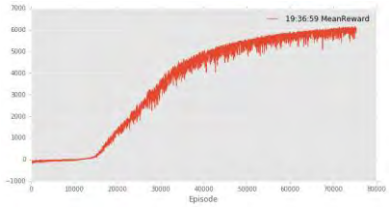

Figure 1 – Mean reward over episodes Coady (2017).

5. Further Work

In the future it would be beneficial to determine the factors that affect these divergences and how we can predict the divergences when applying this technique to predict the outcome policy for an AI robotic system.

6. Conclusions

These have yet to be determined until after testing is completed. Ultimately determining if we can adequately predict the future policies for an AI trained in the RW would be significantly beneficial for future implementation of AI robotic systems.

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Using Non-Infrared UAV Imagery To Assess The Health of Dairy Farming Pasture

Sponsor – School of Civil Engineering and Surveying & Nobelius Land Surveyors

Kristopher Stephens

Bachelor of Spatial Science (Honours) (Surveying)

Supervisors: Ms Zahra Gharineiat, USQ

Mr Benjamin Nobelius, Nobelius Land Surveyors

Keywords: Agriculture, UAV, and Vegetation Index

1. Introduction

Cell grazing involves the rotation of cattle from paddock to paddock. Drone utilisation within this setting is a relatively new an exciting prospect with a number different applications. Applications involving measuring vegetation health have traditionally relied on infrared technology, which involves modifying consumer standard UAVs.

The Visible Atmospherically Resistant Index (VARI) was identified as a reliable, non-infrared vegetation index, which could be incorporated into a drone mission. The dissertation has attempted to measure and assess its relative accuracy.

2. Background

This project is important because a UAV when paired with VARI could potentially provide dairy farmers with a time saving, cost effective method of checking their pasture health. Healthy or dying vegetation could be quickly identified and profits would be maximised. This project is not specifically surveying based but it is hoped that it will extend onto knowledge within the agricultural sector.

3. Methodology

Ground vegetation had to be physically measured for comparison to assess the accuracy of VARI. This was undertaken using a specialised ruler in a number of quadrats placed at random locations around the selected dairy farm. Figure 1 shows the field measurement technique.

Figure 1: Field Measurement Technique

4. Key Outcomes

Once the relevant background research was completed a field measurement programme was designed and the field work was completed in the allotted timeframe. The data collected was then processed successfully and analysed. Key outcomes included non-infrared index maps of the dairy farm, comparison measurements at specified locations. These were interesting because there is very little reaseach into non-infared vegetation assessment within dairy farms.

5. Further Work

Almost all aspects of the project were addressed. Initially the measurement phase included attending the dairy farm in dry and wet seasons but due to time constraints this aspect was reassessed. It was decided that one set of data would be sufficient.

6. Conclusions

The main conclusion gained from undertaking this piece is that UAVs and non-infrared indices could assist farmers when assessing overall pasture health. However more research needs to be undertaken to get a better idea of their accuracy.

Acknowledgements

Firstly I would like to acknowledge Glenn Campbell for the initial brainstorm that identified dairy farms as an area of interest. Secondly my employer, Nobelius Land Surveyors, for the use of the UAV. Finally my supervisor, Zahra Gharineiat for the support during the year.

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Sensor Development for Detection of Water Advance in Surface Irrigation

Sponsor – Centre for Agricultural Engineering

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Master of Engineering Science
Major Agricultural

Supervisors: Dr Malcolm Gillies, USQ

Keywords: *Irrigation, Sensor, Automation, Wireless*

1. Introduction

Development of sensor for detecting the water advance in surface irrigation is the main objective of the project. The Taggle advance sensor prototype is a water sensor to detect the water front in surface irrigation which was built by the Centre for Agricultural Engineering. Taggle advance sensors monitor the irrigation advance in real time which is important for precision furrow irrigation control systems. The Taggle radio receiver receives signal from the sensor and remotely stores the advance data on a web server. Advance data from the taggle advance sensor can be used to predict the optimum irrigation time, water depth, and any unnecessary irrigation water loss and helps to take irrigation decision on real time. The Taggle advance sensor prototype requires further testing and development before it is deployed commercially in the field.

2. Background

In Australia, surface irrigation is the most common method and 69% of agricultural businesses practice surface irrigation (ABS 2010). Various automation and sensors have been developed and are used in agriculture industry to save water and labour (Hibbs et. al, 1992, Gillies et al, 2017), but there is a lack of practical technology to monitor furrow water advance in real time. The data from advance sensors can be used in the surface irrigation system to increase the efficiency by predicting optimum irrigation time and applied water depth, and therefore reducing irrigation water loss.

3. Methodology

The major focus of this project is the performance testing of the prototype taggle advance sensor (Fig. 1). Each main component including the moisture sensor, Arduino board logic and taggle transmitter will be evaluated. Based on the performance evaluation data, further changes will be implemented so that the device can reliably respond to the advance with minimal false triggering. Data collected by CAE from cotton and sugar fields will be analysed to investigate the impact of variability of advance time between furrows. SIRMOD/SISCO modelling will be conducted to analyse the sensitivity to this variability and test ways to combine data from multiple sensors in a single field.

Fig. 1 - Testing the Taggle advance sensor prototype

4. Key Outcomes

Initial testing has indicated that false triggering of the device is occuring. This could be overcome through either modification of the board logic or use of a different soil moisture sensor. The prototype was evaluated to assess the effect of surrounding temperature, air and soil type with gradually added water conditions. The results show that surrounding temperature and air conditions do not affect the response. However, a sensor placed in soil did experience false triggering without adding water.

5. Further Work

Remaining further work of the project are as follows:

- developing logic algorithm
- sensitivity analysis of cut-off time to advance time of irrigation
- determining the single advance time from multiple furrow data.

6. Conclusions

Sensor will be developed which will detect the water advance in the surface irrigation. It will help farmers to predict optimum irrigation time, water depth and water losses and to take irrigation decisions.

Acknowledgements

I would like to express gratitude to my supervisor Dr. Malcolm Gilles. I am very thankful to CAE who provides equipment and tools for the project.

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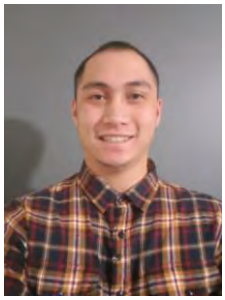
The use of a Terrestrial Laser Scanner and Visual Alignment in Urban Cadastral Surveys

School of Civil Engineering and Surveying



Christian Tanwangco

Bachelor of Spatial Science,

Majoring in Surveying

Supervisors: Dr Zhenyu Zhang, USQ

Keywords: Terrestrial Laser Scanning, Cadastre, Surveying.

1. Introduction

Terrestrial laser scanning (TLS) has been a revolutionary method in the surveying industry. It has proved its ability to accurately and precisely record high detail 3-dimensional data.

With Melbourne approaching the age of 200 years since it's foundation, a lot of buildings, from skyscrapers to town houses, are passing their time. A lot of these buildings require a detailed survey (3D nature) to allow for design and engineering and the TLS is proven to be highly optimized for this task.

2. Background

With the constant urbanization of cities, the ability to record the position of structures in relation to Title Boundaries becomes more and more apparent. For the integrity of the Cadastre only registered or licensed surveyors are to complete these types of Surveys. Traditionally measurements are completed with a Total Station. This dissertation will highlight and validate the use of a TLS in Cadastral Type Surveys.

3. Methodology

For Validation of the TLS a quantitative methodology was used. For it to be recognised as a Cadastral Survey capable instrument it's abilities must be comparable to that of a modern Total Station. This is executed in the form of a case study.

Not only must it take measurements at the same standard as a Total Stations, but it must do so whilst abiding State Survey Regulations and Legislations. To evaluate this these regulations are analysed in the form of the *Survey Practice Handbook*. Published by the Surveyors board of Victoria.

Figure 1 – Point Cloud – Eastern Rd, South Melbourne

	Easting	Northing	Error Vector
High:	0.009	0.020	0.021
Low:	-0.013	-0.010	0.001
Mean:	0.000	0.002	0.008
Std.Dev:	0.006	0.007	0.005

Table 1 – TLS vs. Total Station - Comparison in Easting and northing of 33 Cadastral Type Survey Points. (metres)

4. Key Outcomes

Upon analysing the results of the case study, it is apparent that the results from TLS are consistent to that of a Total Station. Please refer to Table 1. It is sufficiently capable of completing a Cadastral Type Surveys, but it is also apparent that the use of TLS in Cadastral Surveys may not entirely comply with the *Survey Practice Handbook*.

5. Further Work

For a TLS to be formally recognised within State Survey Legislations, outdated regulations require updating and innovative regulations must be formulated. It is not within the scope of this research paper, but it can be assumed an inevitable research topic.

6. Conclusions

The TLS is a highly capable instrument and it's use in Cadastral Type Surveys Should be recognized.

Acknowledgements

I'd like to thank Veris Ltd. Australia, especially the Melbourne team. This project would not be possible without the resources and knowledge they offered. I'd like to thank my family and friends for their help and support throughout the year.

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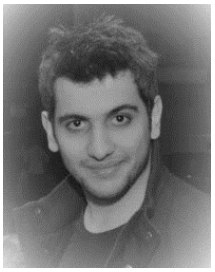
A harmonic filter design for improvement of power quality in USQ Toowoomba campus

Sponsor – School of Mechanical and Electrical Engineering



Hasan Taqi

Electrical and electronics engineering

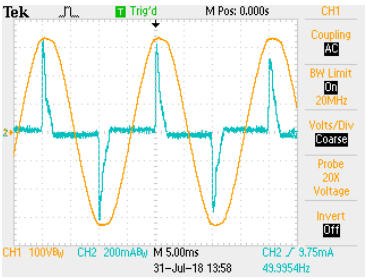


Figure 1 – Waveforms of voltage (yellow) and current (blue) of an LED lamp

Supervisors: Mark Norman, USQ

Keywords: LED, harmonics, power quality.

1. Introduction

The proliferation of LED lighting technology brings on important advantages in terms of energy conservation. The economic and environmental benefits of the LED technology have motivated replacement of incandescent and CFL light bulbs in USQ campus with LEDs. However, the non-sinusoidal current of LED lights which is originated from the LED driver circuit, may deteriorate the power quality.

In this project, the issue is investigated by studying the internal circuitry of LED bulbs and analysing their performance. A cost effective solution is proposed, in which the harmonics are eliminated by using a cheap passive harmonic filter.

2. Background

Over the recent years, power quality issues have become more significant due to the increasing use of nonlinear loads, which are characterized by non-sinusoidal currents. The non-sinusoidal current of such loads gives rise to voltage distortions. Recently, light emitting diode (LEDs) are being increasingly used as an energy efficient alternative for incandescent, fluorescent and even compact fluorescent lamps (CFLs). Unlike the other types of lighting, LED lights are operated by an electronic circuit, which produces significant amount of harmonics. Given the large number of LEDs being installed, the cumulative effect of harmonics generated by LEDs might become significant, hence causing serious problems in the electrical networks [1].

3. Methodology

The Project investigates the impact of lighting technology on the power supply quality on the USQ Toowoomba campus. To that end, the harmonic pollution generated by different types of LED lights which are installed in the campus are experimentally measured. Figure 1 illustrates the waveform of the voltage and current of an LED light. It is observed that the LED current is comprised of spikes, which implies a high level of distortion. Therefore, the harmonic pollution within the USQ campus may rise to significant levels due to the continuing installation of LED lights.

4. Key Outcomes

The experimental results conveyed in this project prove the significance of harmonic distortions generated by LED lights. To mitigate the issue, a harmonic filter must be designed and implemented.

5. Further Work

The next stage is to design a harmonic filter for mitigation of harmonics produced by LED lights. The filter may be a small module which is installed beside each LED light or a larger box designed for harmonic mitigation in the classroom/floor/building level.

6. Conclusions

The fact that LED lights degrade the power quality has been proven both mathematically and experimentally. The solution is to design a harmonic filter.

Acknowledgements

I would like to thank my supervisor for his help and support during both theoretical and experimental phases of the research.

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Evaluating the Impact of New Technology on Construction Project Performance, Methodologies and Productivity

School of Civil Engineering and Surveying

Jace Thimios

Bachelor of Construction (Honours) Majoring in Management.

Supervisors: Dr Nateque Mahmood, USQ

Keywords: Project performance, BIM, construction productivity

1. Introduction

With technology and programing advancing at a rapid rate, businesses within the construction industry must follow. Within this research the technology forecasted to influence construction are stipulated, and a statistical analysis is outlined to determine industry acceptance between demographics.

2. Background

The purpose of this study is twofold.

1. Firstly, to acknowledge the upcoming technology that will affect the construction industry and management processes.
2. Secondly, to understand the barriers we face with the implementation of new technology from the standard practice

The current research gap stems from lack of demographic consideration and Australian studies

3. Methodology

In order to establish an in depth understanding of part one, a qualitative approach was encompassed to determine what effects performance, productivity and methodology, via a substantial literature review. In order to cross reference the relation to emerging technologies, a mixed approach was formed through creating a statistical analysis of number or citing's, and relevance of citing's.

Part two used a quantitative methodology through the use of an RII structured survey to determine the consensus within the industry consensus.

4. Key Outcomes

BIM, AR and VR, are foreseen to be the next influential aspects of modern construction management within the commercial sectors (as shown in Figure 1), through further development is required within residential construction.

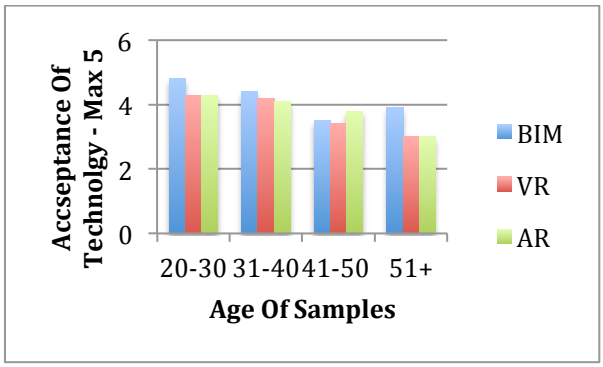

Figure 1 - Age/acceptance of emerging technology

3. Further Work

Further studies are presented to establish the reasoning behind differences of samples. Further analysis able to be performed on technology advancement for the industry to embrace the movement.

4. Conclusions

Industry professionals are not striving to implement change at an adequate rate. We must consider ways to strategize implementation.

5. Acknowledgements

I would like to thank you Nateque Mahmood for supervising me through this research process. I would like to acknowledge all survey participants for their supports.

6. References

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Sinkhole induced subsidence investigation

School of Civil Engineering and Surveying

Tyron Thomson

Civil Engineering Degree

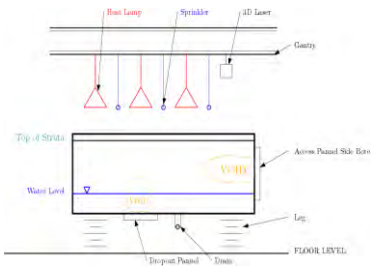

Figure 1 – Subsidence Void Test Rig.

Supervisors: Dr Jim Shiau, USQ

Keywords: *Sinkhole, Subsidence, InSAR, Prediction, Monitoring*.

1. Introduction

Subsidence and sinkholes are a significant risk to people and property. Early detection of these hidden disasters, can save lives and reduce the cost to the community.

2. Background

Currently, there is no reliable standard prediction system to locate and identify the state of subsurface voids such as sinkhole.Most sinkholes are found via costly testing, or after a collapse event.

3. Methodology

Subsidence void test was not the initial primary objective, but after looking at 'how to create an early warning system for sinkholes', it became apparent that the underlying understanding of soil dynamics based on time and weather events had not been developed.

This research leads to a possible link with subsurface stability and vertical displacement as a potential early warning system trigger event via the use of satellite surface mapping technology such as InSAR. Thus the main focus of the research to understand surface movement and underground void propagation and eventual collapse as a life cycle.

To develop the test rig concept, the analysis of emprical gelological differenced between the USA and England by Lee and Abel Jr (1983) is of the primary consideration.

Taboada and Estrada (2009) highlighted the limits to which vertical displacement can be measured and Z. Du, Ge, Li, and Hay-Man Ng (2016) showed how the dynamic properties of rock and soil can change the dynamic behaviour of strata collapse. These lead the design of the test rig shown in Figure 1.

4. Key Outcomes

Identifying a new line of geological research along that includes time, and an event-driven predictive algorithm will lead to better risk management options.

The sinkhole void test will significantly contribute to increasing level of confidence with ground movement and be used for comparison with computer simulations.

5. Further Work

The subsidence void test rig once built could first validate the principles the test rig has been designed to evaluate. Subsequently, it could then be used to establish strata reaction with respect to time and local weather simulations. This analysis then the baseline for predictive algorithms that would link weather reports, seismic activity and vertical height displacement to create an early warning system with a GIS framework.

6. Conclusions

This project illustrates the scientific approach to solve the problem of developing a sinkhole lifecycle predictive algorithm.

The standardised void collapse test will enable a standard approach to geological life-cycle computer model validation.

Acknowledgements

I would like to thank my supervisor Jim Shiau for his support and counsel.

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Smart Collision Avoidance System for mining using LTE for inter-vehicular communication

Faculty of Health, Engineering & Sciences

Chris van den Heever

BENG(HONS) Electrical and Electronic Engineering

Supervisors: Dr Alexander Kist, USQ

Keywords: GPS, LTE, CAS.

1. Introduction

This study investigates LTE performance in a mining environment and whether it could be used for Collision Avoidance Systems (CAS).

2. Background

Since 2004 GPS based collision avoidance systems have been used in mining (Maeder & Morari, 2011) but unfortunately communication technology has stagnated by relying on WiFi and GSM technologies for too long. Today we are at the dawn of new technologies such as DSRC and LTE that will soon be mandated for deployment in new cars for safety systems and more. How well will LTE work in mining? Not much is currently known about LTE performance in mining, therefore the aim of this research is to address this very important question.

3. Methodology

A privately owned eLTE network at a WA coal mine was used as test site together with two Arduino prototype GPS based Collision Avoidance Systems. The network performance such as latency and packet loss rates were recorded over a period of one month. In addition, GPS data from the Arduino prototypes were also recorded and compared with data from a high precision GPS system. Recorded weather data over the one month period demonstrates the effect of weather on LTE performance. Data analysis were done making use of Matlab, SQL scripts, Global Mapper and Google Earth. Figure 1 demonstrates one of two identical prototype CAS systems that was constructed and used for data collection.

Figure 1 – Arduino Collision Avoidance System prototype

4. Key Outcomes

The site test using two prototype Collision Avoidance Systems is a sucess. Better than expected latency results and GPS accuracies were obtained over a one month period.

5. Further Work

Following on from here, research need to be done in fast signal processing of spatial information such as Haversine algorithms and improved GPS accuracies using filtering such as Kalman filtering.

6. Conclusions

First, LTE is a great solution for the use in mining capable of transporting critical safety information. Second, the low precision GPS CAS systems is sufficiently accurate.

Acknowledgements

I would like to thank Dr. Alexander Kist for being my supervisor. I would like to mention 5G Americas (2016) for the insight into 5G development and Jeffrey et al. (2018) for the insight into the technical benefits of LTE over DSRC technology.

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Fault Analysis on Vision System of Autonomous Blast Hole Drills

Sponsors – School of Mechanical and Electrical Engineering, Rio Tinto

Shannon Veivers

Bachelor of Engineering (Honours) – Instrumentation Control and Automation

Figure 1 – Vison stream as seen by a remote operator

Supervisors: Mr Mark Phythian, USQ
Mr Michael Kellow, Rio Tinto

Keywords: PTZ Camera, functional safety changes, maintenance improvements, autonomous machines.

1. Introduction

Rio Tinto has several autonomous blast hole drills operating on multiple sites in the Pilbara, Western Australia. The vision system on these drills forms a critical layer of the functional safety system in which they operate. This research project is to objectively analyse fault data to ascertain best practice solutions to reduce lost time for repairs and maintenance to the components of this system.

2. Background

An autonomous blast hole drill operates on a blast pattern in an active mining environment. These drills need to be able to interact safely with other production machines, support vehicles and personnel on foot at all times. The vision system is used by a remote operator in Perth in conjunction with an object detection system to safely operate, shown in Figure 1.

3. Methodology

By analysing historical fault data and interviewing support personnel, common fault modes and patterns can be identified. In depth analysis will be performed on each type of failure, the probable causes, repair options and failing in the current processes.

4. Key Outcomes

Targeting these common fault modes reveals two areas of improvement and their respective solutions. Low complexity hardware faults of gears or motors and software configuration faults on the PTZ cameras. By delivering a handheld configuration tool to resolve the configuration problems for any user hardware and software the software issues on the PTZ cameras can be overcome.

5. Further Work

Key elements are:

- Adapting PTZ programming tool to purely a software tool to support new models.
- Creating a more rugged design to perform in the harsh mine environment.
- Sourcing replacement gears for the PTZ cameras to remove the bottleneck in repairs.

6. Conclusions

The PTZ camera configuration tool dramatically reduces the repair time just by reducing the complexity of the task. Also, by taking ownership and responsibility of low complexity repairs the time and cost savings can be significant, especially in remote mining environments.

Acknowledgements

I would like to thank my manager Hume Saunders and engineer Michael Kellow for proposing and supporting this project from Rio Tinto. Mark Phythian has also been of great assistance in supervising this project and offering sage advice.

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Voltage Control of Rural Networks by Virtual Power Plant

School of Mechanical and Electrical Engineering

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Bachelor of Engineering (Honours).

Major in Power Engineering

Supervisor: Assoc. Prof Tony Ahfock, Head of School (Mechanical and Electrical Engineering), USQ

Keywords: Virtual Power Plant (VPP), Load Flow Analysis (LFA), Energy Storage System (ESS), Distributed Energy Resources (DER).

1. Introduction

A Virtual Power Plant (VPP) is a cloud-based distributed combination of generators, loads and Energy Storage Systems (ESS) which are connected in a manner that allows them to operate in unison while being geographically dispersed amongst an electricity network. This research project measures network voltage changes during charging and discharging of batteries on a trial VPP on the North Coast of NSW. The area has a high penetration of Photovoltaic (PV) generation and features light loading supplied by a mix of three wire, two wire and Single Wire Earth Return (SWER) feeder construction.

2. Background

Customers within the trial area have installed incentivised ESS through a partnership with Essential Energy, Australian Renewable Energy Agency (ARENA), Reposit Power and the Institute for Sustainable Futures. This research utilises the infrastructure and aggregator control systems to measure the voltage regulation capability of power dispatch used as means to defer or avoid major network investment.

3. Methodology

A series of active power charge and discharges, termed dispatch tests are performed. The VPP aggregator software is used for scheduling and voltage recording devices are used for measurement at various locations within the trial network area. Real world testing is compared against load flow analysis to verify simulation against measured behaviour, a sample of which is seen in Figure 1. A model is used to simulate scenarios which use both active and reactive power.

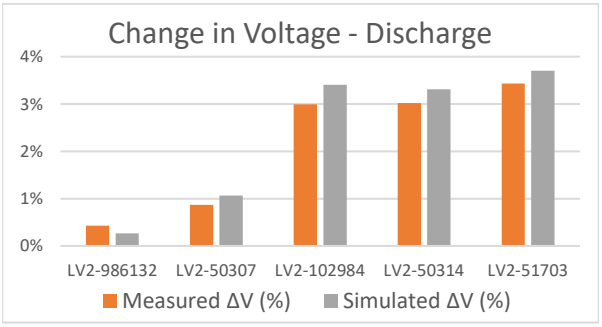

Figure 1 – Comparison of Measured and Simulated Results

4. Key Outcomes

Real world VPP testing confirms active power dispatch can be utilised for voltage regulation on high resistance rural networks. Reactive power dispatch expands voltage control on areas with low resistance supply. Load flow analysis is used to construct a voltage sensitivity matrix which can be used to optimise member commitment.

5. Further Work

An increased reliance on low voltage asset data accuracy in distribution networks is identified for accurate modelling of VPP behaviour. An algorithm to optimise unit commitment and automate VPP response to network constraints is essential.

6. Conclusions

A VPP is a viable and cost effective means of addressing voltage constraints on rural networks. Strategic member placement is key in achieving maximum voltage regulation value.

Acknowledgements

Essential Energy for the opportunity to use network assets for research purposes and Assoc. Prof Tony Ahfock for countless hours of supervision feedback, suggestions and discussion.

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Mechanical Behaviour of Wagners Composite Bridge Decking under Point Load Testing

Sponsor – Wagners Composite Fibre Technology WCFT

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School of Civil Engineering and Surveying

Supervisors: Prof Karu Karunasena, USQ
Mr James Burke, WCFT

Keywords: Composite Fibre, Bridge Decking, AS5100

1. Introduction

Composite fibre materials are set to become the material of the 21st century with Wagners Composite Fibre Technology leading the way with their structural grade composite fibre members. Composite fibre materials are quickly becoming a more viable option as the technology advances, costs become lower and as the industry becomes more aware of the impressive characteristics of the material.

2. Background

Many traditional structures across modern society are reaching the end of their life span, Infrastructure leaders are seeking a longer-term solution, and that's where composite fibre materials stand out from the rest. Composite materials have an extremely long design life, significantly low maintenance cost and offer a superior strength to weight ratio. This particular research project is investigating the mechanical behaviour of WCFT 125 Bridge Deck, which is set to replace traditional steel and concrete road bridges

3. Methodology

Firstly, a prototype of the bridge deck panels was manufactured. It was then subjected to a large variety of loadings in accordance with AS5100 (see figure 1). The results were then analysed and compared to those found in the theoretical model to validate the results. The information collected was then used to determine the span specification and deflection limits achievable of the product.

4. Key Outcomes

The project helped develop a clear understanding of the strengths achievable by a glass fibre reinforced polymer (GFRP). The results showed an impressive strength to weight ratio, with the decking able to withstand the heaviest loads under the conditions of SM1600. When the loads were applied the decking acted in an elastic manner with the failure point yeilding gradually. The material acted in a predictable way in which the physical tests agreed very closely with those predicted in a finite element model. The decking structure is able to withstand high loads but does so with higher than expected deflections.

Figure 1: WCFT 125BD Under Loading

5. Further Work

The project has laid the ground work to bring Wagners Composite Fibre Bridge Decking to the market. The work completed has opened up an opportunity where WCFT 125BD is being used to construct two road bridges for the Armidale City Council. Remaining future works include fatigue testing to determine the durability, and testing of the bond between a wearable bitumen spray seal to the surface of the decking.

6. Conclusions

In conclusion the project clearly identifies the impressive strength characteristics of glass fibre reinforced polymers for road infrastructure, which opens up new possibilities for the product.

Acknowledgements

I would like to thank WCFT for allowing me to conduct my research with their product. Special thanks go to James Burke for his expert assistance through the project.

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Use of small sphere targets to georeference Terrestrial Laser Scan, Photogrammetry and Total Station point clouds within a rail corridor environment

Faculty of Health, Engineering and Sciences

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Bachelor of Spatial Science

Supervisor: Dr Xiaoye Liu, USQ

Keywords: Sphere target, laser scanning, photogrammetry.

1. Introduction

A large array of survey target varieties exist which require skilled personnel to set up every time spatial data is collected. The costs associated with this continual process could be minimised by the installation of permanent targets which can be utilised by all types of measurement instruments and software. The installation of permanently mounted sphere targets, measureable from any angle of incidence is one potential solution to this problem.

2. Background

This research project attempts to discover what limits the use of small sphere targets when used to georeference Total Station, Photogrammetry and Terrestrial Laser Scan (TLS) data when used within a rail corridor. The discoveries may provide an insight into what improvements to future spatial data measurement technologies will be required to enable the use of a small sphere target control network.

3. Methodology

A control survey incorporating the sphere targets was established using total station reflectorless measurements. Baseline measurements were made to specific features typically of interest in rail corridor surveys. Terrestrial laser scanning data and photogrammetry images where then collected throughout each site and point clouds produced. The]point clouds were interrogated to determine the centroid coordinate of each sphere and the coordinates of each specific feature point which was then compared to the total station baseline points. Please see Figure 1 for an example of a sphere target.

Figure 1 – Sphere Targets

4. Key Outcomes

Total station and TLS measurements to the sphere targets were of acceptable quality only at short ranges. Use of sphere targets to georeference photogrammetry was possible but the quality of the outputted point cloud was poor.

5. Further Work

Measurement equipment and software not used in this project may provide more useful results. Mobile laser scanning or UAV methods may be able to utilise regularly spaced sphere targets.

6. Conclusions

Total station, TLS and photogrammetry methods are able to utilise small sphere targets only at short ranges which is impractical for rail corridor surveys. Future advances in measurement equipment and software may warrant the use of small sphere targets.

Acknowledgements

I would like to thank Dr. Xiaoye Liu for supervising my project and my manager Fergus Stokes for providing me with time and equipment.

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Analysis of a Thermal Oxidiser Systems' Behaviour using Numerical Methods

School of Mechanical and Electrical Engineering

William Whittle

Bachelor of Engineering

(Mechanical)

Supervisors: Dr Ruth Mossad, USQ

Mr Steve Sullivan, Pyrocal Pty Ltd

Keywords: Thermal Oxidiser System, Finite Element Analysis, Thermal Expansion

1. Introduction

Many industrial processes are the cause of hazardous pollution via volatile organic compounds (VOC). Thermal oxidising systems are systems designed to combat this pollution through the combustion of the VOC's at high temperature. Pyrocal Pty Ltd currently utilise a thermal oxidiser system which experiences thermal expansion due to the high temperature operation required. Thus, the project's aim is to analyse the current thermal oxidiser system and propose a method of controlling and reducing the consequences of the thermal expansion, and extending the overall length of the thermal oxidiser.

2. Background

Whilst the system operates acceptably and efficiently, it is of significant interest for Pyrocal Pty Ltd to continually analyse and improve the systems design. Currently, there is an existing knowledge gap in the industry on the behaviour of thermal oxidiser systems due to the high operational temperatures and filling this gap provides many benefits to Pyrocal Pty Ltd for future improvements of the thermal oxidiser system.

3. Methodology

The analyses of the current system were completed using the Autodesk Nastran In-Cad package. Firstly, the required geometry was generated. Appropriate boundary conditions (loads and constraints), mesh and surface contacts were applied to the model, and the model was run using a combination of linear steady state heat transfer and linear static analyses. This procedure was also utilised for the analyses of proposed designs. The results were then observed to determine the behaviour of the system.

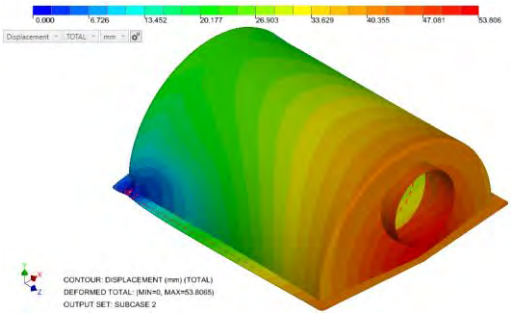

Fig. 1 – Displacement (mm) Due to Thermal Expansion of the Current Thermal Oxidiser System

4. Key Outcomes

Steady state simulations were run for the current system at operational conditions which shows the behaviour expected when in operation (Figure 1). It was noticed that despite being pinned (fixed in the Z axis) at two locations, expansion occurred in both the positive and negative z direction. The observed behaviour has allowed for proposed designs to be constructed, featuring modifications such as a cylindrical oxidiser shell and sliding duct joints for extending the overall length by connecting individual oxidiser units.

5. Further Work

The results of several proposed thermal oxidiser system designs are to be analysed. The final proposed design will provide insight into acceptable methods of improving the current thermal oxidiser system.

6. Conclusions

The results obtained provide vital information for future modifications and improvements to the thermal oxidiser system. Furthermore, the results obtained provide new information on the behaviour of the system which was not available to Pyrocal Pty Ltd previously.

Acknowledgements

I would like to thank my supervisors Ruth and Steve for their continual guidance and assistance throughout this project. I would also like to thank Pyrocal Pty Ltd for the opportunity to undertake work on this project. Lastly, I would like to thank my family and friends for their support.

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Simple communication mesh for disaster zones

Sponsor – School of Mechanical and Electrical Engineering

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Bachelor of Electrical & Electronic Engineering

Supervisors: Dr Andrew Maxwell, USQ

Keywords: Mesh, communications, ISM, LIPD, Peer-to-Peer.

1. Introduction

When hurricane Maria ravaged the Caribbean island nation of Puerto Rico in September 2017 it left a trail of destruction, damaging key public infrastructure and that left the public services overwhelmed. During the crisis rescue and aid efforts through out the island nation were hampered by a lack of communications.

In order to support the delivery of aid to those in need the Red Cross called on the American Radio Relay League (ARRL), the organisation governing amateur radio operators in the united states to help. The ARRL sent volunteers to Puerto Rico to help the emergency service and aid workers establish the lines of communications needed for their operations. However, this still left a communications 'black hole' for civilians in Puerto Rico wanting to contact their loved ones and let them know they were safe or otherwise.

2. Background

When natural disasters and conflict strike one of the first services to collapse are the telecommunications networks. Sensitive communications infrastructure like radio towers, buried cables and power infrastructure are easily damaged leading to long term communications outages. When communications is restored by government and aid agencies it is for their exclusive use and not extended to the general public.

3. Methodology

The aim of this dissertation is to investigate the requirements, and develop a simple to deploy communications system to restore basic communications to the general public during a disaster situation. In investigating the requirements a literature review will be completed focusing on legal requirements and the band width requirements of various voice and data communications protocols. Using this information I intend to develop a communications protocol capable of transmitting the volume of data needed to maintain limited communications for persons in a disaster zone.

4. Key Outcomes

After examining the existing text and voice communications protocols, it was evident that the server to host nature of these protocols was to overhead intensive for a low power mesh network. The goal of my thesis is to device a true peer to peer communications protocol that will allow democratised communications between citizens in a crisis.

5. Further Work

The concept of operations could be applied to other protocol stacks, for example WiFi. A future studies should involve making the application network agnostic.

6. Conclusions

The need to communicate is fundamental to the development of community and self. In times of crisis this need can be compromised, jeopardising the communities recovery. My dissertation provides a simple communications means to aid in the recovery.

Acknowledgements

I would like to thanks the University of Southern Queensland for providing the topic for my dissertation, and to Andrew Maxwell for his support in defining the topic.

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Residential Feature/Contour Survey Using the Trimble SX10

School of Civil Engineering and Surveying

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Bachelor Of Spatial Science

(Surveying)

Supervisors: Dr. Zhenyu Zhang, USQ

Keywords: Trimble SX10, Contour Survey, Scanning

1. Introduction

Topographic surveys go by many names, contour plans, detail survey, and feature surveys to name a few. It is an everyday type of survey that consists of locating the details of a site such as existing structures, vegetation, adjoining properties and the contours (slope of the land), which is used mainly for design of buildings. The level of detail needed varies from site to site and can become somewhat tedious measuring each feature one point at a time, with the survey information ending up sparse in nature. With the new technology of the Trimble SX10 which incorporates scanning and photogrammetry functions into a total station, this dissertation is to evaluate the SX10 functionality conducting residential Feature / contour plans.

2. Background

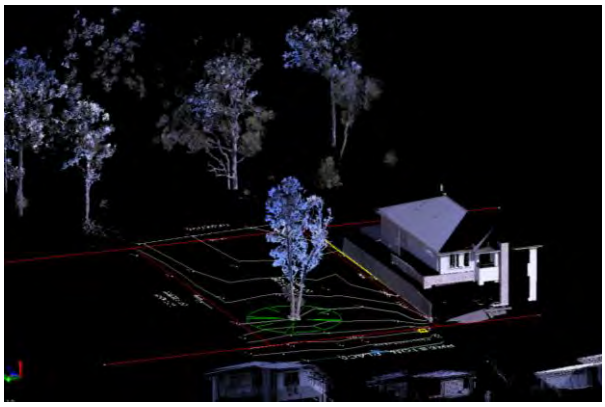
With the Trimble SX10 combining the 'Traditional' Total station with a Laser Scanner and photogrammetry function, this new technology should reduce the time in the field, whilst maximising the amount of data collected and at the same time removing most of the manual single point measurements. The use of point cloud data is seen also to reduce the office drafting time with the cloud data automatically representing the site features without further drafting required such as joining line strings and single point data.

3. Methodology

The methods used to undertake this research was to compare the time and accuracy of a topographic survey using a traditional survey method of a Trimble S3 Total Station and surveying the same site with the Trimble SX10. The results of the 2 surveys analysed and comparing Key features such as; Wall Offsets to Boundary, Lengths of walls, Point coordinates X,Y,Z, Scanning Times, Photo point accuracy etc.

4. Key Outcomes

The scanning results were based on the coarse setting approx 30mm spacing @ 40m. This is due to keeping the time down in line with traditional survey methods. Although the coarse setting whas used, the results were



all under 10mm comparitivly to tradition survey methods. This result is well within the range expected for this type of survey. The accuracy of the computed photo points was suprisingly similar as the scanning results.

5. Further Work

With all survey work, line of sight is paramount in helping reduce the time in the field and it is no different with scanning or the SX10. Testing on more complex sites would be beneficial as well as development of a scanning roving device like that of the Trimble V10

6. Conclusions

With accuracy and time of the Trimble SX10 with in reasonable limits the instrument is very useful undertaking topographic surveys, especially making use of the combination SX10 functions, the best result in the end was a plan integrating both scanned and traditional survey methods. Which can be done solely with the SX10 (See figure 1 above.)

7. References

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FIRST EXPERIENCES WITH THE TRIMBLE SX10 SCANNING TOTAL STATION
FOR BUILDING FACADE SURVEY

8. Acknowledgements

I would like to thank DR. Zhenyu Zhang, USQ and my Family.

Effect of Variable Speed Drives on Power Station Boiler Feed Pump Operation

Sponsor – Stanwell Corporation (Tarong Power Station)

Michael Winter

Bachelor of Engineering (Hons) [Electrical/Electronic]

Supervisor: Catherine Hills, USQ

Keywords: Energy Efficiency, Boiler Feedwater Pumps (BFP), Variable Speed Drives (VSD).

1. Introduction

For coal fired power stations auxiliary energy consumption, that is the power required to run all the internal processes required for electricity generation, is one of the largest contributors to costs and losses of power production. Improving efficiency in auxiliary power usage not only reduces operational costs but also reduces the emissions generated by the station.

2. Background

The Boiler Feed Pumps (BFP) are the largest single contributor to this auxiliary power usage. They are used to recirculate water back to the boiler drum after it has been used to drive the turbines. The existing BFP's use hydraulic couplings for speed control which are known to be extremely inefficient. Replacing these with Variable Speed Drives (VSD) has the potential for significant gains in both efficiency and operational capability of the BFP's. However there are substantial capital costs up front required to do this.

3. Methodology

A detailed literature review was conducted to understand the effects of efficiency gains on the auxiliary power usage for power stations and in particular those on boiler feed pumps, and to develop an understanding of VSDs, pumps and the feedwater system operation to allow the development of a BFP model using VSD. Using this model to run simulations of a variety of plant operating scenarios it is hoped to determine if the efficiency gains from using a VSD will be enough to justify the capital expenditure.

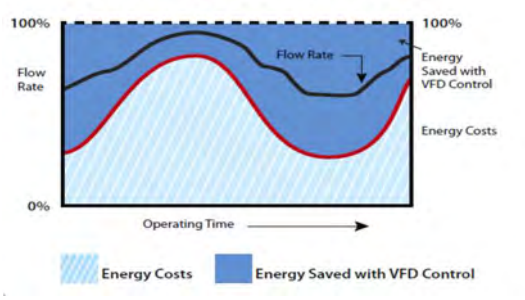

Figure 1 – Energy Savings of using VSD for BFP Control (Rockwell Automation 2013)

4. Key Outcomes

From the research and literature review there is clear evidence of the benefits in both cost savings and reduced emissions from the efficiency gains of using VSD on the BFP's for speed control (refer figure 1). Both ABB and EPRI go as far as indicating the potential breakeven point could be as little as two years depending on the situation and operational scenario.

5. Further Work

Complete the model, analysis of the data, and the development of a budget costing for the installation of VSD for BFP control. This information could then be used in future work analysing the other major drives involved in the auxiliary power usage of the station.

6. Conclusions

While the literature review identified clear efficiency gains in using VSDs for BFP Pump Control the ultimate question still remains do the efficiency gains of the VSD justify the capital cost of its installation in this application.

Acknowledgements

I would like to thank Catherine Hills, USQ for her support, guidance and patience without which completion would not have been possible. Also thanks to my Stanwell for sponsoring the thesis and to my wife and daughter for their understanding and support.

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Evaluating the suitability of reflectorless electronic distance measurement for various natural and built environments

Sponsor –School of Civil Engineering and Surveying

Robert Winter

Bachelor of Spatial Science

(Surveying)

Figure 1. Manufactured supporting bracket

Supervisor: Prof Kevin McDougall

Head of School (Civil Engineering and Surveying), USQ

Keywords: reflectorless, accuracy, EDM

1. Introduction

Reflectorless technology has driven innovation in the industry in the past two decades and is now typically a standard feature in modern total stations. However, Holley et al. (2011) reports a significant lack of knowledge and confidence in its application across the industry. Reflectorless technology facilitates considerable benefits in terms of safety and efficiency and therefore understanding its potential and limitations is of significant importance to the surveying profession.

2. Background

There is extensive existing research into the accuracy of reflectorless measurements. Key parameters that influence the accuracy of a measurement are identified as range, angle of incidence and size, shape, colour and material of the target (Kowalczyk & Rapinski, 2014). However, none of the existing research examines the influence of the laser wavelength. Total stations typically operate in either the red visible or near infrared band of the electromagnetic spectrum. Both bands have distinct properties which influence its interaction with an environment. Accordingly, it is feasible that two measurements to the same target using two different wavelengths will return different results.

3. Methodology

Reflectorless measurements will be made to a variety of objects under a variety of controlled environments and compared to prism measurements (control data). Fundamental to the success and efficiency of this testing regime was the design and manufacture of the tribrach adapter supporting bracket shown in Figure 1. The bracket enables each target material to be accurately located and rotated about the centre point of the control data coordinates. The second stage of the methodology involves the reflectorless measurement of various natural and built surfaces in simulated field conditions for comparison against prism-obtained control data.

4. Key Outcomes

The key outcome of this study is to determine the suitability of reflectorless observations for a variety of surveying applications. In particular, to quantify the expected accuracy for various scenarios and provide recommendation for the utilisation of reflectorless technology.

5. Further Work

Further comprehensive testing and analysis is required to achieve the study outcomes. It is hoped that this study may form the foundation for further research into the possibility of correction factors for reflectorless observations.

6. Conclusions

Initial reconnaissance and testing has confirmed that angle of influence will be a significant influence on accuracy. Further testing and analysis is required to determine the influence and magnitude of other parameters.

Acknowledgements

I would like to thank Prof Kevin McDougall for his guidance and my family for their patience and support.

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Use of Waste Car Tyre in Pavement Construction

School of Civil Engineering and Surveying

Hwa Khai Yong

Bachelor of Engineering (Honours) – Civil Engineering major

Supervisors: Dr Andreas Nataatmadja, USQ

Keywords: Waste car tyre chip, soil stabilisation, expansive soil, pavement, subgrade strength.

1. Introduction

Millions of tons of waste car tyres (WCT) are generated from cars around the world. Recycling companies are reluctant to recycle WCT due to lack of economy incentives because of its low rubber contents. In addition, recycling WCT often involves complex mechanical and chemical processes to rejuvenate the rubber in order to be useful. Therefore, the potential pollution of the environment due to discarded care tyres is significant.

2. Background

Crushing is a process of shredding the WCTs into smaller fragments in the form of strip, chip, pellet, crumb, and powder. These small fragments are called shredded tyres. This research project focus on the form of WCT chip (WCTC) mixing with expansive soil to form a soil composite.

3. Methodology

The research is based on experimental methods according to Australia Standards – AS1289. Tests conducted are Liquid Limit and Plastic Limit, Soil Compaction and Density, Particle-size Distribution Curves, California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) and swell tests. WCTC with 13.2mm and 9.5mm nominal sizes are chosen because of the minimal fibre fragment contents. Two expansive soils obtained from Department of Transport and Main Roads are chosen to be mixed with the WCTC.

Table 1 – Initial Data

Expansive Soil	A	B
Plasticity Index	46	19.5
OMC	22.8%	38.4%

4. Key Outcomes

Table 1 shows the basic characteristics of two expansive soils from SE Queensland, which will be mixed at their OMCs with WCTC in saturated surface dry states.

5. Further Work

The soil composites from Table 1 are to be tested for their CBR and UCS values, and to analyse their swelling potentials, strengths and suitability for pavement subgrade improvement. The CBR test will determine the swelling potential and saturated strengths. The UCS test will determine the undrained compressive strength. The use of WCTC should lead to an improvement of the subgrade strength.

6. Conclusions

Soil composites with CBR of at least 5% would be useful for pavement subgrade. Successful soil stabilisation with WCTCs would largely reduce the potential pollution of our environment and provide significant economic benefits.

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Speech Analysis for Identification of Emotion

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1. Introduction

Emotions play a significant role in expressive speech. The emotional state of a speaker is demonstrated by physiological signs, in the form of changes in respiration, phonation and articulation.

This research project examines whether it is possible to identify distinct aspects of speech samples to represent varying emotion in speech by examining the prosodic features of each emotion.

2. Background

Speech analysis has typically used specific algorithms to detect features in samples to link a speaker to their sample (Juslin, and Scherer, 2008). In particular, parameterisation of samples using Linear Predictive Coding (LPC) and Mel Frequency Cepstral Coefficients have had success in speech analysis (Hess 1983). These parameterisations are used to identify and distinguish features. These features can then be used to classify samples according to speaker. This research project continues with this theory, applying the above techniques to determine if speech samples can be classified according to one of eight emotions.

3. Methodology

In this research project, the classification of emotion in speech is divided into four stages, silence removal, speech sample pre-processing, feature extraction and emotional classification.

Feature extraction was completed using several parameters, all outputting different results. The most basic parameter was calculating the mean and standard deviation of a reference set of six files and comparing this to each of the unknown files, showing mixed results. The most accurate parameterisation was the calculation of 18 LPC for each reference set, and measuring the distance of each of these to the coefficients of each unknown file using the Mahalanobis measurement, see Figure 1 for details.

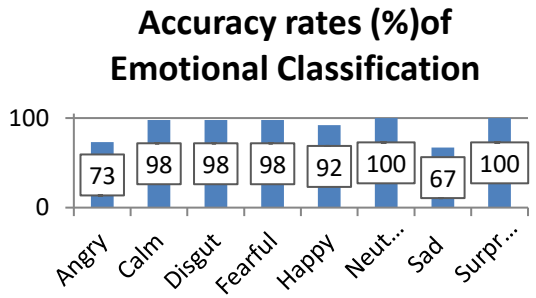

Figure 1 – Results showing accuracy in percent of classifying 48 files for each emotion using LPC parameter

4. Key Outcomes

This project has had outcomes demonstrating that paramenters used in speech identity recognition can be applied to classifiy speech samples into specific emotions. The most successful parameter was the LPC, with the results shown in Figure 1. By applying the LPC parameter to the speech samples, general features of each emotion were able to be extracted to allow unknown samples to be compared and classified into the correct emotion in up to 100 percent of the cases.

5. Further Work

Further work in this area could be undertaken in order to be able to more accurately identify the remaining two emotions. The techniques used in this project could in the future, also be used to layer emption onto computer generated speech for a more realistic interaction with computer machines.

6. Conclusions

Through the research conducted in this project, it was shown that it was possible to classify speech samples according to emotion. Although the results generated were not accurate in 100 percent of cases, the method used provided an appropriate accuracy level.

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