ABSTRACT APRIL 17-19, 2017, PORT MORESBY, PAPUA NEW GUINEA

1.0 INTRODUCTION

An integration of an ethylene plant with Papua New Guinea Liquefied Natural Gas plant utilizing available ethane produced from the LNG processing plant is proposed. The ethylene plant is to be constructed at Konebada Petroleum Park close to the PNG LNG processing plant. Current feasibility studies show that about 1.3 MTPA ethane as feedstock is required. And this is feasible, viable and economical for PNG.

The proposed ethylene plant capacity is 1 MTPA and its petrochemical derivative Liner Low Density Polyethylene (LLDPE) and High Density Polyethylene (HDPE) plants are targeted at producing 0.636 MTPA LLDPE and 0.278 MTPA HDPE respectively for sale both locally and internationally to produce finished polyethylene products. The balance of 0.086 MTPA will be other saleable by-products. PNG will have the largest integrated ethylene plant in the Pacific region. And PNG’s location in marketing the ethylene products is central and an eye opener to Asian and Pacific island countries.

Economic evaluation indicates that the proposed integrated ethylene, LLDPE and HDPE plants are promising. The net present value (NPV) calculated is US$1,163.23 million with a payback period of 10 years. The positive NPV indicates that the benefits of this proposed project outweighs costs. Therefore the project is considered viable.

2.0 BODY

2.1 Innovation

Project Title: Integration of an ethylene plant in PNG

Project Location: Konebada Petroleum Park

The proposed PNG Ethylene Plant to produce ethylene at a rate of 1 MTPA. Ethane feedstock of 1.273 MTPA piped to the ethylene plant from PNG LNG Plants. And 0.7 MTPA ethylene piped to the Liner Low Density Polyethylene (LLDPE) plant to produce 0.636 MTPA LLDPE. Another 0.3 MTPA ethylene piped to the High Density Polyethylene (HDPE) plant to produce 0.278 MTPA HDPE. And the balance saleable by-products.
Table 1 Integrated Ethylene Plant largest in the Pacific Region

<table>
<thead>
<tr>
<th>Plant</th>
<th>Location</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene Plant</td>
<td>Konebada Petroleum Park, Central Province, PNG</td>
<td>1 MTPA</td>
</tr>
<tr>
<td>LLDPE</td>
<td>Same area-integrated</td>
<td>0.636 MTPA</td>
</tr>
<tr>
<td>HDPE</td>
<td>Same area-integrated</td>
<td>MTPA</td>
</tr>
<tr>
<td>Other Saleable by-products</td>
<td>Same area-integrated</td>
<td>0.086 MTPA</td>
</tr>
</tbody>
</table>

Summary Description of Project

- Integration of an ethylene plant with PNGLNG Plant.
- Project involves integration of ethylene plant, linear low density polyethylene plant (LLDPE) and high density polyethylene plant (HDPE).
- Ethane as feedstock from PNGLNG Plant of about 1.3 MTPA.
- Design: Ethane converted to ethylene in six main processing steps; cracking furnace section, quenching section, compression & acid gas removal section, drying/deethanization/acetylene hydrogenation section, chilling & demethanization section, and product separation section.
- 0.7 MTPA ethylene goes to LLDPE plant to produce 0.636 MTPA LLDPE.
- 0.3 MTPA ethylene goes to HDPE plant to produce 0.278 MTPA HDPE.
- Other saleable by-products.
- Downstream processing of PNG gas condensates.
- This project is in line with PNG government’s vision 2050 pillar 2 “Developing Our Resources & Creating Wealth”, growing petrochemical industries and opening up business spin off activities in PNG.
- Commercialization of our natural gas condensates from existing gas fields.
- Developing petrochemical industries and so opening up business spin off activities.
- The integrated ethylene plant project would create about 10,000 construction jobs and about 6,000 permanent workforce.

Estimated Project Implementation Period: 2 – 3 years

<table>
<thead>
<tr>
<th>Summary Estimate Project Cost (kina)</th>
<th>Proposed Project Funding Source (kina)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment: 8 600 000 000 (FCI)</td>
<td>Donor Source: 5 500 000 000</td>
</tr>
<tr>
<td>Capital works: 2 400 000 000</td>
<td>Government Grants: 5 500 000 000</td>
</tr>
<tr>
<td>Total Capital Investment: 11 000 000 000 (TCI)</td>
<td>Total Capital Investment: 11 000 000 000(TCI)</td>
</tr>
</tbody>
</table>

2
### 2.2 Sustainability

Possible risks and management table

<table>
<thead>
<tr>
<th>Risks</th>
<th>Consequences</th>
<th>Probability</th>
<th>Risk Rating</th>
<th>Risk Management Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Political/Administrative Support</td>
<td>Likely</td>
<td>Unlikely</td>
<td>Likely</td>
<td>All clients should communicate effectively and work collaboratively to achieve the objectives.</td>
</tr>
<tr>
<td>Low capacity of key personnel</td>
<td>Likely</td>
<td>Unlikely</td>
<td>Likely</td>
<td>✓</td>
</tr>
<tr>
<td>Land not secured</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Lack of community support</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Poor transportation</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Process design operation and maintenance</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>Process design and facility is of world class and we anticipate no problem or minimal problems in these risk areas.</td>
</tr>
<tr>
<td>Checking pipelines for possible ethylene leakage</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Ongoing OHSE training for staff</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Ensure emergency evacuation team/firefight</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Processing facility closed system</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Workplace hygiene promoted/maintained.</td>
<td>Low</td>
<td>Unlikely</td>
<td>Low</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Project Benefits**

- PNG Government and people of this country.
- Infrastructure development, education & national content plan, improve standard of living, economic and business spin off activities.

**Technical Aspects**

- Environmental Impact Assessment, Economic Assessment, and selection of technology to build the plant.
- Policy change in owning certain percentages of our natural gas condensates.
- KPHL and Operator Company to own and responsible for infrastructure, equipment and materials that comes out of the project.

**Cross-cutting issues**

- Project is environmentally friendly because it is natural gas.
• Environment Impact Assessment necessary.
• Project will be fair to all, no gender issues and related negative impacts.
• Project will consider a national content plan.

2.3 Collaboration

Institutional Capacity of Implementing Agency

• PNG Government (KPHL) and contractor (operator) to implement the project.
• The world leading ethylene plant constructor – Lumus/Toyo technology will implement the project.
• Lumus Technology current capacity is 1.4 MTPA ethylene plant capacity. We are proposing to build 1 MTPA ethylene plant capacity.
• Lumus Technology has the manpower and technology, and rates 21% ethylene plant constructor worldwide.
• Lumus and Toyo Technology combined rates 40% globally.
• Operator 50% owned and 50% government and local companies owned.

The financial funding sources recommended and to consider are;

• Asian development Bank (ADB).
• Australia Commonwealth Bank.
• International Monetary Fund (IMF).
• PNG Government and local companies.

CONCLUSION

Based on the results obtained from the discounted cash flow analysis, the economics of the proposed integrated ethylene, LLDPE and HDPE plants are promising. The base case discounted cash flow analysis yielded a NPV of US$1,163.23 million with a payback period of 10 years. At the projected end of the facility’s 25 year’s operating life IRR is 10.94%, MIRR is 11.49% and the ROI is 9.57%.

The NPV of the facility is positive which suggests that the project provides a return at a rate greater than the discounted rate of 8.0%. Therefore the results of this economic evaluation on the 1.0MTPA ethylene plant and derivative LLDPE and HDPE plants are encouraging.

Attachments:

Business Proposal for integrated ethylene plant
Economic Evaluation
Ethylene Plant Equipment Design & Tag List
Abstract By: Nick Kuvida

TITLE: USING CLEAN TECHNOLOGY MECHANISM TO CONTROL & REDUCE POLLUTION.

Increasing trends in global pollution rates are a direct result of domestic and economic activities compared to pollution caused by the natural activities. Global pollution is mainly influenced and encouraged by human activities that require daily application of technologies for sustenance of global economic growth and flows to meet the demands of growing population. Nevertheless, having not considering the harmful effects it will have on our planet and general environment, our planet earth is being squeezed to become vulnerable to threats and we have been filling up the atmosphere with pollution.

Apart from land and sea pollutions, air pollution from burning of fossil fuels release huge quantities of carbon dioxide directly into the earth’s atmosphere can be fatal which the entire globe is already experiencing the consequences of our own ignorance. Daily reports prove that other developed countries of the world like China, Japan, India, America and Britain are some of the major contributors to air pollution which in recent year, newspaper publication showed carbon emissions in China and Japan raised serious concerns where people were forced to be given gas masks to survive on oxygen. Such giant industrial nations heavily relying on technology require policies that will help guide industries to adopt and apply clean technology mechanisms to control direct carbon emissions from major plants and factories into the earth’s atmosphere to help reduce air pollution. This clean technology mechanism policy can be made effective and efficient and generally accepted into the waste disposal and management system by industries. The idea of keeping carbon emissions relatively low every time as to regenerate and create clean healthy air, free from air pollution has been made possible in some countries with some great achievements through innovative ideas, new designs and inventions replacing old methods and techniques widely used by industries worldwide. This has already been made possible paving the way for solar powered car engines to operate on batteries and hydrogen without the use of fossil fuels and other possible ways to help control and reduce carbon emissions from major industries.

PNG in the next 20 - 50 years or so, may experience air pollution from direct carbon emissions from LNG plants, canneries, palm oil mills and explosions in new mining activities in other parts of the country like Port Moresby, Lae and Madang. PNG needs to have a policy in place to control and monitor economic activities of industries including domestic activities in PNG guiding experts in the engineering and technology fields work on having clean technology mechanism sustainable and environmental friendly. There are alternative options PNG can adopt and apply as early as possible to have complete control over air pollution is to revisit waste disposal and management systems used by industries. With advanced technology, PNG can achieve such milestone by replacing old model engines/chimneys that encourage direct carbon emissions and come up with new inventions and devices that can trap cool and freeze carbon spews from factories and plants.
ABSTRACT

TOPIC: HELA PROVINCIAL ROAD TRANSPORTION NETWORK PLANNING THEORETICAL NOTIONS
INTRODUCTION

Mobility is undergoing constant change, in terms of both volume and spatial patterns. The traffic infrastructure has to respond to this continual process of change. Where bottlenecks emerge, improvements can be made from a whole palette of measures, varying from traffic management and pricing to the expansion of capacity in stretches of road and junctions. This kind of bottleneck-oriented approach has offered some degree of solace for some time, but occasionally the need arises to completely review and rethink the whole structure of the network:

**Does the existing structure come to terms with changing mobility patterns and is it sustainable?**

Is structural modifications necessary, such as a reconsideration of the categorizing of roads and the associated road design, expanding the robustness of the network, disentangling traffic flows, or changing the connective structure of urban areas? In other words: there is a need to redesign the network.

BODY

The methodology has been developed for the integral design of the transport networks of different modalities. In this the focus lies on networks on a regional scale that has following key features:

1. Basis of the analysis, separate from the present infrastructure, an ‘ideal network’ is designed.

2. Design occurs together with the stakeholders on the basis of clear, practicable steps.

This function of the ideal network is providing a long-term horizon within which short term measures have to fit.

By reducing the theoretically highly complex design problem to a number of successive design steps or decisions, this methodology provides insight and is applicable in practical situations. What is important in this respect is that for each step there is commitment from the stakeholders before the next step is taken. It is, then, most effective when the methodology is used in a workshop-type situation whereby these parties themselves participate in the design process.
The result of the methodology is that stakeholders gain a clear picture of the crucial dilemmas and decisions. This methodology prevents thinking in terms of end solutions. Instead, the functions of the different parts of the network can be analysed in terms of whether they actually fulfil the functions for which they were designed or to which they are now assigned. Analysis may result in a whole palette of possible recommendations, function adjustment coupled to modification of the road design and disentangling or expanding existing connections, to the construction of new junctions or new connections.

CONCLUSION

The approach described is based on a classification of transport systems (ECMT 1998). This classification is used to emphasize that what matters is the quality that is offered, not the modes and technologies used. It distinguishes five levels of scale (represented by their trip length) and two different types of organization (individual or collective transport).

Designing successful transportation networks requires more than the application of the functional classification. In order to assist stakeholders in the design process, a step-by-step design process is to be set up which can inform stakeholders exactly what to do, merely a framework within which they make decisions.
ABSTRACT
Tony Morisause

Fibre optic technology—a sustainable innovation for PNG ICT needs

A robust, reliable and high capacity telecommunication network is a fundamental catalyst for socio-economic development in Papua New Guinea. But the current networks lack capabilities to meet this expectation. Most network infrastructure are wireless and have limited transmission capacities, restricting the transmission of voice, data and internet traffic in the country and on the international links. Wireless networks that have sufficient carriage capacity often suffer from signal degradation, resulting from atmospheric propagation losses and prohibitive environmental conditions. The increasing need to provide online health, education and other government services, coupled with the need to exchange huge data files between data centres, on newer platforms like cloud computing and between physically isolated locations demand the use of enabling technologies that are reliable, have sufficient bandwidth and are capable of supporting current needs with simpler and seamless migratory path to cater for future growth. This paper discusses fibre optic technology that meets these needs quite comfortably. PNG DataCo Limited, a newly established state-owned company, has installed over 500 kilometres of single mode fibre optic cable on electricity transmission towers and distribution poles, connecting six of the seven highlands provinces within a 12-month period. This type of fibre optic cable operates at a wavelength of 1550nm and its very narrow beamwidth, enables the laser signal (light) to travel over long distances with negligible losses. This essentially allows electronic equipment located in provincial centres and districts that are far apart from each other to be easily connected. Benefits that this infrastructure offers is immense. There are huge transmission bandwidths available in these locations. Education, health and other government departments and agencies can connect and use this network. Corporate organisations and commercial entities can also utilise the network to transfer massive data files for business purposes. This enormous bandwidth of the fibre optic cable together with its durable mechanical structures guarantee reliable operation of the network, while keeping operations and maintenance costs consistently low. The installation of the cables on the electricity distribution infrastructure reduces the likelihood of sabotage, which is a common cause of network failures for most communication service
providers. Installation cost was low as existing electricity distribution infrastructure were used to install the fibre optic cables instead of building new infrastructure. Despite these benefits, this extensive fibre optic cable grid has its challenges too. Operational risks for the electricity transmission and distribution infrastructure, landowner concerns and compensations, environmental considerations and public safety were some of the factors accounted for and managed throughout the project life. The role of the fibre optic cable technology and network to overcome the limitations of other transmission technologies and networks currently supporting the local ICT market is appreciated. Superior performance attest to this innovation will be explored in light of the need to establish a cost effective, resilient and sustainable communication network infrastructure for PNG ICT needs. The paper then concludes with a look at current and future development plans to extend the fibre optic cable network to all parts of the country and overseas.
Title: A DESIGN OF A 345-kV TRANSMISSION LINE INTERLINKING RAMU AND ROUNA GRIDS

ABSTRACT

Reliable and efficient supply of electricity is a key pillar in stimulating economic development and growth in any country in the world. In Papua New Guinea (PNG) however, the growth and sustainability of the economy is often discouraged because of certain key development issues and challenges in the power sector. For instance, due to the aging infrastructures there are a lot of power losses and reliability issues in the system. Moreover, because of the isolated power grids in PNG the emergency or standby generating capacities are stretched to the limit in the event of scheduled or emergency shutdowns. Consequently load shedding has become very consistent and frequent hence disrupting daily business operations and leaving consumers dissatisfied with the electricity service provided.

The rate of the peak electrical load in PNG has grown steadily over the years. Recent projections by PNG Power Limited (PPL) put the near-term annual growth at about 2.3% over a 2.5 year period. Based on this growth rate, PNG's peak power demand is expected to increase from 210 MW in 2012 to 347 MW in 2026.

The peak load, although growing at a smaller rate, will continue to require expansion of utility transmission systems. The subject of this project is the electrical design of a 345-kV transmission line that will be required to achieve this expansion and interconnect the Ramu and Rouna grids. It concerns the calculation of specific electrical design phenomena associate with 345-kV EHV transmission. The analysis procedures cover the areas of transmission circuit performance, insulation design, corona performance, and induction phenomena.

The design of the transmission line is critical because of its significant impact on the cost and performance on the transmission addition. While carrying out the design, due considerations are given to the mechanical, electrical, environmental and economic aspects of this project. However, much of the design calculations are done on the electrical aspects of the transmission line. For instance, for the insulator string selections, according to IEEE Standard 1313.2-1999, the number of standard I-string units for a moderate contamination severity is 24 which is proven in calculations and recommended to be used henceforth in this project.
There are other calculations performed include transmission line impedance and capacitance, EMF intensity, corona generation and loss, audible noise, and radio interference. The calculations are done and verified in accordance to the relevant established standards such as IEEE and NESC (and NEC) to ensure the design conforms to these standards.

This project when implemented will alleviate the power woes in the country and maximize the economic benefits. The principle economic advantage would be a reduction in reserve generating capacity by pooling existing reserves. The amount of reserve capacity that must be built by individual networks to ensure reliable operation when supplies are short can be reduced by sharing reserves within the interconnected network. Substantial costs could also be saved from pooling reserves from private generations which are often very expensive.

Abstract by: Francis Sakato – Graduate Electrical Engineer
MATHEMATICS AS A MEANS OF NATIONAL DEVELOPMENT

Professor John Pumwa
Mechanical Engineering Department
Papua New Guinea University of Technology, Lae,
PAPUA NEW GUINEA.
Email: jpumwa@mech.unitech.ac.pg

ABSTRACT

National development is the ultimate objective of any democratically constituted government for any nation. Scholars, including engineers, scientists and philosophers, have tried to point out the significance and essentials of national development in many ways. Some believe it is technological development alone that is essential; some however, believe that it is the development of human resources and social welfare; while others have submitted that it is political stability. Many have provided plans and suggested various ways of achieving it. While agreeing that all those and even more submissions may be essential in nation building, there is a single variable that is a common denominator and also of utmost importance in the equation of all these attributes for any serious plans for national development, namely, good education for all citizens of a nation. In this paper, attempts are being made to highlight in simple terms what mathematics, which is an important component of education, is actually all about and in the process give a bird’s eye view of the vast amount of mathematical terrain employed in many important disciplines that move a nation forward. Attempts will also be made to discuss ways of enhancing classroom mathematics delivery in our present day classroom; and in the process suggest ways of improving the quality of its teaching and learning.
Title of the Paper
Sulphating Roasting of Ramu Laterite ore – Papua New Guinea

Authors
Robert Junior Nyoo¹, Anna Mote², Wilson Kobal³

Affiliation
1 Papua New Guinea University of Technology (Former student)  
2 Papua New Guinea University of Technology (Former student)  
3 Papua New Guinea University of Technology

Address
1 Not available  
2 Simberi Gold Mine, NIP, Papua New Guinea  
3 PNG University of Technology, PMB, Lae 411, MP, Papua New Guinea

Contacts
Telephone No. +675 473-4671  
Corresponding Author Email wkobal@mining.unitech.ac.pg or wilson.kobal@pnguot.ac.pg

Text (500 words or less)
Abstract:
This work was performed to study the extraction of nickel (Ni) and cobalt (Co) from the laterite deposit of Ramu nickel-cobalt Project in Papua New Guinea using the Sulphating roasting technique instead of the conventional HPAL route employed by the Ramu NiCo Mine. Chemical analysis by Inductively Coupled Plasma (ICP-AES) atomic emission spectrometer, SPS-3000 (Seiko Instruments (Inc.), showed the ore contained 48% Fe, 1% Ni, 0.1% Co, 1.8% Al, 0.14% Mg and 0.8% Mn. Characterization by X-ray diffraction (XRD) analysis of the laterite ore obtained from the mine site showed the ore contained 70 to 80% goethite (FeOOH), assuming Fe content of 48% is mainly from goethite. The ore also contained 11% quartz (SiO₂), 1.3% MnO, 1.6% NiO, 0.9% Cr₂O₃, 3.7% Al₂O₃ and 1.3% MgO.

The laterite ore sample was left in an oven overnight at 80 °C to remove moisture, followed by rolling in preparation for screening and splitting. The ore was screened with a 53 µm screen and separated by splitter to obtain 100 g fractions to be used in subsequent tests. For the sulphating experiments, the 100 g samples were mixed with 4 M H₂SO₄ until they were in paste form and then shaped into balls. For all roasting experiments, 100 g ball samples were roasted for 1 hr at various temperatures ranging from 300 to 900 °C. For all leaching experiments 10 g samples were obtained from the roasted material and put into 300ml beaker containing 100 ml of distil water. The slurry sample was then put into a 1L beaker containing cooking oil (oil bath) for temperature control and placed on a magnetic stirrer/heater and stirred continuously for all test runs. Top of beaker was closed with opening for thermometer, sampling and exhaust line preventing evaporation. After the leaching period, the slurry samples were filtered to obtain filtrate for AAS analysis to monitor nickel and cobalt extraction. Solid samples at the end of all tests were dried and weight. According to the test results, over 90% of nickel and over 15% cobalt were extracted into solution within 1h between 80 and 90 °C in distil water. These results were obtained at roasting temperature between 300 and 700 °C. However, when roasting temperatures were further increased to 800 and 900 °C, the recovery decreased. Nickel extraction only reached 8% and cobalt extraction reaching only up to 3%. At the end of each leaching test, magnetite was seen to attach to the magnetic stirrer.

The study showed nickel can be completely leached into solution but cobalt only up to 16%. Further studies in progress to obtain complete dissolution of both nickel and cobalt.

Brief Bio (Less than 80 words)
1 Mr. Robert Junior NYOO  
2012: Bachelor of Engineering in Mineral Process Engineering

2 Ms. Anna MOTE  
2016-Current: Graduate Metallurgist – Simberi Gold Mine  
2014: Bachelor of Engineering in Mineral Process Engineering

3 Mr. Wilson KOBAL  
Lecturer, Mineral Processing and Extractive Metallurgy, Mining Engineering Department  
2014-Current: Lecturer  
2013: Senior Technical Instructor  
2010-2012: Master of Philosophy Student & Technical Officer, Mining Engineering Department, PNG University of Technology  
2006-2009: Technical Officer, Mining Engineering Department, PNG University of Technology  
2001-2004: Graduate Metallurgist, Ok Tedi Copper Mine (PNG)  
2000: Bachelor of Engineering in Mineral Process Engineering
Exploring innovative and sustainable industrial control systems with PLC/DCS in Papua New Guinea

Joseph Kim Suwamaru (PhD)

Abstract

PLCs have become indispensable in control systems in major infrastructures and will continue this trend as PNG journeys into the future. Control systems in public and private processing plants consist of PLC and DCS technology owing to the proven efficiencies and benefits in production time and economic outcomes. In this technology driven world, possessing a working knowledge of PLCs and DCS is an invaluable asset for technicians and engineers in PNG. This paper uses freely available PLC software to simulate real world examples, demonstrating that proficiency can be easily acquired by technicians and engineers who may be unfamiliar with conventional programming languages. By using ladder diagrams, sequential functional charts and instruction lists, valuable PLC competence can be acquired.

Introduction

Cities such as Port Moresby and LAE use traffic lights at major road intersections including shopping malls and high rise buildings where elevator and lift systems are not uncommon. The average traveler arriving or departing Jacksons airport can expect to be assisted with luggage handling by the automated conveyor belts. Whether one is aware or not, PLCs are increasingly being used to improve efficiency in Papua New Guinea (PNG).

The major brewery company uses PLC based bottling and packaging routines to achieve greater efficiency with more economic gains. At the Napanapa oil refinery and in mining operations across PNG, PLCs are extensively installed to improve operations. The cigarette manufacturing company in Madang, uses PLC controlled robots within its packaging routines. Similarly, the LAE cement production company and the gas turbine at Kanudi owned by PPL to generate electricity, all use PLC based control systems. Also the country’s Palm Oil processing utilizes PLCs to their advantage including the Ramu sugar manufacturing plant in Morobe which uses PLC based control system at the core of its operations.
PLCs may be employed in their native or enhanced form referred to as ‘distributed control system’ (DCS) depending on the nature of operations. In cases where multiple processes occur in inaccessible and hazardous locations and downtime must be minimized, DCS is preferable than plain vanilla PLC. The DCS at Napanapa oil refinery is an excellent example (Figure 1). Increased efforts are required from technicians and engineers to build competence levels in tandem with advancing PLC technology.

**Madang coconut oil storage and dispensary** (Figure 2)

For this simulation the flowchart to guide the PLC programming using the ladder diagrams was set out as shown below (Figure 3).

![Flow chart of PLC controlled coconut oil storage and dispensary - Madang](image)

The ladder logic diagram for the coconut oil storage and dispensary purpose is shown as follows (Figure 4). There are three input devices namely low level sensor, high level sensor and the internal relay which also acts as an input to the motor actuator. Notice that the internal relay and motor actuators are software functions rather than physical devices. It is...
these software functions that feed the ON/OFF signal to start or shut-down the physical motor.

Figure 4: TriLogi Simulation of coconut oil storage and dispensary facility

The I/O points form the interface by which the sensor devices are connected to the PLC controller for appropriate processing and action. The ladder diagram language is a symbolic set of instructions, easy to learn which are used to construct the control program, which upon compilation is translated into the machine language to be understood by the computer. The ladder instructions are setup following the flowchart to obtain the desired control logic which is entered into the memory of the PLC. PLCs will find increased use in PNG as this simple simulation showed where benefits are recognizable.

Conclusions

Although knowledge and experience concerning PLCs need not be such a difficult enterprise, observations across PNG show that few PNG technicians and engineers have mastery over the trade. This is true as confirmed by continuous over reliance on foreign expertise by PNG organizations. The simulation of the Madang coconut oil storage and dispensary routine using freely available software showed that it is not difficult to take a paradigm shift towards learning PLCs. There are many innovative and creative simulations that can be experienced such as pick and place routine, conveyor belt system, sorting and packaging robot among others.

In this technology driven world, possessing a working knowledge of PLCs is an invaluable asset for technicians and engineers in PNG. This paper used freePLC software to simulate real world examples, demonstrating that invaluable knowledge and experience can be easily acquired by technicians and engineers who may be unfamiliar with conventional programming languages. This may contribute toward growing the PLC knowledge base in PNG.

Author

Ensisi Valley, Port Moresby where he enjoys running, gardening, reading and writing. Email: pengtel@hotmail.com.
Reaction kinetics of iron oxides in the Ok Tedi pyrite concentrates

1M.Kama, 2N. Kama, 3P. Leki

1Lecturer in Mineral Processing Engineering, Mining Engineering Department, PNG University of Technology, Papua New Guinea. Corresponding Author Email: mkama@mining.unitech.ac.pg
2Graduate Metallurgist, Ok Tedi Mining Ltd, TABUBIL, Western Province, PNG.
3Plant Metallurgist, Barrick Pogera, Enga Province, PNG.

Abstract

The Ok Tedi Copper Mine in Papua New Guinea has concentrated large quantities of pyrite into the Bige dam where they are buried below the water table. Substantial amount of iron have accumulated over time in the pyrite concentrate which are most likely of some economic value. Therefore, this study was done to investigate the possibility of extracting the iron in the form of sponge iron for commercial purposes.

Analyses of the pyrite concentrates by Scanning Electron Microscopy (SEM) – Electron Dispersive Analysis X-ray (EDAX) showed; 29.6 % Fe, 11.8 % C, 23.5 % O, 0.1 % Mg, 1.2 % Al, 4.1 % Si, 28.1 % S, 0.6 % K, and 0.7 % Ca by mass. Oxidizing roasting of the pyrite concentrates was conducted to increase the grades of iron oxides. Several samples of particle sizes ranging from 150 µm to 106µm were used in the tests.

Ranges of temperatures from 700 - 1000 °C were used to oxidize the pyrite concentrate samples within the times, ranging from 5 to 40 minutes. SEM-EDAX analysis of the oxidized products of 1000 °C and 40 minutes showed; 52.3 % Fe, 20.7 % S, 12.3 % O, 5.2 % C, 5.7 % Si, 3.4 % Ca, 0.3 % Cu by mass. Oxidizing roasting of the pyrite concentrates was conducted to increase the grades of iron oxides. Several samples of particle sizes ranging from 150 µm to 106µm were used in the tests.

Ranges of temperatures from 700 - 1000 °C were used to oxidize the pyrite concentrate samples within the times, ranging from 5 to 40 minutes. SEM-EDAX analysis of the oxidized products of 1000 °C and 40 minutes showed; 52.3 % Fe, 20.7 % S, 12.3 % O, 5.2 % C, 5.7 % Si, 3.4 % Ca, 0.3 % Cu by mass. Loss of mass during oxidizing were observed and recorded. Results of gravimetric analyses indicated that the oxidizing kinetics were marginally faster at 850 °C. However, sulphur was not completely removed but the iron content was appreciably upgraded.

The oxidized products of 1000 °C and 60 minutes were reduced by charcoal carbon isothermally. About 30 g of oxidized products were mixed with carbon of 30 % by mass and reduced at temperatures ranging from 900 - 1000 °C and reduction times from 30 to 120 minutes. Analysis of the reduced products at 1000 °C in 120 minutes by SEM EDAX showed; 52.7% Fe, 4.7% C, 33.6% O, 0.7% Mg, 0.7% Al, 4.4% Si, 4.5% S, and 0.7% Ca by mass. Oxygen was not completely removed, but the iron content increased appreciably due to removal of sulphur.

The results suggest that the oxidizing temperature for the pyrite concentrate is between 850 – 900°C with reduction time passed 120 minutes to completely remove sulphur. It also suggests that the reduction temperature needs to be below 1000°C because CO₂ is unstable above this temperature. Reduction of iron oxide will occur more efficiently if the sulphur is low in the charge. Hence magnetic separation of the iron oxides may be tried to increase the grade of iron.

Key words: pyrite, concentrates, sponge iron, kinetics, tailings.
Title

SUSTAINABILITY OF A COMPANY’S OPERATION OR PROCESS THROUGH RELIABILITY CENTRED MAINTENANCE

Introduction

Many manufacturing organizations go into business with a lot of capital as investments, because of the added value to their capital. The investors are taking into account risks of either success or failure.

For most manufacturing organizations, the feasibility study and plant design and equipment they have selected, needs to be in operation for a set period of time, it could be years for large investments, to ensure the company can generate money to pay-off all commitments such as bank loans, equipment hire, and finally get a profit for their investments.

The Sustainability of these high valued equipment or plant to be in production is very significant. Reliability Engineering and Reliability Maintenance do both have an impact to improve the reliability and performance of either a the equipment, or the processing plant to achieve the designed life cycle of the plant, and equipment, in extending the life cycle.

Main Discussion

The costs versus revenue graph below, clearly show the need for sustainability of the production, and the critical factor for the organization to realize the value added to the investment.
Total Cost of Business is made up of Fixed Cost and Variable Cost. The fixed cost can be attributed to the effort for the organization to maintain its competitiveness in the business. The revenue generated to meet the total cost will be generated over a time period. This is the minimum time for the plant to be in production.

Industry consolidation and world wide competition has placed emphasis on doing better from the existing set-up. This is indicated in financial pressure, and very often there are cuts made in the operations and maintenance budgets.

Therefore plants must increase the productivity of their existing maintenance and operations personnel, and even encouraged to reduce costs even further. Efficiency is the criteria for most companies.

This paper will discuss the various maintenance programs available, and how these can be synchronized to reduce the fixed costs component, and maintain the variable cost at the certain level and does do not change drastically over the period of operation. Some these issues will be through better selection of condition-monitoring practices, operational parameters overlaps, and training of current personnel.

**Conclusion**

The use of reliability centered maintenance is recommended as a way forward to improve the equipment or plant life cycle, and also improve the efficiency of current personnel. The RCM will enable the owners of the plant or and equipment, predict the condition of the equipment or facility and thus carry out maintenance when it is most relevant.
The following information will be captured when the RCM is established for the organization such as:

- Improve the capture of data on failure.
- Select the appropriate reliability-centered maintenance plan.
- Improved determination of MTTF for the specific component or equipment in the plant.
- Analyze the failure data information to formulate a better inventory management.
- Understand how to improve on the Replacement Asset Value for each equipment.

Brian N’Drelan Member IEPNG

PNG Mechanical Engineering Department
Abstract: A LONG TERM SOLUTION FOR WASTE MANAGEMENT IN PNG.

Background
This impact project is presented as a result of research into sustainable approach especially on managing domestic and industrial wastes. The current legal practise of handling domestic and industrial wastes at municipal landfills is identified to have health, social and environmental hazards and risks and these potential hazards and risks can be controlled and managed through this engineering project.

Project Concept
The proposed waste management concept for Papua New Guinea is though a Waste Management Facility (WMF). This WMF will manage both domestic and industrial wastes.

Waste Management Strategy
This project will address the waste management issues in any towns or cities in the country by utilising the recycle, reuse, reduce and dispose strategy of managing both domestic and industrial wastes.

Engineering Technology
- Incineration Technology
- Recycling Technology

Project Objectives
This impact project will address the following;

1. Will address industrial and domestic wastes.
2. Will achieve the five directives and principles mentioned in the preamble of the constitution of Papua New Guinea and seven identified strategic focus areas mentioned in the PNG Vision 2050.
3. Will address the areas where investment is needed and provide responses to the guiding principles as mentioned in “Stars, National Strategy for responsible sustainable development for PNG”

Risk Assessment
There are risks associated with this project and engineering controls have been identified to address these.
### Significant Risks Identified Controls

<table>
<thead>
<tr>
<th>Significant Risks</th>
<th>Identified Controls</th>
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<tbody>
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<td>Polluted air</td>
<td>Advance Air Pollution Control systems</td>
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<tr>
<td>Polluted water</td>
<td>Water treatment system</td>
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<tr>
<td>Polluted soil</td>
<td>Bio-remedial sites</td>
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<tr>
<td>High operational costs</td>
<td>WMF income generation</td>
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</table>

**Sustainability of Operation**

Income will be generated through the following;
- Dump / WMF user fees
- Domestic waste fees
- Industrial waste fees
- Recycling income

Pre-calculation utilizing figures from NCDC’s domestic waste rates and comparing population figures from any urban township indicate that this facility will be sustainable.

The suppliers of industrial and domestic wastes are from the following;
- Waste tyres and cars from motor vehicle industry
- Scrap metals from steel industry etc.
- Food, Mining and Petroleum Industry scrap metals and waste tyres
- Building, construction and quarry industry wastes
- Hotels and restaurants wastes etc.
- Residential / domestic wastes

**Implementation Schedule**

This impact project is scheduled to be completed in 200 working days.

**REFERENCES**

1. **Conflict in Campania: Waste emergency or crisis of democracy**, Giacomo D’Alisa, David Burgalassi, Hali Healy, Mariana Walter, 23 July 2010
Power System Stability at the Cost of Reliability

Mr Baloiloi Wayne, BSc Eng MScEE

*Supply Side Management, System Operations Business Unit, PNG POWER Limited, Port Moresby, National Capital District, Papua New Guinea

wbaloiloi@pngpower.com.pg

PPL as the Primary National Utility has a mandate to ensure reliable power supply to the Nation of Papua New Guinea. Following the rapid economic growth in PNG, the demand for electricity has increased at such an exponential rate that it has put strain on the power system infrastructure throughout the nation. As such, system stability has become a major concern with the operations and directly affecting the reliability indices of performance by PPL. Planned and managed outages of load sharing, manual and emergency load shedding, and automated under frequency load shedding all reduce the availability of power adding to the already fault prone systems.

This paper will use current data and experiences in the 3 main PPL System and attempt to justify the need for reduction in reliability to ensure the balance between load and generation to ensure the stability and security in the power system within a Papua New Guinea context.

Author

I. BIBLIOGRAPHY

1. Mr Wayne Baloiloi

Mr. Wayne Baloiloi is currently the Team Leader for Supply Side Management under the System Operations Business Unit with PNG Power Limited. Prior to this he was part of the academic Faculty at the Department of Communication and Electrical Engineering PNG University of Technology. In his current capacity, he is responsible for the operational efficiency of generation and transmission within the 3 main systems. He has been part of a few major infrastructure works such as the Testing and Commissioning of the TM2500 Gas Turbines, in Kanudi and Lae as well as the Commissioning of the Exxon Mobil Export project and technical assistance to the formation of the ICCC Grid Code. Mr. Baloiloi is well versed in System Modeling and tasked regularly to assess system stability for optimization and outage contingencies as well as third party effects on system performance. Completing his Masters of Science in Engineer at such a young age, he has fostered a zeal and wide interest in research and analysis giving him the ability to contribute to Government Departmental projects such as the Stanley Gas Development forum and the Bio Fuel Industry Workshop organized by the Department of Petroleum and Energy.
Abstract

Benson K Gusamo

Title: Utilization of balsa end-grain-panel as a core material for manufacture of engineered wood panel products: plywood and door

Introduction:

A light weight and low density balsa wood (*Ochroma pyramidale*) is ideal for utilization as a core material to manufacture innovative/engineered products such as plywood and door for buildings. Presently, an industry in East New Britain Province (ENBP) is processing balsa logs into end-grain-panels and exporting to overseas markets as there is no market and end use in Papua New Guinea (PNG). The utilization of balsa end-grain-panels for engineered products (plywood and door) is innovative because balsa will replace traditional wood presently used as core materials. The end-grain-panel will be sourced from sustainably managed balsa plantations in ENBP.

Body:

Balsa, a fast-growing tropical hardwood native to South America is widely grown in plantation in ENBP, PNG. In year 2009, balsa plantation was 3,500 ha but the capacity has increased to 6,200 ha in 2012 mainly owned by agri-industries and tree farmers. This plantation capacity is expected to increase in future due to global market demand for balsa wood. Balsa processing/marketing in PNG is a small industry compared to South America. Presently, about 10,000 to 17,000 m³ of balsa sawn boards and end-grain-panels are exported to overseas markets. The sawn boards and end-grain-panels are further manufactured into various finish products that find end uses in many engineering applications (e.g. wind turbines to generate bio-energy, thermal insulation boards, ship and aeroplane constructions, etc). A more recent
innovative product made from balsa panel is a floatation device (pull buoy) for swimmers to support their legs during swimming session in Canada.

This research aims to investigate the potential of utilizing balsa end-grain-panel as a core material in standard panel products: plywood and door constructions.

a) Plywood:
The balsa end-grain-panels will be cut between 3-12 mm thicknesses using a band mill and assembled to form 2400 x 1200 mm plywood size board. The 2400 x 1200 mm end-grain-panel will be coated with PVA adhesive on both surfaces and veneer sheets will be carefully laid as face and back veneers to compose a plywood. The plywood composed will be pressed tightly with G-cramps so as to compress the board for 30-40 minutes until PVA adhesive is cured.

b) Door:
The balsa end-grain panels will be cut into 15-20 mm thickness and use as core material in composing standard size door. The surfaces of end-grain-panels will be spread with PVA adhesives and lay veneer sheets as face and back composites and compressed for 30 minutes until adhesive is cured.

Major tests to conduct on these two products are weight, gluability/bonding and strength according to international standards (American ASTM or Australia/New Zealand AS/NZ).

Conclusion:

The innovation of using balsa end-grain-panels in composing plywood and door products will reduce pressure on state-own plantation pines in Bulolo. Also, the success of this study will increase the sustainable management of balsa plantation in ENBP, create market opportunity and end use in PNG. Further, balsa composed plywood and door products will be light in weight and can act as insulation boards in buildings and other engineering applications.
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Foot-Note:  Abstract of 500 words

1- Introduction  100 words
2- Body/Discussion  300 to 350 words
3- Conclusion/Recommendations  50 to 100 words

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1.0 Introduction

Our connectivity to the outside world is tremendously so narrow. The PNG growth in demand for voice and data does necessarily requires a paradigm shift in how we connect to the world.

This paper presents a new submarine fiber-optic cable: PIPE Pacific Cable-1 (PPC-1) which provides high bandwidth (10 Gbps) capacity between Sydney and Guam, but with a cable Branching Unit (BU) providing access to PNG via a Cable Landing Station (CLS) in Alotau. The Alotau connection will foster national development not only in urban areas or hand-picked organizations and industries, but generally perceived areas of enormous potential for PNG.

2.0 Statement of need

When we emphasize the complexity of interdependent systems of technology and society, we can see that learning occurs through time and that this has the potential to change habits and to redefine cultural, social or economic goals, consistent with environmental priorities. Instead of treating ICT as part of a rag-bag of exogenous factors, we need to crave for it just like we all require electricity as necessary need.

3.0 PIPE Pacific Cable (PPC-1)

PNG and Australia are both geographically isolated island nations dependent on undersea cables for quality and reliable international telecommunications. PIPE Pacific Cable (PPC-1) is the third cable for Australia’s reliable global connectivity which provides voice, video and data bandwidth to telecommunication carriers and internet services providers (ISP).

3.1 Path of PPC-1

The northern portion of the 6900km PPC-1 submarine cable passes through Vitiaz Straight parallel to the Finisterre Range, skirting Astrolabe Bay where the Madang BU4, and the BU3 are located, before veering north and traversing deep ocean trenches on its way to Guam.
A long haul trunk Optical Fiber Network begins and ends with digital electrical signal entering and leaving the fiber optic network.

Electrical data is first converted into optical pulses using Lasers on a particular wavelength (lambda) before entering a multiplexer (MUX) where the separate wavelengths converge onto a single fiber using Dense Wave Division Multiplexing (DWDM). The MUX/DEMUX equipment is housed in the Submarine Line Terminating Equipment (SLTE).

To overcome signal attenuation, Erbium Doped Fiber Amplifiers (EDFA) are periodically inserted in the network at up to 100km intervals to maintain the desired signal level along the fiber.

3.4 Branching Units

Branching units are strategically located to enable some of the lambdas to service intermediate points along the 6900km cable. Initially, the Branching unit to Madang (BU4) - Figure 2, was activated few years ago and currently serves as part of the PNG National Broadband Network (NBN) platform.
Of special interest in this paper, is the BU3 proposition for Alotau in particular. This branching unit will provide internet access to Alotau and PNG.

3.5 Alotau Cable Landing Site

The fiber pair from BU3 of PPC-1 will have a landing point on the coast line of Rabaraba district adjacent to the Alotau Township. After the cable passes through a series of hauling manholes, the cable will be terminated at a Cable Landing Station (CLS) situated on the Exchange Rabaraba premises.

4.0 Conclusion

This paper has attempted to propose a third PNG submarine fiber cable link for global interconnectivity via PPC-1 cable that runs from Sydney to Guam branching off under sea between Alotau and Popondetta. Similar to Madang link, the Alotau connection will have the capacity (10 Gbps) to provide PNG with increased access to internet connectivity within PNG and the outside world. Whilst the PPC-1 has the potential to positively impact on the other sectors of the economy of PNG, much of its success will depend on the timelines, costing and delivery of this asset to the end users at large.
5.0 Reference

RENEWABLE ENERGY RESOURCE MAPPING IN PAPUA NEW GUINEA: SOLAR AND WIND POWER, CASE STUDY IN MARKHAM VALLEY, MOROBE PROVINCE

SammyS. Aiau, Kandasamy. Pirapaharan, Sailesh Samanta, Paul.R. Hoole

Introduction: Papua New Guinea (PNG) has an ambitious programme to provide electrification to 70% of its scattered population by the year 2030. The emphasis in this research will be on solar and wind energy resource mapping. The purpose of the map is to facilitate the development of solar and wind energies for both utility-scale generation and for village power and other off-grid applications.

Basic Equations for Solar and Wind Power Calculations: Solar power is a renewable energy resource that can be harnessed to produce electricity. The daily average output power for a photovoltaic (PV) system depends on the temperatures or its efficiency and solar irradiation and can be derived from the global formula.

\[ E = A * r * H * PR \] (1)

where \( E \) is the energy (kWh), \( A \) is the total PV module area (m\(^2\)), \( r \) is the PV module yield (15.6% for a 250 W\(_p\) module), \( H \) is the annual average solar radiation on tilted PV modules with no shadings and \( PR \) is the performance ratio, the coefficient for losses (default value=0.75).

Wind is renewable energy resources that can be harnessed to produce electricity. Wind speed varies with height; the higher the wind turbine tower, the greater the average wind speed. Using the equations for kinetic energy, the work done in displacing an object from rest to a distance under a force and Newton’s Law of force and the equation for motion, the average output power from the wind turbine can be determined by;

\[ P = \frac{1}{2} \rho AV^3 C_p \] (2)

where \( P \) is power (W), \( \rho \) is air density (\( \rho = 1.225 \text{ kg/m}^3 \) at 15\(^\circ\)C), \( A \) is swept area by the blade (\( A = \pi r^2 \) in m\(^2\)), \( V \) is wind speed (m/s) and \( C_p \) is power coefficient (\( C_p = 0.4 \)).

The sample calculations based on equations (1) and (2) and the Geospatial Information System (GIS) data shows that there is solar and wind potentials for the new Umi Township and the villages in the Markham District of Morobe Province. As no ground-based measurements have been carried out yet, the initial study to consider the development of Renewable Energy power generation in the Markham valley of the Morobe Province will be based on the GIS data. GIS is a technological tool for comprehending geography and making intelligent decisions. These GIS data can be used for mapping out the potential sites for solar and wind energy throughout PNG, which can be used for utility planning for both urban and rural populations. It is noted that solar energy is among the largest potential sources in PNG. The average insolation in most parts of PNG is 400-800 W/m\(^2\), with 4.5 to 8 sunshine hours per day all year round. The Markham valley has sunshine for about 8 hours per day and an average insolation of about 500 W/m\(^2\) each day with average solar power of 900 Wh/day. Also from visual survey of the site it is noted that there is wind potential due to the hilly terrains and ridges surrounding the Markham valley spreading for kilometers. At a height of about 50 m from the ground, the wind velocity averages to 3 m/s with average wind power of 27 W/day.
Conclusion/Summary: In this paper we present the initial GIS based study to consider the development of Renewable Energy power generation in the Markham valley of the Morobe Province. The paper will also present the preliminary evaluation carried out by ground-based measurements of solar irradiances and wind speeds by a portable weather station at the Umi research site. It will also draw some general conclusions from the analysis carried out for the Markham valley of the Morobe Province that could be adopted for the entire PNG.
Self Healing Distribution Network to Improve System Reliability

Mr. Simo Kaupa, IEPNG Registered Member

System Operations Business Unit, PNG Power Limited, Hohola, NCD, Papua New Guinea
skaupa@pngpower.com.pg

Abstract

Economic growth and increasing population translates to more energy demand which is around 4.6 percent nationally and 6 percent for Port Moresby (POM) annually. As the demand continues to increase, it put much constrain on the distribution network which affect the reliability and quality of power delivered to the connected customers. Apart from generation and transmission reliability issues, distribution is one of the keys areas of concern as it directly interfaces PNG Power Limited (PPL) system with the connected customers. Major power system disturbances and prolonged outages have a significant economic, social impact and security of supply become more and more important issues.

The supply reliability and power quality are the two main areas of concern at the distribution end. Reliability is defined by the system average interruption duration index (SAIDI) and the system average interruption frequency index (SAIFI). Power quality refers to the quality of supply to the consumers and it is measured by the voltage deviation, frequency, voltage fluctuation and flicker, harmonics, phase unbalance and momentary interruptions in the distribution network.

This paper addresses the optimal solution to improving reliability indices for the mesh distribution networks especially POM and Lae where fed with multiple generation plant. In fact the investigation is to look into the automated self-healing feeder which anticipates improving distribution reliability and power quality with distributed control scheme based on the IP communication.

Deploying self-healing system and best possible segmentation matrix can provide viable solution to planned and unplanned outages on the distribution network such as fallen power lines/trees, faulty transformers, and fallen trees on the conductor; which would require human intervention. It automatically avoids or mitigates long power outages, power quality and service interruption using real-time information from the embedded sensors and the automated controls to anticipate, detect and switch between different feeders seamlessly.

Authors

1. Mr. Simo Kaupa IEPNG Membership No. 8780.
Mr. Kaupa is an employee of PNG Power Limited based at National Head Office. Prior to joining PNG Power Mr. Kaupa was a faculty at UNITECH from 2005-2013 in Electrical and Communications Department. His current area of interest and research is in the SmartGrid technologies to improve power reliability and quality through research and implementation. He is UNITECH alumnus with a Masters of Science in Electrical Engineering. He's current incumbent position is Manager - Efficiency & Quality within the System Operations Business Unit and a registered member of IEPNG.
SIR MANASUPE HOUSE FIRE & BUILDING MANAGEMENT SYSTEM

Julieth Jiap – GIEPNG
IEPNG Membership No. 6503
Graduate Mechanical Engineer
KRAMER AUSENCO (PNG) LTD

There is nothing innovative about a fire, however, the process and procedures in the event of a fire has had gradual sustainable development. Awareness on high rise building fire safety is paramount. A building may not be fire-proof, however, the design and construction, based on the Building Code of Australia (BCA), as adapted in Papua New Guinea (PNG), ensures the safety of the building’s occupants.

Say if the unlikely event of a fire occurred in one of the middle floors of Deloitte Tower, or Grand Papua Hotel or the recently built Sir Manasupe House? Every occupant in a building should know their escape route and/or otherwise analyse the safest location in the event of a fire. To do that, they need to have a brief understanding of how the building management system functions in the event of a fire. The Sir Manasupe House’ Fire and Building Management System, will be studied in detail to give us a clear understanding. During the final commissioning of the building, I was part of the Kramer Ausenco building services team witnessing the proper operation of the mechanical (Heating Ventilation and Air Conditioning), fire and smoke control system. The building was manually put into fire mode one level at a time in order to witness the operation of the major equipment’s activation.

Knowing your escape route is not always the solution in a fire. If your escape route is blocked off by a fire than knowing the safest location to be whilst waiting for the fire brigade is essential. You can only do that by better understanding of the building management system in fire mode. Sir Manasupe House building management system is a typical system used on other buildings in PNG.
An ICT model to narrow the digital divide in PNG viewed through Metcalf’s law against the backdrop of mitigating factors

Joseph Kim Suwamaru (PhD)

Introduction

Notable changes in the Information and Communication Technology (ICT) industry in Papua New Guinea (PNG) begun in July 2007. The aftermath of the freer ICT landscape witnessed the entry of Digicel, however, an attempt by GreenCom was thwarted by mitigating factors. Over the horizon, the other sectors in the industry experienced domino effects to the benefit of citizens. Viewed through Metcalf’s law, these benefits flow from the value of squaring distinct connections comprising users engaged in all manner of activities for their intended purposes. The activities encapsulate a spectrum of benefits experienced by citizens. Amidst a number of ICT sectors, a reliable, robust and cost effective connectivity guided by competent and transparent regulations can install an ICT model to narrow the digital divide in PNG. In simple terms, digital divide refers to existing differences between citizens who enjoy ICT services and citizens who are denied the opportunity to do so. Hence, narrowing the digital divide reveals silhouettes of Metcalf’s law, however, mitigating factors persist. This paper argues that an effectively interconnected network may narrow the digital divide assisted by competent regulatory support.

Challenges/opportunities

ICT services are supplied by providers covering fixed, mobile and satellite options through wired and wireless technologies. The fixed network comprises a hierarchy of switches covering local, primary, secondary, transit and international exchanges that serve both the domestic and international routes. As citizens get ICTized, there appears a growing demand for multimedia content. In the face of diversified and advanced technologies, multiprotocol label switching (MPLS) may effectively serve differing routes on demand whilst satisfying the growing demand for content.

However, recent video conferencing trials stymied due to bandwidth limitations and delays in transmission systems. Network dimensioning involving trunk networks, microwave systems, satellite links and switches need upgrading and improvement. Fibre-optic infrastructure can support high speed voice, data and video connectivity within and between places, serving colleges, universities, government institutions and corporate customers among others. Regulatory competence is necessary in ensuring that interconnections between fixed, mobile and complementary services are not discriminatory. More important is the systematic monitoring and benchmarking of quality of service (QoS) levels dispensed to citizens. If left unchecked service availability, accessibility and affordability may become mitigating factors requiring competency in regulations to enforce through systematic monitoring.

\[ \text{Network links} = \frac{n(n-1)}{2} \] or simplified to \( \sim n^2 \) implying that the value of an ICT network is proportional to the square of the number of connected users.

2 A term coined for this paper to describe citizens being engulfed by ICT services.

3 MPLS is a data-carrying technique for high performance ICT networks that routes data from one network node to the next based on shortest path labels.
Recently, the mobile sector witnessed unprecedented growth, with the current estimate being over 5 million users. Mitigating factors persist involving lack of mobile number portability, biased interconnection rates, dismal signal presence in some rural areas worsened by lower QoS. Landlines may have been decimated by mobile phones but they remain relevant despite dilapidated copper cables impacting on reliability and QoS. Regulatory measures should ensure that interconnection between mobiles and landlines are based on reasonable terms and no party is unfairly disadvantaged. While in urban areas fiber-optic may serve premises such as large corporate institutions, others could be served by a range of DSL services over copper cables. Wireless solutions are ideal for rural areas but non-discriminatory interconnection with other networks is again vital.

Complementary technologies such as very small aperture terminals (VSATs), WIMAX and CDMA among others serve niche markets and outlying regions. These add to the socioeconomic benefits when leveraged for health, education and income earning activities. Interconnecting with other networks, these technologies contribute in narrowing the digital divide, but regulatory intervention is important. The ICT model is the summation of values of individual ICT networks transforming Metcalf’s law to yield \( \sum_{i=1}^{m} n_i^2 \).

**Conclusion**

Metcalf’s law suggests that the value of an ICT network is the square of the unique customer connections in a network. These connections enable citizens to indulge in myriad ways to their advantage. Effective and non-discriminatory interconnection of independent networks using different technologies may reach even higher values by summing the square of connected users in those networks. This would be an ICT model required to narrow the digital divide in PNG. Information exchanged over ICT networks contain an array of subjects which are dear to citizens. Competent regulatory interventions are necessary to achieve the ICT model.

---

4 The aggregate value of transparently interconnected networks can be expressed as: \( \sum_{i=1}^{m} n_i^2 \) where \( n \) = # of connections and \( m \) = # of independent technology specific networks.

5 Digital subscriber line – a technology for delivering broadband over conventional copper wire.
REMOTE SENSING & GIS BASE GEOSPATIAL INFORMATION SYSTEM FOR RURAL DEVELOPMENT PLANNING AT MICRO LEVEL - A Geospatial Analyses

(A Case Study of Gumine District in Simbu Province, PNG).

Presented By

Nebare Poi
GIS Specialist
Email: nebarepoi@gmail.com
Digicel phone #71854675

Note:
This abstract is taken from my Research Study to Fulfil Partial Requirement for the Award of Master of Science Degree in Remote Sensing and Geographical Information System at PNG University of Technology.

(The Dissertation paper will be submitted to Department of Surveying and Lands Studies in December 2016 - In three months’ time)

Moto: Turning Data into District information tool for development planning, monitoring and decision making at Micro-Level
Abstract

Papua New Guinea (PNG) is in the midst of major reform changes to its decentralised governance arrangements. In 2013, a major reform to organic laws was Decentralised Governance which has led the current government to establish District Development Authorities (DDAs). The DDAs place districts and Open member of parliaments (MPs) at the centre of economic developments across PNG. The aim of decentralisation was to improve service delivery and strengthen the implementation capacity of districts in PNG. In which the current Government has been pivotal in providing MPs with more power and discretion to distribute development projects directly to their Districts.

However, those people in district authority have failed to deliver public services effectively and efficiently to rural communities in PNG. The reasons may be contributed towards lack of base line data, difficult geography, lack of proper awareness, lack of awareness in using appropriate technology to design correct plan, lack of input in appropriate format and other factors to service the needs of planners and decision makers. As a result, basic infrastructural developments in rural communities remain unchanged. The citizens continue to confront difficult socio-economic circumstances as a result of widespread breakdown in basic services. Only small number of rural households has had the blessings of few basic services thus far.

As such Geographical Information System (GIS) together with remote sensing applications are such technologies that allows us to develop a spatially connected database of any geographical area, which is very crucial in planning, monitoring and decision-making at all levels from macro to micro. Therefore, this research however, focuses on utilising Remote Sensing and GIS technologies to analysis geospatial data infrastructure at village level in each local level Governments (LLGs) of Gumine District. The geospatial information system develop from this study will serve as District information tool to help up-lift the existing service delivery functions to enhance better planning and resource mobilization as well as help in informed decision-making at micro level.

A GIS based geospatial data infrastructure will be generated at micro administrative unit. In which a village will be considered as viable micro-administrative unit. That means, village-level spatial and non-spatial data will be integrated into GIS environment to Develop ageospatial information system. The GIS based geospatial data will consist of various thematic maps like, village LLG map, LLG boundary maps, District map, Land use land cover maps etc., demographic data, socio-economic data and data related to infrastructural facilities like roads, educational facilities, health facilities, drinking water, power supply, population etc., in a single platform.

The geospatial data in this system is modular and can be updated to accommodate additional information about the district in the form of new thematic layers. The menu driven graphical User Interface (GUI) would be developed as user friendly and incorporates various spatial utility maps including education and health facilities, road network, water supply, electricity, etc. which will increase its acceptability and utilization among planners and decision-makers and is expected to increase the efficiency of local administration.
**Institute of Engineers Papua New Guinea (IEPNG)**

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Theme: Innovation and Sustainability

Abstract: To provide innovative solutions to sustain engineering projects and developments
**Theme: Innovation and Sustainability**

Engineering Projects and Developments are reality of change that provides to meet the needs of people. Engineers do really need every detail about a specific project or development, from engineering to procurement and construction. This, however, is not always the case for engineers in Papua New Guinea. In most cases, engineers got hired in the construction stage, which is the late stage for any engineering inputs. Cheap engineering has yielded itself in some projects and developments around the country. Therefore, an innovative solution is now introduced.

Engineers in PNG must be fully engaged and involved throughout any engineering projects and developments in the country. Even with the engagement of any consultation firms. They must be fully engaged and involved from the engineering stage to procurement of materials and construction stage, to ensure quality control of the projects. An engineering working tool is required for all engineering documents management between the Project Owner/User and the Contractor, in these EPC stages, for documents reviewing, verification and approving purposes.

The project owner/user shall always provide its requirements and expectations of the project, as Project Design Specifications (PDS), through its engineering team, based on global practices and standards. This will absolutely determine the quality of the finish project, and standard of guiding the contractor through its project development. With a close watch of the owner/user, the finished project will maintain satisfactory quality control, as all engineering documentations will be approved and documented by the owner/user.

Quality Control (QC) Inspections shall be conducted throughout various stages of the project development, including; materials inspection and different installation and construction stages. With the engineering team of the owner/user being fully engaged and involved in the project development, with the provision of PDS, will have confidence to carry out inspections considerately. This will be a tri-party inspection at the most, involving the sub-contractor (if there is), contractor and the owner/user.

This will alleviate any cheap engineering and helps to build a strong PNG. To name few engineering projects/developments which may have yielded cheap engineering and poor QC inspections are; the Lae wharf harbor, which was reported cracks in the concrete basement along the basin after project completion, one of the Umi bridges, which was seriously described and known as slippery and had several incidents and accidents already occurred. Not only in the government sectors, but private too. For instance; some companies do forget about the involvements of their local engineers, or restrict their involvement, not even during installation/construction, with their consulting firms and contractors, etc. But the operation and maintenance (local) engineers do rectify a lot of problems during maintenance with the mismatching of engineering documentations and as-built.

Fully engaging and involving PNG Engineers, even with the consulting firms, from engineering to procurement and construction/installation will avoid cheap engineering practices and helps to build a strong PNG. In case, the owner/user is company, it takes full ownership of its work organization and execution. This innovative solution is applicable to where the owner/user is public sector.
Abstract
PNG is undergoing many project developments of various magnitudes within various technological disciplines with majority of the expansions taking place in Port Moresby, transforming the Nation’s Capital to an elevated city for a developing country; however a developed project must have the capability of sustainability for the long term. It is a concern when projects either cease midway through construction and after or undergo maintenance after a short term of service. What are they doing wrong? This paper, to be presentable, will identify projects in PNG and then establish all project particulars from their conceptual design to commissioning. From these established factual literature, this paper will demonstrate three reoccurring outstanding realities that is causing the reduction of the expected quality service life span of projects. Based on these establishments, this paper will determine their improvement.

AUTHOR’S BIBLIOGRAPHY
Ms Donnia Bomai IEPNG Membership No. 8352. Bachelor of Science in Applied Physics 2005-UNITECH
Ms Bomai is an employee of PNG Power Limited based at National Head Office. Her current concentration is on Smart fuel technologies to promote the remote monitoring in of fuel in real time.
Utilisation of Rain Pot as a means of Rain Harvesting for PNG Rural Communities

Contributors: David Kinavai, Winterford Gombu, Heirona Retaw and Kevin David

Water PNG

PetrominHaus, Section 45, Allotment 04, Ground Floor & Level 2, Sir Hubert Murray Highway, 2 Mile.
P O Box 2779,Boroko, NCD
Papua New Guinea

Introduction

Papua New Guinea has a population of around 7.7 million. About 87% of this population lives in the rural areas. Accesses to improved water and sanitation services have been one of the major challenges that the GoPNG had to face over the years. Out of the 87% rural population, only about 40% have access to improved water supply which means that about sixty-percent of Rural Communities in Papua New Guinea still do not have access to clean and safe drinking water. This fact has driven the desired goal of providing this basic service through all tiers of Government in PNG. Health, Sanitation and Hygiene are major health factors which require swift intervention from all stakeholders.

Use of unclean water can lead to the following types of waterborne diseases in PNG such as cholera, typhoid and diarrhea, water washed diseases such as trachoma, water based disease such as schistosomiasis, water related disease such as malaria; and water dispersed infection such as legionillosis

Provision of improved water quality source and access has the potential to lead to reduced likelihood of occurrence for all types of water associated diseases.

The rain port concept was initially developed to address the issue of having inaccessibility to clean and safe drinking water in order to reduce water poverty in PNG.

Utilisation of the Rain Pot as a means of Rain Harvesting

The rain pot is an innovative idea that would be very useful for the PNG rural communities who do not have the basic equipment available to collect and store rain water as a source of clean and safe drinking water. The upright built structures with its roof as a catchment

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medium for providing good clean rain water for use has been mainly applicable to urban areas rather than rural areas at a larger scale.

People in the rural areas are now having road access to facilitate their needs and therefore some rural communities are now establishing permanent buildings and using the roof to harvest rain water. However for the majority who are unable to afford the establishment of permanent buildings still rely heavily on other water sources for drinking and general purposes while having access and vulnerability to high risk in contacting water borne diseases via contaminated water.

The Rain Pot has a base design capacity of 100 Litres suitable for a household consisting of five (5) family members. According to this apparatus the demand estimation would be about 2 litres per capita per day. It would only be used for drinking purposes and no other uses. It can be managed by individuals for their rain water harvesting and usage and it changes the concept of collecting from a roof to collecting from a pot and simplifies it and making it more convenient and manageable in that you are able to physically mobilise and demobilise the unit to harvest rain water during heavy rain falls.

**Design Concept**

The rain collecting or harvesting apparatus consists of a conical rainwater catchment area placed above a cylindrical body and supported by a pedestal at the base. The design features are based on a typical rain gauge that stands upright like a measuring cylinder and has an inverted conical section that would collect rain water. The design simply takes the inverted conical section from inside the rain gauge and places it on the outer top section so that it forms a conical basin for harvesting rain water.

![Rain Gauge](image1)

![Rain Pot](image2)

There may be other rain harvesting concepts in place but this concept allows rural people the opportunity to own their rain harvesting apparatus so that it enables them to collect rain water
at any time it rains and allows them to also have access to clean drinking water at their door step without going far distances to collect water from other water source. As from the above in Figure 1 multiple drum filling can be implemented so that during heavy rain falls they could be refilled in several drums simultaneously so that you produce a bigger rain harvesting capacity to maintain a sustainable water demand which can be able to supplement the household family members.

Figure 2 Rain Pot

The design specifications are as outlined below:-

- Volume (Cylindrical) – 100 Litres
- Cylindrical diameter (D₁) – 400mm
- Cylindrical Height (H₁) – 796mm
- Volume (Conical) – 50 Litres
- Conical diameter (D₂) – 800mm
- Conical Height (H₂) – 300mm
- Rain water collection surface area – 50.272cm²
- Rain water collection angle - 20°
Social and Economic Impact

The rain pot is designed so that it is made cheap and affordable to every rural population so that they can have access to safe and clean drinking water and improve living standards as well as reduce water poverty.

Affordability ties down to the ability of the rural population to purchase the rain pot. Given that most of the rural population in PNG are subsistence farmers, the rain pot is designed specifically for drinking purposes only.

It is estimated that in a day, an individual may consume up to 5 litres. However, in a rural setting where the catchment is rainwater, an individual may consume up to 2 litres per day so as to conserve supplies effectively. This is captured in the design of the 100 litres portable rain pot which is estimated to cost about K500.00 per apparatus.

However, for rural populations who do not have the ability to pay for the rainpot, it is envisaged that arrangements will be made with the district and local level governments to purchase and distribute to communities as part of their programs.

Material for Construction

The material for construction considered would be polyethylene plastic, aluminium, fibreglass UPVC and light weight stainless steel. All materials are chosen for ease of handling and durability. However, the suitable material to be used has to be economical and sustainable. The preferred material for this model design is light weight stainless and further studies would be conducted for its structural stability.

Conclusion

Although the rain pot may not harvest much rain water than the roof catchment it provides individual families with good clean drinking water according to their requirements rather than harvesting and storing large volume of rain water which may be affected by environmental conditions such as PH, Temperature and dissolved oxygen if stored for a long period of time.

A study of the Rainfall data for each selected locations in rural PNG would also be seriously considered when conducting research into this concept.

Climate changes due to global warming is causing a lot of problems such as tsunami, river flooding, land slips, and heavy rainfalls are also causing natural disasters and displacing rural communities and when this happens there is extreme shortages of good clean drinking water and we therefore see the need of the rain pot taking its place amongst these severe circumstances in the process of alleviating poverty.
ABSTRACT
As the road system in the city is getting bigger to improve traffic from point A to B, we must also consider enhancing the road safety and create avenues to provide safety on the road within the city 24/7.

Utilizing ICT with proper video data not only maximize the rate of traffic offenders being caught and charged accordingly but also to increase safety by using world-class detection equipment and combining it with robust, secure and flexible back-office systems.

Sonia Edward
Graduate Trainee Telikom PNG
PORT MORESBY SMART ROAD SYSTEM

Road safety in the city is becoming an alarming concern as frequent accidents leading to death is in a high rise. Car crashes, over ran vehicles on road sides are common scene in POM city almost every day and worse on the weekends. Car theft and reckless driving are all part of issues on road safety concern in Port Moresby City.

Department of Transport do have rules and regulations in place to ensure motorists drive safely and responsibly ensuring safety of the lives of commuters and pedestrians alike. The Motor Vehicle Insurance Limited do inspect vehicles and ensures that road worthy vehicles and qualified licensed drivers are on the road.

However, statistics have shown that too many road accidents occur within and out the city roads. This has shown inefficiency of the safety measures taken by road safety regulating bodies. PMV drivers and Taxi drivers in the city are the worst traffic offenders and many a times they seem to get away with it. By simply paying directly to the traffic officers without proper receipting and acquittals of the traffic offence spot fine.

Furthermore criminal activities are on the rise such as carjacking and burning of vehicles that may have crashed on the road side.

As the road system in the city is getting bigger to improve traffic, we must also consider enhancing the road safety and create avenues to provide safety on the road within the city 24/7.

Verbal interviews of several commuters, pedestrians, school children, teachers and drivers alike have suggested a smarter and safer road system in the city.

This proposal is aimed at utilizing ICT to enhance road safety. Charges can be all systematized and the offender is charged according to the offence committed without leniency if a so called wantok is a traffic officer. Many drivers get away with bribes and the traffic offence has sky rocketed instead of subsiding.

Smart road system enhance road safety by implementing the following;

- Secure-Park
- Photo Radar
  - Speed Enforcement (Fixed or Mobile)
  - Red Light Systems
  - Work Zone Safety
  - School Zone Monitoring and Alarms
  - Crosswalk Safety
  - Tunnel safety system
  - Vehicle identification system

Utilizing ICT with proper video data not only maximize the rate of traffic offenders being caught and charged accordingly but also to increase safety by using world-class detection equipment and combining it with robust, secure and flexible back-office systems.
Smart Road System incorporate Police Department, Transport Department, National Road Safety and Motor Vehicle Insurance Limited to address issues like unregistered vehicles, over speeding, careless driving, usage of mobile devices on the road, road unworthy vehicles, stolen vehicles and other traffic offence.

Moreover, establishing a smarter, safer road system will have a grand effect of enabling the seven pillars of the strategic vision 2050.

A more detailed description of the system is underway and will be available during the presentation of the PORT MORESBY SMART ROAD SYSTEM during the IEPNG conference next year.
Testing a greenhouse solar coffee dryer using a re-radiated heat energy for the high altitude region

Abstract

Coffee drying is an important post-harvest process to producing a high quality coffee where wet coffee parchment at 54 % w.b is dried to the recommended 12 % w.b moisture content. It is critical especially during the initial white stage drying process where high temperature is required for rapid water removal. Several drying options have been trialled by various coffee entrepreneurs however; open sun drying remains the common drying method although not recommended due to quality problems. Most of the coffee is grown in the high altitude (>1600 masl) region where coffee season coincides with high rainfall period and less solar radiation thus, poses unfavourable drying conditions during this period. There is a need to develop a natural solar dryer with a high drying temperature for the initial drying stage compared to the ambient conditions. It is envisaged that this can be achieved by utilising a re-radiated energy from within the dryer without much influence from the ambient conditions.

Green house solar dryer was the option taken for this study and was designed based on the principle of condensation as a means of removing water from the coffee product. The dryer was designed in such a way that it was all covered with clear plastic and a small allowance for controlled air venting. The floor area was 4 m² and the longer and shorter vertical heights were 2 m and 1 m respectively thus, creating an angled roof facing towards the sun. The wet coffee parchment beans were placed inside the dryer after having measured their initial weights and moisture contents. There was hourly measurement of coffee weights during the entire drying period. The drying conditions were measured using three Tiny tag micro weather stations located at three locations inside and outside the dryer. A conventional open sun drying using the same amount of coffee samples were compared with under the same drying regime.

Various datas were recorded and analysed in terms of temperature, relative humidity and moisture on an hourly basis. The results were compared with the conventional sun drying method. A simple drying model was developed describing the drying curve. An economic analysis was conducted to assess the economic viability of the dryer.

The greenhouse dryer showed a favourable drying temperature range of 35 - 45 °C , which is a difference of 5-12 °C related to ambient air temperature. There was also a reduction of relative humidity (RH) in terms of daily average from 75-95 % to 55-65 %. From the P - Chart, air at 40 °C and 55 % RH, was cooled to 28.5 °C, which was suitable temperature for allowing condensation to occur. The study revealed that at a 7cm batch thickness and loading capacity of 15kg/m², the drying rate was shorter by 4 days in reducing moisture from the 54 % to 20 % w.b, compared to the traditional sun drying time of 14 days. It is therefore achieved by condensation using the re-radiated heat energy generated from the coffee product inside the dryer. The study shows that favourable drying conditions are achievable for the initial drying stage in the high altitude regions of the country.

The simple exponential model was the most suitable model for describing the drying curve of the solar drying process of coffee parchment with $r^2 = 0.998$. An economic analysis showed a cost of drying of K0.55 to K1.35 which is considered economically viable.
Title of the Paper: A Geotechnical Investigation of the Kassam Pass Road to establish a Geotechnical Database for Engineering Design.

Authors: Simpson Timothy¹, Cedrick Kau ²

Affiliation: 1 Papua New Guinea University of Technology

Address: 1 PNG University of Technology, PMB No1, Lae 411, MP, Papua New Guinea (Former Student).
2 PNG University of Technology, PMB No1, Lae 411, MP, Papua New Guinea

Telephone No.: +675 473 4671; +675 76102316; +675 71536842; *Corresponding Author Email: cedrick.kau@gmail.com

Abstract:
This geotechnical investigation was undertaken to establish the geotechnical properties of rocks along the Kassam Pass road segment of the Highlands highway in Papua New Guinea (PNG) in order to create a geotechnical database for engineering designs. The overstep slopes associated with frequent slope instability (landslides) issues especially on the overlying sedimentary beds. This geotechnical investigation captures relevant rock strength parameters including strength and joint index and general rock categories relating to the subsequent geological timescale so as to provide a geotechnical database for engineering purposes.

The Kassam Pass road, which opens into the Arona Basin of the upper Ramu river, is the route of from the Markham to elevated plains of the Highlands Provinces of PNG. It is a vital link that connects the development between the Morobe, Madang and the five highlands provinces of PNG. The construction of the 9.65km section of the roadway from the Kassam camp in the Markham valley at a reduced level of 670.56 to the top of the pass 1500m was officially opened on the 19th of November, 1965. It was indicated after completion of the project that constant slope stability issues will pertain until unstable slopes reach consolidation and stability as a result of natural weathering and consolidation processes. Thus requiring routine inspection on the behavior and physical characterization of the rocks and structures.

There were basically two different approaches were taken to assess geotechnical properties of the Kassam pass roadway. The first approach is through field assessment (including visual examination) and the latter is laboratory test works relevant to establish a geotechnical database of the area.

The Kassam pass area is situated within the Miocene – Pliocene sedimentary sequence which form the northern extension of the structural unit of New Guinea known as the Aure trough. Upper tertiary sediments – shale, siltstone, limestone, and conglomerates extend to the west and south of the area into Papua. Laboratory tests were conducted in order to establish uniaxial compressive strength (UCS) of dominant rock types; basalt, granodiorite, andesite and interbedded sandstone. Test results indicated that basalt and andesite from the intrusions display higher UCS and of 78MPa and 110 MPa respectively while sandstone and granodiorite ranged between 17MPa and 42MPa respectively. High competency zones - made up of intrusions of basalt and andesite - were stable while most instabilities including development of new tension cracks were common in the low competent areas of sandstone and siltstone, of the lifted sedimentary beds. Hence major geotechnical instabilities occur along the overlain strata of sedimentary beds striking in the east-west direction generally. Further studies are in progress to further establish the scope of the research.

Text (500 Words)

Brief Bio (100 words)
1 Mr. Cedrick Kau
2013 – Current – Technical Instructor, Mining Engineering, Mining Engineering Department, PNG Unitech
2011 (Nov) – 2012 (Feb): Trainee Mining Engineer – Simberi Gold Company Limited
2008-2017: Bachelor of Engineering in Mining Engineering, Mining Engineering Department, PNG Unitech

2. Mr. Simpson Timothy
Former Student – Bachelor of Engineering in Mining Engineering, Mining Engineering Department, PNG Unitech
Studies on Fatigue Behaviour of Dissimilar Al to Ti Friction Stir Lap Welds

Steve Ales Korakan
The PNG University of Technology, Department of Mechanical Engineering, Private Mail Bag
Lae, MP 411, Papua New Guinea
Ph: +675 4734852 Mobile: +675 71668368
Email: skorokan@mech.unitech.ac.pg

Key words: FSW; Fatigue Properties; Microstructures; surface Morphology

Abstract
The solid-state process of friction stir welding (FSW) of dissimilar aluminium (Al) to Titanium (Ti) in lap geometry is necessary, with the focus on the fatigue behaviour of the FS welds. The Friction Stir Lap Weld (FSLW) of dissimilar metals is necessary in many industries especially in aerospace industry because of high quality joints are difficult to obtain with fusion welding. According to a recent research by Chen and Yazdanian, with FSLW using force control, position monitoring and pin penetration was necessary to explain the uncertainty in the microstructural nature of the joining interface for achieving high strength values in FSL Al-to-Ti welds and the details of temperature measurement method for FSWL and gripping of a sample shear tensile testing of lap joints were explained. The experiment was conducted using a Milling machine with a LowStir unit for calibration, monitor and log welding parameters for later analysis. The two dissimilar materials used in the FSLW were 6mm Al6060-T5 top plate and 2.5mm hot rolled annealed Ti64 bottom plate. It has been reported that the tensile shear load per unit width ($F_m/w$) ranged from 525 N/mm to 703 N/mm with an average of 610 N/mm which is significantly higher than the results obtained with other methods, with the highest value reported to be 480 N/mm. In the same study it was also found that depth of penetration ($d_p$) had significant variations on the results where non-penetration value was 654N/mm while with penetration at 525 N/mm which implies that $d_p \approx 0$ is considered to be effective condition for the high $F_m/w$. However, so far no studies have been reported on the fatigue behaviour of these FSL welded Al to Ti joints. Additionally, the effect of the microstructures and the interface layers (consisting of mix stir zone and intermetallics) on the fatigue strength is yet to be studied. Most aerospace components are subjected to cyclic loading during their service life which can lead to fatigue fracture. Therefore one of the essential requirements is that the fatigue strengths of FSLW products need to be matching the requirements. Without the knowledge of fatigue properties, designers and manufacturers will not adopt the promising FSLW technique for joining Al to Ti joints. Thus, the proposed research relates to the study of fatigue behaviour of FSL welded Al to Ti joints and the effect of various process parameters on fatigue properties of these alloys. The objectives of this project include is to determine the FSLW parameters responsible for affecting fatigue properties of the dissimilar joint (considering microstructures of the interface layers formed and evolved) and also to study the fatigue behaviour, examining how crack initiate and propagate in the interface regions under cyclic loading conditions.
1.0: INTRODUCTION

Applying of Innovation and Sustainability in the Institute of Engineers of Papua New Guinea (IEPNG INC) are two vital tools out of main others down the list. In every engineering or construction career for Engineers, there must be Innovation and Sustainability in place to effectively exercising the roles of the Engineers according to Standardized Engineering Ethics derived within the Institute of Engineers (IEPNG INC).

This paper will discuss brief views of a Professional Civil Engineer on current issues faced in the country (Papua New Guinea) by detailing out the definitions of Innovation and Sustainability. In other words, the author discusses few factors depriving the rights of practicing engineering in the country with accordance to IEPNG working ethics and delivering of quality engineering products.

2.0: ENGINEERING ETHICS NOT UPHOLD

It has being observed that most Engineers in the country do not apply more than half of what they have studied in Universities. That is, they (Engineers) do not comply with most Work Ethics governed by the Institute of Engineers Papua New Guinea (IEPNG)

The Engineers’ rights to be exercised according to IEPNG work Ethics are deprived in many ways but here one scenarios that is operating in Papua New Guinea as a loop;

(i) Qualification of The Director or Owner of the company/firm the particular Engineer is employed

Most Engineering Construction Companies/firms in the country today are owned by people who haven’t studied the field their company is involved. For example, a Medical Doctor or a Coffee Buyer has registered a Civil Engineering Construction company to build roads & bridges in the country because he or she has money to buy equipment and so on.

Here is what happens when this type of people are awarded million kina contracts;

(a) Counterfeit Materials used in construction works giving rise to sub-standard works. Taking a portion of a road section with Soft Spot & water log as an example. The Engineer employed will requesting for Standard materials to be purchased for treating a Soft Spot section. When the Engineer submits his quotation of K10, 000 to treat a 20m x 8x 0.4m water log portion, the Director of the company usually have many thoughts. Since the Director is not a Civil Engineer, he considers the money value without taking into consideration the quality of the work to be delivered. Eventually, the Engineer is instructed by the Director to engage bolder rocks and continue with other pavement layers. The unfortunate Engineer as to follow what he has being instructed, even though he (Engineer) knew that it is a wrong practice. How can the poor Engineer talk back to the Director or his employer.
On the other end, the Client of the project is the Provincial Government, which means the project has being awarded through Provincial Supply & Tenders Board (PSTB). That is, the Provincial Works Department is the Engineer supervising this particular road project. The above described sub-standard work couldn’t be rectified because the project was awarded through some connections with the Governor, Open Member, and Provincial Administrator and so called high profile office bearers in the Provincial Government.

Even thought, the project is 100% completed with most Sub-standard works, there is no independent inspection body during project progress or completion. This type of road projects only lasts for 6 months or a year and frequently affected by defects. The poor people’s money has being a complete waste for someone’s self-gain.

(b) Project Clients/ Funding Agents.

Portion of this (Funding Agent) has be mentioned earlier in Section 2.0 (a) paragraph two (2).

It has being observed that when projects are awarded to a contractor, there is no proper screening carried out. The person (Governor, Minister, MP) who is involved in counter funding this particular project manipulates the tendering process people.

This is done by awarding the contract to someone personally known to the MP. Since the MP will be running for the coming elections, which requires money, therefore awarding a contract to someone know to him (MP) will sustain his election operations. These types of masterminded plans bring up the following current facts faced in the country today in terms of service delivery;

- Contracts worth millions of kina being awarded to companies without qualified human resources, plant/Equipment and materials.
- Contract figures are exaggerated without substantive facts. A particular road of say 1.6km Upgrade to Seal would cost at least K2.5 million, but when the above mentioned concepts are applied it costs K8.6 million. The existing condition of the road is very excellent with deterioration sealing portions. The suspicious part is where the remaining balances of K6.1 million gone.
3.0: CONCLUSIONS & RECOMMENDATIONS

People in this country have been crying for quality service since Independence. Few of the factors neglecting quality service delivery has being pointed out above. One as to know that the cheapest mode of transportation is the “land transport”. Therefore, for other basic Governmental services (schools, hospitals, police stations & so on) to reach a community in the most Remote or Urban centers of Papua New Guinea, the road connecting these places must be of good quality.

This country must place a firm law in connection to all businesses to be carried out in the country, Papua New Guinea. Here is what to be done;
(i) If you are a Civil Engineer by merit – you can register a Civil Engineering construction company
(ii) If you are an Architecture & Builder by merit – you can register a Design & Building Company
(iii) If you are a Lawyer by merit – you can start a Private Law Firm
(iv) If you are a Doctor by merit – you can start a Private Hospital
(v) And the list goes on

By imposing such laws, we will achieve quality service delivery because everyone will be more than 100% sure of what he/she is capable of doing when operating his or her business.

At the same time, awarding of contracts shall consist of the following boards;
(i) The PSTB & Tender Evaluation Board excluding any Member of Parliament and provincial administrators. Instead, PSTB & Tender Evaluation Board shall be an Independent Body with the Provincial Works Manager, Provincial Planner, Provincial Engineer
(ii) Whether it’s a PSTB Contract or CSTB Contract or any other type of contract, IEPNG should be part of the Board doing Contract Evaluation & Awarding. That is, IEPNG shall employ Engineers all around the country (Provincial Capitals) to work alone with PSTB/CSTB for Tender Evaluation and Awarding. IEPNG Engineers can also assist in project supervision within their respective provinces.

Innovation & Sustainability would be achieved by applying some of the discussed points. This eventually gives rise to quality service delivery in Papua New Guinea.
Research Title: Wood Strengths of Age 24 Hoop and Pinus Trees from Bulolo Forest Plantation.

Abstract.

The increasing need for the sustainable supply of wood for the current development and housing boom especially experienced throughout the country will require the second crops of the Natural and Plantation trees for wood structural applications (housing, bridges and poles) requirements. However, there are no established mechanical properties of the second crop of the plantation Hoop and Pinus trees in Bulolo and PNG. Therefore this case study was done to certify the wood quality of the second rotation 24 years old Hoop and Pinus trees from Bulolo Forest Plantation and verify their applications in the building and other related wood structural fields use appropriateness.

The compressive and bending wood engineering behaviors were determined using American Society for Testing Materials method (ASTM) D143. The strength tests were done using the Universal Testing Machine at the Civil Engineering Department structures laboratory of the University of Technology in Lae, Morobe Province, PNG.

Preliminary results from the tests carried out revealed that age 24 (unthinned) Pinus tree was classified in Strength Class Five while Hoop pine trees fall under Strength Class Six respectively. Pinus tests specimen scored 29.873, 48.97 and 19.36 x 10^3 mega Pascal for max compression, max bending and the max elastic strengths respectively. While, Hoop pine test specimens registered 17.1731, 46.267 and 18.267 X 10^3 mega Pascal respectively for the different green moisture strengths (S.K.Anakime Et al 2013).

Hoop being at K90.63/m3 and Pinus at K38.36/m3 doesn't make sense with their respective fiber quality as portrayed by this case study’s results. Pinus and Hoop share the same production cost but as per the BWNFS Project Agreement 1995, don’t have the same selling price is confusing and uneconomical to the project.

Keywords: Wood Strength, Compressive and Bending Wood Engineering Behaviors, Strength Class, Wood Structural Engineering Application.
AUTOMATIC HYDROLOGICAL TELEMETRY SYSTEM TO OPTIMIZED HYDRO-POWER GENERATION

Mr. William Buka, IEPNG Intending Member*1

System Operations Business Unit, PNG Power Limited, Hohola, NCD, Papua New Guinea

wbuka@pngpower.com.pg

Abstract

The introduction of automatic hydrological and telemetry system of catchment areas (reservoirs and river inflows) is an important means to realize modernization and optimization of hydro-power management.

PNG Power Ltd manages two of the largest and oldest dams and hydro-power facilities in Papua New Guinea to maintain and support the expanding demand for use of electricity both in Port Moresby (POM) and Ramu regional grid. The two major catchments include Yonki catchment in Eastern Highlands Province, and Sirinumu catchment in Central Province.

This paper stresses on the optimization of hydro-power generation through the introduction of automatic hydrological telemetry system for Sirinumu and Yonki catchment areas to replace the traditional manual way of collecting and recording hydrological data. Through the introduction of this new system, the work intensity of prediction will be greatly decreased and the integration of telemetry, forecasting and monitoring will be realized for the optimization of hydro-power generation.

The basic structure of the automatic hydrological telemetry system will be briefly discussed in this paper as well.

Authors

1. Mr. William Buka.

BIBLIOGRAPHY

1. Mr. William Buka.

Mr. Buka is an employee of PNG Power Limited based at National Head Office. Prior to joining PNG Power Mr. Buka worked as a drilling fluids engineer with various companies in the Oil & Gas industry through integrating drilling fluids optimization and technology from 2010-2015. His current area of interest and research is in the optimization of hydro-power generations through the use of automatic monitoring and telemetry system. He is a UNITECH alumnus with a Bachelor of Science in Electrical & Communication Engineering. He's current incumbent position is Water Management Officer in the System Operations Business Unit and an intending member of IEPNG.
Planning and Design Considerations for Adaptation to hydrologic impacts of climate change in infrastructure and resource sectors in Papua New Guinea

Dr Bishnu Devkota¹, Dr Ashok Aryal²,

¹Principal Civil, Environmental Engineer and Hydrologist, Tetra Tech/Infra Tech Pacific, email: bishnu.devkota@infratechpacific.com.au
²Senior Civil, Water & Geo-environmental Engineer, Tetra Tech/Infra Tech Pacific, email: ashok.aryal@infratechpacific.com.au

Abstract

The hydrologic impacts of climate change is well known that includes increased rainfall, decreased rainfall and increased intensity of rainfall. In Papua New Guinea (PNG) the rainfall has been increasing with more extreme rainfall days, increased rainfall due to less frequent but more intense cyclone, combined with extended periods of droughts. These have made infrastructure highly vulnerability to coastal and riverine flooding, erosion/water quality issues resulting the loss of human life; damage, failure and operational disruption of infrastructures (roads, bridges, ports, dams, water and power systems) across PNG. The increased period of drought and water scarcity has been experienced in Highlands and low land areas of Central Provinces and communities along Milne Bay, Morobe and Madang, resulting impacts to water supply, hydropower generation, agriculture, fisheries, environment and overall economy. The current international best practice options and framework for adapting these hydrologic impacts and its application in infrastructure and resource sectors in PNG at planning, design, operation, and asset renewals/upgrade are reviewed. The options and framework includes better hydrologic prediction, adaptive planning, design, integrated river basin and water resource management approaches that can be implemented at different scenarios for increasing climate resilience of the infrastructures and resource management.

Key words: climate change adaptation, resilience, hydrology, infrastructure, asset renewals, planning, design, integrated water resource/river basin management.
ADVANCED ONSHORE AND OFFSHORE WIND POWER TECHNOLOGY

Wind Power Plants, like other renewable energy generating plants have contributed effectively to the attention paid to climate changes, the energy demand and have up-lifted the hope of sustaining electrical energy. However, the contemporary struggles to innovate advance wind plant devices for the plant’s reliability, its cost factor, the suitable topology for the plant’s location and its sustainability are vital considerations, needed to give satisfactory output for both onshore and offshore grids. Therefore, in order to achieve the above goals, a scientific study based on different theories and practical experiences was done.

In the particular case study made in Italy in 2010, the energy produced from wind source was about 8.3 GWh out of a total energy demand of about 326 TWh. This has increased by 335% since 2004. On a worldwide scale, by using the wind energy, it could be possible to produce 12% of the total requirement of electrical energy by 2020. The Italian government, in its “Position Paper”, anticipated a wind energy potential available in Italy by 2020 of 12 GW of installed power, 10 GW of which onshore and 2 GW offshore (in shallow water up to 30m depth). However, to achieve the target, a careful research was done to the wind plants, starting with generalities on wind power plant, main components of a wind turbine and theory of wind turbines, energy producibility and their regulation systems. This led to a deeper investigation on the power generation systems, protection against overcurrent, overvoltage and earth faults, wind power in electric-power systems and finally, solutions offered for wind power applications.

The research fortunately discovered outputs that are very effective as different types of modules of wind power plants came into technological construction. One of those beneficial types that were studied closely was the new model of the offshore turbine named Aerogenerator X. Its innovative design has V- structure allows exploitation of wind energy, regardless of the direction the wind blows, and is 130m high and 275m wide and rotates with a speed of about 3rpm with generating capability of about 20 MW of power. However, the disconnection of these modules from high voltage transmission network might jeopardize the system stability, causing cascading interruptions during failed operations. Therefore, for continuity purpose, the new frequency converters based on Low Voltage Ride Through (LVRT), or Fault Ride Through (FRT) technology, which enables the uninterrupted operation of the wind units within presence of network disturbances, and supports it with the injection of reactive power was developed.

Economically, it is noted that more economical options are acceptable as long as they end up with the same technical results or better but wind energy has so far proven to be economical in the energy industry. These low costs in the plant’s production and maintenance, its technological advancement and a potentially accommodative topology like the one here in Papua New Guinea may boost the energy demand and positively contribute to climate changes and sustenance of electrical energy.

Name: James Towa Abiso Wakrima, Title: Electrical and Electronic Engineer, Contact: jwakrima@mail.ru
PORTABLE HYDRO POWER GENERATOR

INNOVATION AND SUSTAINABILITY ABSTRACT 2016.

TOKO'VARIA. DIGGS
Member of the Lusmhan Natures Trinity Group, NCD-PNG.
PORTABLE HYDRO POWER GENERATOR

Introduction

All around the world Scientists and engineers have worked around the clock and are still working to design renewable and environmental friendly engines that will operate without the use of fuels but rather natural forces to produce energy. To date, no one has ever attempted or produced a Diesel-free engine with a realistic experiment and its system circuits to prove another unseen theory.

More than ever there is serious urgency to innovate and take serious decisions to implement energy options that accelerate the shift towards sustainable development. The very important and significant aspect of this project is that it has greater advantages and potential to compete with other energy sources after all perceptions of the research is concluded to the final phase.

'Considerably, improved access to modern energy services, improved affordability, reliability and greatly enhanced use of technologies that address the challenges of sustainable development is what we want to engage in.'

Alternatively, we now wish to unveil something to the Technology Industry by introducing a newly invented Portable Hydraulic and Compressed generator. It is the ultimate outcome of a simple practical experiment and theory designed to operate on compressed and recycled Water. Despite the fact that the new engine, functions with the combination of Air, Water and Solid system circuits; it is arranged in a logical manner that act on each other creating potential force on one single main shaft. The under pressure forces (water/ air) is then circulated equally to operate the engine without the discharge of carbon emissions.

The proposed project is primarily envisaged to generate energy source that provides electricity, water and improve waste management to suite rural settings. Generally, the purpose of the diesel-free generator is the science solution in alleviating problems and issues posed by global warming and climate change.

The primary focus of the fight against global warming is to assist the rural areas of Papua New Guinea through innovative use of existing technologies in utilizing available renewable energy resources. The machine is designed according to the simple Practical Experiment that was done to prove its theory. This experiment is explained with the drawings to demonstrate and actually prove it.

Research Idea

A simple experiment was conducted as depicted in the figure 1.
A hole with engrave diameter equivalent to the rubber tube's diameter was created on the lid and at the bottom of an empty container. The tube was then inserted through the hole before removing the lid and filling up the container with water to the halfway mark. Later the container was tilted upside down to allow for ball pump insertion.

The ball pump was then used to pump the air into the empty space thus increasing pressure. The water level in the rubber tube rises up and over the normal water level mark and flowed back into the container provided the end of the rubber tube is submerged in the water inside the container. The idea now is to harness the energy of water in continuous circulation while maintaining air pressure at required value.

Results

It was observed that as air pressure increases, the speed of observable dust particles in circulation increased, depicting the movement of water. However, after 3 minutes without pumping air into the container's empty space, the movement of dust particles slow down and the water eventually settles back to its original position, thus the water level in the rubber tube and container matches.

It is the circuit system of its own designed to operate the plant itself and has the capacity/energy to recycle the water and further uses these energy sources for continues electrical output. The continuous electrical output is controlled by a main control valve (Water and Air control valve).

The meteorological theory implies (3) main forces affixed to the energy plant that are combined to cause and generate efficient flow of a similar fuel engine. These natural forces are discussed as follows;
1. Liquid Force

*The Water tank*

The tank which holds all water required of the engine is positioned above the setting of the engine block some meters above ground floor. It has the cone type shape at the bottom of the water tank to centralize the gravity to act central point of the center at the bottom. Again, the tank stores the contained under pressure water above the engine at an angle of 90 degrees’so when the main control valve is opened, the under pressure water is released through a supply channel where a hydraulic nozzle pressurises the under pressure water to act on the water turbine. At this time, the flow of the force is directed vertically straight down to the water turbine housing which then turns the water turbine before it is pumped back to the water tank as used water. The water tank is that of a Brake master cylinder of a car that is filled by hydraulic fuel to maintain the level in order to avoid brake failures or causing malfunction to maintain the level to the circuit.

*The Water turbine*

The Water turbine is connected to the main turbine shaft, the main turbine shaft sits on the roller bearing which is at the center of the sectional frames. This is a round shape component which is formed by the spherical turbine blade welded closely to each other in circle shape. At the center of the round turbine is where the main turbine shaft is attached.

2. Air Force

*The Air Compressor*

In a form, the turbine is coupled to the second drive gear of the Air Compressor assembly and, at least part of the pressurised air from the Air Compressor is provided to the air supply inlet of the hydro power generator to which causes suction. Likewise, the suction hose sucks the air in the housing of the air turbine in which, has the capacity to recycle the water. The machine through the Air suction valve and Pressure release valve located at the Air compressor tank. Both the Air suction valve and Pressure release valve is placed to balance the Air vapour created during the operation of the machine.

*The Air turbine*

The front side of the Air turbine is connected to the main turbine shaft to where the water turbine is attached; the main turbine shaft sits on the roller bearing which is at the center of the sectional frames of the water section and the air section. The Air turbine has additional blades than the water turbine.

3. Solid Force

This force is operated by gear mechanisms, the gears are well arranged in a manner that will turn the turbine shaft 6 to 7 times for 1 revolution. Next to the air turbine section directly bolted onto the main turbine shaft which the water and air turbine are connected.
PORTABLE HYDRO POWER GENERATOR

The gears are arranged in a ratio form. It is a Round solid thick metal iron like the fly wheel of a highway truck mounted and forms the Main turbine shaft which produces torque force to drive and operate the machine. As the main turbine shaft slowly picks up its speed, it eventually operates the (2) forces. Once it has reached the required RPM, all functions of the components activating the nature forces will be air tight. This gives the accurate RPM efficiency of this engine. Therefore, opening the water-tap determines the working RPM.

The Idea and Design is verified is used to combine the forces to start the machine which eventually operate other components to create pressure in the circuit system to build and supply high pressure to the forces’ which then turns the turbine in order to operate the running of the machine.

Embodiments

*Car battery*
Is inserted to provide the required 12 Voltage electricity and is the source of the electricity. In particular, the storage electricity component that supplies power to all the electrical circuit components of the machine is attached on the side end of the machine.

*Step-Up Electricity Convertor*
It is attached to convert 12 Volts of the car battery power to 240 Volts that is required by the Electric Motor.

*Electric Motor*
Purposely the component is to induce electricity. The source of the electricity is from the 12 Volts (N70) truck battery. The battery is connected to the inverters (Transformer) that step-up the Voltage from 12V to 240V which later diverts the 240 V to the electric motor. The electric motor induces voltage and diverts it to the Main Switch Board for power use.

*Main Switch Board*
Purposely this component is to safeguard the electric motor if anything causing short circuit during the use of electrical appliances and also helps to distribute and control the amount of power induced from the electric motor for electrical appliances.

The project seeks to tackle the dilemma of unreliable and often expensive power supply through the use of diesel operated engines which costs the state enterprise PNG Power Ltd half a billion of government’s budget to purchase and install new hydro-turbine engines for the rural communities.
One skilled in the art will appreciate that, for this and other processes and methods disclosed herein, the functions performed in the processes and methods may be implemented in differing order. Besides, the self created energy machine, meaning the machine will harness the contain water and air.

Summary

The Theory of designing this invented machine is proved by the Practical experiment. Many engineers and Scientists have worked on this theory but do not produce the right design and mechanism emplaced that will force the water back and Recycle the water constantly. As for this case, the designed invented engine/ machine has several mechanisms emplaced to solve this problem and this mechanisms are as follows:

- The Diaphragm and the coil tensional spring set in the water tank that compressed the air, and the water is then under pressured by air.

- The setting of the water pump section above the sectional frame, levels with the water in the water tank to avoid resistance of the Gravity Force acting on the water force used.

- The arrangement of the Drive Transfer Mechanism that drive the water pumps and air compressor. It is arranged in a manner that it multiples the speed and the force of the Main Turbine Drive Gear and turns the water pump gear and the Air Motor Compressor fast. This action creates vacuum in the circuit systems of the forces to flow smoothly and efficiently.

- The water vapor Condenser circuit system is designed on the machine is to supply constant water to the water reservoir tank to supply the water tank. This circuit is to make available the constant flow of the water to the water tank.

While this project stands to be sound, affordable and a sustainable one can only be manufactured in our country and will serve better to the remote inland populations of the country.

The main problem we seek to address can be culminated in to these (3) following points;

- Keeping all energy options open, including the safe use of diesel operated power and the promotion of renewables;

- Achieving access to commercial energy for the two billion people in the world who do not now have it and;

- Implementing advanced cleaner technologies to reduce the impact of human-induced emissions on the quality of human life and the natural world around us.
PORTABLE HYDRO POWER GENERATOR

We believe the project will be a major player in economising the society by delivering opportunities of greater job employments for elite and ordinary citizens. More often than not, the financial requirements of energy projects are a bigger challenge than accessing the technology and know-how.

The idea now been established in our minds that not only this project can address the global attempt to alleviate global warming but encourages the employment of clean energy to generate electricity which can be applied in bigger power plants, factories and also private household supply. This will in turn underpin the various goals of the medium term developments (MTDS).

The challenges of environment dilapidation are great and the importance of energy in achieving sustainable development goals cannot be overstated. Government agencies and energy companies such as Office of Climate Change and Rural Energy Supply have come to realise and appreciate the potential of this anonymous project.

These mechanisms and system circuits are placed to actually make the designed machine workable. These mechanism and system circuits designed on the invented engine answers the questions for the Scientists and Engineers all over the world who had tried this kind of theory to design engine but to no success.
Estimation of Soil Bearing Capacity and California Bearing Ratio from Dynamic Cone Penetration Test Data: A Review of the Current Best Practice

Dr Ashok Aryal¹, Dr Bishnu Devkota²

¹Senior Civil, Water & Geo-environmental Engineer, Tetra Tech/Infra Tech Pacific, email: ashok.aryal@infratechpacific.com.au

²Principal Civil, Environmental Engineer and Hydrologist, Tetra Tech/Infra Tech Pacific, email: bishnu.devkota@infratechpacific.com.au

Abstract

For the design and construction of foundations for any civil engineering structures (building, bridges, pipeline, water and power system), it requires soil bearing capacity and other geotechnical parameters. For design of road pavements, there are several methods (depending on the country to country), but all methods require 4 days laboratory based California Bearing Ratio (CBR) test. But estimating the soil bearing capacity and CBR requires extensive laboratory testing that are expensive and time consuming. To reduce time and cost, Dynamic Cone Penetrometers (DCP) tests that are simple and can provide on-site rapid soil testing can be used. However, there several methods for estimating soil bearing capacity and CBR using DCP tests results and also there are varieties of DCP test instruments. We present a review of current best practice for DCP tests and equipments, estimation of soil bearing capacity, CBR and other geotechnical properties from DCP test results and its application to various civil engineering structures and road pavement design.

Key words: soil bearing capacity, C.B.R test, Dynamic Cone Penetrometers test, civil engineering, foundation design.
BEHAVIOUR OF LONG-SPAN ROOF SHEETING UNDER THERMAL LOADS

Yaip K Telue* and Kim JR Rasmussen**

*Professor, Telue Engineering Institute, Lae PNG, yaiptelue@gmail.com.

**Professor and HOS, School of Civil Engineering, University of Sydney, Australia
k.rasmussen@civil.usyd.edu.au

Abstract

Steel-clad roofing systems are composed of an orthogonal grid of purlins, which are attached to rafters, and sheeting panels which are attached to purlins. The sheeting may be attached using screws (pierce-fixing) or concealed clip fasteners which do not perforate the sheeting. In the case of pierce-fixing, the screws undergo combined shear and bending as the sheeting contracts or elongates under thermal movement, and may fail as a result of the thermal-induced deformations. Consequently, Australian manufacturers recommend limits on the lengths of roofs to be fixed using screws. However, these recommendations are not based on scientific evidence or analysis.

The paper details a numerical investigation into the deformations and internal stresses developed in the sheeting and screws of long-span roofing systems. The FE analysis models the purlins and sheeting using shell elements and applies contact surfaces between the sheeting and purlins to accurately model the conditions at the interface. It models the screws as beam elements and the connection between the screws and sheeting using coupling constraints. The paper highlights the main challenges overcome in constructing the FE model and the execution of the combined thermal/structural analysis. Results are shown for the deformations of the screws and the induced stresses as functions of sheeting length and temperature.

Key words: Long Roof Sheeting, Cold-formed Steel, Finite Element Modelling, Thermal Stresses.
WELDABILITY OF SHEAR STUDS THROUGH Z350 GALVANISHED STEEL DECKING PROFILES

Yaip K. Telue* and Kim J. Rasmussen**

* Professor, Telue Engineering Institute, Lae, PNG.
** Professor and Head, School of Civil Engineering, University of Sydney, Sydney, Australia.

Abstract: Composite concrete-steel slab systems have become increasingly popular in the Australian domestic and high-rise building industry, particularly with the development of composite slab systems in the 1960s, in which metal decking profiles provide a formwork and reinforcement system during construction and an efficient method of supporting floor loads in the finished structures. To activate composite action, shear studs are welded through the metal sheeting to the supporting beam girders. The commonly used galvanizing coating mass has been Z200 (200g/m²), and existing procedures for stud welding have been developed for this coating mass. However, to provide addition corrosion protection, modern Australian steel decking profiles now have a coating mass of Z350 or higher. The thicker coating layer is presenting difficulties in securing adequate penetration of the welded stud to the steel girder and many studs fail the bend test accordingly. The paper details a study into the weldability of shear studs through Z350 decking profiles. The welding parameters, including amps and voltage setting, lift, and weld time, were varied to identify the ranges of these parameters which provide satisfactory pass rates.

Keywords: Welding, Shear Studs, Steel decking profiles, Cold-formed steel, Composite Steel-Concrete.
Abstract:

This report describes a set of bearing tests on a new range of cold-formed steel sections, LiteSteel™ Beam (LSB™), subjected to concentrated bearing load. LSB sections are manufactured using a unique dual resistance welding process which forms a channel section with hollow flanges. The tests were performed under interior two flange loading (ITF) and exterior two-flange loading (ETF) conditions. The ITF and ETF bearing loads were applied at the top flange at the centre of the beam and at the bottom flange at both ends of the beam respectively. Some different stiff bearing lengths were selected.

The test strengths are compared with the design strengths obtained using current and proposed versions of AS/NZS 4600. All tests show capacities well above those predicted by either the current AS/NZS 4600 (1996) or the draft DR 03518 (now AS/NZS 4600 (2005) (overstrength 96% or 40% respectively for ITF loading condition and overstrength 49% or 43% respectively for ETF loading condition).

The test results were compared with the predictions of AS/NZS 4600 (2005) and AS/NZS 4600 (1996), and reliability analyses were carried out. AS/NZS 4600 (2005) does not provide a reliable method of determining the ETF and ITF bearing capacity of LSBs. AS/NZS 4600 (1996) provides a reliable method of determining the ETF and ITF bearing capacity of LSBs. It is therefore recommended that the AS/NZS 4600 (1996) formulation be used.

Keywords: Steel, Hollow section, SSHS, Channel, Web crippling, Buckling, Hollow flange, LiteSteel Beam; Bearing, Interior loading, Exterior loading.