JURUTERA

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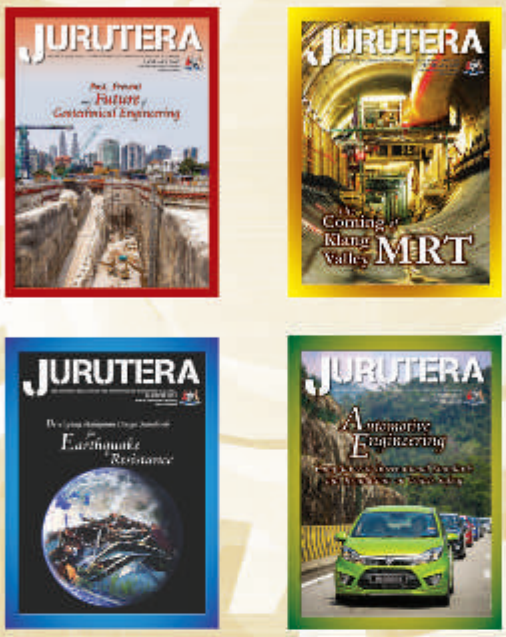

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Agriculture: Water Quality And Waste Management

By Ir. Yong Hong Liang

Ir. Yong Hong Liang *graduated from Universiti Putra Malaysia with Bachelor Engineering (Agricultural) and Master Science (Soil & Water Engineering). He has over 15 years of experience in development of oil palm plantation and rural area in Malaysia and Indonesia. He is the Head of Engineering of TSH Resources Berhad. Currently, he is the Chairman of Agricultural and Food Engineering Technical Division, IEM.*

Agriculture is the single largest user of fresh water. It is also a major cause of the degradation of surface and ground water quality. Aquaculture is also recognised as a cause of environment ecosystem damage.

Expert say that, in the next century, pollution can no longer be remedied by dilution and freshwater quality will become the principal limitation for sustainable development. According to Food & Agriculture Organisation (FAO) of the United Nations, this will mean serious effects such as a decline in sustainable food resources and an escalating cost of remediation that exceeds economic benefits.

Agriculture pollution has a huge impact on our health, so it is vital to manage waste. On farms, this is often overlooked because it is not seen as a part of the actual farm operations. Improper management of agriculture waste is contributing towards climate change as well as water and soil contamination.

Globally, 140 billion tonnes of biomass are generated annually from agriculture, including oil palm empty fruit bunch (EFB), coconut husk, sugarcane bagasse, etc. But this can be converted to energy and raw materials to replace fossil fuel, reduce emission of greenhouse gases and provide renewable energy in developing countries.

Biomass waste has huge potential for large-scale industries and community-level enterprises. As the debate on food vs fuel intensifies, biomass can offer extra income to farmers without compromising on the production of food and non-food crops. ■

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Sustainable Practices The Key to Healthy Palm Oil Industry

by Zoe Phoon

Palm oil mill

Ir. Kumar Subramanian *is currently a council member of IEM for 2013-2016 session and was the Chairperson for Agricultural and Food Engineering Technical Division (AFETD) for 2007-2010 session. He is the Managing Director of SGT Konsult Sdn. Bhd., an engineering consultancy firm dealing with design and implementation of agro-based process plants.*

Ir. Kumar has more than 20 years of experience in implementing palm oil mills, kernel crushing plants, bio-gas and biomass power plants, waste water treatment plants and compost plants. He has been involved in palm oil industry since 1993 and been exposed to direct field projects in Malaysia, Indonesia, India, Papua New Guinea, Africa and South America. His published works are mostly related to palm oil plant technology, waste treatment systems guided by green technology solutions. He also serves as an advisory panel member for engineering faculties of University Putra Malaysia (UPM), Universiti Malaysia Perlis (UniMAP) and The University of Nottingham Malaysia Campus. JURUTERA recently speaks to Ir. Kumar on issues related to palm oil industry.

To protect the palm oil industry, agricultural engineer Ir. Kumar Subramaniam says all those involved should be fully committed to protecting the environment.

Agriculture is one of the country's key economic sectors providing rural employment and palm oil produced from oil palm is among the major contributors to the national economy.

However, oil palm cultivation gives rise to some environmental concerns. In rural areas, for instance, rivers are often contaminated with chemicals from agricultural activities. One of the often-asked questions is whether small-scale farmers or big planters have done enough to prevent surface run-off arising from chemical fertilisers and herbicides applications, to the adjacent waterways.

According to Ir. Kumar Subramaniam, farmers and planters can do more to address the actual problem of surface run-off as incidents of water contamination and severe water source pollutions are still issues that need to be overcome.

"A lot needs to be done. Education for the farmers is inadequate. Knowledge on the negative effects of improper applications of chemical fertilisers needs to be improved. Control measures to carry out sustainable agriculture activities to improve production and protect the environment need to be emphasised," said Ir. Kumar.

He said the run-off may end up in the sea or a water catchment area. When this happens, water quality will be seriously affected and the water will not be fit for human consumption downstream. It will also affect coral areas off the coast. With the increase in aquaculture activities in the country, water quality has become a key aspect for the growth of the industry.

Ir. Kumar noted that government agencies such as the Department of Agriculture and the Department of Irrigation & Drainage do provide technical consultancy services but the problem is the lack of awareness and the dissemination of information to farmers, in particular, the cash crop growers with oil palm estates of less than 20 acres.

On the other hand, big plantation companies which own at least a few thousand acres each, have their standard operating procedures (SOPs) for dealing with surface run-off and water contamination. In addition to the SOPs, they also have to comply with the Round table on Sustainable Palm Oil (RSPO) principles and criteria relating to good agricultural production practices as well as waste management such as zero burning at the estates and methane capture at the palm oil mills.

RSPO PRINCIPLES AND CRITERIA

Ir. Kumar said the main objective of RSPO is sustainable palm oil production. The RSPO principles and criteria are summarised and listed below:

- Principle 1: Commitment to transparency – Criteria 1.1 and 1.2 touch on providing adequate information for decision making and public assessment.
- Principle 2: Compliance with applicable laws and regulations – Criteria 2.1 to 2.3 touch on compliance with local, national and international laws and regulations as well as on right on use the land.
- Principle 3: Commitment to long-term economic and financial viability –Criterion 3.1 touches on management plan to economic and financial viability.
- Principle 4: Use of appropriate best practices by growers and millers – Criteria 4.1 to 4.8 touch on the operating procedures to maintain soil fertility, minimise soil erosion, maintain quality of surface and ground water, control of pests, diseases, weeds and the proper use of agrochemicals that ensure the health and safety of all staff, workers, smallholders and contractors.
- Principle 5: Environmental responsibility and conservation of natural resources and biodiversity – Criteria 5.1 to 5.2 touch on action plans by plantation and mill management that mitigate the negative impacts on endangered species. Criteria 5.3 to 5.6 touch on reducing wastes, recycling wastes, re-using waste and disposing waste in a responsible manner including reduction of pollution and greenhouse gases emissions and the conversion of the wastes into renewable energy.

Biogas plant

- Principle 6: Responsible consideration of employees and of individuals and communities affected by growers and mills – Criteria 6.1 to 6.6 touch on plantation and mill management, on communication and consultation, on complaints and grievances, on compensation and others.
- Principle 7: Responsible development of new plantings – Criteria 7.1 to 7.7 touch on social and environmental impact assessment studies, on proper acquisitions of suitable lands, on zero burning in land clearing, etc.
- Principle 8: Commitment to continuous improvement in key areas of activity – Criterion 8.1 calls on the growers and millers to regularly monitor and review their activities for continuous improvement in key operations.

So, unlike the big plantation companies which already have stringent systems in place to protect surface run-off and provide sustainable cultivation, it is the smallholders who need greater exposure and to be made more aware of the impact of agricultural activities on water quality, said Ir Kumar.

In terms of education, he said the Malaysian Palm Oil Board (MPOB) has come up with many programmes for smallholders but such programmes need to be enhanced and must reach the target groups. He suggested more information dissemination through radio and TV programmes and articles in newspapers to the small farmers.

> "Maintaining good agricultural practices together with good engineering practices are key factors that will ensure water resources and water quality are maintained or enhanced."
>
> by Ir. Kumar Subramanian

He said what big plantation companies have been doing can be easily measured, with increased output and much less pollution incidents recorded. For example, they will consider the various RSPO criteria and guidelines before applying fertilisers to oil palms. However, smallholders will not carry out the activities with similar stringent guidelines. It is also additional cost to smallholders in the beginning.

The RSPO organisation is solely for palm oil producers. When the smallholders carry out planting activities with proper RSPO guidelines, clean water and less pollution can be achieved in a sustainable manner.

Under the RSPO as summarised earlier, he said big plantation companies are subject to required standards in waste management methods and discharge. As a result, environmental protection has been enhanced for sure. For example, 10 years ago, the palm oil mill effluent (POME) final discharge quality was 100ppm (parts per million) for BOD (Biological Oxygen Demand). Today, it is below 20ppm and there is no direct discharge allowed into the water course.

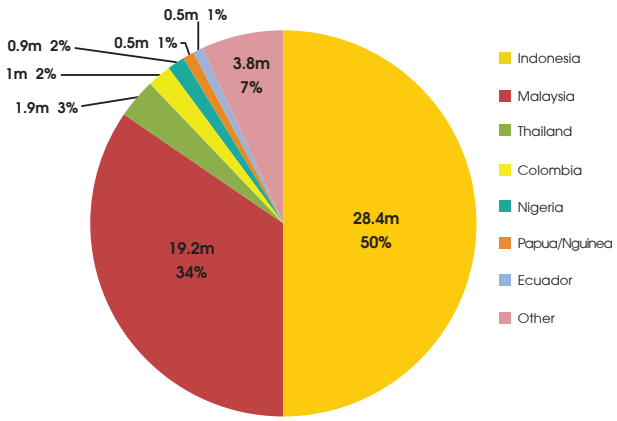
The final treated effluent is to be used for land irrigation, to reduce the volume of discharge to water course and reducing BOD impacts on water quality, he said, crediting the Department of Environment (DOE) for coming up with farsighted environment protection policies.

"In a nutshell, the waste treatment methods have improved a lot and protection of the environment is


Floating palm oil mill


Press and digester

Palm Oil Production 2013 - Tonnes



Data: oil world March 2014 database

Indonesia & Malaysia = 84% market share

being given top priority. Biological/microbes methods are being used in waste water management, methane gas enhancement and the sulphur removal treatment process. This shows the commitment from the industry," he added.

He said smallholders should be encouraged and given incentives to implement the RSPO principles and criteria in order for oil palm plantation activities to be carried out on a long-term sustainability basis. Otherwise, the entire production chain will be affected as the RSPO guidelines start from land clearing itself (RSPO Principle 7) until delivery of final product.

"The other area of concern is open burning as practised by the less educated sector of the industry. This largely contributes to the annual haze phenomenon in this region. The blame game will not help the situation but good education and exposure on the ground, provided to the small section of the non-complying members, will help greatly. Losses are great due to haze but we shall discuss this at another forum," Ir. Kumar added.

USE OF BIOMASS/BIOGAS FOR POWER GENERATION

Commenting on the utilisation of biomass and biogas for power generation, Ir. Kumar said the biogas/biomass energy sector has emerged as one of the top sectors benefiting from RSPO. Many companies have ventured into generation of electrical power from biomass.

The recent focus in the industry is on biogas capture and utilisation. The captured biogas is used as boiler fuel, replacing mesocarp fibres and kernel shells, which can be sold as industrial solid fuels.

The captured biogas can also be used in gas engines and gas turbines for electrical power generation. A recent practice is to add the EFB (empty fruit bunch) biomass from palm oil mills to the biogas plant to produce more methane, resulting in increased biogas production. The remainder of the EFB, upon completion of the process, is then transferred to the plantations as a bio-organic soil enhancer.

Ir. Kumar said there is an increase in the number of biogas/biomass plants in Malaysia, Indonesia and Thailand. By 2018, all palm oil mills in Malaysia must have the methane gas capture system and the boiler emission control system in place to meet the emission standards set by the DOE. The RSPO is also encouraging this initiative.

There is a requirement for plantation companies selling palm oil on the world market, to be verified and certified that they have complied with the RSPO requirements. RSPO-certified crude palm oil has access to the US and EU markets and can fetch a premium price. During any oil glut situation, certified products are given top priority for commodity transaction, which is surely an advantage in the competitive market.

Meanwhile, there is limited new land for oil palm cultivation, said Ir. Kumar. In the peninsula, a strong demand for new townshipsh as made it necessary to convert plantation land into land for new housing schemes; this has pushed land cost up sharply. In Sabah and Sarawak, the impact is not as great yet but the cost of agricultural area has gone up very sharply too.

He said Sarawak still has a vast landbank but the State government has put a stop to converting land for plantations, as per the latest regulations. There is a standard land development scheme under Sarawak's Land Custody and Development Authority (Pelita) with a stake holding of 60:30:10 (Investor: Natives: Pelita) system being enforced in line with RSPO Principles 5 and 7, specifically for oil palm plantation cultivation.

The RSPO Annex on Land Acquisition follows the international guidelines under ILO Convention 169 (1989) on Indigenous and Tribal Peoples (Articles 13-19). This pertains to respecting and safe guarding rights to lands and natural resources traditionally occupied and used, respecting customs of inheritance, no forced removals and compensation for loss and injury.

BACKUP PLANS TO UP CPO PRODUCTION

"When we lose out on the total planted hectarage, production will decrease and so will CPO output. However, the industry is looking into various aspects to make up for the loss of plantation areas via biotechnological approaches. One approach being introduced is the use of better oil palm clones which produce higher yield per hectare, of up to 45 metric tons per hectare compared to 30 metric tons per hectare previously," said Ir. Kumaron the backup plans to increase CPO production.

"Many big plantation companies including Felda, Sime Darby and United Plantations are already planting new oil palm clones that will increase palm oil yield and crop quality."

He added: "Malaysia definitely has backup plans, including planting new oil palm clones and adopting methodologies such as the application of biomass organic fertilisers to improve soil conditions to absorb chemical fertilisers with improved efficiency. Replanting has been carried out for many cycles now in Malaysia and therefore soil conditions need to be enhanced to improve yield.

"Unfortunately, we have lost our status as the No. 1 CPO producer to Indonesia since 2013. In 2007, Malaysia produced about 16 million tons of CPO while Indonesia produced about 14 million tons. In 2013, Indonesia produced about 22 million tons of CPO while Malaysia produced about 19 million tons. Do take note of the increased output from our country despite losing the top producer status to Indonesia.

"To counter the loss of the status and the lack of land to operate big plantations at home, our companies are also expanding their land bank overseas in Indonesia, Papua New Guinea and Africa."

Asked to comment, as an agricultural engineer, on how significant the skills equipped are able to solve water quality and waste issues in upstream agricultural activities, Ir. Kumar said skills are "inadequate" and that graduates need to be given greater exposure to the importance of clean water and preserving water resources. To deal with the changes in climate and operating conditions, the engineers will have to try and acquire more knowledge on managing the situation and being sustainable.

"Maintaining water quality is a very important factor in operating agricultural activities. Agricultural engineers should have in-depth knowledge of water quality, waste management and preserving water resources with the required quality,"

Reactor of biogas

said Ir. Kumar. "Maintaining good agricultural practices, together with good engineering practices, are key factors that will ensure water resources and water quality are maintained or enhanced."

He said more must be done to understand the bigger picture of water resources for humans, industry use and agriculture activities. Raw water needs to be treated for specific consumption requirements and this will involve raw water treatment plants and associated rising operational cost factors. A clean water source will help avoid the high cost of treatment plants and operations and in turn, will benefit the entire consumer sector in the loop.

He added that the recent dry season in Sabah had forced palm oil mill operators to buy water at a very high cost from other sources for operational purposes. In the long run, this will eventually increase their production cost on a non-sustainable basis due to low current CPO prices. Mill owners should implement methods to preserve water resources and water quality available in their area to overcome the dry season and to protect the environment in total.

POTENTIAL OF BIOMASS/BIOGAS ENERGY SECTOR

On the present position and the potential of Malaysia's biogas/biomass sector, Ir. Kumar said POME (palm oil mill effluent) and EFB (empty fruit bunch) biomass are considered as mill waste water and mill waste products, respectively. Lately, these liquid and solid wastes from the mill have been redefined as by-products. Today, methane (from the effluent treatment) and EFB biomass are being used to produce electricity ranging from one megawatt to 4.0 megawatts depending on the size of the palm oil mill.

The by-product of kernel shells, which comes with high calorific value, is being sold on the open market as solid fuel at prices from RM170 per ton to RM200 per ton. International demand for such solid biomass fuel is great and there is increasing demand from countries like China, Korea, Japan and India. Export of long fibre from EFB and bio-organic fertilisers is also increasing due to high demand from overseas. Domestically, there are ready buyers for excess mesocarp fibre at very attractive prices.

However, the growth of the Malaysian biogas/biomass energy sector is slow compared to that of Thailand and Indonesia due to issues related to policy, demand, tariff rate and logistics.

In view of the huge potential of biogas/biomass, Ir. Kumar said it is surely an area to be improved on with the right policies in place to support the entire activity and to take it to the next level of efficiency. Government agencies should encourage plantation companies with downstream activities to produce electricity and supply this to the nearest grids.

He said liquefied bio-methane gas is another viable option to replace fossil fuel supply for plantation activities. The technology is available and farm machineries are fitted with the required change-over kits to use this liquefied gas.

"The government should consider offering attractive buyback tariffs as well as tax exemptions for power plant machineries and incentives for plantation companies with palm oil mills, to encourage them to embark on biogas/biomass power plants, with improved confidence of sustainable contributions," he said.

"Biogas/biomass power projects are economically and commercially viable but to bring this business activity to the next level, the buyback tariffs have to be attractive."

He also noted that the operations of biogas/biomass power plants should be monitored to make sure the wastes produced are treated properly and according to existing stringent guidelines. All these are necessary to ensure that these plants do not turn into pollution centres on their own.

Previously, palm oil mills were regarded as pollution centres. With the required regulations in place, the negative image is slowly being removed but it still requires close monitoring of practices in order to fully emerge as a clean industry.

In terms of policies and incentives, Ir. Kumar said the Thai government is "doing enough" for owners of palm oil mills who have put up biogas/biomass power plants but more need to be done to take the industry to the next level of sustainability.

On the technological limitations and hurdles in Malaysia, he said the available technologies can definitely be improved to enhance efficiency in many related aspects of power production from biomass/biogas. The mechanical and heat efficiency within the plant is surely one aspect that can be improved drastically. Control measures on quality of raw materials and volume are other aspects that can enhance power plant output.

Overall, he said, the palm oil industry (from the point of land clearing to the delivery of the final products) has recently gone through great improvements "in a very sustainable method".

Government policies and commitment from plantation companies have contributed largely to this. However, this should be enhanced to ensure the country's largest agriculture activity will ensure and contribute strongly to the safety and preservation of the environment. Commitment from all sectors involved is required for it to be sustainable not only in improved production but also in improved climate and environment.

Ir. Kumar said that with or without governing regulations, the industry should be fully committed to protecting the environment in order to protect the palm oil industry. ■

Insight into Lignocellulosic Biodegradation and Its Potential for Enzyme Production

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In 2006, Malaysia was the second largest producer of palm oil with 15.88 million tonnes or 43% of the total world supply. In 2007, there were 4.3 million hectares of productive oil palm plantations, a 3.4% increase from 4.2 million hectares in 2006 (1).

As palm oil production increased, there was a corresponding increase in the amount of residue generated. One hectare of oil palm plantation can produce about 50-70 tonnes of biomass residue. So the oil palm industry is currently the largest producer of biomass in the country. Of 70 million tonnes, about 17.4 million tonnes come from oil palm empty fruit bunch (OPEFB) fibre and 53.1 million tonnes from palm oil mill effluent (2).

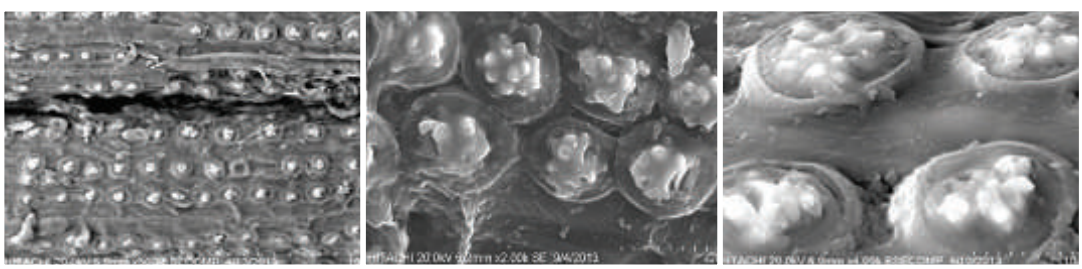
The use of OPEFB has been well explored in various industries such as biocompost(3), biosugar(4), bioethanol(5) and biogas(6). However, due to the presence of silica bodies on the surface of the OPEFB fibre, additional pre-treatment is required in order to obtain maximum usage of the OPEFB since the removal of the silica bodies would increase the porosity and breakage of the lignocellulosic material.

Silica bodies are in organic silica protrusions embedded in the surface of the OPEFB fibre. These are contained in their own craters and scattered randomly on the OPEFB fibre surface (Figure 1). Some researchers claimed that the presence of silica bodies contribute to the strength and rigidity of the OPEFB fibre(7). In this article, we observe the relationship of the silica bodies with OPEFB fibre, which includes the effect of silica body geometry, anisotrophy/orthotropy and debonding mechanism.

A stress-strain curve of OPEFB fibre is presented in Figure 2 where there are three regions observed during the analysis: Elastic region, plastic/debonding region and fracture region. In the first region, the bonding of silica bodies with fibre was tight and perfect while no failures or breakages were observed on the interface of the silica bodies. In the plastic/debonding region, the interface of the silica bodies started to debond, causing the curve to deviate from elastic line. In the final region, the debonding continued until complete failure or breakage was observed.

A 2D model development was performed using Abaqus software where the silica bodies were considered as filler and the OPEFB fibre as matrix. The effect of filler volume fractions (10%, 15% and 20%) was performed using the simulation of 10-spikes filler. A control of no spikes (circular filler) was also compared.

The results showed that the models with spikes were almost similar with the circular filler. The same result was also obtained for different volume fractions (Figure 3). The effect of the number of spikes (5, 10 and 20) on the silica bodies was also investigated, using the similar volume fraction of 15% (Figure 3). Due to the



(a) (b) (c)

Figure 1: SEM micrograph of silica bodies on EFB fibre under 500x magnification (a), 2000x magnification and 4000x magnification (c)

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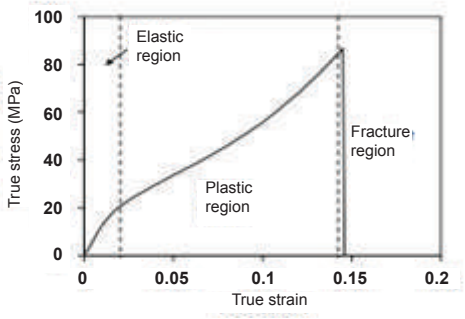

Figure 2: Stress strain curve of EFB fibre, indicating elastic, plastic and fracture region.

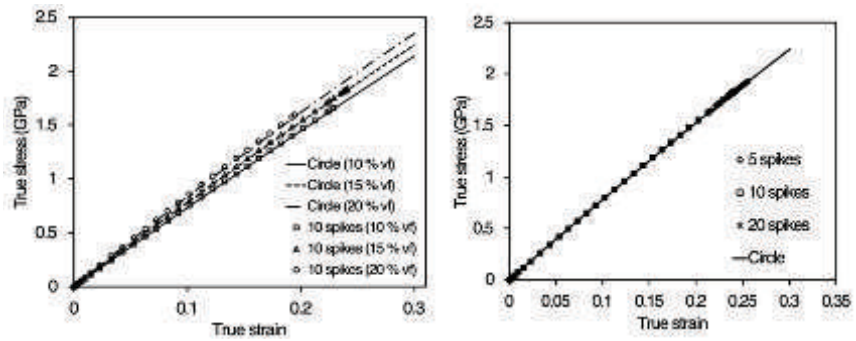

Figure 3: Effect of filler volume fraction under (left) uniaxial tension and (right) effect of number of spikes using volume fraction 15%

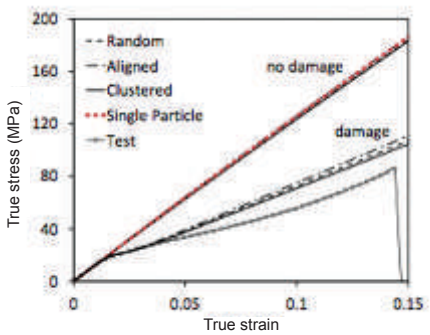

Figure 4: Modelling results of 2D models for aligned, random and clustered arrangements of silica bodies.

longitudinal arrangement of silica bodies along the fibre, there was a possibility of direction-dependant behaviour (anisotropy). The results showed that the 10-spikes models of anisotropy A (Ey = 3.235 GPa) and anisotropy B (Ey = 1.617 GPa) were not much different from the models with circular filler (no spikes).

The effect of silica bodies arrangement was also investigated in a 2D multi-particle model. The model consisted of 20 particles representing the inorganic silica bodies surrounded by the fibre as matrix.

There were three types of silica body arrangements – aligned, clustered and random. Using zone cohesive modelling (CZM), the debonding between the silica bodies and the fibre surface was investigated. Early termination (at 0.02 true strains) was observed in all models with damage, while all models without damage showed similar results with all types of arrangements (Figure 4).

This 2D model was also found to be more sensitive to critical stress than silica bodies spiked geometry, arrangement of silica bodies on the fibre surface and cohesive energy. Naturally, the silica bodies were found to be

embedded halfway in the fibre surface. The damage of silica bodies at the cross-section of the fibre might be present.

A 3D development was developed to investigate the effect of silica bodies on elasticity and damage along the cross-section of the fibre. The difference in thickness of the fibre was investigated. The thickness of fibre/matrix was varied from 0.03 to 0.3 mm to observe the effect of fibre thickness on the elasticity of fibre-protrusion system.

The numerical results showed that the effect of silica bodies on the elasticity of the fibre was not significant when fibre thickness was more than 0.2 mm. Cell wall opening was later incorporated in the 3D model, where the thickness of the cell wall was set at 0.005 mm and the opening size was set at 0.02 mm. Both models showed similar results, indicating that different mechanisms of the fibre might be responsible for the plastic region of stress-strain curve in addition to the silica bodies and fibre interface damage.

The effect of silica bodies was also investigated in ligninolytic enzymes production where the OPEFB fibre was used as the substrate. A local isolated fungus was used in order to produce the ligninolytic enzymes from OPEFB fibre.

The OPEFB fibres used were both raw and chemically treated. The 10-day fermentation results showed that treated OPEFB was preferred by the lignin degrader to produce high ligninolytic enzymes. A 5-10% of the increment in the lignin peroxidase enzyme activity was observed. A similar observation was also found with manganese peroxidase and laccase production. This was mainly due to the removal of the silica bodies and a considerable amount of lignin was achieved in the treated OPEFB.

As mentioned by Shamsudin S. *et al.,* (8) the removal of silica bodies left hollow craters, exposing larger surface areas for the enzyme to digest the lignocelluloses materials. The same phenomenon was also found by Harun N.A.F *et al.,* (9). These silica bodies were present to prevent the fibre from microbial attack. The silica bodies and waxy layer on the outer surface of the fibre act together as an impermeable layer, preventing the fibre from being oxidised and hydrolysed by oxygen and microorganisms. ■

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Sediment Transport : Study Evaluation of Proposed Causeway in Tanjung Manis Port, Sarawak, for Industrial and Aquaculture Development

Ir. Dr Hii Ching Poon

Dr Wang Zhi Qian

Ir. Chong Sun Fatt

Ir. Lim Sin Poh

The Sarawak Government has proposed Tanjung Manis Halal Hub (TMHH) as the largest integrated halal hub in the State. It covers 77,000 ha of agriculture land, stretching from Pulau Bruit in the north to Sarikei Town in the south. In line with the Government's aspirations under the New Economic Model (NEM), TMHH is planned to attract investors with high value projects and transform the region into a high-income generator zone.

Through the Sarawak Timber Industry Development Corporation (STIDC), the Sarawak Government is currently looking at ways to expand the economic activities in the vicinity of existing waterways, from the current aquaculture industry to other activities such as refineries, oil & gas onshore facilities and ship building.

The area of study is located in deltas and estuaries of several major rivers, including Batang Rajang. The near-pristine environment includes mangroves and coastal peat forests, which are ideal for agriculture. The proposed area is located at the meandering channel in a coastal wetland that is subject to diurnal tides. It is approximately 8-10km from the river mouth and near Belawai Island. An approximate location of the study area is shown in Figure 1.

Figure 1: Proposed development at Tanjung Manis port

NUMERICAL SIMULATION CONDITION

Numerical models were established to assess environmental impacts which might be caused by the waterway separation. Numerical models were established to simulate the complex coastal response to the proposed engineering works. Delft3D was used as the numerical modelling tool to investigate hydrodynamics, sediment transport and morphology, water quality for fluvial, estuarine and coastal environments.

The coastal hydraulic model consisted of hydrodynamic, sediment transport and pollution tracer dispersion modelling. Hydrodynamic modelling was carried out to simulate the water level variations and current velocities induced by a variety of force functions, such as tides. This model formed the basis for carrying out the subsequent coastal processes.

At this stage, the effluent characteristics from industrial works were not known. Therefore, tracer dispersion would be modelled to assess

Figure 2: Selected outfall locations for simulations

the dilution and spreading of possible pollutions in the delta area. As the ship building area will extend about 10km along the riverbanks, three typical locations have been selected to represent the discharge points upstream, downstream and midway of the project site (Figure 2).

HYDRODYNAMIC RESULTS

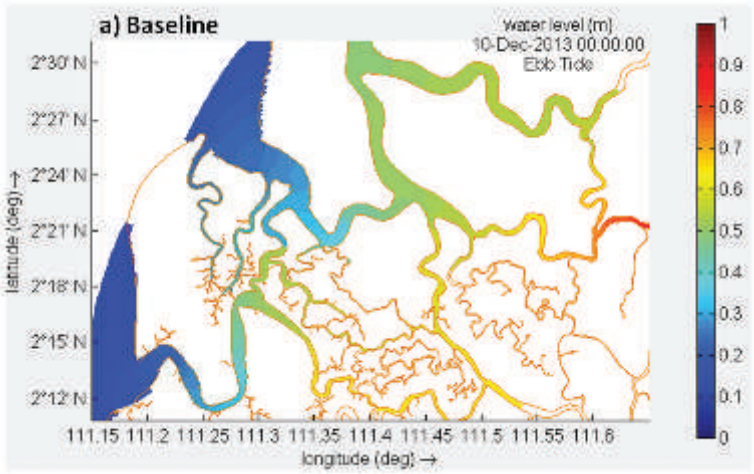
TIDE AND CURRENT

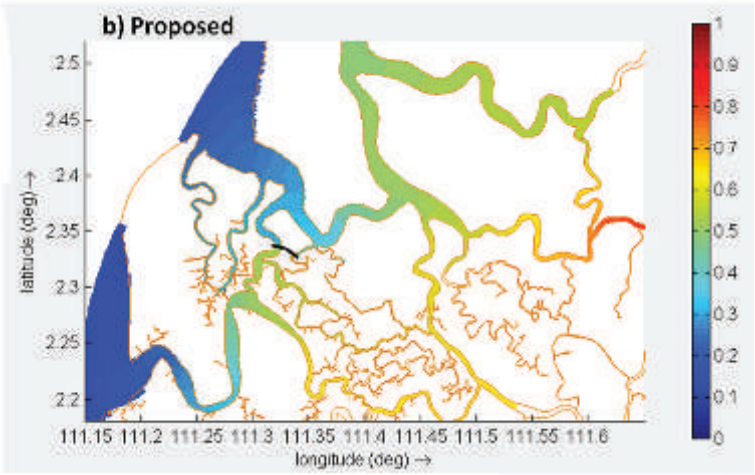
Hydrodynamic modelling was carried out to simulate the water level variations and current velocities induced by tides and river flows under existing condition and the proposed option.

Water level and current plots for the exit conditions and with the proposed causeways during the typical tide stages, are shown in Figures 3 and 4 respectively. The results show that the current flow at the project site is dominated by the tidal variations.

Hydrodynamic impacts can be assessed by comparing the flow conditions between existing conditions and the proposed causeways. Based on the results, it is possible to conclude that:

1. The proposed causeways block the flow in the two waterways, LobaBuan and LobaPaloh. The flow field in the vicinity of causeways is nearly stagnant.
2. Water level difference before and after the construction of the causeways is in the order of 0.1 m in the blocked waterways.
3. The maximum current speed difference is in the order of 1.0 m/s in the blocked waterways.





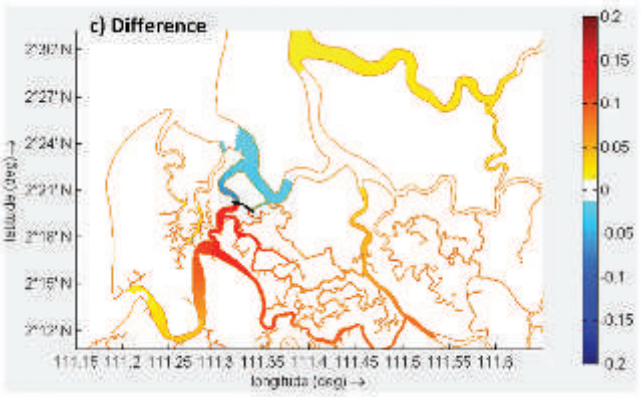


Figure 3 (a): Typical water level at ebb tide for a) baseline; b) with proposed causeway, and c) the difference

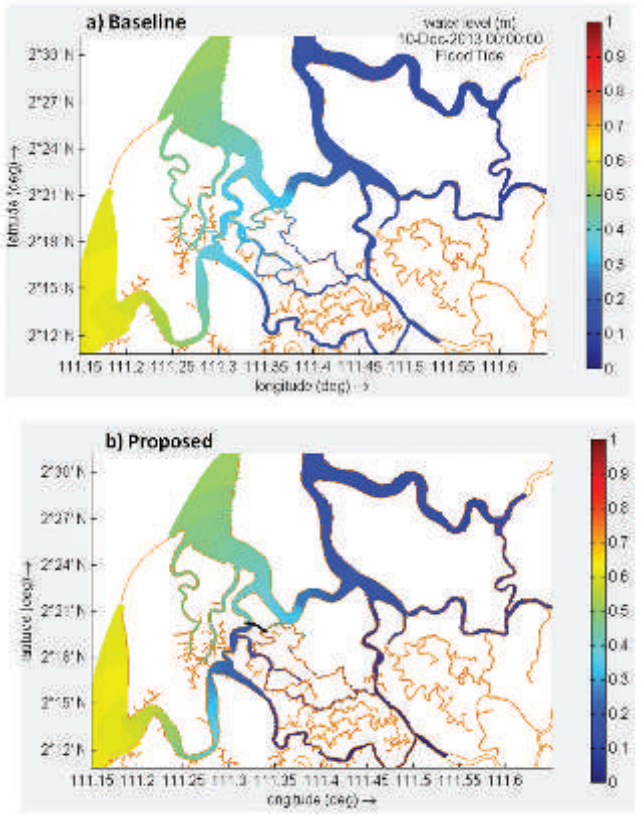
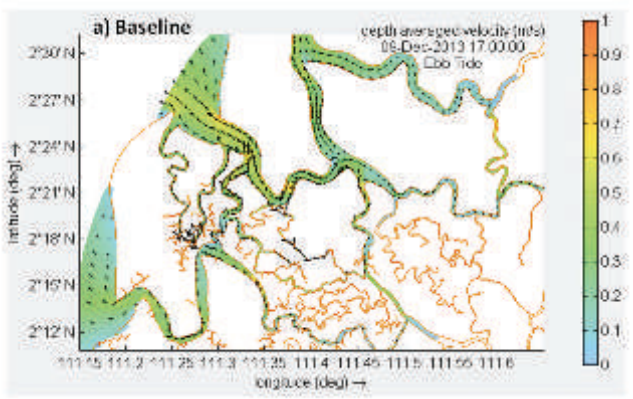
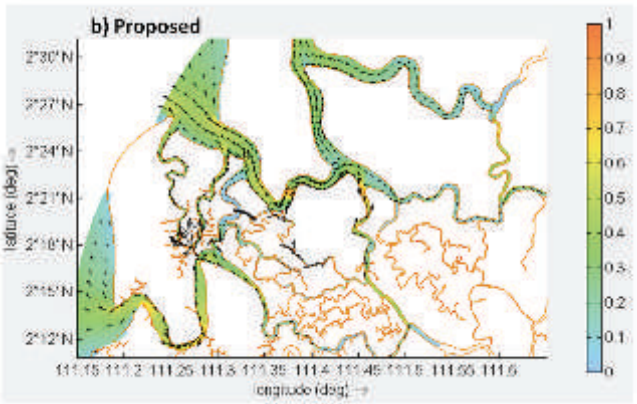


Figure 3 (b): Typical water level at flood tide for a) baseline; b) with proposed causeway, and c) the difference





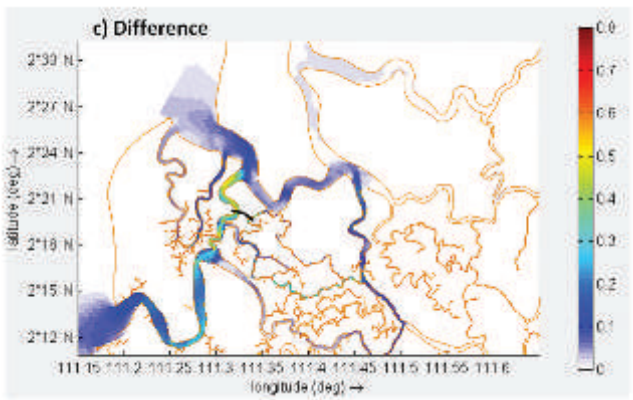
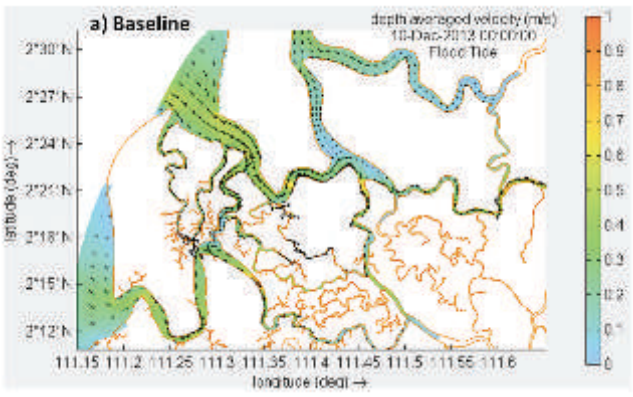


Figure 4 (a): Typical tide current at ebb tide for a) baseline; b) with proposed causeway, and c) the difference



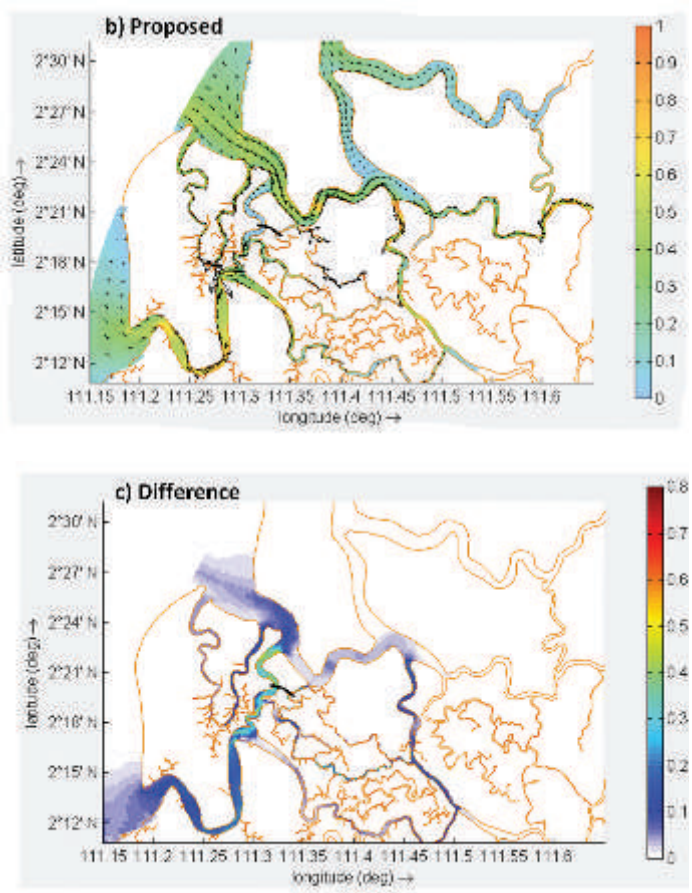


Figure 4 (b): Typical tide current at flood tide for a) baseline; b) with proposed causeway, and c) the difference

SEDIMENTATION AND COASTAL MORPHOLOGY

The sediment transport pattern can be affected by the proposed development works when the local flow field is modified. Siltation and erosion processes will cause the local morphology changes. The simulation was carried out to assess the sediment transport before and after the development works and the impact on the local morphology variations. The mean sediment transport rate and accumulated erosion or siltation under normal flow conditions are shown in Figures 5.1 and 5.2, respectively.

The impacts on sediment transport can be assessed by comparing the typical sediment transport rate between the existing conditions and with the proposed causeways. Based on the results it is possible to conclude that:

1. Sediment transport patterns in the waterways of LobaBuan and LobaPaloh and adjacent river reaches are different if the flow is blocked by the causeways.
2. The sediment transported into LobaBuan and LobaPaloh can be trapped in the outer reaches of the long waterways. See Figure 5.2 (b). The maximum accretion rate under normal flow condition is in the order of 1 m/year.
3. However, further inside the waterways to the causeways, siltation or erosion is less as the flow is smaller and sediment transport rate is much lower in the inner reaches. See Figure 5.2 (b).

POLLUTANT DISPERSION

The dispersion pattern of pollutants discharged from three different outfall locations along the river is shown in Figure 2. For analysis purposes, it is assumed that the discharge is 10 m3/s with the initial concentration of 100 ppm (or 0.1 kg/m3), which is continuously discharged from each outfall. This assumption is conservative for common applications of pollutant discharge from plants.

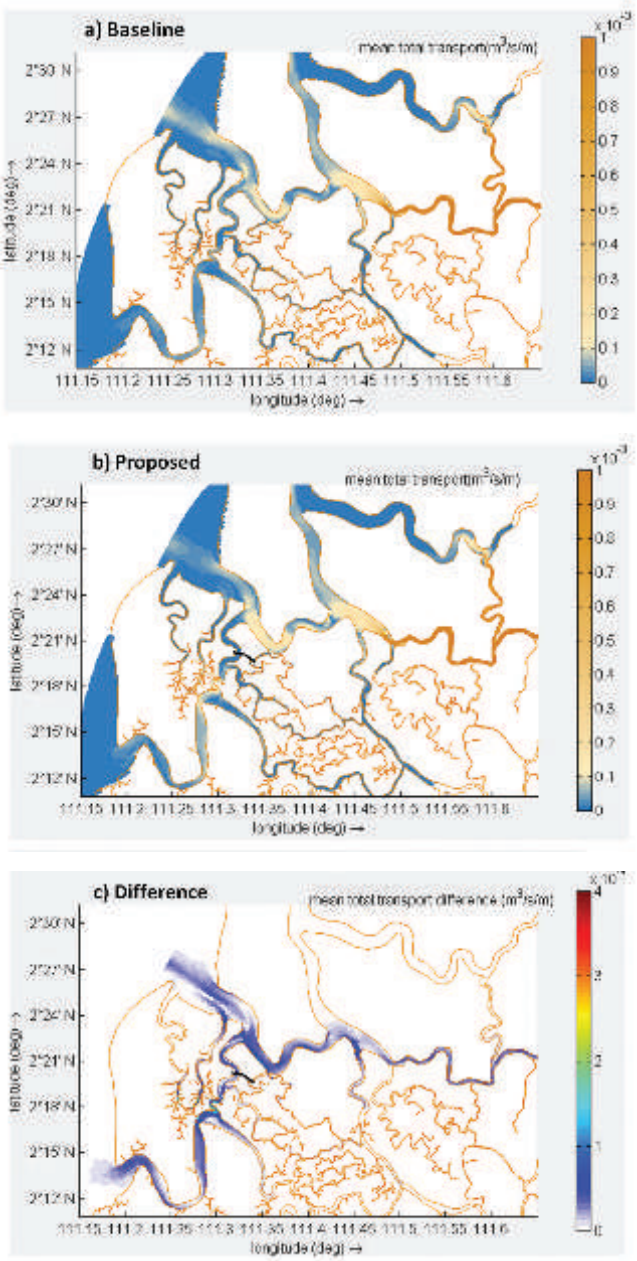
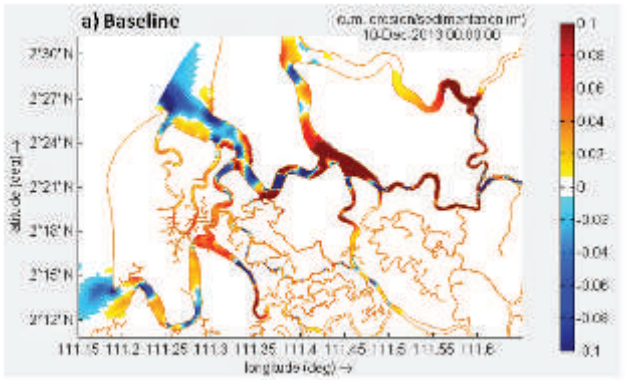


Figure 5.1: Mean sediment transport rate under normal flow condition over the simulation period for a) baseline; b) with proposed causeway, and c) the difference



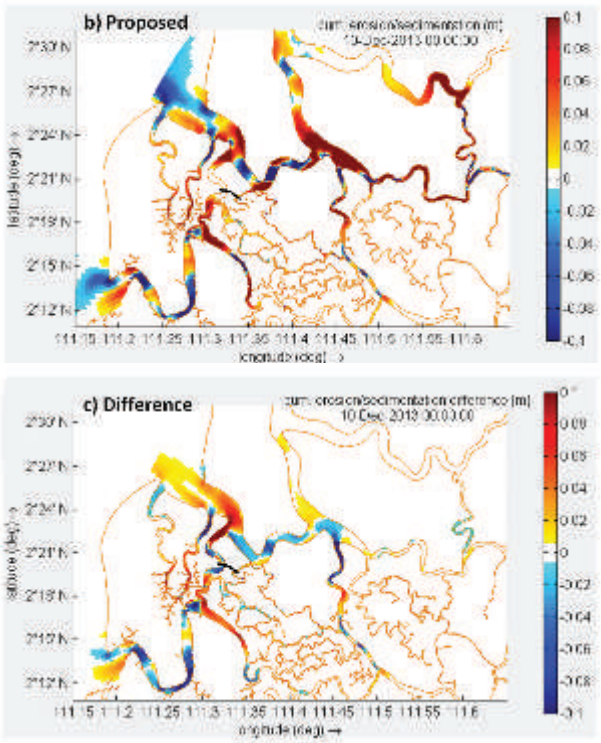


Figure 5.2: Mean erosion/sediment rate under normal flow condition over the simulation period for a) baseline; b) with proposed causeway, and c) the difference

The typical dispersion patterns are plotted in Figures 6.1 to 6.3 for different discharge points, respectively. The pollutant plume can reach the designated aquaculture regions through LobaBuan and LobaPaloh and other waterways. The concentration, however, is very low at this region. For example, at the point located in the northern part of aquaculture area, the concentration is 1.5x10-3kg/m3, i.e. only 0.15% of the assumed initial value. With the causeways, no discharge plume is dispersed through LobaBuan and LobaPaloh. However, trace pollutant is still observed in the aquaculture area as this can be dispersed via other waterways. The concentration is further decreased to 2x10-4 kg/m3. The time series of pollutant concentration during simulation period are shown in Figure 6.4.

Based on the results it is possible to conclude that:

1. The pollutant dispersion pattern and concentration distribution in the waterways of LobaBuan and LobaPaloh are different for the three outfall points.
2. Most of the pollutant load is diluted in the main river of Btg. Paloh as the outfalls are located along the river. The pollutant plume is also dispersed into the neighbouring tributaries and waterways.
3. The pollutant plume can reach the designated aquaculture regions through LobaBuan and LobaPaloh and other waterways. However, the concentration is very low in the region. With a soluble pollutant loading of 100 ppm at 10 m3/s flow rate, the concentration is decreased to less than 0.02 ppm.
4. For some special cases when the pollutant matter is insoluble and transported in the form of small particles or patches, the concentration may occasionally reach up to 1 ppm.

5. The causeways can block the dispersion through LobaBuan and LobaPaloh and the concentration is substantially decreased behind the causeways. The concentration is decreased to below 0.002 ppm.

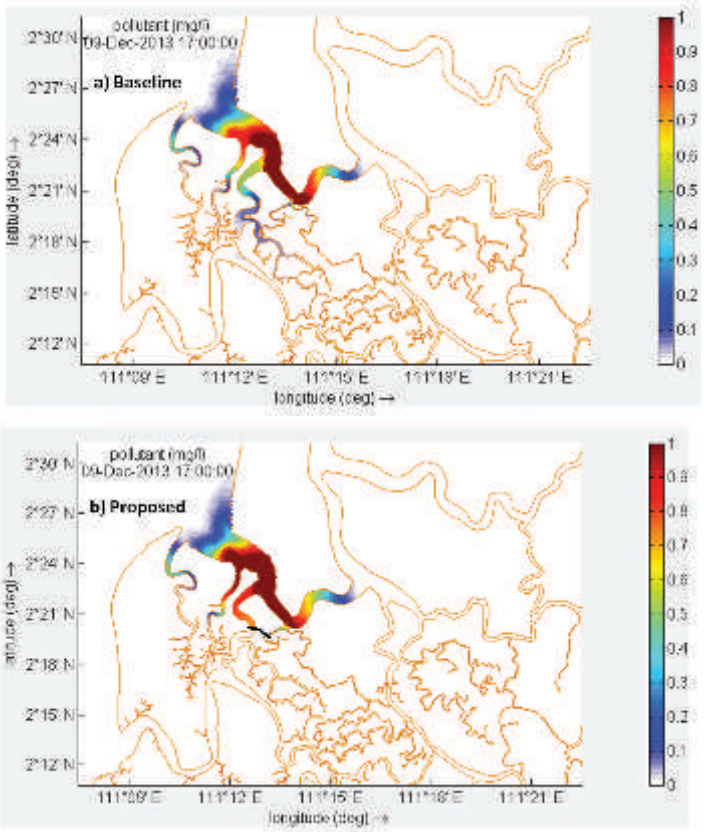


Figure 6.1: Typical dispersion pattern (mg/l)from discharge outfall-1 a) baseline; b) with proposed causeway

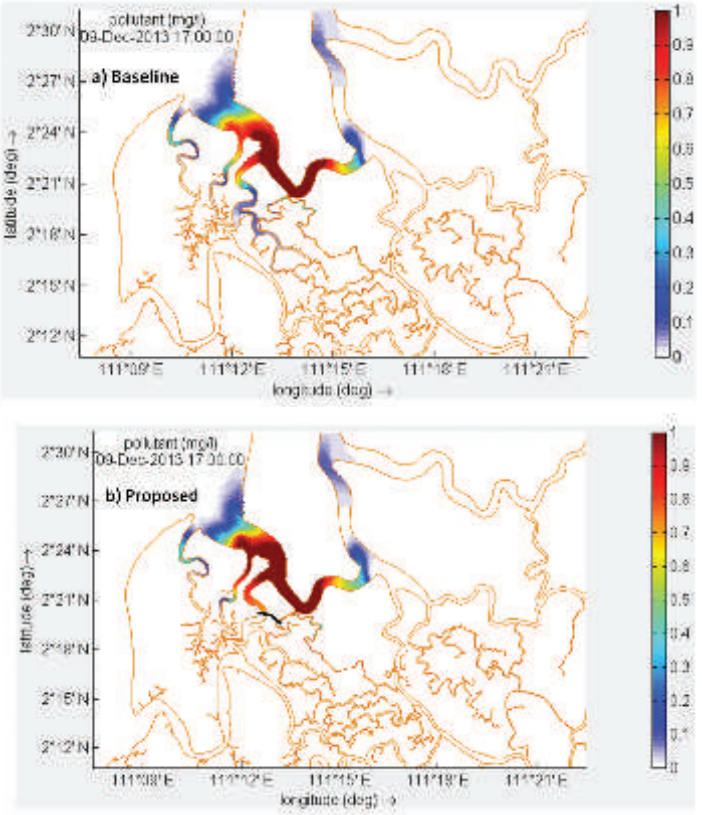


Figure 6.2: Typical dispersion pattern (mg/l) from discharge outfall-2 a) baseline; b) with proposed causeway

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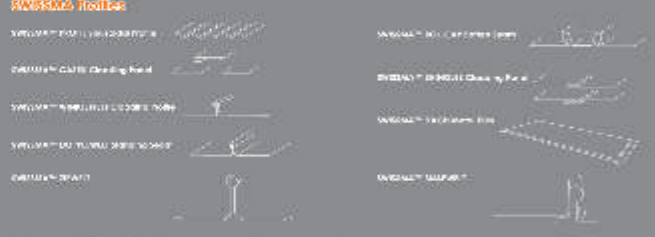

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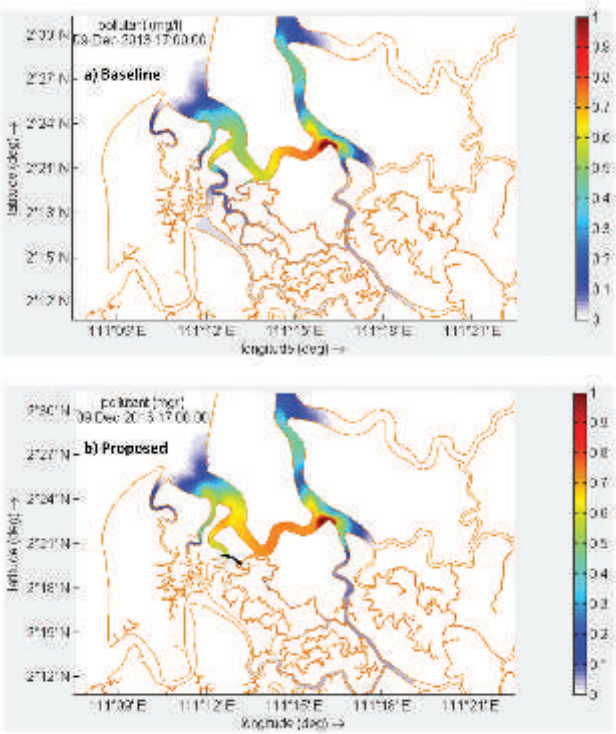


Figure 6.3: Typical dispersion pattern (mg/l) from discharge outfall-3 a) baseline; b) with proposed causeway

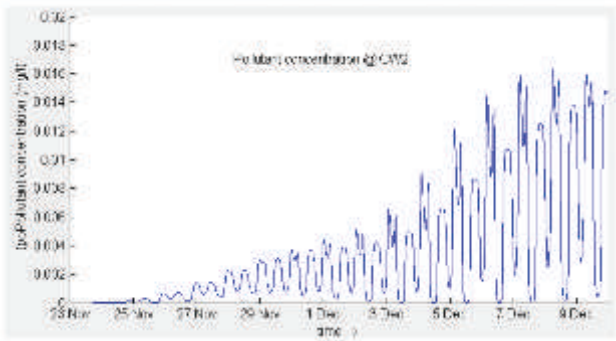


Figure 6.4 (a): Time series of concentration without separator, which is located in the northern part of aquaculture area

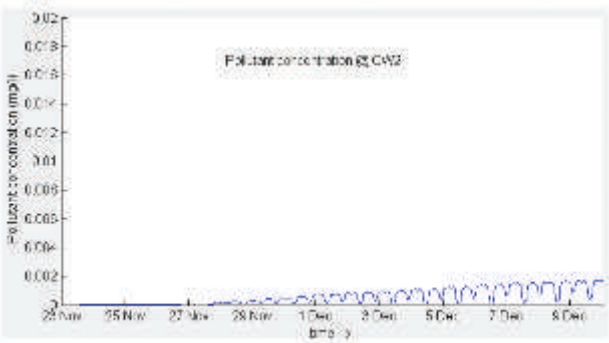


Figure 6.4 (b): Time series of concentration with separator

CONCLUSION

This coastal hydraulic study investigates the impact of the proposed causeways in term of hydrodynamic, sediment transport, sediment and pollutant dispersion. Based on the results, it can be concluded that:

1. The proposed causeways block the flows in the two waterways, LobaBuan and LobaPaloh. The flow field in the vicinity of the causeways is nearly stagnant.
2. Water level difference before and after construction of causeways is in the order of 0.1 m in the blocked waterways.
3. Current speed difference is in the order of 1.0 m/s in the blocked waterways.
4. Sediment transport patterns in the waterways of LobaBuan and LobaPaloh and adjacent river reaches are different if the flow is blocked by the causeways.
5. The sediment transported into LobaBuan and LobaPaloh can be trapped in the outer reaches of the long waterways. The maximum accretion rate under normal flow condition is in the order of 1 m/year.
6. Further inside the waterways to the causeways, siltation or erosion becomes milder as the flow is smaller and sediment transport rate is much lower in the inner reaches.
7. The pollutant dispersion pattern and concentration distribution in the waterways of LobaBuan and LobaPaloh are different for the three outfall points.
8. Most pollutant load is diluted in the main river of Btg. Paloh as the outfalls are located along the river. The pollutant plume is also dispersed into the neighbouring tributaries and waterways.
9. The pollutant plume can reach the designated aquaculture regions through LobaBuan and LobaPaloh and other waterways. However, the concentration becomes very low in the region. With a soluble pollutant loading of 100 ppm at 10 m3/s flow rate, the concentration decreases to less than 0.02 ppm.
10. The causeways can block the dispersion through LobaBuan and LobaPaloh and the concentration is substantially decreased behind the causeways. The concentration is decreased to below 0.002 ppm.
11. For special cases when the pollutant matter is insoluble and transported in the form of small particles or patches, the concentration may occasionally reach up to 1 ppm. ■

Ir. Dr Hii Ching Poon *is director of Hydrology and Hydraulic Section at Jurutera Adda Sdn. Bhd. His working experiences include hydrological studies of major water resources projects, water quality study, river hydraulic and coastal modelling study, flood mitigation projects, drainage and rivertraining design.*

Dr Wang Zhi Qian *graduated with a PhD in Nanyang Technological University (NTU) Singapore in 2006 and served as Research Officer at NTU. He has vast experience in Hydraulics, Numerical and Physical Modelling of river and coastal processes and sediment transport. He is currently the Managing Director of G&P Water (Singapore) Pte. Ltd.*

Ir. Chong Sun Fatt *obtained his B.Eng (Hons) in Civil from University of Malaya in 1978 and M.Sc. (Irrigation Engineering) from KU Leuven, Belgium in 1991. He served in the Department of Irrigation and Drainage Malaysia from 1978 to 2003. He was involved in numerous hydrological, water resources, flood mitigation and Irrigation and Drainage projects. He is currently the principal advisor in G&P water and Maritime Sdn. Bhd.*

Ir. Lim Sin Poh *graduated from Universiti Teknologi Malaysia with a B. Eng (Civil) and completed his post graduate studies in Nanyang Technological University Singapore, graduating with a M. Eng. (Civil). He started his career as a hydrology and hydraulic engineer. He has been in civil and structural engineering consultancy for more than 15 years and is currently the Managing Director of G&P Water and Maritime Sdn. Bhd.*

Waste Management: Value-Added Products From Oil Palm Empty Fruit Bunch (EFB) After Treatment

by Ir. Hor Kok Luen

Ir. Hor Kok Luen *graduated from University of Science Malaysia (USM) in 2001 with Bachelor of Degree (Hons.) in Mechanical Engineering. He is currently chief engineer of a established palm oil group involved in palm oil mill processing, long fibre plant, short fibre plant, solvent extraction plant, biogas capturing plant and of green energy generation for grid connection.*

He is a corporate member of The Institutions of Engineers Malaysia (IEM) in Mechanical discipline and a registered Professional Engineer with the Board of Engineers Malaysia (BEM). He is currently a committee member of Food & Agricultural Engineering Technical Division (AFETD).

In palm oil mill processing, Oil Palm Empty Fruit Bunch (EFB) is treated as biomass waste. Currently, with the correct approach, matured engineering and technology innovations, this biomass waste can be further processed and treated as a value-added product which can generate profits.

These products are mainly dried long palm fibre, short loose fibre and pressed EFB liquor. Dried long palm fibre makes a good substitute for coconut fibre in furniture industries (e.g. mattress fibre and cushion production). Short loose fibre can be turned into fuel in the solid fuel boiler (volatile matter at 40% maximum). The liquid based product, pressed EFB liquor, is the main source for Chemical Oxygen Demand (COD) enhancement for boosting the formation of methane gas, capturing renewable energy and power generation.

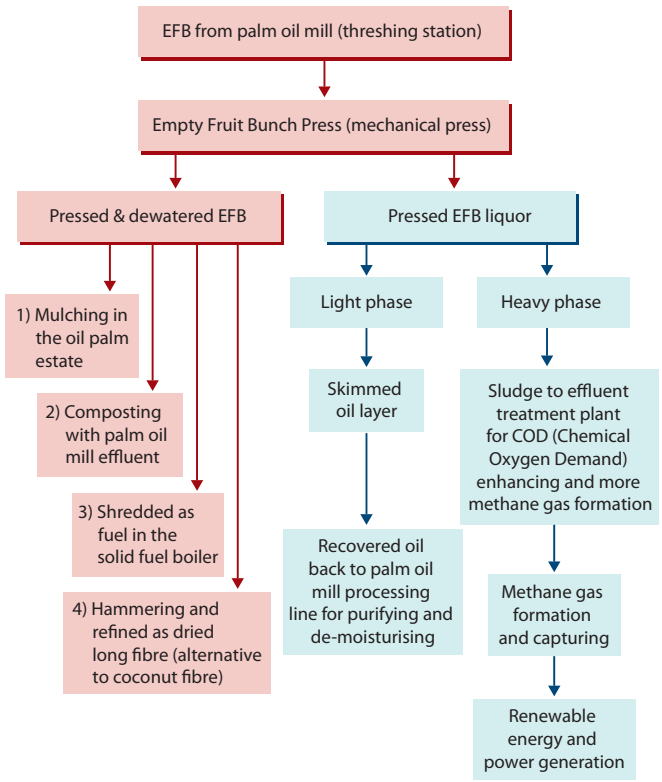
This paper briefly elaborates, with a clearer scope, about the value-added products which are a significant new milestone for downstream activities in conventional palm oil mill processing.

PROCESSING OF EMPTY FRUIT BUNCH

In a simple mass balance analysis, the composition of the Empty Fruit Bunch (EFB) is typically about 21% of the overall Fresh Fruit Bunch (FFB). Oil Palm EFB used to be treated as biomass waste in the palm oil mill processing. Handling and disposal of EFB was a serious problem and a great challenge to the industry. If not handled properly, it has a huge, negative impact on the environment. Currently, this oil palm biomass waste is further processed to produce value-added products.

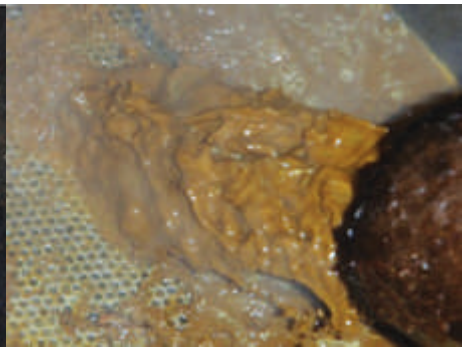
Below is a typical EFB treatment process flow chart which is used in most palm oil mills today. It is becoming more popular as the related machines are now more mature in design, with user-friendly operations and maintenance and well as safe to use. As illustrated, after the treatment of the EFB, there are various downstream activities for producing value-added products. These value-added products can be commercialised while the related production lines are practical and workable.

EMPTY FRUIT BUNCHTREATMENT AND VALUE-ADDED PRODUCTS FLOW CHART



EMPTY FRUIT BUNCH (EFB)

PRESSED EMPTY FRUIT BUNCH (PEFB)



PRESSED EFB LIQUOR

RECOVERED OIL FROM PRESSED EFB LIQUOR

SHORT LOOSE FIBRE AS BOILER FUEL

DRIED LONG FIBRE

BIOGAS PROJECT-METHANE GAS CAPTURING

COMPOSTING PROJECT

EFB MULCHING IN THE ESTATE

RAW EFB AND SHREDDED EFB

From the EFB treatment flow chart and photographs as illustrated here, the value-added products are explained briefly below.

EFB FROM PALM OIL MILL (THRESHING STATION)

Conventionally, the sterilised oil palm fruitlets attached to the bunch must be detached, threshed and recovered through processing. The non-fruitlets bunch is called the Empty Fruit Bunch (EFB). The EFB will be separated and treated as biomass waste.

APPLYING EFB PRESS WITH GOOD & MATURED ENGINEERING DESIGN

The EFB removed from thresher will be fed to the bunch press for further treatment (pressing process). The solid phase of the pressed product is called pressed & dewatered EFB (with moisture content of about 50%). The liquid phase of the pressed product is called pressed EFB liquor.

SOLID PHASE: PRESSED AND DEWATERED EFB

1. **As mulching material in the oil palm estate**

   EFB will degrade fully in about 6 months.The degradable pressed and dewatered EFB can partially rehabilitate and recuperate the nutrients in the soil. However, it requires a lot of effort and energy as well as added costs as it is very labour intensive to transport and distribute in the estate.

2. **As composting material to produce organic fertiliser**

   The pressed and dewatered EFB is mixed with palm oil mill effluent (POME), composted, bio-reacted and degraded to produce an organic fertiliser which is suitable for rubber and oil palm plantations, vegetable farms and plant nurseries.

3. **Alternative fuel for palm oil mill solid fuel boiler**

   In addition to getting pressed liquor and to recover oil, the pressed and dewatered EFB bunch from the EFB press can also be utilised as short and loose fibre. This shredded EFB fibre, mainly ½" to 2" in length, with a maximum moisture content of 40%, is a good combustible fuel for solid fuel steam boilers in palm oil mill as well as other industries. Furthermore, this also means a lower consumption of palm kernel shell and mesocarp fibre (the fibre from the oil palm fruitlets skin) as fuel for steam boilers. The palm kernel shell saved can be sold to other industries such as the glove, latex and bricks factories. This will generate extra revenue for the company. Currently the price of the raw palm kernel shell (ex-mill) is RM150 to RM170 per metric ton.

4. **To produce dried long fibre (DLF): Highest value-added products**

   Pressed EFB bunch can be used to produce dried long fibre as a raw material for fibre-based end products such as mattresses and cushions which traditionally use coconut fibre. The DLF produced is biodegradable, healthy and environmental friendly. It contains no toxic elements. With this the pressed and dewatered EFB can be used to produce higher value-added products and generate even more revenue for the company besides solving the Department of Environment (DOE) issues on EFB liquor (water pollutant-based liquor). Not only that but it can also solve another potential DOE issue, that of EFB disposal. This is linkable to the government enforcement programme which strictly controls the application of burning EFB in the incinerator, especially in Sarawak. It was prohibited in all other States a few years ago.

LIQUID PHASE: PRESSED EFB LIQUOR

THE VITAL APPLICATION OF THE HEAVY PHASE OF THE PRESSED EFB LIQUOR

- **Heavy phase as High COD (Chemical Oxygen Demand) agent for enhancing methane gas formation**

  Chemical Oxygen Demand (COD), in layman's terms, is the standard method for indirect measurement of the amount of pollution (which cannot be oxidised biologically) in a sample of water. The COD test procedure is based on the chemical decomposition of organic and in organic contaminants, dissolved or suspended in water. The result of a COD test indicates the amount of

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water-dissolved oxygen (expressed as parts per million or milligrams per litre of water) consumed by contaminants during two hours of decomposition from a solution of boiling potassium dichromate. The higher the COD, the higher the amount of pollution in the test sample. For contaminants that can be oxidised biologically, the biological oxygen demand (BOD) method is used.

- **In line with Biogas Capturing Project (MPOB and DOE requirement) – Higher COD obtained**

  Besides the free oil recovery, the EFB press machine serves to remove excess water in the EFB (moisture reduction) to suit its various applications as well as requirements from the relevant government authorities.

BIOGAS CAPTURE AND CDM PROJECT IMPLEMENTATION FOR PALM OIL MILLS IN MALAYSIA

Under the National Key Economic Areas (NKEA) plan by the Government in the 10th Malaysia Plan (2011-2015), efforts have been put in to transform the country from a middle-income to a high-income nation.

The importance of biogas trapping is evident from its inclusion as one of the eight Entry Point Projects (EPPs) of the palm oil sector under NKEA.

In this context, the Malaysia Palm Oil Board (MPOB) and the DOE have set up regulations towards this implementation. The basic requirements on biogas capturing can be summarised as follows:

1. MPOB Licence condition for all the palm oil mills (compulsory)
2. For existing mills to have biogas capturing by 1 January, 2017, or the latest by 1 January, 2020.
3. Compulsory criteria and condition for upgrading or extension of existing palm oil mills or construction of new mills, effective 1 January 2014.

VITAL ROLE OF PRESSED EFB LIQUOR IN BIOGAS CAPTURING PROJECT

The pressed liquor after EFB bunch press will be collected and pumped to a vertical oil recovery tank. The heavy phase of the clarifier tank will be pumped to the effluent treatment plant together with waste water from condensate pit and oil room sludge pit.

Conventionally, the COD of raw palm oil mill effluent without EFB pressed liquor, will be in the range of 45,000mg/L (milligram per litre) to 55,000mg/L. By having the EFB pressed liquor, the COD concentration can be as high as 75,000mg/L to 90,000mg/L.

The higher value of COD will definitely help generate significantly more biogas (methane gas). With more biogas formation and captured, useful applications or utilisations can be implemented more cost effectively besides fulfilling the requirements set by the authorities. ■

IEM DIARY OF EVENTS

Title: 2-Day Course on Construction Contracts - Traps and Pitfalls

5 - 6 October 2015

Organised by : Project Management Technical Division
Time : 9.00 a.m. – 5.30 p.m.
CPD/PDP : 14

Title: 1-Day Course on Traffic Impact Assessment

7 October 2015

Organised by : Highway and Transportation Engineering Technical Division
Time : 9.00 a.m. – 5.30 p.m.
CPD/PDP : 0

Kindly note that the scheduled events below are subject to change. Please visit the IEM website at www.myiem.org.my for more information on the upcoming events.

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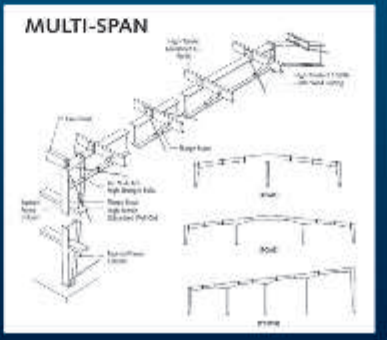
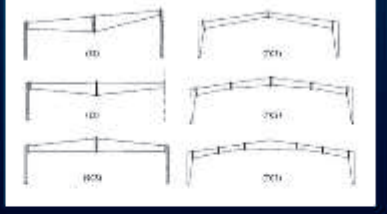


CLEAR-SPAN



		BUILDING WIDTH	SIDEWALL HEIGHT
	Multi-Span		
(TCM1)	Tapered Column Modular One Interior Column	18m - 100m	3.5m - 12m and over
(TCM2)	Tapered Column Modular Two Interior Column	28m - 120m	3.5m - 12m and over
(TCMSS)	Tapered Column Multi - Span Single Slope	20m - 160m	3.5m - 12m and over
	Clear-Span		
(SS)	Straight Column Single Slope	4.5m - 22m	3m - 9m
(LT)	Straight Column Lean To	3m - 22m	2.4m - 9m
(SCS)	Straight Column Clear Span	8m - 22m	3m - 9m
(TCS)	Tapered Column Clear Span	6m - 30m	3.5m - 12m and over
(TCS)	Tapered Column Clear Span - Two Piece Rafter	12m - 85m	3.5m - 12m and over
(TCS)	Tapered Column Clear Span - Three Piece Rafter	12m - 85m	3.5m - 12m and over

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IMPORTANT DATES

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Notification of full Paper Acceptance
15th April 2016

Early bird registration
15th August 2016

Organised by: I.E.M.

Jointly with: Centre for Fluid Dynamics; MMU Multimedia University

Supported by: Sarawak Convention Bureau

SAFE TEA TIME

3As To Gaining Ownership

Let us look at activities that can drive us closer to ownership.

AWARENESS

Have you ever seen dramatic posters or statistics that scream out about how unsafe we are? What is your reaction (really)? Do you have the urge to jump up and do something about it immediately or do you just ponder deeper on the information?

If you're the type who jumps up and gets straight into action, you will be extremely proactive and engaged. Most people will just ponder deeper on the information. These shock videos, gory pictures and screaming statistics are just meant to create a basic phase of "Awareness". These methods are used to reinforce messages or support presentations. But alone by themselves, these are rarely a call to action.

ACKNOWLEDGEMENT

The next phase is when we share an in-house story of an incident or a friend shares his personal experience. This is much more moving and the closer the story is to the group, the stronger will be the emotional link. At such a moment, those in the group will feel that "it is possible that it may happen to me".

The listener will feel an urge to do something and to take action. This is the crucial stage to push a person into taking action. This is the "Acknowledgement" phase.

The next time you attend a presentation or training that you feel is impactful, take a moment to analyse how the speaker has used stories and emotional links to create that atmosphere.

ACCEPTANCE

The final phase is when we involve the person(s) in a hands-on activity. It can be coaching a new employee, standing up to share his personal experience or taking part in an inspection. This is the crucial phase to gain ownership. This is as close as we can get possibly to drive ownership.

So, the next time someone says that the message has gone out and that the recipients should take action, think again. Perhaps the ownership element is missing. Think of the 3As that we have highlighted here.

Own up – share with me your challenges in getting things moving: *pub@iem.org.my*.

Ownership drives results; not statistics. ■

The safest risk is the one that you did not take. Often it is the gap in the risk perception that leads to a gap in risk control.

by Ir. Shum Keng Yan

Ir. Shum Keng Yan *is a chemical engineer and a certified accident prevention and safety practitioner. He advises on EHS in the chemical, fast moving consumer goods, heavy metal manufacturing and building services industries across Asia Pacific and beyond. He regularly delivers talks at conferences, forums and universities.*

The 10th Asia Pacific Conference on Transportation and the Environment (APTE) on 8 -10 November 2016

In recent years, there was rapid growth in transport infrastructure development in Malaysia, specifically in Klang Valley region. With the construction of highways and mass rapid transit lines as well as the extension of light rail lines, these developments are likely to cause impact on the environment. Careful planning and mitigation strategies are necessary to handle the potential issues and challenges arisen from such development.

The 10th Asia Pacific Conference on Transportation and the Environment (APTE) is held with the objective to provide a platform of discussion for both local and international experts on the transport related environment issue. It provides the opportunity for the experts, researchers, and consultants from various disciplines to exchange ideas and opinions on the effective strategies and planning to mitigate the potential negative social and environmental impacts caused by transport activities.

The theme of the 10th APTE is Green Transport Development for Sustainable Future. The topics of interest include, but not limited to: transport system resilient during disaster, transport safety, economic, social and environmental impacts of transport activities and development, impacts of land/sea/air transport operation, transport and environmental issue, impact of logistics and freight transport, rail development and impact assessment, pavement materials, public transport, and others.

The 10th APTE is co-organized by the Highway and Transportation Technical Division, IEM, Centre of Disaster Risk Reduction, Universiti Tunku Abdul Rahman, and Transportation Science Society of Malaysia (TSSM). It will be held on 8 to 10 November 2016 at Armada Hotel, Petaling Jaya. We welcome Abstract submission for those who are interested to present paper in the conference. The deadline of submission is 15 December 2015. Best paper award will be given and selected good papers will be published in the Journal of Traffic and Transportation Engineering. Please visit: www.utar.edu.my/apte2016/ for more information. ■

Technical Visit to Grundfos Pumps

AGRICULTURAL AND FOOD ENGINEERING TECHNICAL DIVISION

reported by
Ir. Yong Hong Liang

Ir. Yong Hong Liang *graduated from Universiti Putra Malaysia with Bachelor Engineering (Agricultural) and Master Science (Soil & Water Engineering). He has over 15 years of experience in development of oil palm plantation and rural area in Malaysia and Indonesia. He is the Head of Engineering of TSH Resources Berhad. Currently, he is the Chairman of Agricultural and Food Engineering Technical Division, IEM.*

Ms. Yew briefing the IEM members

PUMPS play a major role in our lives today. At the petrol station, we use a pump to fill up the car petrol tank. At home, pumps are also used in a number of ways, from the removal of wastewater to boosting the pressure of the incoming water supply. Similarly, in commercial buildings, pumps are also used in a wide variety of applications such as for air conditioning, heating, wastewater removal and fire protection.

What then is a pump? Simply put, a pump is a mechanical device that uses suction or pressure to raise or move fluids, compressed gas, or forces air into inflatable objects. Clearly a pump is there because it serves a purpose. It brings comfort to the habitat.

In order to gain a greater insight into pumps, 15 IEM members visited Grundfos Pumps Sdn. Bhd. in Shah Alam on 28 March, 2015. Incidentally, Grundfos is the world's largest

Presenting a souvenir to a representative from Grundfos Pumps

pump manufacturer. Based in Denmark, it was founded by Poul Due Jensen in 1945. The company has some 18,000 employees globally.

The briefing given by managers of Grundfos Pumps Sdn. Bhd. was divided into four parts.

PART 1: Mr. Aew Chan Hoong touched on topics surrounding the hydraulics and pump theories. He discussed the various types of pumps, calculation of pump flow and head, friction losses, pump curves and different situations/elements to consider when sizing pumps and also troubleshooting.

PART 2: Ms. Yew Pei Ling gave a briefing on the solutions available to reduce total electricity consumption via the Grundfos' optimisation and consultancy services. This service helps to determine if a pump should be repaired or replaced. According to Ms. Yew, a pump installation is analysed to reduce energy and money expenditures. In order to achieve this, a plant-wide energy reduction approach is taken. At the end of this exercise/service, the customer receives a full report, with documented savings and payback. This topic was one that participants were greatly interested in as many of their customers were looking for energy efficient solutions.

PART 3: Ms. Vennise Phang highlighted the relevant pumping solutions, namely propeller pumps and rubber dams for flood solutions, and wastewater transport pumps. She also briefed participants on the range of KPL submersible axial flow propeller pumps and KWM submersible mixed flow pumps for flood control and other heavy-duty pumping applications. These include innovative features such as the Turbulence Optimiser which increases efficiency by up to two percentage points. Turbulence Optimiser is an innovative solution for reducing turbulence in the gap between the pump volute and the column pipe. A further positive effect is that misalignment and production tolerances of the column will no longer affect efficiency.

To handle wastewater, processed water and unscreened raw sewage in heavy-duty municipal, utility and industrial applications, SE and SL pumps are used instead. Ms. Phang explained that these pumps are suitable for freestanding installation or for use as portable utility pumps. The S-tube impeller is the only one in the market designed to cope with the challenges of modern wastewater with varying dry matter content. The simple and robust design of the S-tube impeller offers world class hydraulic efficiency without compromising on free passage.

PART 4: Mr. Ho Ching Wah talked about the nationwide after-sales service available from Grundfos, including the new testbed facility available at the head office.

The participants were later taken on a tour of the showroom and the testbed facility. ■

IEM Charity Golf 2015

BUILDING SERVICES TECHNICAL DIVISION

reported by
Ir. Cha Hoong Kum

Ir. Cha Hoong Kum *graduated from the University of Westminster of UK with a Bachelor of Engineering (Mechanical) Second Class Honours (1st Division) in 1991 and obtained his Master of Business Administration from Leicester University, UK in 1992. Ir. Cha is currently a committee member in the Building Services Technical Division Session 2014/2015.*

All work and no play makes Jack a dull boy. With that in mind, the Institution of Engineers organised the Malaysia Charity Golf 2015 on 30 June at Kelab Rekreasi Tentera Udara, Subang, Selangor.

The response was overwhelming with a maximum 128 participants registered. These comprised members and corporate business associates. However, four participants did not turn up on the day of the tournament.

This was a record for IEM charity golf since its inception. The committee was glad that IEM President Dato' Ir. Lim Chow Hock, Vice President Ir. Gopal Narian Kutty and our special guest, YB Dato' Ir. Donald Lim, could find time to join the golfers at the event.

It was a good day. The weather was near perfect, with plenty of sunshine and a cool breeze. The fairway was dry. For the last couple of years, the course had gained a notorious reputation for its soggy fairway, especially during the rainy seasons. However we were truly pleased to be enjoying such fine weather and the game proceeded smoothly.

The Organizing Committee had secured Unique Fire Industry Sdn. Bhd. as the main sponsor for the event. The other sponsors were as follows:

- ACSON Malaysia Sales & Services S/B
- Dato' Donald Lim
- GTS Plumbing Sdn. Bhd.
- Orchid Dynamics
- Pyrogen Manufacturing Sdn. Bhd.
- Seng Choon Hardware (M) Sdn. Bhd.
- SMARTECH International Sdn. Bhd.
- SPIND Malaysia Sdn. Bhd.
- TOPAIRE Sales & Services Sdn. Bhd.
- Truewater Cooling Towers Sdn. Bhd.
- WISEPRO Sdn. Bhd.

Hole 7 was selected for the Hole-in-one (the prize, a One-HP Air-conditioner, was sponsored by ACSON). As there was no winner, the prize was given out as a lucky draw prize at the end of the event.

The winners of the tournament, listed below, were based on System 36:

IEM Member Category

Champion	:	Mat Amir	37-points	Handicap-21
1st Runner Up	:	Nik Arris	36-points	Handicap-15
2nd Runner Up	:	Ho Kim Yee	36-points	Handicap-18

Non IEM Member Category

Champion	:	See Kim Seng	38-points	Handicap-11
1st Runner Up	:	Lee Chuk Khai	37-points	Handicap-9
2nd Runner Up	:	Ronald Chung	37-points	Handicap-9

Winners of IEM Charity Golf 2015, from left with IEM Vice President, Ir. Gopal Narian Kutty, Champion of Non-IEM Category, Mr. See Kim Seng, Mr. Liew Sen Hoi from Unique Fire Industry Sdn. Bhd, Champion of IEM Member Category, Mr. Mat Amir, Chairman of Building Services Technical Division (BSTD), Ir. Wong Chu Loong and Ms. Catherine Yap from SPIND Malaysia Sdn. Bhd.

From the contributions received from the event, the Organising Committee was able to fulfil its pledge of RM12,000 for the Wisma IEM Building Fund which has an outstanding amount of RM3,879,767.40 as of 30 May 2015. IEM Vice President Ir. Gopal Narian Kutty accepted the mock cheque on behalf of the IEM President.

The Organising Committee wishes to express its sincere gratitude and thanks to the sponsors, in particular Unique Fire Industry Sdn. Bhd., participants and the secretariat staff who helped make this a successful event in the Institution of Engineers Malaysia calendar. ■

Technical Visit to Transformers Manufacturer, AM SGB Sdn. Bhd.

ELECTRICAL ENGINEERING TECHNICAL DIVISION

reported by
Ir. Faridon Talib

Ir. Faridon Talib *is currently the Vice President with Technip Consultant (M) Sdn. Bhd. an oil & gas engineering Consultant Company. He has been with the oil & gas industries since graduation. He is a fellow member of IEM and also a committee member of IEM Electrical Engineering Technical Division.*

To the layman, a transformer is an electrical device that changes alternating current (AC) voltages from one level to another within the power networks. It is an important component in the transmission, distribution and utilisation of electrical energy. Without it, there would be a lot of wastage of energy in the system.

For a better appreciation of transformers and how they are made, the Electrical Engineering Technical Division (EETD) arranged for a visit to one of the largest transformer manufacturers in the region, AM SGB Sdn. Bhd., on 12 March, 2015. Its factory is in the Arab-Malaysia Industrial Park in Nilai, Negri Sembilan. EETD committee member, Ir. Faridon bin Talib, led the group of 15 IEM members.

It started with a briefing by an official of AM SGB Sdn. Bhd., who said the company was incorporated in 1994 and commenced production in early 1996. Initially the intention was to manufacture small rating oil distribution transformers up to 5000 kVA to meet Tenaga Nasional Berhad's (TNB) demand.

Now, with the installation of a state of the art production facility, it can produce power transformers up to 40 MVA. To further improve quality and reliability for the benefit of its customers, AM SGB Malaysia opened a new manufacturing facility to make cast resin coil and transformers. It is the only manufacturer of its kind within the ASEAN region.

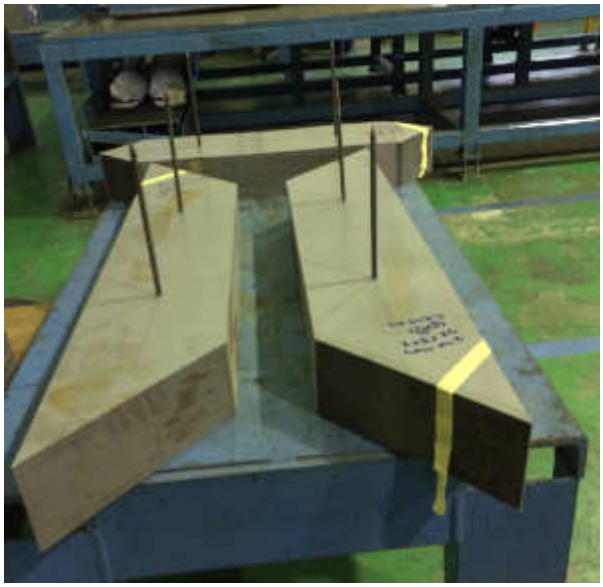
With this development, Malaysia is taking a unique leadership position in ASEAN as far as the transformers are concerned. So far the company has delivered close to 25,000 units of various ratings of transformers for use in the region that include Africa, Asia, Australia Oceania and Middle East.

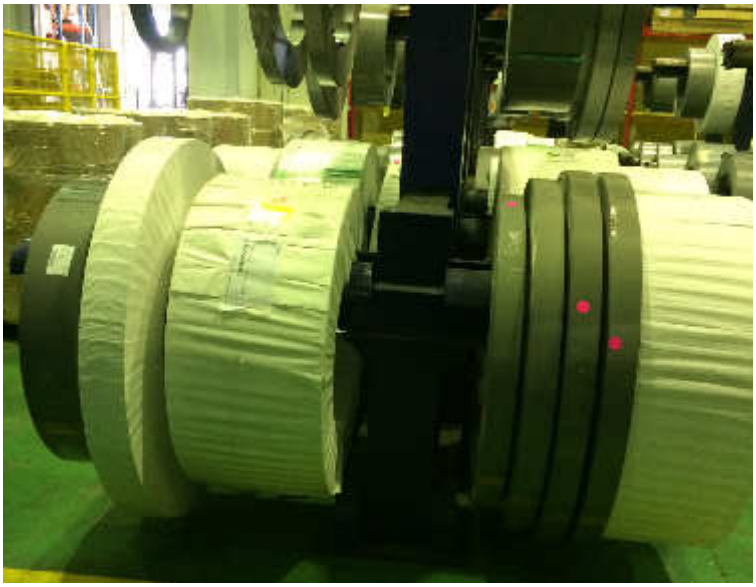
After the briefing, the visitors were divided into three groups which would visit the following facilities separately.

1. Insulation area: This was where we were introduced to the various types of insulation papers and the insulation process.
2. Coils and Accessories: Here, we saw the process of making coils. With the help of

At the core cutting, stacking and assembly area.

Insulation area. IEM participant listening to the briefing on types of insulation papers.





At the core cutting, stacking and assembly area.

Cast resin transformer ready for delivery

Transformers are ready for testing

Exchanging tokens

modern machinery and high quality materials, high quality transformers were produced.

3. Core Cutting and Stacking: In this area we were exposed to the core cutting method with different sizes of silicon sheet steel. An optimum core design was achieved with the use of high quality cold rolled, grain oriented electrical sheet steel, step-lap cutting procedure and modern lamination methods without using internal bolts.
4. Distribution Assembly Area: Here, the various parts such as HV coils, LV coils, core, tank cover etc, were assembled to form the active parts.
5. Dryer: The active parts were dried in the dryer to remove any moisture in the assembly and insulation material. It takes roughly 48 hour to do this.
6. Tanking and Oil Filling: After drying, the active parts were inserted into the tank and bolted. Oil filling was completed through the "oil bleeding process" to remove any air and bubble in the transformer oil. The time required for oil settlement was roughly 24 hours for a distribution transformer and 48 hours for a power transformer.
7. Testing Area: To comply with the Quality Standard, AM SGB follows strictly all testing requirements before delivery to customer. Testing was done as per International Standards IEC60076, ANSI AS, Oil & Gas (PTS, DEP). Some of the tests performed were:
   - Routine test
   - Impulse test
   - Partial discharge testing
   - Sound ranging chamber
   - Oil testing
8. Cast Resin Factory: The cast resin factory used the latest and most modern state of the art technology. Its coil machine was connected to SGB in Germany where any error would be detected and corrected immediately. According to the company spokesperson, cast resin transformers have the following operational advantages:
   - High impulse voltages and controlled safety.
   - Thermal withstand capability makes overload possible.
   - Expansion and contraction of coils in service is tolerated, even for short circuits.
   - Long service life is guaranteed.

The visit ended with a certificate presentation ceremony, an exchange of souvenirs and a light lunch. ■

IEM Upcoming Conferences

THEME:
WE Diverse
Work Life
Towards
Future

WOMEN ENGINEERS SUMMIT - WE SUMMIT 2015

26 November 2015

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Electrical Engineering Technical Division
The Institution of Engineers, Malaysia

IIEC 2015

http://iiec.org.my

IET The Institution of Engineering and Technology

The Institution of Engineers, Malaysia (IEM) and
The Institution of Engineering and Technology Malaysia Network (IET Malaysia),
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30 November - 2 December 2015
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Deep Excavation and Ground Improvement

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Dorsett Grand Subang, Subang Jaya, Malaysia

15th Asian Congress of Fluid Mechanics

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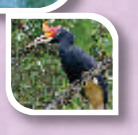

Call for Papers

IMPORTANT DATES

Deadline of full paper submission
15th December 2015

Notification of full Paper Acceptance
15th April 2016

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BUATAN MALAYSIA

IEM FUNDAMENTAL OF ENGINEERING EXAMINATIONS (FEE)

by Standing Committee on Examinations and Qualifications

IEM is introducing the IEM FUNDAMENTALS OF ENGINEERING EXAMINATIONS (FEE) to final year engineering students as well as fresh engineering graduates.

WHAT IS FEE?

The FEE is an examination on the fundamentals of engineering in the various disciplines. It covers the subject matter in a typical EAC-accredited engineering degree programme curriculum. The examination would comprise two parts – a Common Paper applicable to all disciplines of engineering and a Discipline-specific paper.

OBJECTIVE OF THE FEE

The objective of the Examination is first and foremost to ensure that ALL engineering graduates from ALL universities (local and foreign) have grasped the basic fundamentals of their engineering studies, in their respective fields. In view of the diverse number of degree programmes offered by the increasing number of universities both locally and abroad, employers are having difficulty in identifying good recruits to be employed.

The FEE would serve as an assurance to employers that having passed the FEE, the graduate had been tested on his/her knowledge on the fundamentals of engineering after graduation and therefore employers are assured that the graduate is trainable. In order to pass the FEE, the graduate would at least have to revisit what he/she had learnt in the early stages of the degree programme and this would refresh his/her knowledge learnt before entering the job market. In short, the FEE will serve as a means of ensuring that graduates have achieved the required standard where engineering fundamentals are concerned.

The FEE helps to provide employers with a preliminary screening mechanism thereby giving you an additional level of evaluation to select the right candidate for your company. Employers would therefore be able to save time and resources as the process automatically shortlists the eligible candidates.

YOUR ROLE AND CONTRIBUTION

However, for the FEE to play its role to assist you in recruitment of engineers, we hope to receive your support for the implementation of the FEE. Being a voluntary examination (engineering graduates take the examination on voluntary basis), we encourage the engineering graduates to attempt this examination.

In this examination also aims to shortlist engineering graduates suitable for various sectors of the industry.

Test questions contributed by the industry would ensure that the FEE would indeed test the engineering graduates in the appropriate areas. We provide below the syllabus and details of the examination's content for your reference.

Your support for this examination is greatly anticipated as a joint effort to improve the engineering profession in the country. For further information regarding the need for this examination, please contact IEM Secretariat.

CONTENT OF THE FEE

The examination would comprise two parts namely:

Part 1 Common Exam comprising 40 Multiple Choice Questions testing on logical and analytical thinking as well as Mathematics and Engineering Sciences.

Part 2 Discipline Specific Exam (Elective Exam) comprising 40 Mulitple Choice Questions testing the candidates on their understanding of the fundamentals of engineering related respectively to the five major disciplines of Civil, Electrical, Electronic, Mechanical and Chemical Engineering.

In order to ensure the standard and quality of the examination, the marking scheme will be as follows:

Marking Scheme

Each correct answer will be given 1 mark. For each incorrect answer:

i. Common Exam - deduct 1/4 mark
ii. Elective exam - deduct 1/3 mark

A candidate will need to accumulate a total of 50% of the marks from each Exam paper to be given a PASS.

Syllabus

Common Exam

i. Engineering Mathematics, Economics and Probability & Statistics
ii. Engineering Science
iii. Analytical Reasoning and Logical Thinking

DISCIPLINE EXAM

A.	Civil Engineering
i.	Environmental Engineering
ii.	Geotechnical Engineering
iii.	Structural Engineering
iv.	Water Resources Engineering
v.	Highway and Transportation

B.	Electrical Engineering
i.	Circuits and Signals
ii.	Digital and Analogue Electronics
iii.	Electromagnetic Fields and Waves
iv.	Instrumentation and Control
v.	Communication Systems
vi.	DC and AC Machines (Single- and Three-Phase)
vii.	Power Electronics and Drives
viii.	Power Systems
ix.	High Voltage Engineering
x.	Electrical Distribution and Utilization

C.	Electronic Engineering
i.	Circuits and Signals
ii.	Digital and Analogue Electronics
iii.	Electromagnetic Fields and Waves
iv.	Instrumentation and Control
v.	Communication Systems
vi.	Electronic System and Integrated Circuit Design
vii.	Microprocessor Systems
viii.	Computer Architectures
ix.	Multimedia Technology and Applications

D.	Mechanical Engineering
i.	Mechanical Design and Analysis
ii.	Kinematics, Dynamics, Vibrations and Control
iii.	Materials and Processing
iv.	Thermodynamics, Energy conversion, Heat Transfer
v.	Refrigeration and HVAC
vi.	Fluid Mechanics and Fluid Machinery
vii.	Manufacturing and Management

E.	Chemical Engineering
i.	Chemistry and Biochemistry
ii.	Thermodynamics
iii.	Material and Energy Balance
iv.	Momentum Transfer
v.	Heat Transfer
vi.	Mass Transfer
vii.	Chemical Reaction Engineering
viii.	Process Control
ix.	Safety, Health and Environment
x.	Process and Plant Design

The Institution of Engineers, Malaysia

CAFEO 33 2015

The Conference of the ASEAN Federation of Engineering Organizations

BACKGROUND

The Institution of Engineers, Malaysia is hosting the 33rd Conference of the ASEAN Federation of Engineering Organization 2015 to be held from 22nd to 26th November. Penang is the hosting city for CAFEO 33, 2015.

The Institution of Engineers, Malaysia (IEM) Penang Branch, as the main host, is pleased to invite other engineering organizations, universities and R&D institutions to participate in this prestigious conference & exhibition with the theme below:

THEMES

From Light to Bytes: ASEAN Engineering Evolution and Future Challenges

SUB-THEMES

- Integrated public transportation system in urban development.
- Electrical, electronic, mechanical, information and communication technology engineering.
- Engineering and technology for sustainable infrastructure design.
- Chemical and environmental engineering development.
- Engineering education and women engineering in developing countries.

CONFERENCE REGISTRATION FEES

The registration fee for conference delegates would include session, tea breaks, lunches and welcoming reception and farewell banquet dinner. The registration fee for AFEO delegates are as follows:

- **AFEO Delegate USD 100 or RM380**
- **WEAFEO Delegate USD 100 or RM380**
- **YEAFEO Delegate USD 60 or RM228**
- **Accompanying Person USD 100 or RM380**
- **Non AFEO USD 200 or RM760**

REGISTRATION

In order to facilitate the planning of the Conference, those wishing to attend are requested to register online at **cafeo33.iempenang.org** or to complete and return the **Registration Form**, and return to the CAFEO Secretariat by email, mail or fax (Refer to the contact detail on following section) as early as possible to facilitate our preparation of your participation.

The first 100 delegates who successfully registered with full payment through online or CAFEO secretariat will be given a door gift.

SPOUSE/ACCOMPANYING PERSON PROGRAMME

The Organizing Committee has arranged programmes for accompanying spouse/person to historical monuments, tourism and commercial centres in Penang. The registration fee shall be **USD 30** or **RM114** for the 2 tours. (Island Tours and Heritage Tours). Visit our website for more information.

CONFERENCE VENUE

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E: info@pen.equatorial.com
W: www.hotel-equatorial-penang.com

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10050 Georgetown, Penang, Malaysia.
T: +60 4 818 2045 F: +60 4 226 4490
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My First Day in Andorra

Ir. Chin Mee Poon
www.facebook.com/chinmeepoon

Ir. Chin Mee Poon *is a retired civil engineer who derives a great deal of joy and satisfaction from travelling to different parts of the globe, capturing fascinating insights of the places and people he encounters and sharing his experiences with others through his photographs and writing.*

On a sunny spring day in 2015, my wife and I left Toulouse for Andorra in a new Toyota Auris Hybrid. I was at the wheel. We had rented the car in Paris earlier so that we could visit the many remote but quaint French villages that would otherwise be hard to reach.

With an area of 468 sq km, the Principality of Andorra is one of the few microstates in Europe. It is nestled high in the eastern part of the Pyrenees, at an average altitude of about 2,000m above sea level. The country is located about midway between Toulouse in France and Barcelona in Spain, being 185km south of the former and 208km north of the latter. The Pyrenees mountain range, which extends from the Atlantic Ocean to the Mediterranean Sea, forms a natural boundary between France and Spain.

We took 3 hours to reach the Andorran border where a border control officer just waved us through. We did not even have to stop. Andorra is one of the few countries in the world that anyone can visit without a visa.

At the start, the road followed the meander of a river. Then it started to twist and turn as it climbed the steep mountain side, creating a series of hairpin turns. After driving a few kilometres, we arrived at the first settlement, Pas de la Casa. As its name suggests, Pas de la Casa is situated on a mountain pass. We stopped and dropped in at the tourism office to get some maps and pamphlets. We also noticed that some hotels displayed very attractive room rates but we decided to push on to the next sizeable settlement, Canillo, which was 15km away.

After a view-point at about 2,400m asl, the road started winding its way down the steep mountainside into a valley. We made a few more stops to admire the spectacular scenery and we reached Canillo at twilight.

At an altitude of 1,526m, Canillo is the largest settlement in the parish of the same name. Andorra is administratively divided into 7 parishes. The parish of Canillo has a population of only 4,850 out of a total national population of 78,200. The village is extremely charming, and we were immediately persuaded, at first sight, to put up the night there.

After checking out various options, we settled for a double room with en-suite facilities in a hotel on the main street for 55.50, inclusive of breakfast. The room was very spacious, well equipped and clean. It was definitely better value for money than hotels in France, generally. At the suggestion of the hotel owner, we had a sumptuous dinner in a very popular Portuguese restaurant to celebrate our 41st wedding anniversary.

We were extremely happy with our decision to visit this tiny country. Only 8% of the country is urbanised and cultivated. The rest is made up of forests, lakes, rivers and mountains. That suited nature lovers like us perfectly well. There was also one other attraction: Petrol here was about 30% cheaper than that in France!

Andorra also has a unique system of government. It is the only country in the world with two heads of state, known as co-princes. They are the Bishop of Urgell, Spain, and the president of France. This peculiarity had evolved from an arrangement rooted in a medieval document known as *Pareatges*. ■

Editor's Note: *We welcome contributions from all members on travel stories.*

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- ☐ Engineering/Design (including chief engineer, chief designer, civil/highway/mechanical/planning engineer, other engineering/design title)
- ☐ Buying/Purchasing (including chief buyer, buyer, purchasing officer, other buying/purchasing title)
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- ☐ Others (please specify) _____

What type of organisation do you work in? *(Tick one box only)*

- ☐ Contractor
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- ☐ Petroleum producer
- ☐ International/national authorities
- ☐ National/regional/local government
- ☐ Public utilities (electricity, gas, water, deck and harbour, other)
- ☐ Manufacturer
- ☐ Distributor/importer/agent
- ☐ Construction department of large industrial/Commercial concern
- ☐ Association/education establishment/research
- ☐ Construction equipment hire/rental company
- ☐ Project/construction management consultancy
- ☐ Others (please specify) _____

What are the main activities of your organisation? *(Tick all that apply)*

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- ☐ Harbours/offshore structures
- ☐ Foundations/tunnels
- ☐ Pipelines/refineries
- ☐ Structures/steel work
- ☐ Building (commercial, industrial)
- ☐ Housing
- ☐ Construction management
- ☐ Deep mining

Manufacturer of:

- ☐ Construction equipment
- ☐ Cement
- ☐ Other construction materials
- ☐ Distribution
- ☐ Construction equipment
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Updated Jul 2015

Tarikh: 14 September 2015

To All Members,

SENARAI CALON-CALON YANG LAYAK MENDUDUKI TEMUDUGA PROFESIONAL TAHUN 2015

Berikut adalah senarai calon yang layak untuk menduduki Temuduga Profesional bagi tahun 2015.

Mengikut Undang-Undang Kecil IEM, Seksyen 3.8, nama-nama seperti tersenarai berikut diterbitkan sebagai calon-calon yang layak untuk menjadi Ahli Institusi, dengan syarat bahawa mereka lulus Temuduga Profesional tahun 2015.

Sekiranya terdapat Ahli Korporat yang mempunyai bantahan terhadap mana-mana calon yang didapati tidak sesuai untuk menduduki Temuduga Profesional, surat bantahan boleh dikemukakan kepada Setiausaha Kehormat, IEM. Surat bantahan hendaklah dikemukakan sebulan dari tarikh penerbitan dikeluarkan.

Ir. Yam Teong Sian
Setiausaha Kehormat, IEM,

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KEJURUTERAAN MEKANIKAL

66828	AHMAD NIZAM BIN MOHAMED AMIN	BSc (WASHINGTON) (MECHANICAL, 1993)
52542	GOH YUEN PHANG	BE HONS (MALAYA) (MECHANICAL, 2007)
41335	GOPINATH A/L RATNAM	BE HONS (UTM) (MECHANICAL, 2012)
52543	LIEW LUI YUE	BE HONS (MALAYA) (MECHANICAL, 2007)
55855	LIM YEE TAT	BE HONS (UPM) (MECHANICAL, 2008)
34020	MOHD SARIZAL BIN ABU BAKAR	BE HONS (UTHM) (MECHANICAL, 2005) MSc (UiTM) (MECHANICAL, 2014)
53770	MUHAMMAD FARIZI BIN SAULIUS	BE HONS (UNITEN) (MECHANICAL, 2011)

KEJURUTERAAN TELEKOMUNIKASI

79009	RAYMOND CHANG TZIN	BE HONS (CURTIN) (ELECTRONIC & COMMUNICATION, 2009) MESc (CURTIN) (ELECTRICAL, 2010)

KEJURUTERAAN BAHAN

25800	ANG BEE CHIN	BE HONS (MALAYA) (MATERIAL, 2004) MESc (MALAYA) (2007) PhD (MALAYA) (2011)
51701	WONG YEW HOONG	BE HONS (USM) (MATERIAL, 2009) PhD (USM) (2012)

ERRATA

Error on TEMUDUGA PROFESIONAL - SENARAI CALON-CALON YANG LAYAK MENDUDUKI TEMUDUGA PROFESIONAL TAHUN 2015 published in JURUTERA September 2015 page 45.

PERMOHONAN BARU MENJADI AHLI KORPORAT

KEJURUTERAAN ELEKTRIKAL

26403	LAU HENG TIEN	BE HONS (UNITEN) (ELECTRICAL POWER, 2005)

KEAHLIAN

PERMINDAHAN AHLI KEPADA AHLI FELLOW

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
13471	AHMAD KAMIL BIN ARSHAD	BE (CURTIN) (CIVIL, 1987)
7594	DENNIS GANENDRA	BA HONS (CAMBRIDGE) (1987) MSC (LONDON) (SOIL MECHANICS, 1989) PHD (LONDON) (1994)
2364	WANG HONG KOK	BE (SINGAPORE) (CIVIL, 1976)
KEJURUTERAAN MEKANIKAL		
11088	KAMARULZAMAN BIN ZAINAL	BSC (TEXAS) (MECHANICAL, 1985)
18975	SANTHA KUMARAN A/L ERUSAN @ KRISHNAN	BE HONS (UTM) (MECHANICAL, 1994)

PEMINDAHAN AHLI KEPADA AHLI KORPORAT

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
43486	AHMAD AZAHRI BIN AWANG	BE HONS (UTM) (CIVIL - CONSTRUCTION MANAGEMENT, 2006)
28237	AZRUL AFFANDHI BIN MUSTHAFFA AL BAKRI	BE HONS (UTM) (CIVIL, 2007) MSC (UPNM) (CIVIL, 2014)
21715	CHAI TZER LUEN	BE HONS (UTM) (CIVIL, 2005)
27953	CHAI YOKE LEE	BE HONS (USM) (CIVIL, 2006)
29166	CHEAH PENG LEONG, FRANKIE	BE HONS (UMS) (CIVIL, 2004) MSC (NANYANG TECHNOLOGICAL) (CIVIL, 2012)
37903	CHEONG FONG CHIN	BE HONS (SOUTHERN QUEENSLAND) (CIVIL, 2005) MSC (MALAYA) (2010)
43206	CHOW PAK LUN	BE HONS (MONASH) (CIVIL, 2007)
24421	CHOY KIM SENG	BSC (IOWA STATE) (CIVIL, 1995)
22111	FAIZUL ZAHRI BIN MOHAMAD ABAS	BE HONS (BRADFORD) (CIVIL & STRUCTURAL, 1999)
69472	FOO SHIN CHIEN	BE (QUEENSLAND) (CIVIL, 2006)
26968	GAN SIM KEAT	BE HONS (UTM) (CIVIL, 2003) ME (UTM) (CIVIL - STRUCTURE, 2005)
71144	HAZLAN BIN MOHD	BE HONS (MALAYA) (CIVIL, 2003)
37216	HISHAM BIN MOHAMAD	BE HONS (UTM) (CIVIL, 2002) MSC (LONDON) (SOIL MECHANICS & ENVIRONMENTAL GEOTECHNICS, 2004) PHD (CAMBRIDGE) (2008)
29601	LEE CHONG LEAN	BE HONS (UTM) (CIVIL, 2006)
27277	MOHAMAD HAIRI BIN OSMAN	BE HONS (KUITTHO) (CIVIL, 2006)
54020	MOHD ARZAHRI BIN ABD RAHMAN	BE HONS (UMS) (CIVIL, 2007)
37228	MOHD AZYZUL BIN YAHAYA	BE HONS (UITM) (CIVIL, 2001)
29122	MOHD FADLI BIN OSMAN	BE HONS (UPM) (CIVIL, 2003)
49896	MOSES SONDOH	BE HONS (UNIMAS) (CIVIL, 2005)
24335	NG CHIU MING @ ROLAND NG	BE HONS (KUITTHO) (CIVIL, 2003)
28394	NG JIA LIN	BE HONS (UTAR) (CIVIL, 2010)
25785	NG SEAN LOK	BE HONS (KLIUC) (CIVIL, 2007)
29032	NIK MOHD NADZRI BIN NIK MUSTAPHA	BE HONS (UITM) (CIVIL, 2005)
10642	RAMLI BIN NAZIR	BE HONS (UTM) (CIVIL, 1988) PHD (LIVERPOOL) (1994)
25972	SHAIFUL MUNIR BIN LEMAN	BE HONS (UTM) (CIVIL, 2006)
22952	SITI AISHAH BINTI ABDULLAH	BE HONS (UTM) (CIVIL, 2000) MSC (UITM) (CIVIL, 2009)
37243	SO WEE SIANG	BE HONS (UTM) (CIVIL, 2003)
29212	TAN CHIN CHIEN	BE HONS (UTP) (CIVIL, 2006)
45341	TAN KHAR MENG	BE HONS (UTM) (CIVIL, 2005)
38845	TAY TSHUNG WANG	ME (PORTSMOUTH) (CIVIL, 2008)
50122	TIEN LOY BONG	BE HONS (CANTERBURY) (CIVIL, 2010) MSC (NATIONAL UNIVERSITY OF SINGAPORE) (CIVIL, 2013)
70430	WAN LOKMAN BIN WAN YUSOFF	BSC (NEVADA, LAS VEGAS) (CIVIL, 1989) MSC (HERIOT-WATT) (CONSTRUCTION PROJECT MANAGEMENT, 2013)
10099	WILLIS ANSOI	BE HONS (MALAYA) (CIVIL, 1986)
47076	WONG CHIEN SOON, KELLY	BE HONS (UNITEN) (CIVIL, 2004) ME (UTM) (CIVIL-STRUCTURAL, 2012)
22091	ZAINAHAIZA BINTI ZAINON	BE HONS (KUITTHO) (CIVIL, 2005)
KEJURUTERAAN BIOPERUBATAN		
54322	LAI KHIN WEE	BE HONS (UTM) (BIO-MEDICAL, 2009) PHD (UTM) (BIOMEDICAL, 2012)
KEJURUTERAAN ELEKTRIKAL		
30644	ADLIE BIN MOHD ALI	BE HONS (UPM) (ELECTRICAL & ELECTRONICS, 2003)
31742	AHMAD FAHMI BIN JAYAHA	BSC (UNITED STATES COAST GUARD ACADEMY) (ELECTRICAL, 1995)
43783	LEE SIANG HOE	BE HONS (USM) (ELECTRICAL, 2009)
66358	LOI CHUN YEW	BE HONS (CURTIN) (ELECTRICAL POWER, 2010)
53790	MOHD NAZMI BIN ABDUL RAHMAN	BE HONS (UNITEN) (ELECTRICAL POWER, 2010)
49414	MUHAMMAD FITRI BIN AYOB	BE HONS (UTM) (ELECTRICAL, 2010) ME (UNITEN) (ELECTRICAL, 2014)
25087	NAVINDRAN ANDIAPPEN	BE HONS (USM) (ELECTRICAL & ELECTRONIC, 2001)
59931	NGU KAT LUNG	BE HONS (UMS) (ELECTRICAL & ELECTRONICS, 2007) ME (MALAYA) (2010)
53994	NORZAMZAMIR BIN ISMAIL	BE HONS (UITM) (ELECTRICAL, 2007)
28789	SEE CHUN HO	BE HONS (UMS) (ELECTRICAL & ELECTRONIC, 2002)
34061	SYED RAFISZAN BIN SYED OTHMAN	BE HONS (UITM) (ELECTRICAL, 2009)
58057	WAN YUSRIZAL BIN WAN YUSOFF	BE HONS (UTM) (ELECTRICAL - ELECTRONICS, 2006)
48435	WEI CHNG KAI	BE HONS (UNIMAP) (ELECTRICAL SYSTEMS, 2010)
KEJURUTERAAN ELEKTRONIK		
29045	FAHMI BIN SAMSURI	BE HONS (UKM) (ELECTRICAL, ELECTRONIC & SYSTEMS, 1999) MSC (UKM) (ELECTRICAL, ELECTRONIC & SYSTEMS, 2002) PHD (CANTERBURY) (ELECTRICAL & ELECTRONIC, 2012)
47548	FAIZ BIN MOHD TURAN	BE HONS (UTM) (ELECTRICAL, 2010)
49609	MOHAMMAD 'AFIF BIN KASNO	BE HONS (UTM) (ELECTRICAL - ELECTRONIC, 2008) ME (DONGGUK, SEOUL) (2011)
76030	MOHD BADRULHISHAM BIN ISMAIL	BE (HARTFORD) (ELECTRICAL, 1997) MSC (UITM) (TELECOMMUNICATION & INFORMATION, 2014)
48466	MOHD NIZAM BIN OTHMAN	BE HONS (USM) (ELECTRICAL & ELECTRONIC, 1999)
51347	MOHD OSNIZAM BIN OTHMAN	BE HONS (UKM) (ELECTRICAL, ELECTRONIC & SYSTEMS, 2001)
52390	MUSA BIN OTHMAN	BE HONS (UTM) (ELECTRICAL, 1998)
23944	SHANKER RAJ A/L KATHIGASU	BE (ABERTAY DUNDEE) (ELECTRONIC, 1996)
54285	SITI FAUZIAH BINTI TOHA	BE HONS (UTP) (ELECTRICAL & ELECTRONICS, 2003) MSC (USM) (ELECTRONIC SYSTEMS DESIGN, 2006) PHD (SHEFFIELD) (2010)
KEJURUTERAAN GEOTEKNIKAL		
21187	EOW THEIN EWE	BE HONS (UTM) (CIVIL, 2002)
KEJURUTERAAN KAWALAN & INSTRUMENTASI		
42526	AHMAD IKRAM BIN MOHAMMAD SHUKRI	ME (SHEFFIELD) (ELECTRICAL, 2007)
26516	AKMAL BIN ABDULLAH	BE HONS (KUITTHO) (ELECTRICAL, 2003)
KEJURUTERAAN KIMIA		
37886	FOO THING YONG	BE HONS (MALAYA) (CHEMICAL, 2008)
43542	LIM AI TEE	BE HONS (UTM) (CHEMICAL, 2007) ME (UPM) (ENVIRONMENTAL, 2013)
38338	NGO SAIK PENG	BE HONS (UTM) (CHEMICAL, 2000) ME (UTM) (ENVIRONMENTAL, 2002) PHD (UTM) (2006)
KEJURUTERAAN LEBUHRAYA		
21245	TUAN APDZAN BIN TUAN MAD	BE HONS (UTM) (CIVIL, 2001)
KEJURUTERAAN MARIN		
21006	KHAIRIZAL BIN OTHMAN	BE HONS (UPM) (MECHANICAL, 2001) ME (UTM) (MECHANICAL - MARINE TECHNOLOGY, 2013)
KEJURUTERAAN MEKANIKAL		
32805	AHMAD ZAMANI MASNIZAM BIN ABDULLAH ZAWAWI	BE HONS (UTP) (MECHANICAL, 2008)
72614	ESMA NIZA BIN NAWI	BE HONS (UTEM) (MECHANICAL, 2008)
23775	HAMIRUL ADLI BIN HASHIM	BE HONS (UITM) (MECHANICAL, 2005)
52576	LAI HAN LYN	BE HONS (USM) (MECHANICAL, 2009)
30983	LEE KEAN YEW	BE HONS (UNIMAS) (MECHANICAL & MANUFACTURING SYSTEM, 2008)
55835	MOHAMAD FAIZAL BIN MALEK	BE HONS (UPM) (MECHANICAL - SYSTEM, 2000)
25175	MOHAMED THARIQ BIN HAMEED SULTAN	BE HONS (KUITTHO) (MECHANICAL, 2004) MSC (UPM) (AEROSPACE, 2007) PHD (SHEFFIELD) (2011)
20564	MOHD NARZAM BIN JAFFAR	BE HONS (MALAYA) (MECHANICAL, 1999)
13606	MOHD SHAMSUNAHAR BIN MOHD SAID	BE HONS (LONDON) (MECHANICAL, 1990)
27528	MOHD SHUKRY BIN ABDUL MAJID	BE HONS (UMIST) (MECHANICAL, 2001) MSC (LIVERPOOL) (MECHANICAL SYSTEMS, 2005) PHD (NEWCASTLE) (2011)
33995	MUHAMMAD FAISAL BIN MANSOR	BE HONS (MALAYA) (MECHANICAL, 2005)
44545	NG YUIT JU	BE HONS (UNITEN) (MECHANICAL, 2008)
52330	NORAZHA BIN ZAIDI	BE HONS (UKM) (MECHANICAL, 2006)
59093	ONG YEE PINN	BE HONS (MMU) (MECHANICAL, 2007)
04679	RAHIMIN BIN HARISH	BSC (STRATHCLYDE) (MECHANICAL, 1976)
37297	SAKTHIASWARAN A/L KALIAPPAN	BE HONS (MMU) (MECHANICAL, 2007)
15219	SYED NURSHADIR BIN SYED IBRAHIM	BSC (BRADFORD) (MECHANICAL-MANUFACTURING SYSTEMS, 1991)
36937	TEO HIU HONG	BE HONS (KUITTHO) (MECHANICAL, 2003) ME (UPM) (MANUFACTURING SYSTEM, 2006)

43668	WONG TIEN SOONG	BE HONS (UNITEN) (MECHANICAL, 2009)
39983	YEOH JIT SHIONG	BE HONS (UTM) (MECHANICAL, 2009)

KEJURUTERAAN PEMBUATAN

59907	GERALD VICTOR A/L RICHARD JOSEPH	BE HONS (UTM) (MECHANICAL, 1992) ME (UKM) (MANUFACTURING SYSTEM, 2005)
30581	WAN AZHAR BIN WAN YUSOFF	BSC (MICHIGAN) (MECHANICAL, 1989) ME (RENSSELAER POLYTECHNIC INSTITUTE) (1992) PHD (USM) (2004)

KEJURUTERAAN PENGANGKUTAN

32741	NOORDINI HARLIYATI BINTI RAMLI	BE HONS (KLIUC) (CIVIL, 2009)

KEJURUTERAAN PERTANIAN

20136	JIVARATNAM A/L RAMASUNDARAM	BE HONS (UPM) (AGRICULTURAL, 1997)

KEJURUTERAAN POLIMER

41157	MOHD BIJARIMI BIN MAT PIAH	BE HONS (NORTH LONDON) (POLYMER, 1996) MSC (UITM) (2005) PHD (UKM) (MATERIAL SCIENCE, 2014)

KEJURUTERAAN TELEKOMUNIKASI

54528	MOHAMED NIZA BIN HANI	BE HONS (UNIMAP) (ELECTRICAL SYSTEMS, 2007)
55873	RENGIAH A/L SINNATHAMBY	BE HONS (UTM) (ELECTRICAL, 2006) ME (ELECTRICAL, 2009)
49298	SHARIFAH HAFIZAH BINTI SYED ARIFFIN	BE HONS (NORTH LONDON) (ELECTRONIC & COMMUNICATION, 1998)

PERMOHONAN MENJADI AHLI KORPORAT

Nama	Kelayakan
KEJURUTERAAN ARKITEK NAVAL	
YONG WU YUNG, DANIEL	BE HONS (LONDON) (NAVAL ARCHITECTURE, 1997)
KEJURUTERAAN AWAM	
AKMAL JUNAIDI BIN HAMZAH	BE HONS (USM) (CIVIL, 1999)
ARIFFIN ANUAR TAN	BSC (CALIFORNIA STATE) (CIVIL, 1996)
AZHAR BIN ABDULLAH	BE HONS (UITM) (CIVIL, 1996)
AZIZAH BINTI MOHD SABRI	BE HONS (UNIMAS) (CIVIL, 1999)
BAHARIN BIN BULAT	BE HONS (USM) (CIVIL, 1998)
KAM SIEW TENG	BE HONS (UPM) (CIVIL, 2007)
LAI TECK YONG, THOMSON	BE HONS (UTM) (CIVIL, 2007)
LEE LIANG CHUAN	BE HONS (BRADFORD) (CIVIL & STRUCTURAL, 2007) ME (BRADFORD) (CIVIL & STRUCTURAL, 2007)
LIEW YUN KHAN, VINCENT	BE HONS (QUEENSLAND) (CIVIL, 2001)
MOHAMAD AZUAN BIN MOHD SHAMSUDDIN TAN	BE HONS (UKM) (CIVIL & ENVIRONMENTAL, 2002)
MOHAMAD REDZA BIN ALI MADAN	BE HONS (UNIMAS) (CIVIL, 2004)
MOHD SAIFUL AFFENDI BIN MOHD SAID	BE HONS (UTM) (CIVIL, 2002)
MUHAMMAD AZHAR BIN AZIZAN	BE HONS (UTM) (CIVIL, 2007)
MUSTAFFA BIN MOHAMMED	BE HONS (UTM) (CIVIL, 1999)
NG CHUN MIN	BE HONS (MONASH) (CIVIL, 1988)
NIK BURHANUDDIN BIN NIK YUSOFF	BSC (STRATHCLYDE) (CIVIL, 1984)
NOR AZIAN BINTI AZIZ	BE HONS (MALAYA) (CIVIL, 2001)
NORHIDAYU BINTI KASIM	BE HONS (UKM) (CIVIL & STRUCTURAL, 2006) ME (UKM) (CIVIL, 2009)
NORUATI BINTI NORDIN	BE HONS (UKM) (CIVIL & STRUCTURAL, 2000)
PEHAN ANAK MAJIS	BE HONS (UPM) (CIVIL, 2002) ME (HIGHWAY & TRANSPORTATION, 2011)
RAJIS BIN OTHMAN	BE HONS (UTM) (CIVIL, 2002)
SITI SUNAIZAH BINTI JAAFAR	BE HONS (UTM) (CIVIL, 2002)
SOFIAH BINTI MAT	BE HONS (USM) (CIVIL, 1998)
TAN VOONG SEONG	BE HONS (UTM) (CIVIL, 2000)
WILLIAM DEVABALAN A/L R. N. ARULSINGAM	BE HONS (UPM) (CIVIL, 1990)
YONG VUI LOONG, CHRISTIE	BE (SWINBURNE) (CIVIL, 2003) MTECH (SWINBURNE) (CONSTRUCTION MANAGEMENT, 2010)
ZAINUDIN BIN SULAIMAN	BE HONS (USM) (CIVIL, 2001)
KEJURUTERAAN ELEKTRIKAL	
CHANG TZE WU	BE HONS (BRIGHTON) (ELECTRICAL & ELECTRONIC, 1993)
LEE PAK FU	BE (SOUTH AUSTRALIA) (ELECTRICAL & MECHATRONIC, 2001)
MAH SONG LING	BE HONS (MMU) (ELECTRICAL, 2002)
MARIANNE SHAMINI A/P CHRISTOPHER GEORGE	BE HONS (UNITEN) (ELECTRICAL & ELECTRONIC, 2005)
MGT NASARUDDIN BIN MGT MAZELAN	BE HONS (UPM) (ELECTRICAL - ELECTRONIC, 2005)
MOHD ASRUL HISYAM BIN SETAPA	BE HONS (UITM) (ELECTRICAL, 2009)
MOHD AZHAR BIN ABD RASHID	BE HONS (UTM) (ELECTRICAL, 1999)
MOHD ZAIDI BIN KASMUIN	BE HONS (MALAYA) (ELECTRICAL, 1996)
MUHAMMAD NASEER BIN ALIAS	ME (WALES) (ELECTRICAL & ELECTRONIC, 2008)
KEJURUTERAAN ELEKTRONIK	
MOHD RAMDHAN BIN RAMLI	BE HONS (UPM) (ELECTRONIC/ COMPUTER, 1999)
MOHD SARIZAL BIN AHMAD BAKERY	BE HONS (UTP) (ELECTRICAL & ELECTRONIC, 2002)
R. BADLISHAH AHMAD	BE HONS (GLASGOW) (ELECTRONICS & ELECTRICAL, 1994)
ROSDIAZLI BIN IBRAHIM	BE HONS (UPM) (ELECTRONIC-COMPUTER, 1996) MSC (AUTOMATION & CONTROL, 2001) PHD (GLASGOW) (2008)
KEJURUTERAAN KIMIA	
FATIHAH BINTI SUJA'	BSC (CLARKSON) (CHEMICAL, 1991) MSC (UKM) (CHEMICAL & PROCESS, 1997) PHD (NEWCASTLE) (2005)
KEJURUTERAAN MEKANIKAL	
KAZREN JUSRI BIN ABDUL KARIM	BE HONS (UTM) (MECHANICAL, 2003)
MOHAMMAD FUAD BIN ABDULLAH	BSC (TEXAS) (MECHANICAL, 1990)
MOHD IKHWAN BIN AHMAD NAWAWI	BSC (PURDUE) (MECHANICAL, 2003)
MUHAMMAD ZAID BIN KAMARDIN	BE (SYDNEY) (MECHANICAL, 2006)
PETER JUMACRINICCO ANAK CHUNJEH	BE HONS (MALAYA) (MECHANICAL, 1995) MSC (CURTIN) (PROJECT MANAGEMENT, 2014)
SAIFUL NIZAM BIN SIDEK	BSC (SEOUL) (MECHANICAL, 2000)
SHAMSHIMAH BINTI SHAMSUDDIN	BE HONS (MALAYA) (MECHANICAL, 2002)
TANG THEAM HOOI	BE HONS (USM) (MECHANICAL, 2007)
ZARIR RAMIZ BIN MUSTAFA	BE HONS (KUITTHO) (MECHANICAL, 2004)
KEJURUTERAAN PEMBUATAN	
WHA BOON KENG	BE HONS (MALAYA) (COMPUTER AIDED DESIGN & MANUFACTURE, 2001)
KEJURUTERAAN SUMBER AIR	
LEE LIANG WANG	BE HONS (UTM) (CIVIL, 2006)
ROSITA BINTI AB RAHMAN	ADVANCED DIP (UITM) (CIVIL, 1995)
KEJURUTERAAN TELEKOMUNIKASI	
MOHD NAZRUL HANIF BIN NORDIN	BE HONS (UTM) (ELECTRICAL-TELECOMMUNICATION, 2004)
NELSON BENEDICT MODILI	BE HONS (ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY) (ELECTRICAL, 2000)
KEJURUTERAAN TRAFIK	
KONG YIK KHAI	BE HONS (UTM) (CIVIL, 2001) ME (UTM) (CIVIL, 2004)

PEMINDAHAN KEPADA 'COMPANION'

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
24299	CHAN SIEW WEN	B.E.HONS.(UKM) (CIVIL & STRUCTURAL, 2005) M.SC.(MUST) (CONSTRUCTION ENRG. & MANAGEMENT, 2015)
20590	FAHRIZAL BIN MOHD ABDOH	B.SC.(UTM)(CIVIL, 2001)
KEJURUTERAAN ELEKTRIKAL		
21083	VYNAYAGAMOORTHY A/L V. KOPATHY	B.E.HONS.(MALAYA) (ELECTRICAL, 2004)
KEJURUTERAAN ELEKTRONIK		
24203	ABDULLAH BIN RAMLI	B.E.HONS.(PORTMOUTH) (COMMUNICATION SYSTEMS, 1997) M.SC. (UITM)(INFORMATION SYSTEMS, 2000)
38304	CHUAH LEWKERN	B.E.HONS.(UTM) (ELECTRICAL-ELECTRONICS, 2005)

PERMOHONAN MENJADI AHLI 'COMPANION'

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AWAM		
78908	AHMAD SARBINY BIN ABD RAHMAN	B.E.HONS.(UTM)(CIVIL, 2000)
79364	AHMAD YUSRI BIN MOHAMAD MOKHTAR	B.E.HONS.(UTM)(CIVIL, 2000)
79053	CHEAH WENG SANG	B.E.HONS.(UPM)(CIVIL, 2002)
79365	KANG HONG PING	B.E.HONS.(UTHM)(CIVIL-CONSTRUCTION, 2006)
79360	LEE EWE SHOON	B.E.HONS.(USM)(CIVIL, 1999)
78903	LIM TECK CHONG	B.E.HONS.(UKM)(CIVIL & STRUCTURAL, 1999)
79043	MOHAMMAD AL-AMIN BIN ISMAIL	B.E.HONS.(UTM)(CIVIL, 2002)
79042	MOHD AZMI BIN ZAHARI	B.E.HONS.(UTM)(CIVIL, 2002)
79358	MOKHTAR BIN ABDUL RAHMAN	B.E.HONS.(UTM)(CIVIL, 2002)
78982	TAN CHAR AI	B.E.HONS.(UTP)(CIVIL, 2005)
78983	TAN HENG LIANG	M.E.HONS.(ICL)(CIVIL & ENVIRONMENTAL, 1999)
78906	WONG YOKE SIONG	B.E.HONS.(UTM)(CIVIL, 2006)
KEJURUTERAAN BAHAN		
79048	DR. HAFIZAL BIN YAZID	B.E.HONS.(MALAYA) (MATERIALS, 2000) P.HD.(UKM)(MATERIALS SC., 2012)
KEJURUTERAAN ELEKTRIKAL		
79363	DR. SOON CHIN FHONG	B.SC.(UTM) (ELECTRICAL, 1998) M.E.(UTM) (ELECTRICAL, 2001) P.HD.(BRADFORD)(2011)
79357	JANE ANAK JAONG	B.E.HONS.(UITM) (ELECTRICAL, 1999)
79045	MOHD IRWAN BIN MOHD FATANI	B.E.HONS.(UTM) (ELECTRICAL, 2004)
KEJURUTERAAN ELEKTRONIK		
79054	DR. AZITA LAILY BINTI YUSOF	B.E.HONS.(UKM) (ELECTRICAL, ELECTRONICS & SYSTEMS, 1999) M.E.(UKM) (COMMUNICATION & COMPUTER, 2000) P.HD.(UKM)(ELECTRICAL, ELECTRONICS & SYSTEMS, 2015)
79368	DR. MAHANIJAH BINTI MD KAMAL	B.E.HONS.(UITM) (ELECTRICAL, 1999) M.E.(UKM) (COMMUNICATION & COMPUTER, 2006) P.HD.(LIVERPOOL JOHN MOORES)(2014)
79370	DR. NINA KORLINA BINTI MADZHI	B.E.HONS.(UITM) (ELECTRICAL, 1999) M.SC.(UPM)(REMOTE SENSING & GIS, 2003) P.HD.(UITM) (ELECTRICAL, 2012)

79049	DR. SUHANA BINTI SULAIMAN	B.SC.(UTAH) (ELECTRICAL, 1996) M.SC.(NEWCASTLE UPON TYNE) (MICROELECTRONICS, 2002) P.HD.(UITM) (ELECTRICAL, 2013)
78902	DR. TEE KIAN SEK	B.E.HONS.(UTM) (MECHATRONICS, 1997) M.E.(UTHM)(2007) P.HD.(LEEDS)(2012)
79369	DR. YUSNANI BINTI MOHD YUSSOFF	B.E.HONS.(USM) (ELECTRICAL & ELECTRONIC, 1998) M.SC.(UITM) (ELECTRICAL, 2008) P.HD.(UITM) (ELECTRICAL, 2013)
79165	DR.DARMAWATY BT MOHD ALI	B.E.HONS.(UKM) (ELECTRICAL, ELECTRONICS & SYSTEMS, 1999) M.E.(UTM) (ELECTRICAL, 2001) P.HD.(MALAYA)(2012)
79570	GAN ENG FOO	B.E.HONS.(MMU) (ELECTRONIC-ROBOTICS & AUTOMATION, 2007)
79366	KALAI SELVAN SUBRAMANIAM	B.E.HONS.(UTM) (ELECTRICAL, 1991) M.E.(UTM)(ELECTRICAL, 1997)
78910	MARIANAH BINTI MASRIE	B.E.HONS.(UKM) (ELECTRICAL, ELECTRONIC & SYSTEM, 1999) M.E(UITM) (ELECTRICAL, 2009)
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79367	SHAFINAZ SOBIHANA BT SHARIFFUDIN	B.E.HONS.(UKM) (MICROELECTRONIC, 2002) M.SC.(UKM) (MICROELECTRONIC, 2003)
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79051	MOHD HAFIZ BIN ZAKARIA	B.E.(MINNESOTA) (MECHANICAL, 2005)
79356	MOHD SABRI BIN WAHAB	B.E.HONS.(USM) (MECHANICAL, 1994)
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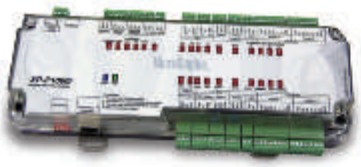

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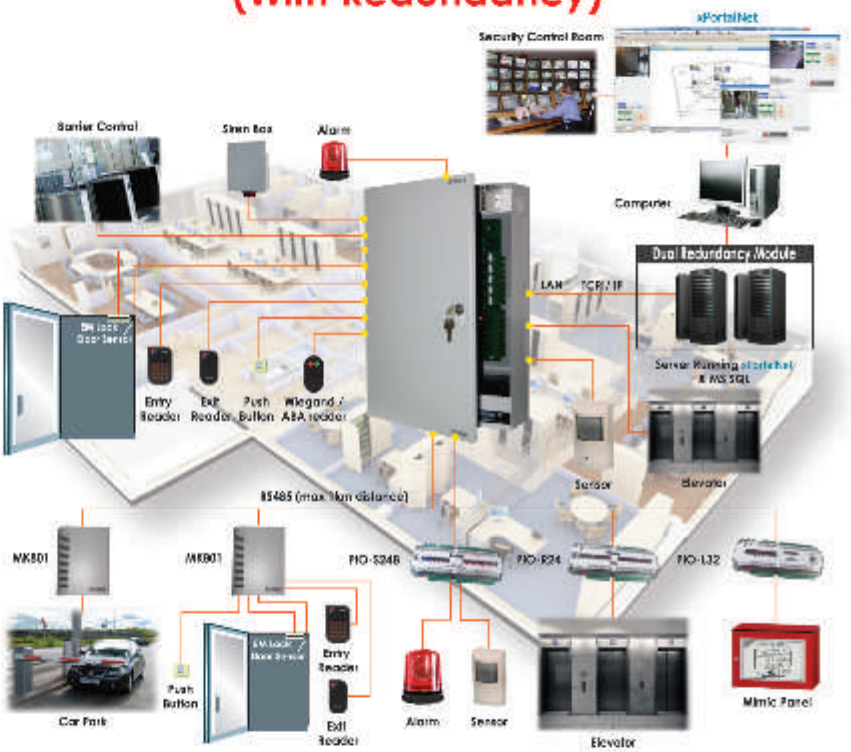

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