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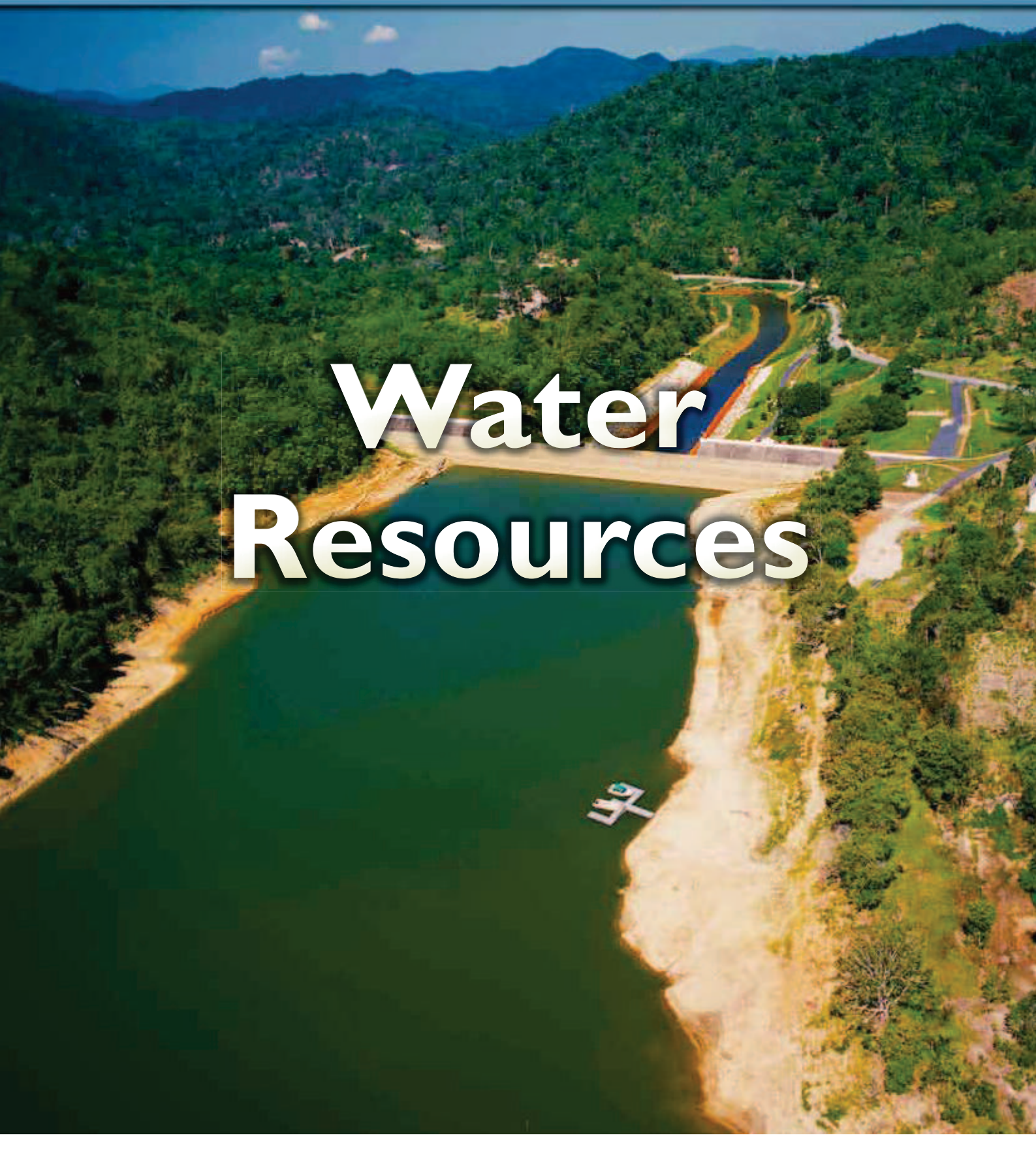

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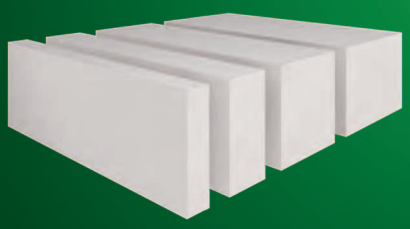

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Non-residential Existing Building (NREB)	EE1 (03) EE5 (13)	EQ13 (01)	-	MR2 (01)	IN1 (01)	-
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NRED: Data Centre	EE1 (03) EE5 (13)	EQ13 (01)	-	MR2 (01)	-	-
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Industrial Existing Construction (IEB)	EE1 (03) EE5 (10)	EQ14 (01)	-	MR2 (01)	-	-
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Towards A Water Secure Malaysia

*by **Dato' Ir. Haji Hanapi bin Mohamad Noor***
Chairman,
Water Resources Technical Division, Session 2013/2014. He is Director of Water Resources & Hydrology at Department of Irrigation and Drainage Malaysia

MALAYSIA, a country with a population of 29 million, is blessed with an average annual rainfall of 3,000mm. This is considered abundant and relatively high when compared to countries like Australia, Japan and United Kingdom.

However, incidences of drought have been experienced in several States including Malacca, Johor, Kedah and Penang. Water shortage may also be due to the polluting of rivers that supply fresh water. In a recent case, Sungai Selangor and Sungai Langat in Selangor were contaminated by effluent discharged from factories.

Therefore we can see that water security can be affected by both quantity and quality as well as the increase in demand for domestic, industrial and agricultural uses.

A review of the National Water Resources Study (2000-2050), carried out by the Department of Irrigation and Drainage Malaysia in 2011, indicates there will be a marked increase of more than 75% in water demand in the domestic and industrial sector – from 14,458 million litres per day (MLD) in 2010 to 25,455 MLD in 2050. Factors that contribute to this increase in demand include population rise, urbanisation and economic growth.

A critical factor that has to be tackled is the high water use per capita of 240 litres per person per day (l/p/d) compared to Singapore's 140 l/p/d. In 2010, the Ministry of Energy, Green Technology and Water undertook a number of initiatives to educate the public on the prudent use of water through its Water Conservation Campaign. However the impact of this campaign has yet to be seen.

To ensure there will be enough water for the nation, we need to look into alternative water resources such as ground water, harvested rain water and recycled water. Currently, 97% of our water supply comes from surface water collected in rivers, dams, ponds and lakes, with the remaining 3% from ground water.

Perhaps it is time to plan for an increased exploitation of alternative water resources. The authorities should also give greater focus to water resources integrity by giving priority to the protection of resources and catchment areas. Some sacrifices may be required at the expense of development, but we must remember that, without water security, the risks are too high for our future generations to absorb.

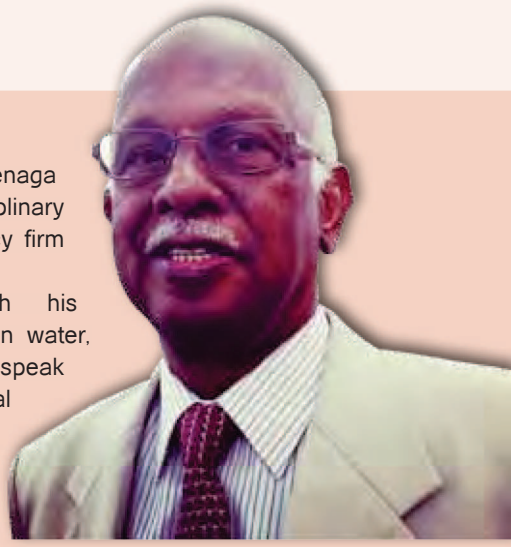
What really is the challenge in ensuring water security for the country? We often hear reports of flooding in various parts of the country but we also hear reports of taps running dry and paddy fields cracking up without water.

The general perception among the people is that there is poor water management and ineffective water governance. The biggest challenge today is to ensure an effective water resources governance structure that is unified and integrated but which does not devolve the rights and privileges of the States since water comes under the jurisdiction of the various State authorities. We hope that this governance issue will be addressed by the authorities at both the Federal and State levels in a "win-win" spirit of co-operation.

Our deepest appreciation goes to the Federal Government for its commitment to address all water issues as well as to provide clear directions and strategies through the National Water Resources Policy launched in 2012. The Policy strongly emphasises that the security and sustainability of water resources shall be made a national priority, to ensure adequate and safe water for all. We look forward for the Policy to be translated into action and reality. ■

Blessed With Water, But Let's Not Be Complacent

by Ms. CC Tan



ANYONE who is anybody in the water management sector in Malaysia today would have heard of Tan Sri Dato' Ir. Shahrizaila Abdullah, a Senior Fellow of the Academy of Sciences who initiated and led the Sustainable Water Management Programme at the academy from 2006 until the middle of this year.

Prior to that, he had a long career in both the public and private sector, one that mainly concerned water. He served the government for over 30 years, retiring as the Director-General of the Department of Irrigation and Drainage in 1995.

During this tenure, he attended the landmark International Conference on Water and the Environment held in early 1992 in Dublin, Ireland which saw the formulation of the momentous Dublin Statement on Water and Sustainable Development, also known as the 1992 ICWE Dublin Principles on Water, subsequently endorsed by the world's first Earth Summit 1992 in Rio de Janeiro, Brazil. This document paved the way for water experts around the world to identify, plan and manage water security issues in their respective countries, and has served as a guide in all global water dialogues since.

Following his retirement, he enjoyed an eight-year stint in the private sector, serving as Chairman and Specialist consultant with KTA Tenaga Sdn Bhd, a multi-disciplinary engineering consultancy firm based in Kuala Lumpur.

In October, with his wealth of experience in water, he was invited to speak at the International Conference on Water and Wastewater Management 2013, where he shared his insights on the topic, "Integrated Water Resources Management and the Transformation of Water Supply and Wastewater Management Services – a Malaysian Road Map".

In this issue of ***JURUTERA***, Ir. Shahrizaila shares more of his thoughts about the realities of water management in Malaysia, and how we must manage this "finite, renewable, yet vulnerable resource" wisely – even if it seems to be in abundance now – to ensure our future needs will always be met.

Q: What is the current outlook for global water security now, compared to say, 20 years ago?

A: The situation is still alarming because, firstly, how do you define water security? This is the global definition: Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

With more than half of humanity currently urbanised, many cities are facing acute scarcity in providing clean, safe water. Urban managers are also increasingly daunted by the complex task of sanitation – i.e. managing wastewater generated by cities so that harmless, clean water is returned to the natural water cycle.

Globally, and Malaysia is no exception, the fast pace of development has inflicted severe damage to the health of both the terrestrial and aquatic ecosystems. One needs only to take a flight over the country to observe the poor state of the "teh tarik" rivers in many locations. It reflects the extent of pollution originating from unfettered development upstream that have led to severe ecosystem changes.

With continued population growth and the pressure on the environment, the challenge is really how to reverse this process. The logical way forward is to arrest the situation with a clear commitment not to inflict further damage with an accompanying roll back plan of rehabilitation.

Q: How do you find current global initiatives that are in place now – are they good enough or has there been too much talk and not enough action?

A: Global dialogues and forums have been useful in highlighting issues and sharing of experiences and solutions

Semenyih Dam Intake
(Photo courtesy of Dato' Ir. Haji Hanapi bin Mohamad Noor)

for common benefit. But how much of this information reaches the grass roots for its adoption and effective implementation leaves much to be desired. There are many good lessons learnt and the onus falls on individual governments to ensure their implementation on the ground. So going by the track records of the last decade or so – while a lot of good things have been done – the actually delivery (of water security goals) is still not up to mark.

Q: Why is that happening?

A: It's basically an issue of resources – both financial and human capital. There are countries that are economically poor and there are countries that are technologically poor. So this is the dimension in which we're talking about. You may have the money but if you are technologically lacking, then things still won't get done. What we'd like to see is governments or individual countries coming up with both capacity building, which means developing the human capital, and incorporating science and technology in problem solving, together with the finance. But one, alone, is not going to provide the solution.

How many countries, especially developing countries, are in a position to do that? In that respect, there is a little bit of a sense of doom and gloom being spread, but I don't think we should concern ourselves too much with that. Solutions are there. The last global Earth Summit and World Water Forum, it's about finding solutions – solutions for water.

Q: Is there any particular country that has struck you where its water management has improved by leaps and bounds?

A: Well, I think when they talk about developed countries, they have it. They have the economic capability, the technological know-how and the talents. Even so, amongst the middle-income countries, there have been some very good success stories and I would say that Malaysia does fare well in that context. We have the means, we have the technology and we also have fairly well-trained people. And there has also been good response from our non-governmental organisations. But I won't say that we have excelled in it.

Our problems have largely been due to the structure of the country's administration – Federal/State dichotomy. There are countries with a similar sort of political environment, for example, the US also has to contend with a system of State governments and a Federal government, and the reason they have overcome it is that the resource is spread across the nation, and every State is individually rich.

(Continued on page 9)

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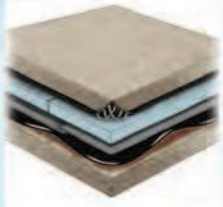

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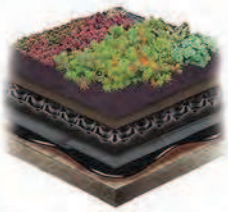

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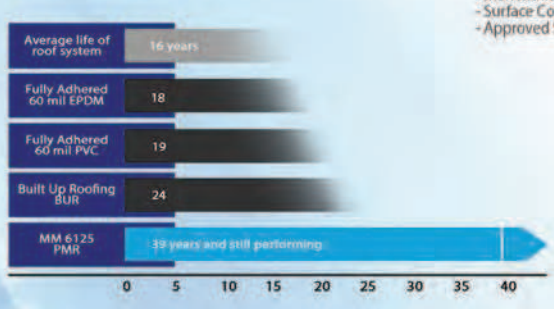

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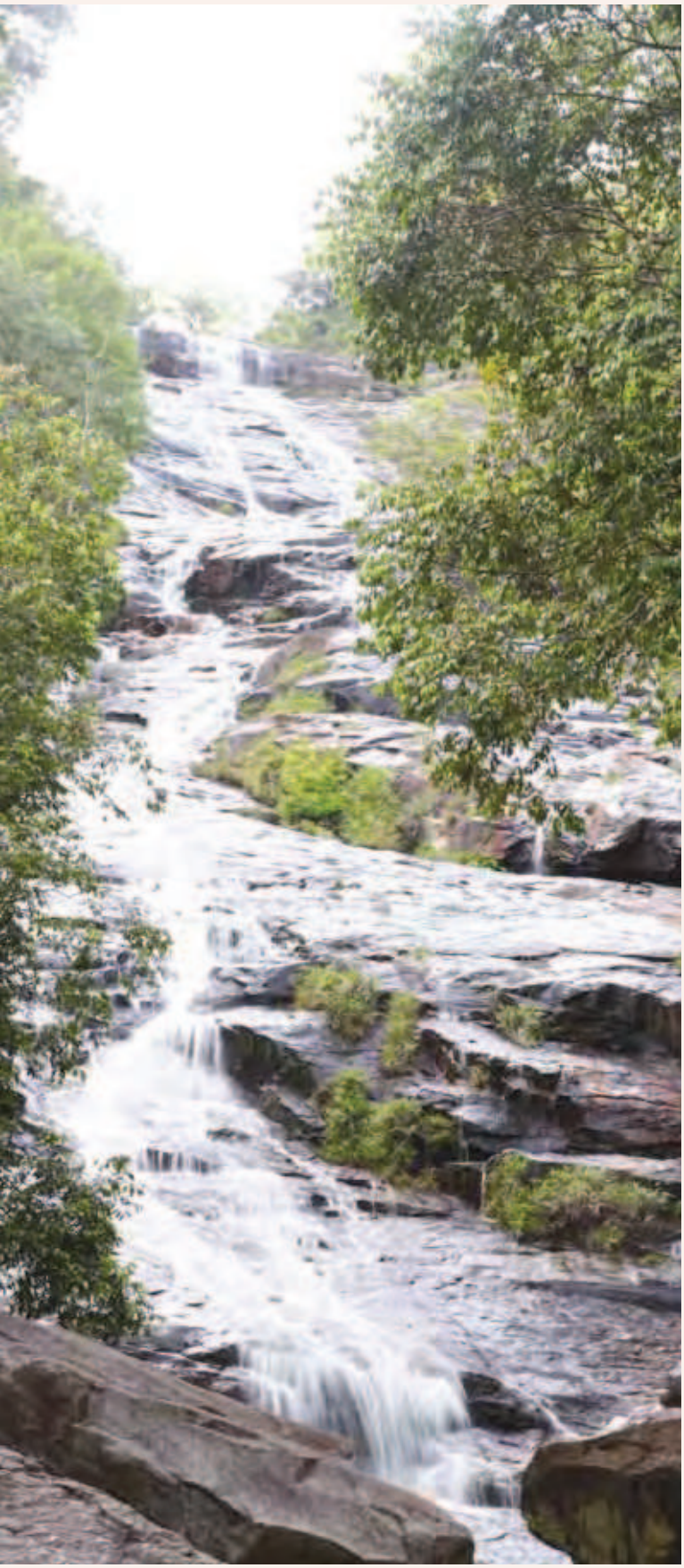

Sri Perigi Waterfall at Yan, Kedah
(Photo courtesy of Dato' Ir. Haji Hanapi bin Mohamad Noor)

Q: So because they are individually affluent, they are able to look at the greater good?

A: Yes. If every State in Malaysia is rich, I don't think they need the (assistance) of the Federal government. So we'll have to accept some inefficiencies because of this.

Q: Is this the main challenge in water security management here – that it is territorial in nature?

A: No. The other reason is that we are blessed with so much water that we tend to be complacent. We have between 2,000 and 3,000mm rainfall per annum – we have so much water, so why should we worry? That is actually a negative attitude for the people to have. Why is Singapore successful?

Q: Because water is scarce in the Republic and necessity becomes the mother of invention there?

A: Yes, it's a very simple question of survival. Scarcity forces them to do everything to put it right. I actually never like to compare Malaysia with Singapore because the country is very different from ours. Every time we talk about a (water management) project, we have to talk about the economics of it – we can't run away from that – and it often ends up that we can't really justify economically some of the things that we want to do because water is aplenty here.

Q: So there's no pressure to allocate whatever amount of money and resources for it?

A: Yes, so people here are therefore more prepared to accept a little bit of pollution here and there, when by right, we should not be. That mentality is not right. Unfortunately, the only thing that can change that is how to get economics into the equation. In other words, we have got to get people thinking that waste water has got its economic value. We have to work on that. That's the only way to get things going. There are good examples of countries which have used waste water successfully and we should do the same, if not for now, then for the future.

Q: Why has Malaysia been resistant to it?

A: It's economics. There's an easier solution to get what you want. Take, for example the case of Sg. Perak. It has plenty of potential for tourism such as river cruises. There's so much to see, so much of history. There are opportunities and economic value. With all this potential, we can invest in proper dredging. The tourism sector will pay for the cleaning up process. At the end of the day, someone has to pay for that.

It's got to be value-added. In trying to clean up, you must also bring in something so that the cost of cleaning up is recovered in the form of new wealth creation. This is what Singapore has been doing, though it's incidental. In trying to get clean water, they have invested in and developed technology – membrane technology to filter water. But in the process, this technology has become a money earner. Countries around the world which want the same technology, will have to pay if Singapore patented it.

Q: You talk about cleaning up the river, economic benefits and such. If people's attitude towards water doesn't change, can this happen?

A: I think Malaysia should reach a point where the community takes care of its own water. If we can reach that stage, then we are there. That is the ultimate. In other words, you care for your own water and if somebody pollutes it, you go after the guy.

Q: Yet there is a very clear lack of ownership among Malaysians. Most will just point at a polluted river and say 'Ini kerana kerajaan tak buat apa-apa' (This is because the government didn't do anything), or that the DID (Department of Irrigation and Drainage) didn't monitor the river's cleanliness

A: That's the point. It'll have to come at some point in time and I'm still hopeful it's possible. But the other point that we need to look at is our local authorities. They have to be strong to enforce rules and regulations. Kuala Lumpur City Hall is strong, but not all the local authorities are like it. Pollution is human created – and the power to curb it is with the local authorities. If they allow rubbish to get into drains, it will eventually flow into the river. I always believe that at the end of the day, the best solution to pollution is to tackle it at the source. In Japan's tube station for example, if the Japanese people see a piece of scrap of rubbish on the floor, they will pick it up and dispose of at the nearest rubbish bin. Are we prepared to do that?

Q: In the past decade, there has been very strong campaigning, not only by the DID but also by NGOs, on loving our rivers and cleaning our rivers. Do you think it has been effective?

A: Awareness has been created but to say that people are now willing to do something about it – that still remains to be seen. It's the complacency that we have, which is the bad effect to having plenty of water.

Q: Talking about plenty, in Malaysia, there has been much talk about water crises and water scarcity is an issue. Is there enough water actually for all our sectors?

A: Malaysia has enough but it's more a management issue. So water security is achievable for us, but it's still a management issue. At the end of the day, when we talk about participatory management, if all these things fall in place, we will be there. The people need to drive this.

Q: What are your thoughts on Supply Management vs Demand Management in water?

A: In the past few decades, we have always been employing the supply management technique in addressing our water needs. When there is a new housing village, we look for new sources of water to accommodate the growing needs. But holistically, it should be both – you can't have one without the other. If we build more dams, we will destroy the environment.

> **"With more than half of humanity currently urbanised, many cities are facing acute scarcity in providing clean, safe water."**

When there is a crisis, when you're short of water, look at the demand side as well – are there ways and means we can take to reduce the demand of water?

Malaysia's current per capita water usage is 240 litres per person, per day, compared to 140 litres per person, per day, for Singapore. So if we can bring down the demand, we don't have to keep looking for new sources of water.

The amount of non-revenue water also need to be brought down – that requires investment. Some of this is due to old-pipe leakage. There is also corruption – the bigger users who steal. They've been doing this too, though the water supply people have been slowly plugging that. One of the good things about privatisation is that you have better efficiency. They also appreciate that when they save water, they can also sell more.

The other aspect of demand management (human system integration) that we should look at is that water policy sits among a larger system of nested policies comprising of economic policy, food policy, health policy, and environmental policy. All these policies should take into account water usage and management. For example in health, clean water and good sanitation contributes to good health.

Q: So all these policies should integrate good water management practices into them?

A: Yes, they should.

Q: What are your comments about the 'Water Crisis' in Selangor?

A: I believe it's always good to invest in the future when it comes to water. One of the good things that we inherited (from the British) was a lot of foresight – in the sense that dams were built much earlier. When I first started my career, the amount of water released from the dams were quite low because dams were planned to accommodate the rise in demand for the next 50 years. Any investment for longer term benefits is always good because it won't be cheap later as land prices will continue to escalate, so Selangor has got to look forward. We should not be talking about fulfilling immediate needs – let's think about looking after the people, two to three generations from now. ■

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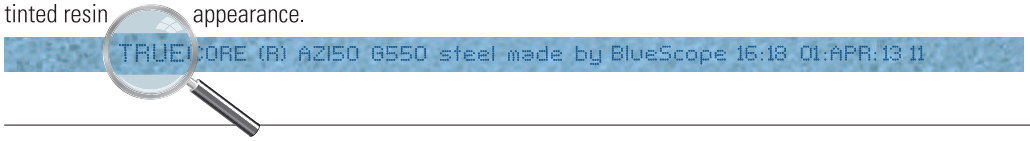

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Ladies, You Can Do It!

by Ir. Choo Kok Beng, FASc

"I do not wish women to have power over men but over themselves."

– Mary Wollstonecraft

THE contributions of women in IEM have been remarkable to say the least. Strangely, it was not until the last two years that IEM set up the IEM Women Engineers Malaysia (IEM WE) section. However, my heart beats for something more.

On a larger scale, female participation in national development has been taken for granted. At the recent 2013 UMNO General Assembly, the Prime Minister pledged that Wanita UMNO was the backbone of the party. He also sent a clear message that women in the country should no longer be ridiculed and marginalised, but must be appreciated and respected.

I think we should do the same in IEM, if not more. Take, for instance, the presidency of IEM. We have never had a woman as President of IEM – yet there is no rule that prevents a woman from assuming the role.

Personally, I believe that if someone is capable of being the President, then that person should be the President – regardless of whether that person is a man or woman!

What I'm trying to say is that I believe women in IEM can do so much more if they set their hearts and minds to it. Take the lead where you can and speak out more. Participate in all IEM activities and demonstrate your capabilities.

As President of IEM, I want to honour and celebrate the female power and talent in IEM. I know there is much unharnessed talent in our women engineers.

Put your heart to it: The possibilities are endless!

You only need to look around you to see how other women have proven public perception wrong.

Look, for instance, at the Director-General of UNESCO, Irina Bokova. She is the first female to head UNESCO. She is the motivation for all women to aim for the skies.

Closer home, we have AirAsia Berhad CEO Aireen Omar who was passed the torch by Tan Sri Tony Fernandes. She may only be 39 years old but she's a strong, iron lady who helms Asia's leading budget airline against many other players in the region. Had she thought that she was incapable, had she hesitated in her dreams, she would not have been where she is today.

So ladies, I urge you to go forward. You are doing an amazing job in IEM but you can do so much more.

As I have always said, I'm always open to discussion and brainstorming. Talk to me anytime if you want to. But don't doubt yourself. You can do it! ■

CONTRIBUTIONS TO WISMA IEM BUILDING FUND

RM 2,251,238.70 from IEM Members and Committees

RM 741,502.00 from Private Organisations

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(ANOTHER RM 9,157,259.30 IS NEEDED)

The Institution would like to thank all contributors for donating generously towards the IEM Building Fund

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(The donation list to the Wisma IEM Building Fund is published on page 49)

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Greywater Reuse: A Sustainable Alternative Water Resource

by Ir. Ellias bin Saidin

INTRODUCTION

Sewage generated in a household may be separated into greywater and blackwater discharges. Greywater is commonly defined as wastewater discharged from laundry, baths, hand basins and (cleaned) dishwashing machines. It excludes discharges from the kitchen, toilets, urinal and bidet (NSW Guidelines, 2008).

The term greywater is used as the wastewater generated is cloudy and the colour compared to white water (clear freshwater) and black water (soiled wastewater from sewage). This water contains nutrients from detergent, soap and organic matter (which is suitable for irrigation of grass, plants and selected vegetables).

The WHO recognises that the utilisation of greywater contributes to less pressure on water resource, reduces health risks of downstream communities, helps to improve environmental health and reduces environmental impacts downstream (WHO Guidelines 2006). In developed communities, the reuse of greywater is part of the practice of Integrated Water Management practices which results in water conservation and reduces impact on the water environment downstream such as flooding, erosion, water quality as well as reduces the cost of providing urban drainage infrastructure.

At present, many local authorities and health department in various countries have given due recognition to the reuse of greywater within the households. Greywater utilisation systems can be installed in homes by complying with guidelines and regulations issued by the authorities.

In Europe, Australia and USA, where the International Plumbing Code is adopted, greywater from showers, bathtubs and hands basins used for toilet flushing contributes to over 30% of domestic demand for water. (Chap 13, International Plumbing Code).

The city of Malibu in California passed a law in 1994 on the standard of greywater systems installed in homes. However it was also reported that in 1992, 8% of beachfront homes and 33% of inland homes were already using some form of greywater systems.

In 2001, the Arizona Department of Environmental Quality issued guidelines and permitted the use of greywater in a residential property generating less than 400 gallons per day, for subsurface irrigation within the premises. The water table has to be a minimum of 1.5m (5ft) below the ground surface, and discharged at 1.2m from building foundations, with the soil being sufficiently permeable without percolation on the surface (Val L Little, 2001).

States in Australia regularly update their guidelines on the installation of greywater systems in the home to be carried out by licensed plumbers and issue certificates of approval for greywater systems. Grants are offered to homes in Australia installed with greywater systems. The government of Cyprus offers subsidies of up to €1700 for the use of greywater in a home.

In Tokyo, greywater reuse is mandatory for buildings >30,000 m^2 or with potential non-potable demand of more than 100m^3/day. (Environment Agency, 2008).

Japanese Cascading Toilet Bowl

Health safety concerns on the reuse of greywater in residential homes are minimal as pathogens are usually killed after being placed in the soil. Pathogens are not spread to others as atmospheric spraying is not permitted (spraying will generate droplets in the air which can be transported to neighbouring premises).

Family members are not at high risk even if they come in contact with these water-borne pathogens as, within the home itself, cross contamination will already occur through bodily contact and other means of contact.

An agricultural concern is the high concentration of salts in greywater, especially sodium in detergents which may inhibit seed germination and break down the clay molecules in soil.

QUALITY OF GREYWATER

The NSW Guidelines conveniently identifies two greywater streams – bathroom greywater and laundry greywater. Bathroom greywater contains soap but in very low concentrations which lets water move more easily around the soil particles. Also, dead skin cells and other body waste from sweat and other organs contain nitrates and minerals which turn into nutrients for plants.

On the other hand, although laundry greywater is easier to collect and use, it is usually contaminated with faecal pathogens from soiled clothing. Laundry water contains phosphates and human organic matter for healthy plant growth.

The quality of greywater is highly dependent on the detergents, soaps and household practices. A typical composition of greywater from a Western Australia home is reproduced (see page 15) from West Australia Water Corporation Draft Guidelines 2002.

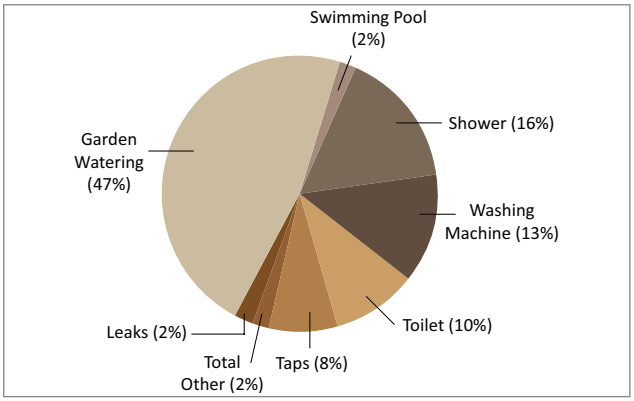
Table 1: Typical Composition of Greywater compared with Raw Sewage

Parameter		Greywater[a]		
		Range	Mean	
Suspended Solids	mg/L	45 – 330	115	100 – 500
Turbidity	NTU	22 – >200	100	NA
BOD_5	mg/L	90 – 290	160	100 – 500
Nitrite	mg/L	<0.1 – 0.8	0.3	1 – 10
Ammonia	mg/L	<1.0 – 25.4	5.3	10 – 30
Total Kjeldahl Nitrogen	mg/L	2.1 – 31.5	12	20 – 80
Total Phosphorous	mg/L	0.6 – 27.3	8	5 – 30
Sulphate	mg/L	7.9 – 110	35	25 – 100
pH		6.6 – 8.7	7.5	6.5 – 8.5
Conductivity	mS/cm	325 – 1140	600	300 – 800
Hardness (Ca & Mg)	mg/L	15 – 55	45	200 – 700
Sodium	mg/L	29 – 230	70	70 – 300

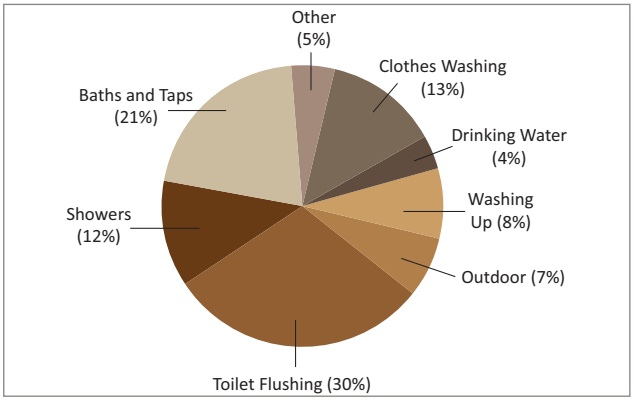
[a] Based on Jeppersen and Solley (1994)
NA = Not Applicable

HOUSEHOLD GREYWATER QUANTITY

The amount of greywater available for reuse in a household may be estimated from the daily household consumption. The charts below show the consumption for a typical home in WA, Australia and Malaysia.



Source: Western Australia Water Corporation (2002)



Water used in Malaysian home
(Source: Bulletin JKR & Alam Sekitar (2006))

The figures indicate that 29% (WA) and 46% (Malaysia) of domestic water consumption may be safely reused without treatment, with up to 40% and 70% respectively available for reuse after basic treatment. It is noted that in WA, where garden watering constitutes 47% of daily water demand, the reuse of greywater is most encouraging to reduce water demand in the home.

GREYWATER REUSE SYSTEMS

Greywater systems range in complexity from direct reuse with no treatment or basic physical and chemical treatment to more complex biological and bio-mechanical treatment which will allow for longer storage periods. The more complex systems are applicable for high consumption and large population conditions and, in the UK, have been reported to be quite unreliable in terms of odour and water quality (UK, Environment Agency; 2008).

In Australia, the NSW Government permits the reuse of household greywater in three categories. The first is where untreated greywater is diverted through pipes for use in lawn subsurface irrigation within the premises. The second is where greywater is partially treated for reuse in toilets and for laundry and open irrigation. The third is where the greywater is manually transported in buckets (NSW Guidelines 2008).

A greywater reuse system comprises the source, piping and conveyance, surge or balancing tanks, filters, pump and delivery piping system. A separate sanitary plumbing system has to be installed to separate greywater from wastewater discharge in a home. Some allowance for chlorine treatment may be necessary.

Components in greywater drip irrigation system
(Source: http://www.platypusenviro.com.au)

The amount of water to be used shall be balanced against the demand requirements of the lawn, vegetables or other user demand. The surge tank should not store the greywater for more than 24 hours to avoid odour and microbial problems unless chemical and/or microbial treatment is provided. The pumping flow rate needs to be matched with the infiltration capacity of the soil with the water being preferably fed through subsurface drip piping systems which feed directly the roots of the plant.

The water shall not be sprayed or otherwise applied so as not to form airborne aerosols. Overflows and bypass systems must be installed for the greywater to overflow into the municipal wastewater system when there is excess or during heavy rainfall.

Under the NSW Code of Practice, 2006, greywater discharges from the laundry and bathroom may be reused through Greywater Diversion Devices (GDDs) without any treatment process. However for kitchen greywater, a Greywater Treatment System (GTS) must be installed before the water can be reused, either for toilet flushing, laundry and surface and/or sub-surface irrigation outdoors.

It is better to install the greywater system during construction as retro fitting is costly and with long investment return periods. Although communal systems may be more reliable in terms of matching supply/demand and water quality, public perception and acceptability has to be overcome.

STUDIES OF GREYWATER REUSE

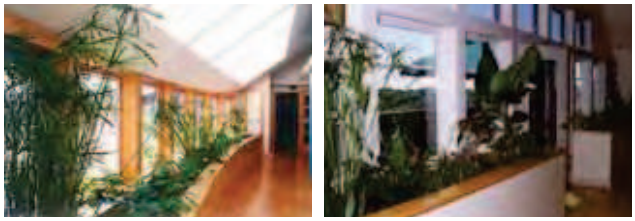
Texas A&MEl Paso Research Center studied the effects of using greywater (laundry water) discharged from a prison (3,500gpd) on vegetable and cotton crop plots in an arid area receiving less than 250mm of rain. It concluded that greywater was a good alternative source for irrigation and landscaping.

Mature cotton plants
Photo: Texas A&M University

Young tomato plants
Photo: Texas A&M University

The Water Environment Research Foundation, USA, carried out a study which concluded that there was no apparent long-term effect on landscape irrigation using household greywater and that the soil microbes seemed to benefit from the nutrients. However, subsurface irrigation was recommended to reduce pathogenically contamination (WERF;11/2007)).

Households in US have reused greywater by feeding it through sandy flower beds in sunlit indoor areas as shown below.



Household indoor greywater reuse with sub-surface bed irrigation
(Source: http://www.greywater.com/samples.htm)

CONCLUSION

The practice of greywater reuse has to be driven by government incentives and regulations. The practice will prove more economical as the cost of water is ever increasing. Public awareness of sustainability practices to conserve resources and to save the environment will result in more turning to the practice of greywater reuse.

In homes, greywater reuse addresses the issue of water conservation, particularly in water stressed areas, and broadly addresses the sustainability of an alternative water resource for the household where the water is utilised at the source generated.

The areas of concern in reusing greywater are potential health threats and the adverse effect on plants and soil biochemistry. With good practices being implemented through issued rules and guidelines from the authorities, the above concerns may be mitigated. ■

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Ir. Ellias bin Saidin is the Advisor, Water Resources Technical Division and he is also IEM Council Member for Session 2013/2014. He is a Principal at Perunding Ikatan.

ANNOUNCEMENT

We are pleased to announce that the **IEM 55th Annual Dinner and Awards Night 2014** will be held on **19 April 2014** (Saturday) at the Imperial Ballroom, One World Hotel, Bandar Utama, Petaling Jaya.

More details will be announced soon.

Ir. Noor Hisham Yahaya
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River of Life – A Green Vision

by Ir. Hj. Ahmad Jamalluddin Shaaban, Ir. Mohd. Zaki Mat Amin, Nurul Huda Md. Adnan and Goh Yee Cai

INTRODUCTION

The River of Life (RoL) is an Entry Point Project (EPP) identified in the Greater Kuala Lumpur/KlangValley National Key Economic Area (NKEA) under the Economic Transformation Program (ETP). RoL aims to transform the Klang River into a vibrant and livable waterfront with high economic value. This transformation is divided into three components: River Cleaning, River Beautification and River Development.

OBJECTIVES

The overall aspiration of Greater Kuala Lumpur is "to be the metropolis in Asia that simultaneously achieves top-20 economic growth and to be among the global top-20 most livable cities by 2020", under part of the EPP (Entry Point Project), the River of Life. The main objectives are:

- Enhancing, rehabilitating and preserving the river and its environment, compatible with the envisaged Greater Kuala Lumpur City status for the project area, including improving and sustaining the Klang River and its tributaries within the study area Water Quality to Class IIB (suitable for body-contact recreational usage) by year 2020.
- Providing adequate level of flood mitigation protection to the project area, in support of achieving the Greater Kuala Lumpur City status.

RIVER OF LIFE COMPONENTS

River Cleaning

River cleaning will be conducted along a 110km stretch of the main river and tributaries within the Klang River basin, covering the municipal areas of Majlis Perbandaran Selayang (MPS), Majlis Perbandaran Ampang Jaya (MPAJ) and Dewan Bandaraya Kuala Lumpur (DBKL).

River Beautification

To increase economic viability of the area, master planning and beautification works will be carried out along a 10.7km stretch along the Klang and Gombak river corridor, starting from Puah Pond in Sentul to Mid-Valley. Significant landmarks in the area include Dataran Merdeka, Bangunan Sultan Abdul Samad and Masjid Jamek.

River Development

The master planning and beautification works will spur economic investments into the areas immediately surrounding the river corridor. To catalyse development along the corridor, potential government land will be identified and tendered out to private developers through competitive bidding.

GOVERNANCE STRUCTURE FOR RIVER OF LIFE

Steering Committee Greater KL/KV

- Chaired by Minister of Federal Territories
- Members include the Mayor of Kuala Lumpur, the Chief Minister of Selangor, Ministry of Finance, Economic Planning Unit, heads of ministries, as well as industry and developer associations
- Sits every month, reporting progress and resolving issues for all EPPs and Business Opportunities (BOs) under GKL/KV

River of Life Joint Development Committee (RoL JDC)

- Headed by the Mayor of Kuala Lumpur
- JDC sits every month where progress for all three components of River of Life are monitored

River Cleaning Taskforce

- Head by the Director General of the Department of Irrigation and Drainage *(Jabatan Pengairan dan Saliran, JPS)*
- River Cleaning Taskforce comprises 26 government agencies across 4 ministries
- Meets every four weeks, where River Cleaning specific issues are resolved and the progress of the 13 Key Initiatives are tracked

River Beautification Taskforce

- Head by the Director of the Physical Planning Department *(Jabatan Perancangan Fizikal, JPF)* of Kuala Lumpur City Hall *(Dewan Bandaraya Kuala Lumpur, DBKL)*
- Meets every month, or whenever necessary, to manage the River Beautification Master Plan and beautification works of all 11 River Beautification Precincts

Land Development Taskforce

- Head by the Director of the Economic Planning and Development Coordination Department *(Jabatan Perancangan Ekonomi dan Penyelarasan Pembangunan, JPEPP)* of DBKL
- Came into force in 2012, to look into the generation of economic value of developments as proposed in the River Beautification Master Plan

The Klang River Basin is the most densely populated region in the country. To accommodate the rapid increase in population, the Klang River Basin has experienced rapid development and land use change over the years. As a result, the water quality of the river has declined due to point and non-point source pollution.

Point sources include sewage treatment plants, manufacturing, agro-based industries, food premises, wet markets, abandoned land fill and animal farms. Non-point sources are defined as diffused sources such as agricultural activities and surface run offs.The main sources of pollution have been identified as:

- Sewerage effluents, both treated and untreated
- Sediment, especially from construction sites
- Solid waste, especially from squatter settlements and markets
- Industrial effluents
- Agriculture effluents

Table 1 shows the inventory of pollution sources.

Table 1: Inventory of pollution sources

No.	Data Collection	Unit		
		DBKL	MPAJ	MPS
1	Workshop	1183	25	513
2	Restaurant / Food Court / Food Stall	4380	664	506
3	Slaughter Spot and Livestock	4	0	3
4	Hotel / Resort	98	5	3
5	Night Market / Uptown	81	3	12
6	Wet market	37	0	7
7	Morning Market	38	2	1
8	Petrol Station	75	11	7
9	Industries (iron, chemical, fertilizer, etc)	949	99	276
10	Hospital and Clinic	112	20	1
11	Nursery	25	3	4
12	Residential types	766	128	27
13	Squatters	75	6	4
14	Shopping Complex	96	5	1
15	Shop lot / mini market	20923	5089	4928
16	Landfill / Construction	537	86	88
17	Carwash (Legal / illegal)	316	143	81
18	Laundry	320	152	67
19	Sewerage Treatment Plant	334	83	78
20	Water Plant	56	25	23
21	Recycling Centre	4	1	0

(Source: JPS River Cleaning KI8 Study)

RIVER CLEANING

Towards achieving the River Cleaning objectives, Jabatan Pengairan dan Saliran Malaysia leads 26 government agencies and departments across 4 ministries, 2 States (Selangor and Federal Territory) and 3 municipals (Dewan Bandaraya Kuala Lumpur (DBKL), Majlis Perbandaran Selayang (MPS) and Majlls Perbandaran Ampang Jaya (MPAJ)) to execute the following 13 Key Initiatives. Figure 1 denotes the project area.

Agencies involved in River Cleaning taskforce:

1. Kementerian Sumber Asli dan Alam Sekitar (KSAAS)
2. Kementerian Tenaga, Teknologi Hijau & Air (KeTTHA)
3. Kementerian Perumahan dan Kerajaan Tempatan (KPKT)
4. Kementerian Wilayah Persekutuan dan Kesejahteraan Bandar (KWPKB)
5. Jabatan Pengairan dan Saliran Malaysia (JPS Malaysia)
6. Jabatan Pengairan dan Saliran Wilayah Persekutuan (JPS WPKL)
7. Jabatan Pengairan dan Saliran Selangor (JPS Selangor)
8. Jabatan Kerja Awam dan Saliran, Dewan Bandaraya Kuala Lumpur (JKAWS DBKL)
9. Jabatan Alam Sekitar Ibu Pejabat (JAS PERSEKUTUAN)
10. Jabatan Alam Sekitar Wilayah Persekutuan Kuala Lumpur (JAS WPKL)
11. Jabatan Alam Sekitar Selangor (JAS SELANGOR)
12. Jabatan Kesihatan dan Alam Sekitar, Dewan Bandaraya Kuala Lumpur (JKAS DBKL)
13. Jabatan Pemudahcara Perniagaan dan Pengurusan Penjaja, Dewan Bandaraya Kuala Lumpur
14. Lembaga Urus Air Selangor (LUAS)
15. Jabatan Perkhidmatan Pembetungan (JPP)

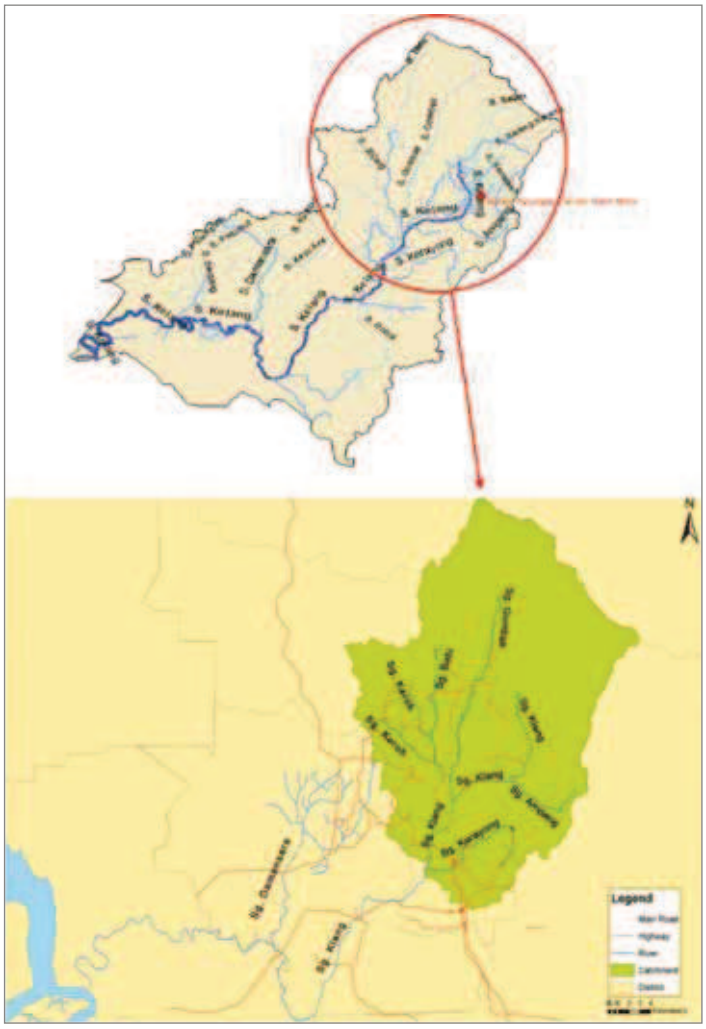

Figure 1: Project area

16. Jabatan Pengurusan Sisa Pepejal Negara (JPSPN)
17. Suruhanjaya Perkhidmatan Air Negara (SPAN)
18. Jabatan Kerajaan Tempatan (JKT)
19. Pejabat Menteri Besar Negeri Selangor
20. Unit Perancang Ekonomi Selangor (UPEN Selangor)
21. Jabatan Perancang Bandar dan Desa (JPBD)
22. Pejabat Tanah dan Galian Selangor (PTG Selangor)
23. Pejabat Daerah/Tanah Gombak (PTD Gombak)
24. Pejabat Daerah/Tanah Hulu Langat (PTD Hulu Langat)
25. Majlis Perbandaran Ampang Jaya (MPAJ)
26. Majlis Perbandaran Selayang (MPS)

KEY INITIATIVES

13 Key Initiatives have been formulated with the respective programmes to clean the river and to achieve Class IIB by year 2020. Currently, these initiatives are in various stages of implementation.

Key Initiative	Description
1	Upgrading existing sewerage facilities is the most impactful and important initiative to reduce Klang river pollution
2	Existing regional sewage treatment plants must be expanded to cater for future growth
3	Wastewater treatment plants need to be installed at 5 wet markets to decrease rubbish and pollutants
4	Installing additional gross pollutant traps will improve the river aesthetics and water quality
5	Utilising retention ponds to remove pollutants from sewage and sullage
6	Relocating squatters will significantly reduce sewage, sullage, and rubbish in the Klang river
7	Implementing the Drainage and Storm-water Management Master Plan to upgrade drainage systems
8	Need for systematic hydrological study and rehabilitation of the river for flow control and to identify gaps for water quality and floods
9	To promote, enforce and manage river cleanliness and health – erosion from urban development
10	To promote, enforce and manage river cleanliness and health – restaurants, workshops, and other commercial outlets
11	To promote, enforce and manage river cleanliness and health – industries that generate wastewater/effluent
12	To promote, enforce, and manage river cleanliness – general rubbish disposal
13	Intercepting sullage and additional wastewater utilising combined storm-water overflow (CSO)

RIVER BEAUTIFICATION

The River Beautification component under RoL aims to transform the Klang and Gombak Rivers into a vibrant and livable water-front with high economic value through revitalisation of public realm along the rivers. This will be done by providing a consistent

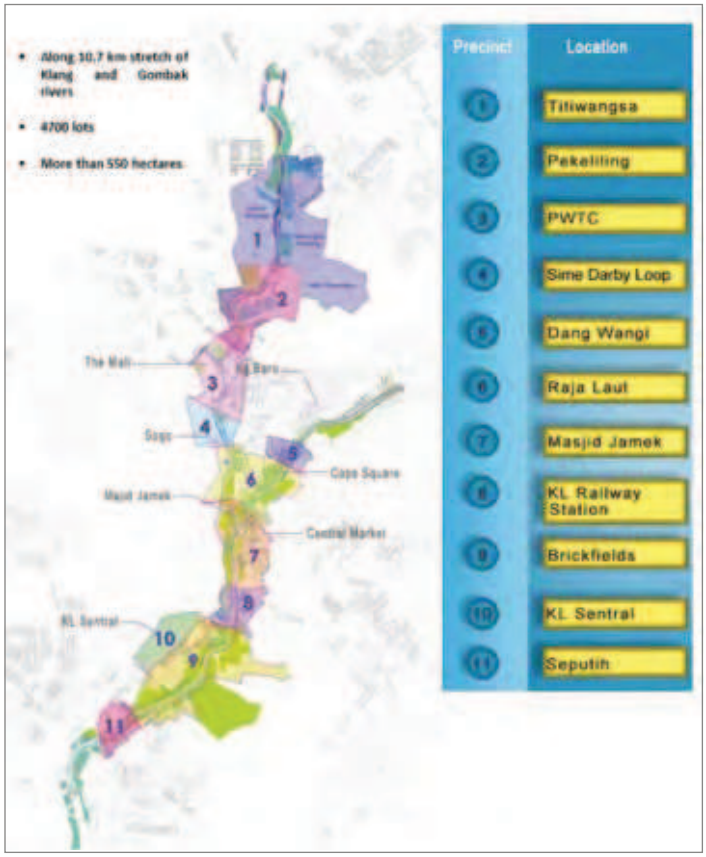

Figure 2: River Beautification Precincts
(Source: DBKL Beautification Master Plan)

design signature, a brand for the city riverfront, in planning, architectural, functional and economic terms.The area concerned is demonstrated below.

RIVER DEVELOPMENT (LAND DEVELOPMENT)

Upon completion of River Cleaning and River Beautification works, the residents of Greater Kuala Lumpur / Klang Valley will benefit from a surge of economic activities and investments in the area. To further drive development along the corridor, potential government land will be identified and tendered out to private developers through competitive bidding. While the RoL project is funded solely by the Government, the government land along the 10.7km river is expected to appreciate upon completionof the River Cleaning and River Beautification projects. This appreciation in value is expected to partially fund the RoL project. The exact amount depends on the transaction value of the government land sold through competitive bidding.

ENGINEERING SOLUTIONS

This vision cannot be turned into reality without introducing new technologies. These are the challenges that fellow engineers at DID, DBKL, MPAJ and MPS as well as consultants are facing. Sound engineering design with good quality control during the construction stage is compulsory to achieve the overall objectives.

(Continued on page 23)

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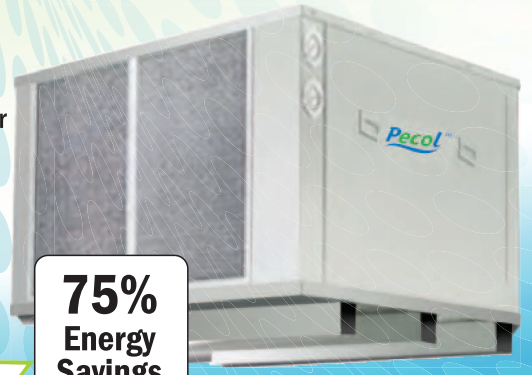

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All RoL initiatives are allocated Key Performance Indicators (KPIs) attached to respective Ministers. Among the technologies used are:

KI 4: Gross Pollutant Trap (GPT)

KI 7: River Water Treatment Plant (RWTP)

KI 7: MSE Wall

KI7: Natural Aerator Stone

KI 7: Floating Wetland and Solar Aerator

KI 7: Hydroseeding

KI 1 & 2: Pipe Jacking for upgrading sewerage

TECHNICAL PERSONNEL INVOLVED

The River Cleaning components involve a large number of technical employees – mainly engineers from agencies, consultants and contractors. The team consists of various engineering disciplines to manage and construct various projects for each Key Initiative. A total of more than 200 engineers and 2,000 supporting staff members make up the teamwork for river cleaning projects.

NON-ENGINEERING SOLUTIONS

River of Life Public Outreach Program known as RoL POP is introduced in the area of RoL Basin which is the sub-basin of the Klang River. The current programmes which focus in Upper Klang and Sungai Bunus areas are people-centric towards non-structural initiative where several target groups have been identified.

The programmes address river water pollution prevention exercise through educating the public on the need to care for the river and the water quality, such as dos and don'ts as well as other skills to preserve the river. It also promotes public participation and a sense of ownership towards the river system as well as initiates a long-term and sustainable paradigm shift towards river conservation.

Meetings with local community

Open Classroom Programme

Site inspection with developers in the river catchment

Creating Environmental Cultured Community

CONCLUSION

In conclusion, with the commitment from all stakeholders, together with the implementation of the structural and non-structural measures, the objective to improve water quality to Class IIB can be achieved by the year 2020.

The project also aims for a sustainable change in behaviour towards an environment-cultured society, thus escalating the overall Greater Kuala Lumpur's aspiration "to be the metropolis in Asia that simultaneously achieves top-20 economic growth and be among the global top-20 most livable cities by 2020". Nature is what wins in the end. ■

Treat the earth well.
It was not given to you by your parents,
It was loaned to you by your children.
We do not inherit the Earth from our Ancestors,
We borrow it from our Children.
~ Ancient Indian Proverb ~

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Malaysia's 1st "Ultra-High Performance Ductile Concrete" Composite Bridge in a Marine Environment

by Datuk Ir. Kuna Sittampalam, Ir. Chen Wai Peng, Ir. Dr Voo Yen Lei and Engr. Sukhvinder Singh

INTRODUCTION

Recently Westports Malaysia Sdn. Bhd. called for tenders to expand its container cargo terminal at Pulau Indah, Port Klang. The project included the construction of four new access bridges (namely Bridge24, Bridge25, Bridge26 and Bridge27) connecting the new wharf to the container stacking yard. Of the four bridges, Bridge25 was to be designed as a special access bridge for overweight and oversized cargo with trailer payloads of up to 3,072 metric tonnes.

Project owner Westports Malaysia Sdn. Bhd. had appointed HSS Integrated Sdn. Bhd. (HSSI) as the Engineer for the project and Putra Perdana Construction Sdn. Bhd. as the Contractor.

HSSI specified the use of Grade150 "Ultra-High Performance ductile Concrete" (UHPdC) precast prestressed beams for Bridge25 in order to carry the exceptionally heavy live loads while maintaining a shallow beam depth of 1m.

The material has also been reported to be highly durable and has the ability to provide a service life in excess of 100 years (JSCE, 2006). Being located in a marine environment, Bridge25 would benefit from UHPdC's extra resistance against chloride attack, which would be a major advantage.

The other three bridges adopted conventional Grade50 concrete composite bridge decks as they were designed for normal highway bridge loadings.

FEATURES OF BRIDGE25

The superstructure of Bridge25 consisted of six 13.0m spans with five of the spans at 22.5m width and the sixth span at 40.5m width. The substructure of the bridge was founded on 800mm diameter Grade 80 spun concrete piles driven to set at an average pile depth of approximately 36m. The piles were framed into Reinforced Concrete (RC) crossheads measuring 1.5m wide by 0.6m deep.

The structural analysis indicated that a total of 77 (seventy-seven) 1,400mm deep by 1,600mm wide conventional Grade50 precast concrete T-beams spaced at 2.0m centres would be required for the whole bridge deck. However, as the T-beams came with a limitation of insufficient freeboard (600mm) below the bridge soffit, the beam depths had to be reduced.

The UHPdC option was considered in order to achieve the same high load carrying capacity required with a shallower beam depth, so that a minimum freeboard of 1.0m from the high tide water level could be achieved.

Figure 1: Construction of Bridge25 using UHPdC beams

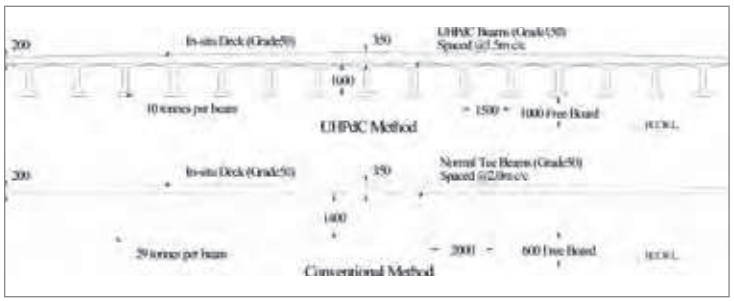

Figure 2: Sectional views of Bridge25 deck options

Figure 2 gives a comparison of the cross-sections of the composite bridge decks for both the UHPdC and the conventional Grade50 concrete T-beam options. For the UHPdC beam option, a total of 102 precast UHPdC beams were required for Bridge25, with each UHPdC beam spaced at 1.5m centre to centre.

The UHPdC beam option also gave a significant dead weight saving of approximately 66% per beam compared to the conventional Grade50 precast concrete beam design.

The composite bridge deck would be completed with a Grade50 in-situ RC deck, with an average thickness of 275mm.

Accordingly, a proposal for using Grade150 UHPdC beams was presented to the Client and subsequently approved.

OVERSIZED CARGO LOAD

In Malaysia, most bridges are designed to the highway bridge traffic loadings specified in the Design Manual for Roads and Bridges (BD 37/01). Bridge25 however, has to be designed for use by special trailers known as "Gold holder 24 lines".

These trailers have a total of 96 axles, arranged with 24 axle lines spaced at 1.5m centre to centre longitudinally and 3 axles side by side at 3.0m centre to centre transversely.

Figure 3 shows an example of the type of overweight and oversized live load that will be using Bridge25.

According to the specialist transporter's specifications, these trailers are able to transport cargo payloads up to a maximum of 3,072 metric tonnes at a time.

Factored live axle line loads of 387kN/axle and 458kN/axle for the Serviceability Limit State (SLS) and Ultimate Limit State (ULS) respectively were used in the structural analysis of the multi-span composite bridge.

Figure 3: Example of similar oversized cargo using the Gold holder 24 lines trailer

GRADE150-UHPdC

The raw materials for the Grade150 steel fibre reinforced Ultra-High Performance ductile Concrete (UHPdC) used in the precast pretensioned beams include Type I Ordinary Portland Cement, densified silica fume containing more than 92% silicon dioxide with particle sizes ranging from 0.1μm to 1μm and surface fineness of 23,700m^2/kg, and washed-sieved fine sand with particle sizes ranging between 100μm and 1,000μm. A polycarboxylic ether (PCE) based super plasticiser was used to ensure good workability of the mix. The micro steel fibres specified for the mix were required to have an ultimate tensile strength of 2,500MPa. The formulation of the mix however has been patented under the trade name DURA®.

For this project, a benchmark value for performance was set for the DURA® UHPdC material to achieve. It was specified that the average 28-day cube compressive strength and modulus of rupture should not be less than 150MPa and 20MPa, respectively.

UHPdC PRESTRESS BEAM

Figure 4 shows the cross-sectional dimensions of the UHPdC beam used on Bridge25. The total length of the beam was 12.1m. The top flange was 1,490mm wide and reinforced with 6 pieces of 15.2mm diameter strands, while the bottom flange was 500mm wide and reinforced with 18 pieces of 15.2mm diameter strands. The web was designed as a thin membrane element of 175mm thickness. Unlike conventional RC beams where steel reinforcement or stirrups are used as primary resistance against all major tensile/shear forces that may occur in the stress/load path inside the beam, the UHPdC beams do not have any conventional

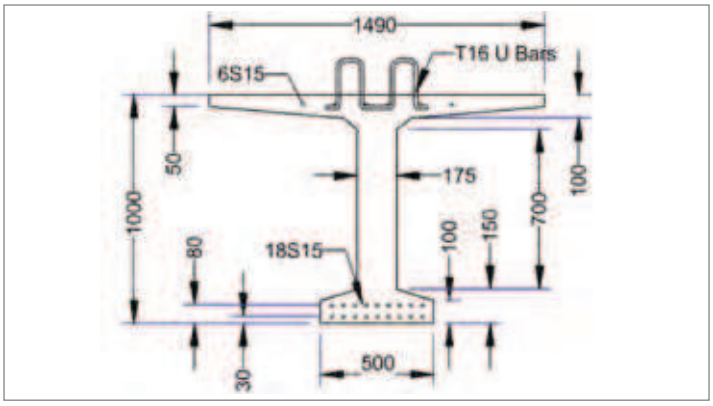

Figure 4: UHPdC beam section details (in mm)

steel reinforcement or stirrups in its section other than the starter bars in the top flange. These starter bars are required only for making the connection to the in-situ concrete deck. Instead, steel fibres are used to enhance the tensile/shear strength of the UHPdC and to improve beam ductility.

LIMIT STATE DESIGN

Bridge25 was designed as a six-span continuous composite bridge with rigid joints at the supports.

Table 1 summarises the critical design force effects both in terms of SLS and ULS from the structural analysis of Bridge25.

Prior to construction of Bridge25 and to verify the strength of the precast UHPdC beam's strength, the Client and the Engineer had requested for full scale performance load tests on the UHPdC beams both in flexure and in shear until failure.

For the purpose of the verification load tests, only the precast beams (i.e. without the RC deck) were tested. First principles of solid mechanics were used to calculate the design load actions on the beams in the absence of the deck. The calculations show that the precast UHPdC beam only (without the deck) will resist 74% of the design bending moment effect and 79% of the design shear force effect of the composite section. These values are tabulated in Table 1.

The UHPdC beam manufacturer had guaranteed that the precast UHPdC beam only (without the deck) would be able to resist a minimum design moment of $M_{Rd,beam}$ = 3,750kNm and a minimum design shear force of $V_{Rd,beam}$ = 1,420kN.

Table 1: Design force effects

	Bridge		Beam Only	
Design Forces	**SLS**	**ULS**	**SLS**	**ULS**
Positive Moment, kNm	2,720	3,228	2,013	2,389
Negative Moment, kNm	-2,853	-3,386	-	-
Shear Force, kN	1,299	1,541	1,026	1,218

Two prototype UHPdC beams were then manufactured and subjected to the strength verification tests as described below.

DESTRUCTIVE PERFORMANCE LOAD TEST

Figure 5a shows the set-up for the flexural strength verification test. The flexural beam was set in a three-point test configuration

with a simply supported span of 11.9m. The applied force from the hydraulic jack was placed at the centre of the span with a stiff steel plate/ beam to distribute the load across the top flange of the beam. One end of the beam was supported on a pinned support, while the other end was sitting on a pin and roller support. The pins and rollers were greased to minimise friction in order to give the required freedom of rotation and horizontal translation.

Three sets of Linear Variable Differential Transformers (LVDTs) were used to capture the vertical displacements of the beam during testing. LVDT1 was the major interest of the test as it was located at the mid span of the beam (i.e. where the applied load was situated). LVDT2 and LVDT3 were placed at both supports to monitor support stiffness.

Figure 5c shows the set-up for the shear strength verification test. The beam was simply supported over a span of 5.67m between centre lines of the supports. The applied concentrated load was similarly placed at the top flange of the beam in a three-point test configuration. The ratio of shear span to effective depth used in the shear test was 2.

The results of both the flexural and shear tests are presented in Figure 5b and Figure 5d respectively, where $P_{cr,exp}$ denotes the applied load measured at first structural cracking, determined by visual tracing of cracks on the specimens or as detected on the load versus displacement curves (whichever is lower), and the symbol $P_{u,exp}$ denotes the maximum applied load recorded at the end of each test.

As the cracks were extremely fine and difficult to be seen by the naked eye, water was sprayed onto the surface of the beam at each load step, to help obtain a clearer trace of the cracks.

In the flexural strength test, the first flexural cracks were observed at the applied load of $P_{cr,exp}$ = 870kN. Using a microscopic crack detector, the crack widths observed were in the order of 0.01mm under this load. The cracking moment capacity (M_{cr}) of the beam can therefore be calculated as follows:

M_{cr} = Applied load x Span/4 + moment due to self weight of girder = 870 x 11.9/4 + 8 x 11.9^2/8 = 2,730 kNm.

The resulting M_{cr} proved that the UHPdC beam did not crack at the Design SLS load condition (see Table 1).

As the applied load increased further, more cracks appeared but these were fine and uniformly distributed across the span. Observations showed that these multiple flexural micro-cracks, which appeared "smeared" across the bottom flange/web area, had crack widths of approximately 0.2mm to 0.3mm at the applied load of P = 1,230kN, corresponding to the guaranteed load carrying capacity in flexure ($M_{Rd,beam}$). As a result, the Design ULS load condition was met.

The maximum applied load captured in the flexural test was P = 1,396kN, which corresponded to a maximum applied moment of 4,153kNm at the mid span, confirming that the UHPdC beam had ample positive moment resistance over the design positive moments shown in Table 1.

The resulting plot of the applied load versus mid-span displacement curve of the test beam in Figure 5b also showed that the test beam exhibited linear elastic behaviour prior to cracking. The mid-span deflection at first cracking was captured to be 16mm. The beam was able to undergo a further 64mm of mid-span deflection before the maximum applied load of P_u = 1,396kN was reached.

In the shear strength test, the measured first cracking load was P_{cr} = 2,130kN (i.e. V_{cr} = 1,420kN) which co-incidentally equalled the guaranteed shear force capacity of the UHPdC beams ($V_{Rd,beam}$).

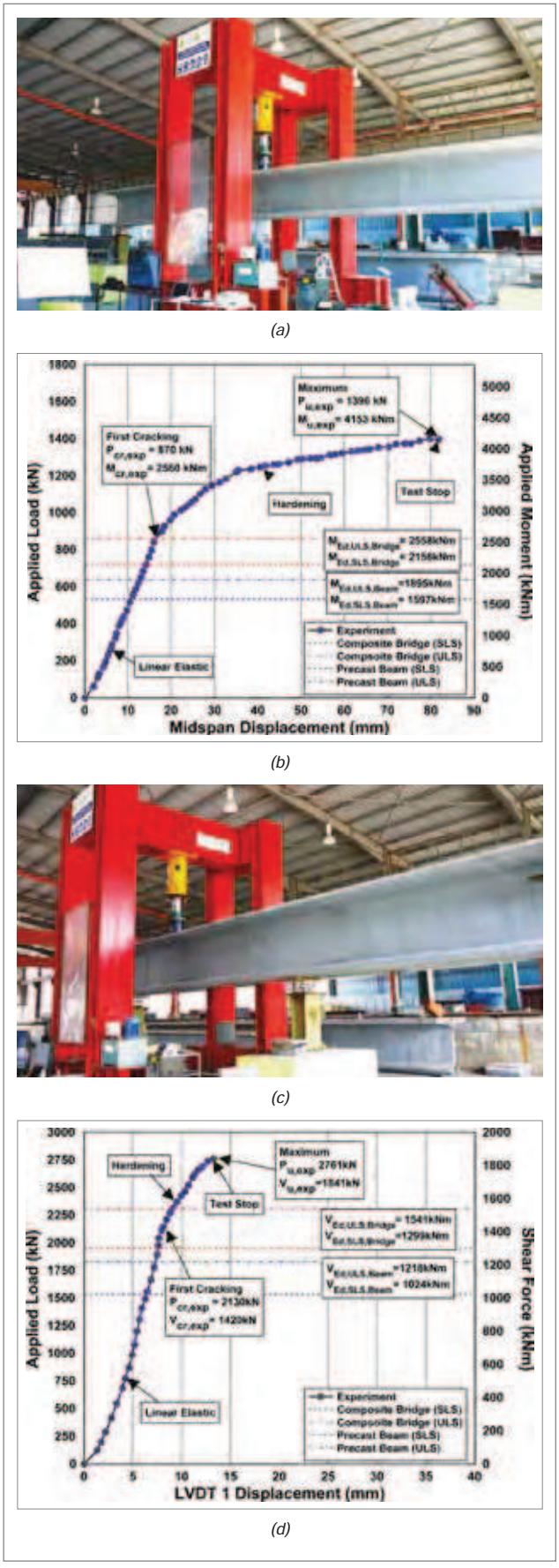

Figure 5: (a) Flexural strength verification test set-up, (b) Flexural test experimental result compared against design moments criteria, (c) Shear strength verification test set-up, (d) Shear test experimental result compared against design shear forces criteria

Assuming that the shear force was taken by only the rectangular section of the web, the cracking shear strength of the beam can be approximated as follows:

τ_{cr} = 2130 x 2/3/(175 x1000)
= 8.1MPa

Figure 5d shows the plot of the applied load versus displacement curve of the beam tested in shear. Beam deflection generally showed linear elastic behaviour before cracking. The monolithic section underneath the applied load (i.e. near LVDT1) was captured with a deflection of 8mm at the first web shear cracking load effect of V_{cr} = 1,420kN.

After first shear cracking, the beam exhibited displacement hardening behaviour until the maximum applied load of P_u = 2,761kN (V_u = 1,841kN) was recorded.

The shear test clearly demonstrated that the UHPdC beam section had sufficient reserves in shear resistance beyond the design shear force (see Table 1).

QUALITY CONTROL AND INSPECTION PROCEDURES

The UHPdC supplier had assured that each batch of UHPdC would have a minimum average cube compressive strength and flexural strength of 150MPa and 20MPa, respectively.

Very strict quality control and inspection procedures were implemented during the production of the 104 prestressed precast UHPdC beams for this project. (102 nos. for the bridge construction and 2 nos. for the destructive load test). Manufacturing of the first UHPdC beam started in early April 2012 and all 104 beams were completed only at the end of July the same year.

Each single piece of precast beam was produced from a new batch mixing of the UHPdC material, and control samples were collected from every batch of the UHPdC mixes.

For this project, a total of 104 sets of UHPdC samples were collected (each set consisting of a minimum of six 100mm cubes and a minimum of one prism). Figure 6 presents the statistical data on the various strength test results of the control specimens.

The cube compressive strength f_{cu} for each batch was determined using a minimum of three cube specimens. The early age 1-day strengths and the 28-day strengths were measured. These are presented here in Figure 6a and Figure 6b, respectively. In general, the UHPdC material was able to achieve 1-day and 28-day characteristic strengths of 67MPa and 151MPa, respectively.

The flexural toughness test in accordance with ASTM-C1018 (1997) was carried out to determine the flexural properties of the UHPdC. Figure 6c and Figure 6d show respectively the frequency distribution of first cracking flexural strengths (f_{cr}) and the moduli of rupture (f_{cf}) of the UHPdC. The test results show that the characteristic first cracking strength and modulus of rupture after 28 days are 10.8MPa and 22.2MPa, respectively.

Though every batch of UHPdC was tested and found to satisfy the required standards, the Contractor and Engineer were both concerned that the material testing results might not fully cover and demonstrate the structural performance of the UPHdC beams. As such, the Engineer further requested for five additional UHPdC beams to be load tested (non-destructively) up to their Design SLS loadings as given in Table 1.

The Client then proceeded to randomly select five beams (i.e. Beams 22, 49, 55, 78 and 95) to be subjected to the SLS load proof test. The passing criterion for the SLS load proof test was for the beams to be able to carry the specified SLS loading without cracking.

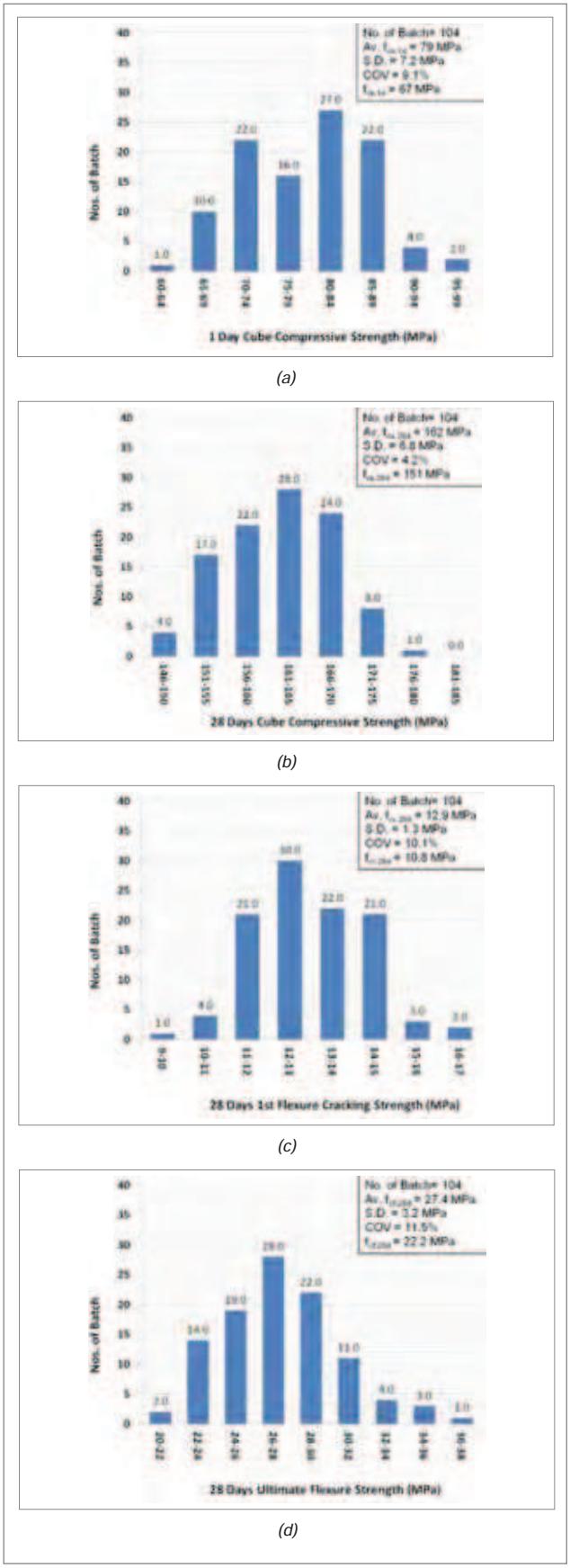

Figure 6: Frequency distribution of (a) 1-day compressive strengths, (b) 28-day compressive strengths, (c) 28-day first flexural cracking strengths and (d) 28-day moduli of rupture for the UHPdC material used in the precast beams

(Continued on page 32)

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   Prof. Dr. Sabu Thomas (Mahatma Gandhi University, India/ Universiti Teknologi Mara, Malaysia)
   Ms. Siti Haslina Ramli (PETRONAS Research, Malaysia)

2. International Symposium on Materials Characterisation and Testing 2014 (ISMCT 2014)
   Theme:
   Technologies & Innovations in Materials Asset Integrity

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   Eur. Ing. Nigel Brewitt (Norimax Sdn Bhd, Malaysia)
   Dr. Andrew Spowage (Woodgroup Intetech, Malaysia)

3. International Symposium on Coatings Technology (ISCT 2014)
   Theme:
   Assuring Integrity & Safety in Coatings Development

   Symposium Co-Chairperson:
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   Mr. David Lim Chee Cheong (ExxonMobil E&P (M) Inc, Malaysia)
   Ms. Nurul Asni Mohamed (PETRONAS GTS, Malaysia)

4. International Symposium on Metallurgy and Welding Technology 2014 (ISMWT 2014)
   Theme:
   Facility Safety through Welding Integrity

   Symposium Co-Chairperson:
   Ir. Dr. Edwin Jong Nyon Tchan (Jurutera Perunding Akal Sdn. Bhd., Malaysia)
   Prof. Dr. A. S. M. A. Haseeb (Universiti Malaya, Malaysia)
   Mr. M. Hasbi B. A. Razak (PETRONAS Carigali Sdn Bhd, Malaysia)

5. International Symposium on Corrosion & Material Degradation (ISCMD 2014)
   Theme:
   Sustaining Technical Integrity through Improved Corrosion Protection Technologies

   Symposium Co-Chairperson:
   Pn. Halimah Pit (Shell, Malaysia)
   Dr. Mahesh Kumar Talari (Universiti Teknologi MARA, Malaysia)

SPECIAL LECTURES (14th May 2014)

1. 

   Datuk Mohd Anuar Taib
   President – PETRONAS Carigali Sdn. Bhd.
   Vice President & Chief Executive Officer, PETRONAS Development & Production.
   Title: Cost Effectiveness in the Oil & Gas Industry– Quality & Safety Assured

2. 

   Ir. Pramod Kumar Karunakaran
   Vice President of Infrastructure & Utilities (Gas & Power Business), PETRONAS, Malaysia.
   Title: Achieving Effective Project Delivery Through A Structured QA & QC Approach

PLENARY SPEAKERS (14th & 15th May 2014)

1. 

   Prof. Dr. Sabu Thomas
   Mahatma Gandhi University, India and Universiti Teknologi MARA, Malaysia
   Title: High Performance Epox Nanocomposites for Coating Applications

2. 

   Dr. Liane Smith
   Director of Woodgroup Intetech Ltd., United Kingdom
   Title: Putting Theory into Practice - Lessons Learnt from Oil & Gas Industry

Important Dates

Submission of Abstract	1 Jul 2013 – 15 Jan 2014
Notification of Acceptance	1 month after submission
Submission of Full Paper/ Presentation (PDF or PPT) for CD	1 Jan 2014- 14 Feb 2014
Full Paper Submission for Journal	16 May – 31 May 2014

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KEYNOTE SPEAKERS FOR SYMPOSIUMS (14th & 15th May 2014)

1. International Symposium on Advanced Polymeric Materials. (ISAPM 2014)


Prof. Dr. Abdul Kariem Arof
Centre for Ionics University Malaya, Physics Department, Faculty of Science, Universiti Malaya,Malaysia.
Title: Chitosan-Based Polymer Electrolytes and Their Potential Application in Dye Sensitized Solar Cells


Prof. Dr. Alejandro J. Müller
1) University of the Basque Country (UPV-EHU), Spain.
2) USB Polymer Group, Materials Science Department, Simón Bolívar University, Caracas 1080-A, Venezuela
Title: The Effects of Confinement on the Nucleation and Crystallization of Polymer Chains


Prof. Dr. Jas Pal Badyal
Durham University, United Kingdom.
Title: Functional Nanocoatings


Prof. Dr. Seng Neon Gan
Department of Chemistry, Universiti Malaya, Malaysia
Title: Environmental Friendly Coating Resins from Palm Oil


Dr. Kong Chin Chew
Heads of Long Term Development Asia Laboratory, Beckers Group, Malaysia
Title: Sustainability in the Coatings Industry


Dr. Mustafa Kansiz
Agilent Technologies, Australia
Title: Novel Applications of FTIR & FTIR Chemical Imaging Microscopy - Simultaneous Spatial and Chemical Information at the Micron Level


Dr. Russell J. Varley
CSIRO, Australia.
Title: Novel Approaches to Sustainable Materials Development using Synthetic, Simulation and Self-healing Strategies.

2. International Symposium on Materials Characterisation and Testing. (ISMCT 2014)


Prof. Dr. David Rugg
Rolls-Royce PLC, UK
Title: The Industrial Application of University Based Materials Science


Dr. Badrol Bin Ahmad
General Manager, Performance Analyses & Diagnostics, Tenaga Nasional Berhad, Malaysia.
Title: Structural Integrity of Materials


Dr. Hasnah Abdul Wahab
Head of Joining & Inspection Services, Technical Services Division, SIRIM Berhad, Malaysia
Title: Failure Analysis in Asset Integrity Management


Mr. Mohamad Azmi Noor
Head Asset Integrity Division HSE, Asset Integrity Division, EPHSE, EVP'S Office, E&P Business, PETRONAS
Title: Asset Integrity Management


Mr. Robert A. Burn
Technical Integrity Manager, Murphy Oil Malaysia, Malaysia
Title: Failure of Welded Structures in the Oil and Gas Industries

3. International Symposium on Coatings Technology. (ISCT 2014)


Ms. Nurul Asni Mohamed
Principal Engineer (Corrosion), Group Technical Solutions, Technical & Engineering Division, PETRONAS GTS, Malaysia.
Title: Coatings Fingerprinting


Mr. Thomas A Jones
SSPC, (The Society for Protective Coatings), USA
Title: Coatings for Asset Management

4. International Symposium on Metallurgy and Welding Technology. (ISMWT 2014)


Prof. Dr. Yu-Ichi Komizo
Joining and Welding Research Institute, Osaka University, Japan
Title: Status & Prospects of Advanced Structural Steel and Its Weldability


Assoc. Prof. Dr. G. D. Janaki Ram
Indian Institute of Technology Madras, Chennai, India
Title:Welding of High Temperature Alloys


Mr. Chee Pheng Ang
Secretary General, Asian Welding Federation, Singapore
Title: Welder Qualification & Performance


Mr. Hasbi Razak
PETRONAS Carigali Sdn Bhd, Malaysia
Title: Welding Inspection


Mr. Hideaki Harasawa
The Japan Welding Engineering Society, Japan
Title: Weld Integrity Analysis

5. International Symposium on Corrosion and Materials Degradation. (ISCMD 2014)


Dr. Reza Javaherdashti
Parscorrosion Consultants, Perth, Australia
Title: Clostridia: (perhaps) the least known corrosion-related bacteria in Industry


Dr. T. S. N Sankara Narayanan
Chonbuk National University, South Korea
Title: Controlling The Corrosion Rate of Magnesium and Its Alloys by Surface Treatments for The Development of Degradable Implants: Prospects and Challenges


Pn. Halimah Pit
Team Lead MCI-KL Deepwater Office, Porjects & Technology, Upstream Major Project (East), Sabah Shell Petroleum Co Ltd, Malaysia
Title: Corrosion Integrity


Tuan Haji Mohd Kamal Azam Ibrahim
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All five selected beams passed the SLS load proof tests without cracking.

ENVIRONMENTAL IMPACT CALCULATIONS (EIC)

This section illustrates an example of Environmental Impact Calculations (EIC) for Bridge25, based on the two different deck options shown in Figure 2. The purpose of this exercise was to illustrate how the advancement of UHPdC technology could help to reduce the carbon foot-print or to reduce the consumption of primary energy to construct the same bridge.

Undertaking a rigorous EIC is a complex exercise and the data required for the calculation varies from country to country due to different local practices and the technologies available. Table 2 summarises the inventory data of the materials used for this comparative study on the two bridges. Details on the derivation of this inventory data can be obtained from Voo and Foster (2010). The table has been prepared for determining the equivalent Embodied Energy (EE), CO_2 content and 100-year Global Warming Potential (GWP) of each particular concrete mix design and the materials used. The information may be updated more frequently as the industry continues to improve its processes.

Table 2: Inventory data for construction material (Voo and Foster, 2010)

	Units	UHPdC	G50	Strand & Reo.
Density	kg/m^3	2388	2344	7840
Cement	kg/m^3	720	480	-
EE	GJ/m^3	7.77	2.70	185.8
CO_2	kg/m^3	1065	480	17123
NO_x	kg/m^3	4.86	1.66	55.4
CH_4	kg/m^3	0.76	0.12	30.7
100-yr GWP	kg CO_2 eq./m^3	2532	978	34392

Elrod (1999) defines GWP as a measure of how a given mass of green house gas is estimated to contribute to global warming over a given time interval. It is a relative scale that compares the gas in question to that of the same mass of CO_2 and a 100-year of time horizon is most commonly adopted, as per the Kyoto Protocol. The GWP formulation can be ambiguous and the adequacy of the GWP concept has been widely debated since its introduction. To date, very little work has been done on this area and the formulations of the 100-year GWP have yet to be unified.

However, Voo and Foster (2010) for the first time suggested that the 100-year GWP can be expressed as:

$$\text{100-yr GWP} = CO_2 + 298\ NO_x + 25\ CH_4 \quad (1)$$

In this comparative study, calculation of material quantities will only cover the super structure, whereas the substructure is assumed to be the same for both cases. A comparison of the EIC results is presented in Figure 7.

In terms of material consumption, the UHPdC option consumed 27% less raw material than the conventional option. In terms of environmental impact, the UHPdC technology has 20.6% less embodied energy and 19% less CO_2 emissions. In terms of the 100-year GWP, the UHPdC solution provides for a reduction of 14.5% over that of the conventional solution.

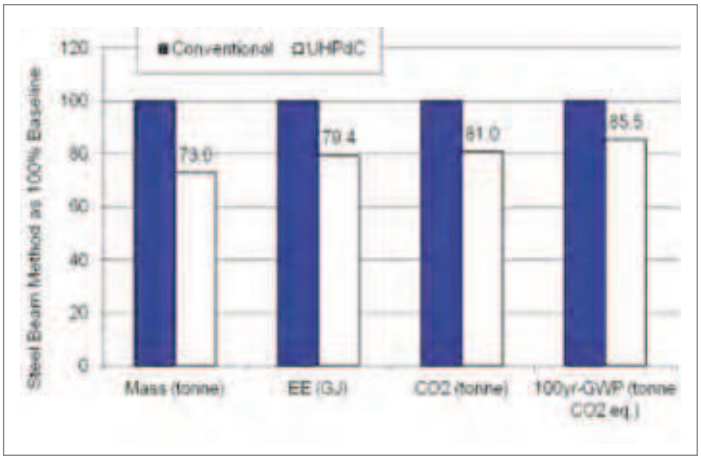

Figure 7: EIC comparison for Bridge25

It also needs recognition that in this example, only the savings at the level of the superstructure have been considered. Further savings will result from the lighter weight of the UHPdC solution requiring a smaller substructure, foundations and lighter machinery and lower transport costs.

DURABILITY DESIGN

To date, there is no single agreed or unified method in the world for obtaining a measure of the 'durability' of a concrete structure in aggressive marine conditions. However, the most commonly accepted model of service life prediction concerning the corrosion of the reinforcing bars was developed by Tuutti (1982). Figure 8 shows the schematic evolution of damage of RC structures due to steel corrosion. In this model, the service life is composed of two periods. The first is the initiation period (t_i) related to the penetration of the chlorides or carbon dioxide, i.e. the aggressive agents, until depassivation of the steel reinforcing bars and the beginning of corrosion in the bars. Second is the propagation period (t_p) where corrosion proliferates. Such a model proposes that service life is to be determined as a function of an acceptable limit of corrosion.

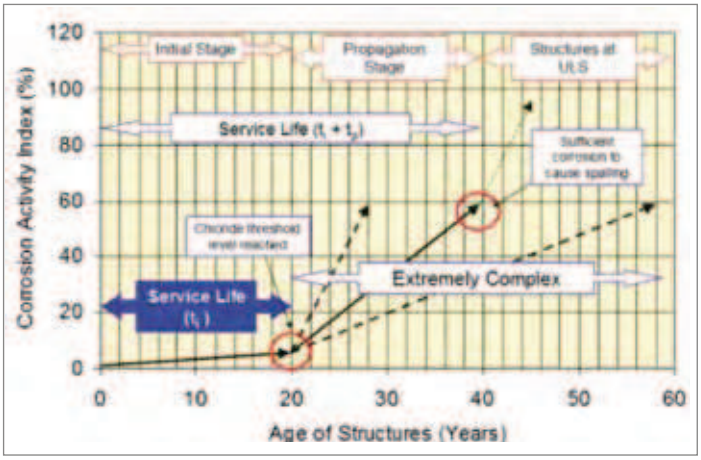

Figure 8: Corrosion model of RC structures

When modelling the initial phase, corrosion is triggered either by carbonation or when the critical corrosion-inducing chloride content is exceeded. The initial phase ends after steel depassivation and corrosion are initiated. Today, many well-tried models are available for the initial phase.

Once steel depassivation has occurred, reinforcement corrosion is dependent on the material quality and the environmental conditions, which must be taken into account in design and into consideration for structural safety.

The consequences of reinforcement corrosion in concrete include the loss of reinforcement cross-section, the development of tensile stress in concrete due to expansion caused by corrosion by-products and a change in the mechanical properties at the boundary between reinforcement and concrete.

The effects of corrosion can be divided into those concerning the reinforcement, the surrounding concrete and the bond between the concrete and the steel.

Equation 2 is the equation that expresses the process of chloride ingress from outside with the minimum number of required input parameters, where C_s is the chloride ion concentration at the exposed surface of the structure, C_x is the chloride concentration at depth X after time t, D_c is the chloride ion diffusion constant of the concrete material and *erf* is the error function (standard mathematical function).Abundant data for C_s and D_c based on this model have been obtained from many kinds of tests and surveys to estimate service life of existing structures. It would otherwise be difficult to verify the validity of the model due to the time dependent nature of the data for the various parameters such as temperature, humidity, carbonation, absorption into hydrated compounds and so on. Thus, Equation 2 is appropriate for the purposes of the comparative study in this paper.

$$C_x = C_s\left[1 - erf\left(\frac{X}{2\sqrt{D_c t_i}}\right)\right] \quad (2)$$

The results in Table 3 show that with a concrete cover of 50mm, and without intervention or any active corrosion prevention system, corrosion of the reinforcing steel in the Grade50 concrete beams will initiate after just 10.5 years. In contrast, depassivation in the UHPdC beam will not start for 154 years. So, without regular maintenance, or passive or active corrosion protection systems, many conventional concrete structures in marine environments fail at an early age.

Table 3: Durability calculation in marine environment (for air-borne salt)

Exposure	Air-borne salt	
Concrete Type	G50	UHPdC
Cement (kg/m^3)	480	720
f_{ck} (MPa)	50	150
X (mm)	50	22
C_s (kg/m^3)	6.403	6.403
C_x (kg/m^3)	1.68	2.52
D_c (mm^2/s)	3.0x10^{-6}	6.87x10^{-8}
Time (years), t_i	10.5	153.5

In comparison UHPdC structures have the potential for significant savings in maintenance costs and a longer service life, leading to sustainable solutions.

This is particularly true if the structural element is pre-compressed to avoid cracking under service conditions.

CONCLUSION

The Bridge25 project provided a unique set of challenges which afforded the Engineer an opportunity to explore the use of UHPdC technology in the design of the multiple span composite bridge for the marine environment.

In the process of design, the Engineer gained valuable exposure to the properties of the material, which imparted unique mechanical behaviour to the beams made from it. These included the high strength obtained from a 1m deep section, the generous reserve capacity after cracking and the ductility that was seen in the test results.

The various and multiple tests gave confidence to the Engineer with regard to the ability of the UHPdC beams to fulfil its role. Such confidence can only be the result of the meticulous selection of materials and careful control of the manufacturing processes.

Bridge25 has provided a live platform to compare and contrast the performance of UHPdC against conventional concrete in terms of strength, durability, material consumption, embodied energy, CO_2 content, embodied energy and global warming potential.

The experience with UHPdC has certainly left the Engineer in a much better position to tackle the questions of durability and sustainability. ■

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Datuk Ir. Kuna Sittampalam is one of the founding member and Joint Managing Director of HSS Engineering Sdn. Bhd., one of Malaysia's largest engineering consultancy companies. His academic background includes Bachelors and Masters Degrees in Civil Engineering from the University of Sheffield, UK. During this time, he won the Miller Prize from the Institute of Civil Engineers, UK.

Ir. Chen Wai Peng graduated with B.Sc (Eng) from Imperial College, University of London in 1977. He has more than 35 years of experience in design of various types of Highway Bridges, Marine Bridges, Urban Elevated Viaducts, LRT Structures, Railways Bridges and Underpasses. He is presently a Consultant with HSS Engineering Sdn. Bhd.

Ir. Dr Voo Yen Lei graduated with a PhD in Civil Engineering (Structural) from University of New South Wales (UNSW) Australia and is the founder, director and CEO of Dura Technology Sdn Bhd, which specialises in the manufacture of precast and customised concrete products made from ultra high performance ductile concrete (UHPdC). He also serves as an adjunct professor in the School of Civil Engineering at the Universiti Putra Malaysia (UPM).

Engr. Sukhvinder Singh is a Bridge/Port Engineer graduated with Masters in Civil Engineering from University of Portsmouth, UK. He has worked with organisations in construction and consulting in Malaysia. He has a total of 9 years of design and construction experience on civil and structural works mainly on ports, various types of highways and railways bridges. He is currently working with HSS Integrated Sdn. Bhd, Kuala Lumpur.

Nuclear Magnetic Resonance Probe Tuning Mechanism

by Engr. Raymond Tan Seng Loon

QUESTION:
Describe your role in the design study on nuclear magnetic resonance 7400 probe tuning mechanism using ultrasonic motor. What were the objectives, problems faced and engineering solutions derived?

INTRODUCTION

Life sciences technology is increasingly becoming crucial and extremely important in today's modern world. As people become more health-conscious, a lot of research is being carried out to explore our biological world. One of the core technologies used in scientific research is Nuclear Magnetic Resonance (NMR), the technology behind Magnetic Resonance Imaging (MRI) which is better known in medical radiology to visualise internal structures of our human body in detail.

NUCLEAR MAGNETIC RESONANCE METHODOLOGY

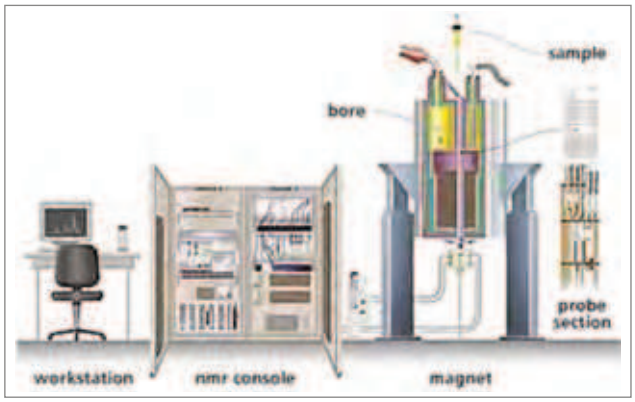

Figure 1: Agilent 400-MR NMR System [1]

NMR has nothing to do with nuclear and that is the reason it does not have the word "nuclear" in MRI. The word nuclear is because it deals with the nucleus of the atom during measurements. It is a technique used to obtain physical and chemical information of a sample based on the resonant frequency of the atomic nuclei. This approach enables us to observe and measure substances and molecules in any form. They can be solid, liquid or gas and do not have to be soluble. The test sample is inserted into the center of superconducting magnet through the bore of the probe. A computer console generates RF pulses that excite the sample's nuclear spins away from their normal state of thermal equilibrium. The changes in energy is measured and analysed. Figure 1 shows a typical Agilent 400-MR system.

CONVENTIONAL PROBE TUNER

The probe in the bore of the magnet needs to be tuned to the resonant frequency of the expecting sample for effective measurement by varying the 7 variable capacitors in the probe. The first generation probe uses a DC motor which is located 5m away from the magnet tank. It rotates the tunable capacitor's shaft underneath the magnet through a flexi rotary shaft. This solution is inefficient and expensive.

PROBE TUNER USING ULTRASONIC MOTOR

All motors operate based on the magnetic field principle. However the generic DC motor is not suitable for installing underneath the NMR magnet because the high and strong magnetic field generated by the NMR magnet will interrupt the motor operation and, in turn, the magnetic field generated by the motor's core will interfere with the NMR measurement. Therefore, a motor which does not have a magnetic core, such as an ultrasonic motor, is preferred and ideal for this application.

An ultrasonic motor, also known as piezoelectric motor, operates using the characteristics of piezoelectric ceramic. Among the common types of piezoelectric ceramic is Lead Zirconate Titanate (PZT), which is an inorganic compound with the chemical formula $Pb[Zr_xTi_{1-x}]O_3$ ($0 \leq x \leq 1$). By applying coordinated AC voltage signals to piezoelectric materials, the ceramic will deform in a manner that creates a travelling wave and a drive force as shown in Figure 1. The ceramic is clamped onto the stator and the stator friction material in place will rotates the rotor to create a rotary motion as shown in Figure 2.

Unlike conventional magnetic motors, piezoelectric motor operation is unaffected by magnetic fields in the NMR magnetic tank. Furthermore, it provides high torque at low speeds without the need for a gear reducer and it provides quick response with excellent controllability.

MOTOR DRIVING OPTIMIZATION

A driver is required to generate these 2 AC waveforms which are 90° out of phase (aka sine and cosine waves) to produce motion. Ideally, each motor is driven by its own motor driver which can be tuned to the desired driving frequency of the ceramic. The optimum driving frequency of the ceramic is

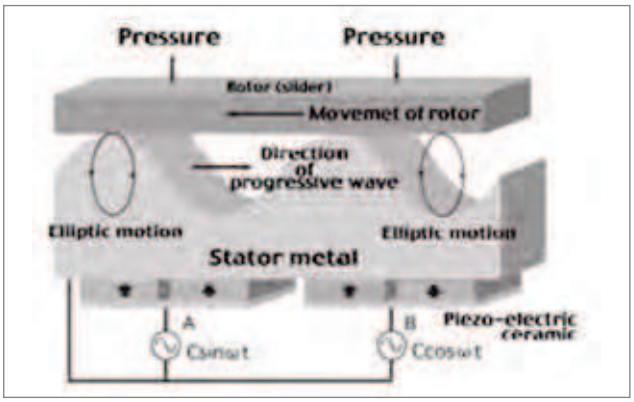

Figure 2: Mechanical motion of ultrasonic motor [2]

very close to the resonant frequency but never exactly at the resonant frequency itself. However, this solution is not very cost effective because there are 7 variable capacitors in a NMR probe which means it requires 7 motors and 7 drivers!

The major problem faced in having 7 motors driven by a single driver is that we need to find an optimum driving frequency which suits all 7 motors. In this analog world, a ceramic of the same element number may have slightly different resonant frequency. A Fluke calibrator is used to determine the optimum driving frequency by sweeping the amplitude from 110 VAC to 140 VAC and the frequency from 48 kHz to 52 kHz. Statistics show that most motors have a resonant frequency close to 49.5 kHz. Based on experiments, the motor is found to produce maximum torque at 100 rpm and 120 VAC. This corresponds to approximately 1 kHz away from the actual resonant frequency.

So what frequency do we tune the driver to? The solution is simple. The idea is to pick 7 motors with the same resonant frequencies so that they have a common value. This way, we can tune to one frequency that will suit all 7 motors!

CONCLUSION

With this probe tuning mechanism, all motors are driven at their own optimum frequency. Assuming all 7 motors in a probe tuner have the same resonant frequency degradation rate, a probe tuner is considered to malfunction only if all 7 motors fail instead of 1. This greatly lengthens the lifespan of the product. ■

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Engr. Raymond Tan Seng Loon is a Hardware Design Engineer with Agilent Technologies.

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Perodua To Collaborate With Local Universities On Vehicle Component Research

Perodua is looking into the possibility of engaging local institutions of higher learning to undertake research on its vehicle components, said its President and Chief Executive Officer Datuk Aminar Rashid Salleh.

"Perodua does not do certain tests in our own research and development facility. As such, some tests can be carried out by universities," he said after flagging off the 2013 Perodua Eco-Challenge at Shah Alam Go Cart here Saturday.

Politeknik Ungku Omar (PUO) was crowned overall champion at the Perodua Eco-Challenge which was introduced in 2009 to expose students from local institutions of higher learning to a real-world working environment. The team travelled 52.38km on 2.5 litres of Petronas Primax 95 fuel provided, and came in first place in the "Best Presenter" and "Styling" challenges.

This year, teams from nine institutions of higher learning, including PUO, Universiti Teknologi Malaysia (UTM), Universiti Teknologi Mara (UiTM) and Universiti Kebangsaan Malaysia (UKM), were given six months to redesign a Perodua Myvi with a totally different look.

(Sourced from BERNAMA, 14 December 2013)

MIDF Offers RM100,000 Emergency Loan For Disaster-hit SMEs

Malaysian Industrial Development Finance Bhd (MIDF) is offering special loans of up to RM100,000 under the SME Emergency Fund (SMEEF) to small and medium enterprises (SMEs) in the manufacturing and services sector affected by the recent floods in the country. The fund range from RM50,000 to RM100,000.

Group Managing Director Datuk Mohd Najib Abdullah said SMEs can apply for the loan if their businesses are affected not only by flood but also by other natural disasters such as storms, droughts, beach erosion or landslides, while SMEs operating in a disaster area as declared by the National Security Council need to provide evidence of the natural disaster via a district office letter or police report copy.

He said the loan, with a five-year repayment period and three per cent annual interest, is eligible for SMEs that are at least 60 per cent Malaysian-owned.

(Sourced from BERNAMA, 13 December 2013)

Subra Orders Daily Ceiling Checks

Health Minister Datuk Seri Dr S. Subramaniam has instructed Serdang Hospital and the ministry's engineering division to do a daily inspection of the hospital ceiling.

The order was issued after five incidents of collapsed ceiling slabs took place at the hospital. The latest occurred last Saturday when a hospital staff's wife and their four children were nearly hit by parts of the ceiling that fell off in a toilet at 1pm.

"If there is any element of danger, we have to remove the ceiling immediately to ensure there is no recurrence of the incident. We have started work to fortify the ceiling and to solve the condensation problem. The rectification work as well as the daily inspection will continue until I am satisfied," he said after the announcement of 10 new projects under the healthcare national key economic area (NKEA) yesterday.

Dr Subramaniam said the ministry had identified two major issues for the collapse – the support structure of the ceiling and condensation due to the hospital's air conditioning system which made the ceiling slabs heavy and detach from its frame.

(Sourced from NST, 13 December 2013)

Barakah Bags O&G Contracts For Pipelines, Equipment

Barakah Offshore Petroleum Bhd's unit has secured contracts to transport and install facilities such as pipelines and related equipment for offshore oil and gas (O&G) fields within Malaysia.

It said on Friday its unit PBJV Group Sdn Bhd (PBJV) had received letters of awards from O&G production sharing companies (PSCs) for these services from 2014 to 2016 under package A.

"The contract period is for three years from December 2013 to December 2016 with a one-year extension option," it said.

Barakah said the total value of the contract would hinge on the actual work orders issued by the PSCs during the contract period.

(Sourced from The Star, 1 December 2013)

Samsung Engineering Seals Terengganu Job

Samsung Engineering has formalised the signing of a US$770 million (RM2.5billion) contract with Petroliam Nasional Bhd (Petronas) and Hess, a United States energy company, to build a large-scale gas terminal in Terengganu.

The South Korean company on Wednesday inked the agreement with Petronas Carigali Sdn Bhd (PCSB), the exploration and production arm of Petronas, and Hess Exploration and Production Malaysia B.V, to carry out the gas terminal development project.

Samsung Engineering was represented at the signing ceremony by its chief executive officer Park Joong-heum, PCSB by its CEO Datuk Anuar Taib and Hess by its vice-president for Asia Pacific, SauuKakok.

In a statement, Samsung Engineering said the gas pre-treatment facility will be built at the Kerteh Industrial Complex in Kerteh, 260km from Kuala Lumpur. The project is expected to be completed in June 2016.

(Sourced from NST, 7 December 2013)

SAFE TEA TIME

Hot Planning

by Ir. Shum Keng Yan

HAVE you ever encountered a crisis unfolding exactly as written in your manual? Probably never. In almost all cases, you will need to carry out hot planning. Don't get me wrong: procedures and processes are necessary and, often, the list of contacts and quick checklists will come in handy during a crisis.

So how do we deal with these "unwritten crises"? Here are the simple steps:

1. Provide initial response to the trigger.
2. Determine if the trigger meets the criteria set by your organisation. *(Refer to November 2013 article).*
3. Gather the facts of the situation.
4. Conduct a situation analysis.
5. Provide an appropriate specific response to the situation.
6. Provide an update to the next level and stakeholders within an agreed interval.
7. Record decisions and actions taken.
8. Review the situation.
9. Repeat steps 3 to 8 again until you approach a crisis resolution.
10. Start the Business Continuity process. This will overlap with step 9. *(Refer to May 2013 article).*

These 10 steps will allow you to carry out systematic hot planning for any unforeseen circumstance. You may notice that almost all crisis management procedures are modelled after the 10 steps. In effect you can then reduce your manual to just the following:

1. Emergency Response (during on-set for various incidents)
2. Emergency Contacts and Communication
3. Media and Public Response
4. List of resources and contacts
5. Business Continuity

If you have any hot plan to share, you can reach me at *pub@iem.org.my*. ■

Do not get too hung up on writing procedures so thick that they only serve as decoration on your shelves or just to please auditors. Happy New Year and all the best!

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.

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Technical Visit to the Three Gorges Dam, China

WATER RESOURCES TECHNICAL DIVISION

by Ir. Dr Wong Wai Sam

THE Water Resources Technical Division (WRTD) organised a technical visit for 11 participants to the Three Gorges Dam from 23 to 27 October 2013.

The visit started with a river cruise from Yichang, heading upstream towards the Three Gorges Dam. On the way, the boat passed through Gezhou Dam, which is 38km downstream of the Three Gorges Dam.

Gezhou Dam is 2,595m long and 47m high. It has 27 gated spillways which can release discharge of up to 110,000 m^3/s and has a total installed hydropower capacity of 2,715 MW. There are three navigation locks and the No.2 lock is one of the largest lock gates in the world. The dam also has two outlet sluice gates for sand by-pass and this reduces the sedimentation problem upstream of the dam.

Along the journey, we also had the opportunity to observe various types of riverbank revetment works, hydraulic structures and bridges.

At our destination, a few technical employees of the Three Gorges Dam Corporation were assigned to provide us with presentations and information as well as a guided tour. Among these were Professor Wang for the overview of the dam and Engr. Wong for the hydropower generation.

We were briefed that the Three Gorges Project is the largest water conservancy project in the world. It is situated in the middle reaches of Yangtze River. The dam site is in Sandouping of Yichang City, Hubei Province, in the areas of Xiling Gorge, one of the three gorges of the river. The upstream catchment of the dam has an area of about 1 million km^2 and an average annual runoff of 451 billion m^3.

The Three Gorges Project consists of the dam, hydropower station and navigation buildings. The river dam is a concrete gravity dam, with the flood discharging section in the middle and the powerhouse and non-overflow section on both sides. The dam crest elevation is 185m, the maximum dam height is 181m, and the total dam axis is 2309.47m long.

Flood control is the primary function of the dam. It has significantly enhanced the flood control capacity of the Yangtze River in the middle and lower reaches. With this, the flood protection level of the Jingjiang River section has been raised from 10-year ARI (Average Recurrence Interval) to 100-year ARI. The total reservoir storage capacity is 39.3 billion m^3, of which flood control reservoir storage capacity is 22.15 billion m^3.

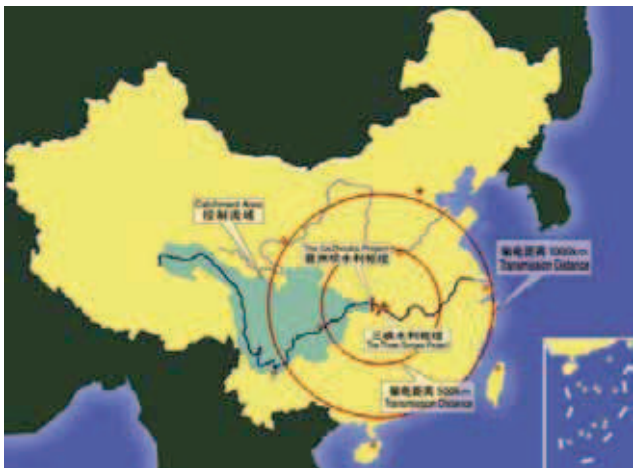
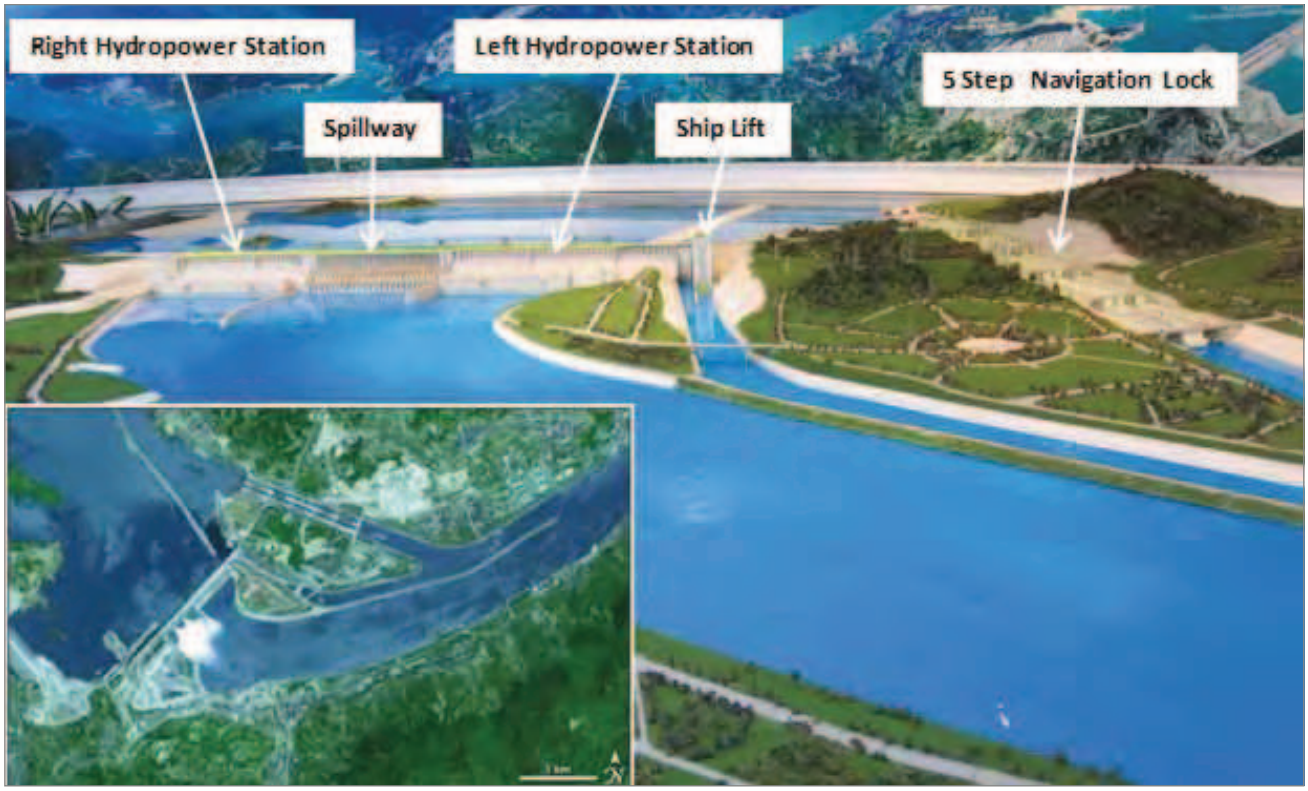


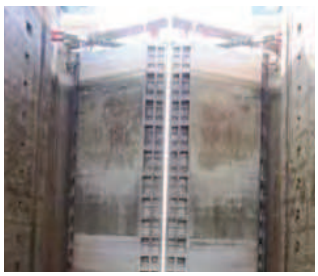
Figure 1: Location and Catchment Area of the Gezhou Dam and Three Gorges Dam



Aerial View and General View (from the Model) of the Three Gorges Dam

The Three Gorges Hydropower Plant consists of the left bank power station, the right bank power station, the right bank underground power station and the power supply station. The left and right bank power stations are located behind the dam. The left and right bank power stations are equipped with 26 sets of 700 MW hydroelectric generating units, together with 2 sets of 50 MW hydroelectric generating units. In addition, 6 sets of 700 MW hydroelectric generating units were installed later in the right bank underground power station. With these, the total installed capacity of the plant reaches 22,500 MW, with the yearly average generation capacity as much as 88.2 billion kilowatt hours, making it the world's largest hydropower station. The Plant has the maximum transmission radius of 1,000 km and the power is sent mainly to the East and Central of China, Guangdong and other areas.

The dam navigational passages have a double-line five-step ship lock and a vertical ship lift that is still under construction. Annual one-way transportation capacity is 500 million tonnes. The dam has managed to improve navigation for 660km, from Yichang City to Chongqing City upstream through inundation of rapids where, the ten-thousand-ton-rank fleet can navigate directly to Chongqing City. ■



Basic Facts and Figures of the Three Gorges Dam

Item		Unit	Dimension / Capacity
Dam type			concrete gravity dam
Top crest length		m	2309.5
Crest elevation		m	185
Total volume of reservoir		m^3	39.3 X 10^9
Flood control storage		m^3	22.15 X 10^9
Reservoir surface area		km^2	1084
Normal water level		m	175
Flood control water level		m	145
Dry season control headwater level		m	155 m
100-year ARI flood	maximum reservoir water level	m	166.9
	maximum discharge flow	m^3/s	56,700
1,000-year ARI design flood	maximum reservoir water level	m	175
	maximum discharge flow	m^3/s	69,800
Check flood (10,000-year ARI + 10%)	maximum reservoir water level	m	180.4
	maximum discharge flow	m^3/s	102,500
	maximum downstream water level	m	83.1
Power plant	maximum water head	m	113
	rated water head (left / right / underground)	m	80.6 / 85.0 / 85.0
	minimum water head	m	71
	installed capacity	MW	22,500
	number of units		32/2
	unit rated capacity	MW	700/50
	guaranteed active power output	MW	4,990
	operating hours per year	h	4,650
	guaranteed rate	%	95
	yearly average electricity generation	kWh	88.2 X 10^9
Ship lock	type		double-line five-step ship lock
	navigation capacity		ten thousand-ton flight
	dimensions of chamber	m	280 X 34 X 5
	annual one-way pass through capacity	t	50 X 10^6
Ship lift (Expected to complete in year 2015)	type		one-line one-flight vertical lift type
	maximum passing through tonnage		3000t passenger and cargo ship
	dimensions of chamber	m	120 X 18 X 3.5
	annual passing through capacity	t	3.50 X 10^6

Ir. Dr Wong Wai Sam is currently the Vice-Chairman of the IEM Water Resources Technical Division (WRTD). He is the Director of the Mega Consult Sdn Bhd consulting firm.

Report on Technical Talk on Subsea Processing and Subsea Factory Vision

by Ir. Ahmad Rafidi Mohayiddin

OIL, GAS AND MINING TECHNICAL DIVISION

THE Oil, Gas and Mining Technical Division (OGMTD) organised a technical talk by Engr. Rudisham Marjohan on the subject of 'Subsea Processing and The Subsea Factory Vision' on Saturday, 24 August, 2013. A total of 63 IEM members attended the talk at Wisma IEM, Petaling Jaya.

Figure 1: Engr. Rudisham delivering his talk

The objective of the talk was to provide an overview of the subsea processing and production technologies available today as well the advances being made to realise the vision of a 'subsea factory' to harness hydrocarbon reservoirs. Engr. Rudisham works with One Subsea, a collaboration company between Cameron and Schlumberger. He was also a past committee member of OGMTD from 2009 to 2012 and has extensive experience spanning almost 18 years, in mining and the oil and gas industry.

The vision of a 'subsea factory' is essentially to bring all the conventional hydrocarbon processing and production facilities and infrastructure that we are familiar with down to the seabed, with only umbilicals to transfer the product to shore or to a floating storage tanker above the water. Its main target is to be able to produce hydrocarbons from wells located underwater without the need to connect the wells with a riser to a host facility.

Figure 2: The audience listening attentively to the speaker

Figure 3: Presentation of token to Engr. Rudisham by Ir. Al Khairi

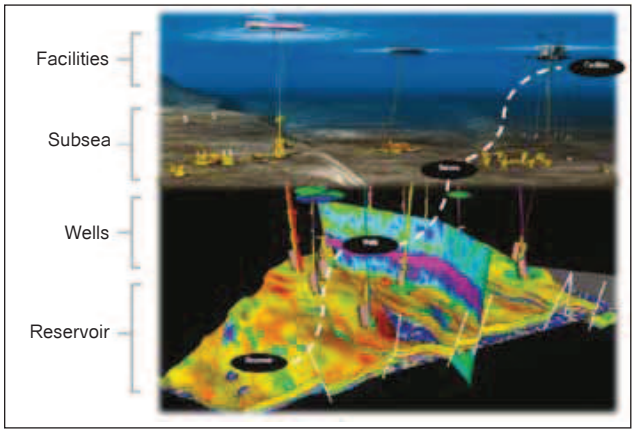


Figure 4: The Subsea System Concept

Engr. Rudisham's talk centered on the definition of the components in a subsea oil and gas development, the reason for having such infrastructure and the equipment and the tools involved in a subsea facility. In addition to the subsea development concept, he also shared with the audience some details about the typical separation and processing equipment that were already available or were being developed to suit the underwater environment such as Subsea Trees, Subsea Power System, Subsea Controls System and Subsea Processing Equipment.

He further described the technological advances in Subsea Processing Equipment which included Seabed Compression System, Seabed Pumping System and Seabed Separation System and explained the application of such systems in developments that were mostly in the North Sea area.

According to Engr. Rudisham, Norwegian oil company Statoil was the first to coin the term 'Subsea Factory' in 2012. The company is at the forefront of development of this vision and hopes to achieve it by 2020. If the vision is achieved, all hydrocarbon extracting facilities that are now above the sea level will be brought down to the seabed, leaving an unintruded view of the empty ocean. ■

Ir. Ahmad Rafidi Mohayiddin is Deputy Chairman of the Oil, Gas and Mining Technical Division of IEM for session 2012/13. He works with a public-listed gas and utilities company and is currently based in Kuala Lumpur.

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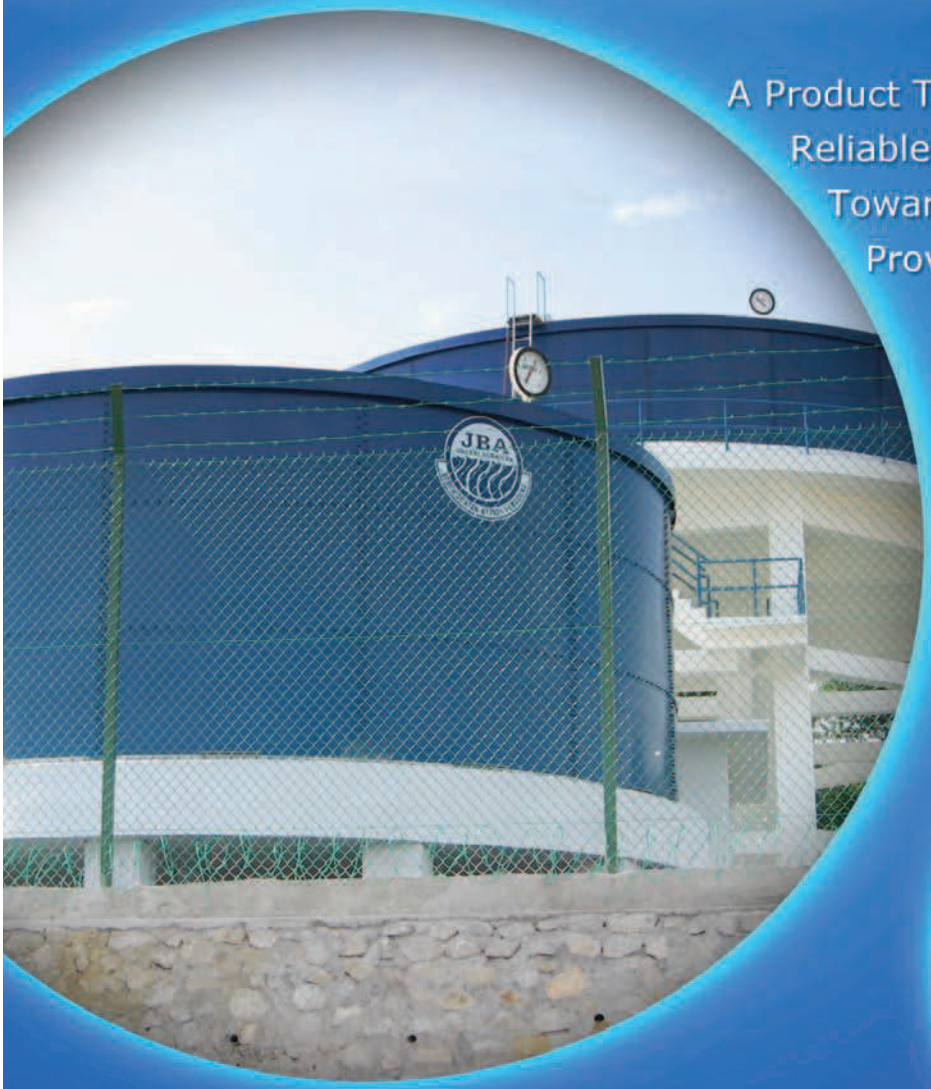

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Integrating Environmental Information in Decision Making

CHEMICAL ENGINEERING TECHNICAL DIVISION

by Ir. Prof. Dr Dominic C. Y. Foo

A technical talk on Integrating Environmental Information in Decision Making – A Petroleum Industry Practitioner's Perspective, was organised by the Chemical Engineering Technical Division (CETD), prior to the CETD annual general meeting on 5 November 2013. The talk was delivered by Ms. Lee Tzee Wan, the Environmental Management Custodian (Discipline Head) of Petronas Group. The talk attracted 84 participants including both IEM and non-IEM members.

First, Ms. Lee explained the driving factors of integrating environmental information into business decision making. She said this allows a company to be labeled as a *green operator*. Besides, getting the *Dow Jones Sustainability* Index will also help to enhance the company's reputation. In some cases, this will also allow access to funding facilities such as the World Bank. She also mentioned that it is a growing trend to address environmental conservation and sustainability in the financial reporting for many corporations.

Ms. Lee presenting her talk

CETD chairman Ir. Prof. Dr Dominic Foo presenting a token of appreciation to Ms. Lee

She next explained the various environmental management tools, such as Environmental Impact Assessment (EIA), fiscal tools, e.g. carbon tax and tax incentives (e.g. water recycling, energy conservation), Environmental Management Accounting framework, and their impacts.

In the last part of the talk, Ms. Lee talked about some key challenges that a practitioner would face in his or her job such as the different scopes and requirements of different countries for the conduct of EIA studies. As for sustainability reports, the issues to be reported and the level of details to be provided are important and have to be strategised carefully.

In conducting environmental due diligence, issues to be addressed include access to site information from the seller, and the estimation of price and liability of contaminated properties.

The talk ended with an interesting question and answer session. The chairman then presented a token of appreciation to Ms. Lee. ■

Note: Slides of the presentation are available on the blog of CETD – http://iemcetd.blogspot.com/

Ir. Professor Dr Dominic Foo is the Professor of Process Design and Integration at the University of Nottingham Malaysia Campus, and is the 2012/13 session chairman for the Chemical Engineering Technical Division (CETD). Ir. Prof. Dr Foo also serves in the editorial board of Process Safety & Environmental Protection (Transactions of the Institution of Chemical Engineers UK – IChemE), IEM Journal and Chemical Engineering Transactions.

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Sidewall Height . 3.5m - 12m and over

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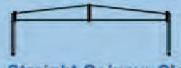
Sidewall Height . 3.5m - 12m and over

Tapered Column Clear Span (TCS) - Two Piece Rafter
Building Width . 12m - 60m
Sidewall Height . 3.5m - 12m and over

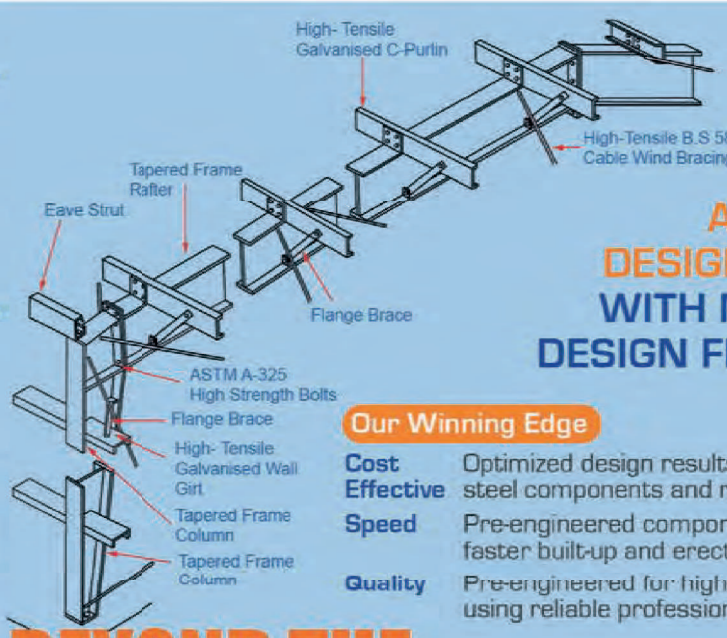
Tapered Column Clear Span (TCS) - Three Piece Rafter
Building Width . 12m - 85m
Sidewall Height . 3.5m - 12m and over

Straight Column Single Slope (SS)
Building Width . 4.5m - 22m
Sidewall Height . 3m - 9m

Straight Column Lean To (LT)
Building Width . 3m - 22m
Sidewall Height . 2.4m - 9m



Straight Column Clear Span (SCS)
Building Width . 6m - 22m
Sidewall Height . 3m - 9m



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Steeproad to ABC

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

IN November 2013, I led a group of 12 Malaysians and 1 Australian to Nepal to trek up the Himalayas. We had chosen to do the 10-day ABC Trek, also known as the Annapurna Sanctuary Trek. It was my 4th trekking trip to Nepal.

Because our visit coincided with Nepal's 2nd general elections, we had to start our trek on 18 November as the following day was polling day and all public transport was halted. On that day we travelled 7 hours in a so-called "tourist bus" from Kathmandu to Pokhara, and then for almost 2 hours more in the same bus to a village called Nayapul, 41km away. From Nayapul, we started our trek and 45 minutes later, we were in Birethanti where we put up the night.

It took us 2 days to reach Ghorepani. We covered a distance of 16km, gained 1,530m in height and climbed 3,421 stone steps up a steep mountain side. The main attraction in Ghorepani is a 3,190m high peak known as Poon Hill, an hour's trek away. There, one is rewarded for the effort with a spectacular panorama of snow-capped peaks of both Daulagiri and Annapurna ranges, including Daulagiri 1 (8,167m, 7th highest peak in the world), Annapurna 1 (8.091m, 10th highest) and the famous Fish Tail.

Two days later, we were in Chomrong, back on the main trail to ABC. Chomrong is 18.5km from Ghorepani but is 580m lower, at 2,170m asl. We stopped at Tadapani on the way.

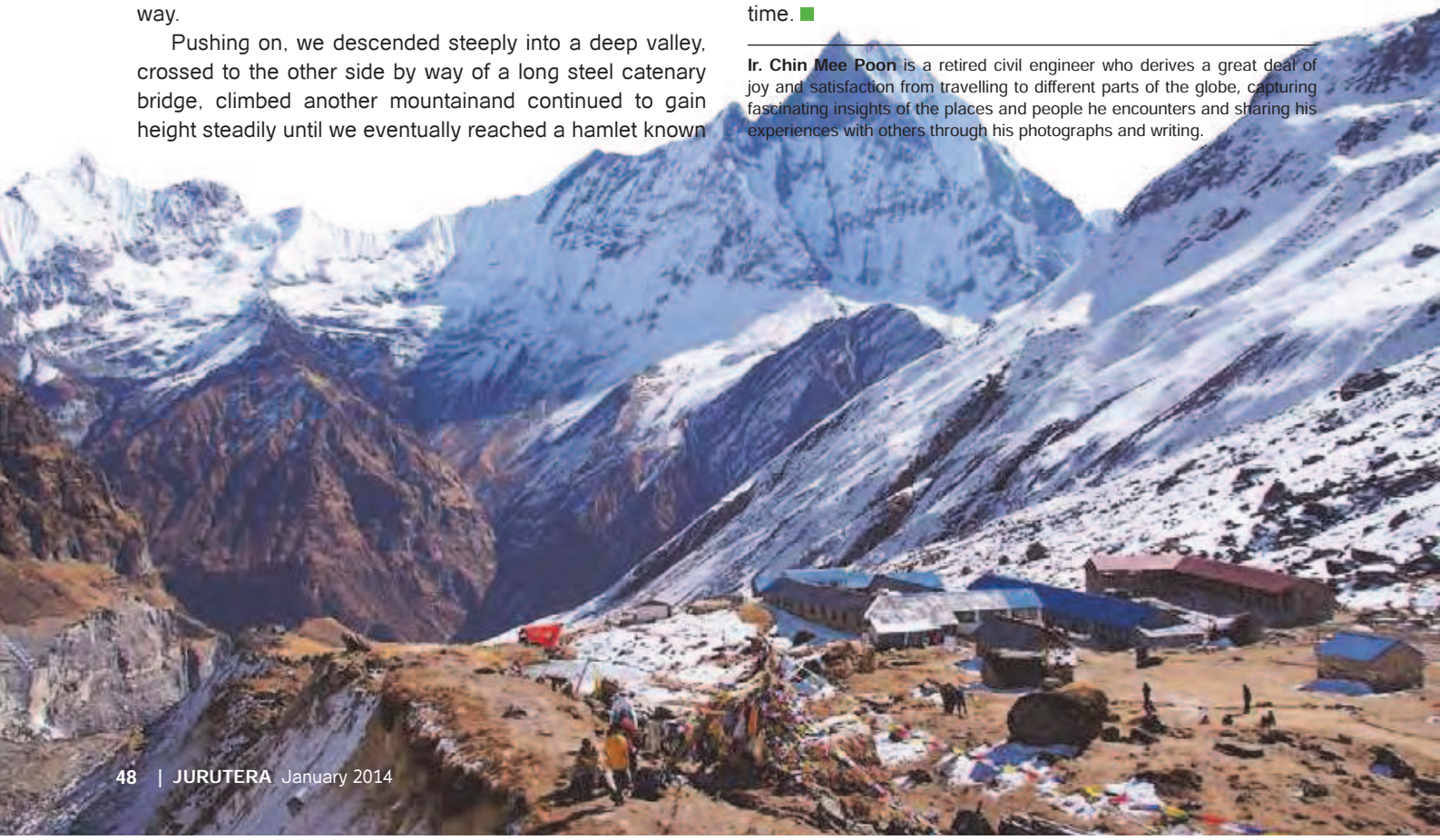
Pushing on, we descended steeply into a deep valley, crossed to the other side by way of a long steel catenary bridge, climbed another mountainand continued to gain height steadily until we eventually reached a hamlet known as Himalaya, some 13km from Chomrong. It was a long day and we actually completed the last section of our trek in a forest after dark.

Himalaya, at 2,900m asl and situated beside the mighty Modi Khola RIiver, had only two guest houses next to each other and nothing else. From there it was a steady climb to MBC (Machhapuchhre Base Camp) at 3,700m asl and 7.5km away. It had taken us 7 days to get this far from Nayapul.

On the 8th day, we finally reached ABC (Annapurna Base Camp, 4,130m asl) in the morning. It was 3.5km away from MBC. The views of surrounding snowy peaks from both MBC and ABC were simply awe inspiring. We spent 2 hours in ABC to enjoy the views before we started to back-track and descend. We put up in Deurali and Sinuwa on the way to Chomrong, where we followed a more direct route (about 20km) to the main road, spent the night again at Landruk before getting back to Pokhara on the 11th day.

Our 10-day ABC Trek had actually taken us more than 10 days to complete. Although we only managed to reach a maximum height that was only slightly higher than Mt. Kinabalu, the many steep climbs we had to do took their toll on me. I was beginning to feel the strain. Perhaps age was catching up on me. Nevertheless, the trek was an exhilarating experience that I will cherish for a long, long time. ■

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.



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Berikut adalah senarai calon yang layak untuk menduduki Temuduga Profesional bagi tahun 2014.

Mengikut Undang-Undang Kecil IEM, Seksyen 3.9, nama-nama seperti tersenarai berikut diterbitkan sebagai calon-calon yang layak untuk menjadi Ahli Institusi, dengan syarat bahawa mereka lulus Temuduga Profesional tahun 2014.

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CONGRATULATIONS

The IEM would like to congratulate **Datuk Ir. Stanley Yap Koon Teck** for being conferred Darjah Pangkuan Seri Melaka (D.P.S.M.) which carries the title "Datuk" in conjunction with the 74th birthday of Yang Di-Pertua Negeri Melaka, Tuan Yang Terutama Tun Datuk Seri Utama Mohd. Khalil bin Yaakob on 13 October 2012.

Editorial Board, IEM

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Institusi mengucapkan terima kasih kepada semua yang telah memberikan sumbangan kepada tabung Bangunan Wisma IEM. Ahli-ahli IEM dan pembaca yang ingin memberikan sumbangan boleh berbuat demikian dengan memuat turun borang di laman web IEM *http://www.myiem.org.my* atau menghubungi secretariat di +603-7968 4001/5518 untuk maklumat lanjut. Senarai penyumbang untuk bulan November 2013 adalah seperti jadual di bawah.

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10	09010	LEONG SANG KHIM
11	06158	MD. NUJID BIN ISMAIL
12	41165	MOHD ASHMAWI BIN BAHARUDDIN
13	18171	NG BOON KIAT
14	21285	NG WENG LIANG
15	21349	OOI SU LOONG
16	27992	PATRICK TUIN
17	36363	ROSIDISYAM BIN SAMSUDIN
18	29614	SYED MUHAMMAD AFDHAL BIN S AHMAD GHAZALI
19	49687	SYED RAJAH HUSSAIN SHAIB BIN A.H. MOHD HANIFF
20	15194	TAN CHUAN HO
21	36838	TE CHOON CHIAM
22	18174	THAM KIN YON
23	10526	TIEW CHENG TAI
24	17478	WAN LATIF BIN WAN ABD RAHMAN
25	41154	YU SENG CHIANG
26	18364	IBRAHIM BIN HUSSEIN
27	07442	MUHAMAD FUAD BIN ABDULLAH @ YEOH KEAT HIAN
28	54313	ZULKIFLLE BIN LEMAN

KEAHLIAN

PEMINDAHAN KEPADA AHLI SISWAZAH

KEJURUTERAAN AWAM

No. Ahli	Nama	Kelayakan
51845	ABDUL MUIZ BIN ROSLAN	B.E.HONS.(UTHM) (CIVIL, 2013)
52852	ABDUL MUTHALIB BIN ABDUL KADIR	B.E.HONS.(UTHM) (CIVIL, 2013)
32815	AHMAD KUSYAIRI BIN OMAR	B.E.HONS.(UiTM) (CIVIL, 2009)
52642	AHMAD SHAHRIN BIN JAMALLUDDIN	B.E.HONS.(UTHM) (CIVIL, 2013)
51861	AIZUDDIN BIN MOHD	B.E.HONS.(UTHM) (CIVIL, 2013)
58201	ALSAD BIN NASRULLAH	B.E.HONS.(UTHM) (CIVIL, 2013)
20592	AMRAN BIN AB. GHANI	B.SC.HONS.(UTM) (CIVIL, 2001) M.EDU.(UTM) (TECHNICAL, 2002)
52605	ASYRAF BIN ANUDAI @ ANUAR	B.E.HONS.(UTHM) (CIVIL, 2013)
47878	CHAN MANG FEI	B.E.HONS.(UTHM) (CIVIL, 2013)
50239	CHEAH MUI YEONG, LILIAN	B.E.HONS.(UMP) (CIVIL, 2012)
52845	CHEAH SHENG HONG	B.E.HONS.(UTHM) (CIVIL, 2013)
47892	CHNG HAN LEONG	B.E.HONS.(UTHM) (CIVIL, 2013)
47882	CHONG CHUI TENG	B.E.HONS.(UTHM) (CIVIL, 2013)
34590	CHONG LUN SZE	B.E.HONS.(UPM) (CIVIL, 2012)
33408	DAYANG NUR FATTHANAH BINTI AMRAN	B.E.HONS.(UiTM) (CIVIL, 2008)
38095	FAHRUL ROHMAN BIN AHMAD	B.E.HONS.(UTM) (CIVIL, 2009)
47271	FARIHAH BINTI MOHD AZIZAN	B.E.HONS.(UKM)
52610	FARRAH WAHIDA BINTI ROSLAN	B.E.HONS.(UTHM) (CIVIL, 2013)
53076	FATIMAH FATIHAH BTE MD YUSUF	B.E.HONS.(UTHM) (CIVIL, 2013)
47858	HANIM BTE ZAKARIA	B.E.HONS.(UTHM) (CIVIL, 2013)
52822	IZAIDAH BINTI ISMAIL	B.E.HONS.(UTHM) (CIVIL, 2013)
50779	JAIMEY ATTAU	B.E.HONS.(UTHM) (CIVIL, 2012)
56655	KHAIRUL ANAM BIN MA HUSSAIN	B.E.HONS.(UTHM) (CIVIL & ENVIRONMENTAL, 2013)
52645	KHAIRUL AZMAN BIN MOHAMED	B.E.HONS.(UTHM) (CIVIL, 2013)
51577	LEE CHOON KUAN	B.E.HONS.(UTAR) (CIVIL, 2013)
47856	LEE SIM YEE	B.E.HONS.(UTHM) (CIVIL, 2013)
41578	LEONG TIEN CHEW	B.E.HONS.(UTHM) (CIVIL, 2011)
51827	LIEW JIUN YUNG	B.E.HONS.(UTHM) (CIVIL, 2013)
51825	LIM JUIN KHYE	B.E.HONS.(UTHM) (CIVIL, 2013)
32027	LING NIENG CHEN, EVIAN	B.E.HONS.(USM) (CIVIL, 2011)
35933	LOW ENG TONG	B.E.HONS.(UTM) (CIVIL, 2012)
44229	MD DAUD BIN MILI @ HASSIM	B.E.HONS.(UiTM) (CIVIL, 2011)
47869	MELISSA LENA ANAK SHAK SHANG	B.E.HONS.(UTHM) (CIVIL, 2013)
47859	MEOR SYAZWAN MEOR HAMDAN	B.E.HONS.(UTHM) (CIVIL, 2013)
52602	MOHAMAD KHAIRANI BIN YUB	B.E.HONS.(UTHM) (CIVIL, 2013)
33217	MOHAMMAD FIRDOUS BIN HAIRY	B.E.HONS.(UiTM) (CIVIL, 2010)
52644	MOHD ADIP MOHD FUAD	B.E.HONS.(UTHM) (CIVIL, 2013)
52657	MOHD AKHIMULLAH BIN YAZAID	B.E.HONS.(UTHM) (CIVIL, 2013)
52641	MOHD ALIAS BIN MOHD NOOR	B.E.HONS.(UTHM) (CIVIL, 2013)
52633	MOHD FAIZ BIN MOHD YAHAYA	B.E.HONS.(UTHM) (CIVIL & ENVIRONMENTAL, 2013)
52289	MOHD FARIS BIN ABDUL MUIN	B.E.HONS.(KLIUC) (CIVIL, 2013)
51847	MOHD NOOR IZWAN B KHALID	B.E.HONS.(UTHM) (CIVIL, 2013)
52636	MOHD RAIMI BIN AZHAR	B.E.HONS.(UTHM) (CIVIL, 2013)
54390	MOHD SAHLAN BIN AWANG AB. GHANI	B.E.HONS.(UTHM) (CIVIL, 2013)
47849	MOO XIAO MIN	B.E.HONS.(USM) (CIVIL, 2012)
47021	MUHAM ZAINI BIN HAMZAH	B.E.HONS.(UiTM) (CIVIL, 2013)
52658	MUHAMAD FAIZ BIN ZULKIFLY	B.E.HONS.(UTHM) (CIVIL, 2013)
52626	MUHAMAD NAIM BIN ABDUL HAMID	B.E.HONS.(UTHM) (CIVIL, 2013)
52614	MUHAMMAD HARITH BIN HALIM	B.E.HONS.(UTHM) (CIVIL & ENVIRONMENTAL, 2013)
52607	MUHAMMAD SYAFIQ BIN TARMIZI	B.E.HONS.(UTHM) (CIVIL, 2013)
38096	NIK YUSNIDA BINTI NIK YUSOFF @ NIK HASSAN	B.E.HONS.(UKM) (CIVIL & ENVIRONMENTAL, 2009)
47035	NIRESH KUMAR A/L SOMASUNDRAM	B.E.HONS.(CARDIFF) (CIVIL, 2011) M.SC. (CARDIFF) (CIVIL, 2013)
41616	NOEL BIN WILL	B.E.HONS.(UTHM) (CIVIL, 2012)
51866	NOOR ADILA BINTI OMAR	B.E.HONS.(UTHM) (CIVIL, 2013)
52632	NOOR AINITA BINTI MOHD BAKRI	B.E.HONS.(UTHM) (CIVIL, 2013)
52604	NOORASYIDAH BINTI ABDUL RASID	B.E.HONS.(UTHM) (CIVIL & ENVIRONMENTAL, 2013)
52859	NOORLIATUL ASIQIN BINTI MGAT MEZE	B.E.HONS.(UTHM) (CIVIL, 2013)
52865	NORANIZA BT AHMAD	B.E.HONS.(UTHM) (CIVIL, 2013)
52827	NORLIZA BINTI MOHAMED RAFIH	B.E.HONS.(UTHM) (CIVIL, 2013)
52628	NUR FASIHAH MOHD NASIR	B.E.HONS.(UTHM) (CIVIL, 2013)
52663	NUR FATIHAH BINTI MAT SAAD	B.E.HONS.(UTHM) (CIVIL, 2013)
52874	NUR HAYATI BINTI ZAINUDDIN	B.E.HONS.(UTHM) (CIVIL, 2013)
52651	NUR HIDAYAH BINTI IBRAHIM	B.E.HONS.(UTHM) (CIVIL, 2013)
52634	NUR HIDAYAH BINTI ZUNAIDI	B.E.HONS.(UTHM) (CIVIL, 2013)
52624	NUR HIDAYU BINTI MOH ZAHARI	B.E.HONS.(UTHM) (CIVIL, 2013)
50787	NUR SHAZWANI BINTI MOHAMED NASIR	B.E.HONS.(UTHM) (CIVIL & ENVIRONMENTAL, 2013)
37088	NURBAIZURA BINTI OTHMAN	B.E.HONS.(UTHM) (CIVIL, 2011)
52661	NURUL AIN BINTI ABDUL AZIZ	B.E.HONS.(UTHM) (CIVIL, 2013)
52878	NURUL ESLYNDA BINTI ROSLAN	B.E.HONS.(UTHM) (CIVIL, 2013)
52640	NURUL FAEZAH BINTI NORDIN	B.E.HONS.(UTHM) (CIVIL, 2013)
32039	NURUL SYAHIDDATINA BINTI MOHD ALI	B.E.HONS.(USM) (CIVIL, 2011)
50050	NURUL SYAZWANI BINTI YUSOFF	B.E.HONS.(UNITEN) (CIVIL, 2012)
45635	ONG CHONG YONG	B.E.HONS.(USM) (CIVIL, 2012)
51862	PUN KOK HOE	B.E.HONS.(UTHM) (CIVIL, 2013)
51853	RAJIV SHAH PILLAI	B.E.HONS.(UTHM) (CIVIL, 2013)
52609	SARMILAH ALAGASAMY	B.E.HONS.(UTHM) (CIVIL, 2013)
52856	SHAFINA BINTI MOKHATAR	B.E.HONS.(UTHM) (CIVIL, 2013)
58857	SITI AZAHAIRANI BINTI RAZALI	B.E.HONS.(UTHM) (CIVIL, 2013)
52618	SITI HAJAR BINTI AHMAD BAHARI	B.E.HONS.(UTHM) (CIVIL, 2013)
52864	SITI KHADIJAH BINTI RIFIN	B.E.HONS.(UTHM) (CIVIL, 2013)
52863	SITI MUNIRAH BINTI HORIEDIN	B.E.HONS.(UTHM) (CIVIL, 2013)
52866	SITI NUR IZWANI BINTI MANSOR	B.E.HONS.(UTHM) (CIVIL & ENVIRONMENTAL, 2013)
43305	SOLOMON SULIS	B.E.HONS.(UMS) (CIVIL, 2012)
52837	SURIATI BINTI ABU BAKAR	B.E.HONS.(UTHM) (CIVIL, 2013)
51820	SYIDA SYAHIRA BINTI MOHD YUSOFF	B.E.HONS.(UTHM) (CIVIL, 2013)
52652	SYUKRI BIN MUHAMMAD NOR	B.E.HONS.(UTHM) (CIVIL, 2013)
57216	TENGKU LIYANA BINTI TENGKU MOHAMED	B.E.HONS.(UTHM) (CIVIL,2013)
47898	WONG KOK LEONG	B.E.HONS.(UTHM) (CIVIL, 2013)
52578	YEW WAN TIAN	B.E.HONS.(UTHM) (CIVIL, 2013)
52867	YOW JIA WEN	B.E.HONS.(UTHM) (CIVIL, 2013)
53873	ZURIDAH BTE ITHSAN	B.E.HONS.(UTHM) (CIVIL, 2013)

KEJURUTERAAN ELEKTRIKAL

48653	AINAL MARDIAH BINTI MOHD YUSOFF	B.E.HONS.(UTHM) (ELECTRICAL POWER, 2013)
48756	FARISZUAN BIN YUSOF	B.E.HONS.(UTHM) (ELECTRICAL, 2013)
17468	LEE SEE FUNG	E.C. PART I & II (2005)
48691	MOHD AIDIL BIN ARDI	B.E.HONS.(UTHM) (ELECTRICAL, 2011)
58263	MOHD ZULHILMI BIN AHMAD	B.E.HONS.(UTHM) (ELECTRICAL, 2013)
58265	MUHAMAD AZMI BIN MAKHTAR	B.E.HONS.(UTHM) (ELECTRICAL, 2013)
48815	NOR AKMAL BINTI ALIAS	B.E.HONS.(UTHM) (ELECTRICAL, 2012)
48751	NORLIZA BINTI OTHMAN	B.E.HONS.(UTHM) (ELECTRICAL, 2013)
48679	NUR ATHIRAH BINTI THAZALI	B.E.HONS.(UTHM) (ELECTRICAL, 2011)
51870	NUR HASLIZA BINTI JAMALUDIN	B.E.HONS.(UTHM) (ELECTRICAL, 2013)
48714	NURFAKHIRAH BINTI ISMAIL	B.E.HONS.(UTHM) (ELECTRICAL, 2012)
36402	NURUL IZZATI BINTI PANDAK JABO	B.E.HONS.(UMP) (ELECTRICAL-ELECTRONICS, 2009) M.E.HONS.(UTHM) (ELECTRICAL, 2013)
48769	SHAZANEE BINTI SHAHROM	B.E.HONS.(UTHM) (ELEELCTRICAL & ELECTRONICS, 2011) M.E.HON.(UTHM) (ELECTRICAL, 2013)
48799	SYAHIRA RAIHAN BINTI OON	B.E.HONS.(UTHM) (ELECTRICAL, 2011) M.E.HONS.(UTHM) (ELECTRICAL, 2013)
48837	UMMU UMAIRAH BTE MOHAMAD ALI	B.E.HONS.(UTHM) (ELECTRICAL & ELECTRONICS, 2011) M.E.HONS.(UTHM) (ELECTRICAL, 2013)
48834	YUSUF ABDI FARAH	B.E.HONS.(UTHM) (ELECTRICAL & ELECTRONIC, 2013)
48602	ZANARIAH BINTI MOHD AMIR	B.E.HONS.(UTHM) (ELECTRICAL, 2013)

KEJURUTERAAN ELEKTRONIK

48765	ABDULWALI ABDULRAHMAN SHEIKH OSMAN	B.E.HONS.(UTHM) (ELECTRICAL & ELECTRONIC, 2013)
26079	CHONG KEY CHUN	B.E.HONS.(UTAR) (ELECTRONIC, 2008)
48622	ELANG KUMARAN A/L SUPPIAH	B.E.HONS.(UTHM) (ELECTRICAL & ELECTRONIC, 2013)
38832	HENG MENG KHEN	B.E.HONS.(MMU) (ELECTRONIC-NANOTECHNOLOGY, 2013)
48829	JAMAL MUHIYADIN SH-ALI	B.E.HONS.(UTHM) (ELECTRICAL, 2013)
21440	MOHD BAHARUDDIN BIN TAJUDIN	B.E.HONS.(MMU) (ELECTRONIC, 2005)

KEJURUTERAAN MEKANIKAL

35766	CHAN YOON TIM	B.E.HONS.(UTM) (MECHANICAL, 2010)
26051	CHE WAN MOHD NOOR BIN CHE WAN OTHMAN	B.E.HONS.(UTM) (MECHANICAL-MARINE TECHNOLOGY, 2007) M.E.(UTM)(MECHANICAL-MARINE TECHNOLOGY, 2009)
51805	CHEW KAR JUN	B.E.HONS.(UTHM) (MECHANICAL, 2013)
48552	HOW HAN LEONG	M.E.HONS.(NOTTINGHAM) (MECHANICAL, 2013)
32357	KHAIRUL FAIZAL BIN KUSHIAR	B.E.HONS.(UiTM) (MECHANICAL, 2009)
53448	LIM CHUI SENG, EDWIN	B.E.HONS.(UTAR) (MECHANICAL, 2013)
50786	MOHD AJMAL BIN ISHAK	B.E.HONS.(UiTM) (MECHANICAL, 2012)
22786	MOHD SYAIFULLAH BIN MOHD AZALI	B.E.HONS.(UiTM) (MECHANICAL, 2005)
31830	MOHD SYAKIRIN BIN RUSDI	B.E.HONS.(USM) (MECHANICAL, 2011)
37582	NG SEE KIAT	B.E.HONS.(SHEFFIELD) (MECHANICAL & MANUFACTURING SYSTEM, 2007) M.E.(UTM) (MECHANICAL, 2013)
37585	NG YEN CHEONG	B.E.HONS.(SHEFFIELD) (MECHANICAL & MANUFACTURING SYSTEM, 2007) M.E.(UTM) (MECHANICAL, 2013)
30772	NURUL FARHANA BINTI MOHD YUSOF	B.E.HONS.(UTM) (MECHANICAL-MATERIALS, 2008) M.SC. (USM)(MECHANICAL,2012)
28626	ROSMAN BIN JALIL	B.E.HONS.(UiTM) (MECHANICAL, 2011)
34987	ROZHAZFARYNA BINTI ROZELI	B.E.HONS.(UiTM) (MECHANICAL, 2011)
49198	SIVA PERUMAL KONAR A/L JAGATHISEN	B.E.HONS.(UNITEN) (MECHANICAL, 2013)
35033	TAJUL AFIQ BIN TAJUL ARUS	B.E.HONS.(UiTM) (MECHANICAL, 2012)
45056	TEH HOOI MENG, TERRENCE	M.E.(NOTTNGHAM) (MECHANICAL, 2013)
42108	YOON CHI YANG	B.E.HONS.(MALAYA) (MECHANICAL, 2012)

KEJURUTERAAN MEKATRONIK

37693	YAP CHOON KIAT	B.E.HONS.(UTAR) (MECHATRONIC, 2012)

KEJURUTERAAN PEMBUATAN

49344	LAM XIAN PAUL	B.E.HONS.(UTAR) (MATERIALS & MANUFACTURING, 2012)

PERMOHONAN MENJADI AHLI SISWAZAH

No. Ahli	Nama	Kelayakan
KEJURUTERAAN AEROANGKASA		
61992	AMIE NORFREEDA BINTI AMIR	B.E.HONS.(USM) (AEROSPACE,2010) M.SC.(USM) (MECHANICAL,2013)
61994	NOR FADILAH BTE SHAMSUDIN	B.E.HONS.(UIAM) (AEROSPACE,2011)
61935	NORILMI AMILIA BINTI ISMAIL	B.E.HONS.(USM) (AEROSPACE,2004)
61993	NUR HAFZAREEN BINTI MD. HANAFIAH	B.E.HONS.(UIAM) (AEROSPACE,2011)
KEJURUTERAAN AWAM		
0	ABDUL HAKIM BIN GHAZALI	B.E.HONS.(UTHM) (CIVIL,2013)
0	ABDUL HAKIM BIN HASHIM	B.E.HONS.(UTHM) (CIVIL,2013)
0	ABDUL HALIM BIN KHAMIS	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	ABDUL MUJIB BIN MOHAMAD HAFIZ	B.E.HONS.(UTHM) (CIVIL,2013)
0	ABDUL RAHMAN BIN MOHD GHAZALI	B.E.HONS.(UTHM) (CIVIL,2013)
0	ABDUL RAZIF BIN ABD MUTHALIB	B.E.HONS.(UTHM) (CIVIL,2013)
0	ADELINE AHYUN	B.E.HONS.(KUiTTHO) (CIVIL,2005) M.E.(UTHM)(CIVIL,2013)
0	ADI HIZAMI BIN MOHAMMAD TAMIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	ADIBAH BINTI MOHAMED YUNUS	B.E.HONS.(UTHM) (CIVIL,2013)
0	AFIQAH BINTI ZAHRIMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	AHMAD FARHAN BIN R RAZAAMI	B.E.HONS.(UTHM) (CIVIL,2013)
0	AHMAD FAUZI BIN SHAHARUDDIN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	AHMAD FIRDAUS BIN HUSSAIN	B.E.HONS.(UTHM) (CIVIL,2013)
62003	AHMAD NAZRI BIN YAHAYA	B.E.HONS.(UiTM) (CIVIL,2009)
0	AHMAD RITHAUDIN BIN EMBONG	B.E.HONS.(UTHM) (CIVIL,2013)
61997	AHMAD RUSDI BIN KAMAL	B.E.HONS.(UTM) (CIVIL,2007)
0	AHMAD SYAIFUDDIN BIN MOHD SABRI	B.E.HONS.(UTHM) (CIVIL,2013)
61898	AHMAD ZAHARUDDIN BIN KAMARUDIN	B.E.HONS.(UTM) (CIVIL,2002)
0	AINI FIRDAUSYAH BT MOHD BAHERI	B.E.HONS.(UTHM) (CIVIL,2013)
0	AKMAL SHAFIQ BIN MOHD BAHKRI	B.E.HONS.(UTHM) (CIVIL,2013)
0	AL-AISYAH BINTI IBRAHIM	B.E.HONS.(UTHM) (CIVIL,2013)
61894	ALDRO SOPIOH	B.E.HONS.(UMS) (CIVIL,2010)
0	ALFFIAN ROBERT	B.E.HONS.(UTHM) (CIVIL,2013)
0	ALIALISANAH BINTI ABD LATIF	B.E.HONS.(UTHM) (CIVIL,2013)
0	ALICE P'NG QIN EN	B.E.HONS.(UTHM) (CIVIL,2013)
0	AMALINA BINTI ABD MUTALIB	B.E.HONS.(UTHM) (CIVIL,2013)
0	AMIRAH SILMI BINTI AHMAD SHAKRI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
62049	AMMINUDIN BIN AB LATIF	B.E.HONS.(UTM) (CIVIL,2008) M.E.(UTM) (CIVIL-TRANSPORTATION & HIGHWAY,2009)
0	ANIS AMIRAH BINTI MUHD SUBERI	B.E.HONS.(UTHM) (CIVIL,2013)
0	ANIS AYUNI BINTI SUIED	B.E.HONS.(UTHM) (CIVIL,2013)
0	ANIS SHAFINI BINTI ABDULLAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	ANIZAEMIRA BINTI ISMAIL	B.E.HONS.(UTHM) (CIVIL,2013)
61985	ARNIE RYZIANNA BINTI ZOHARI	B.E.HONS.(UMS) (CIVIL,2007)
0	ASMARINI BINTI ABDUL RAHMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	ATIKAH BINTI ARIPIN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
61951	AUGUSTINE ANAK KUDI	B.E.HONS.(ITM) (CIVIL,1999)
0	AZI ZATIKA BINTI PUADE	B.E.HONS.(UTHM) (CIVIL,2013)
0	AZIEZAN BIN AKMURULLA	B.E.HONS.(UTHM) (CIVIL,2013)
0	AZIZI BIN HASSAN BASRI	B.E.HONS.(UTHM) (CIVIL,2013)
0	AZURAIDA BINTI AHMAD SABRI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	BIBI AISHAH BINTI BAHAROM	B.E.HONS.(UTHM) (CIVIL,2013)
0	CARLO DULLI	B.E.HONS.(UTHM) (CIVIL,2013)
61929	CHAN KWONG CHALL	B.E.HONS.(KLIUC) (CIVIL,2009)
0	CHAN TIC SHEN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	CHE KU HAFIZAH BINTI CHE KU YAHAYA	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	CHE KU NUR ZAIDATU BINTI CHE KU ZAINAL	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	CHE NOR SYAHIDA BT CHE RAHIM	B.E.HONS.(UTHM) (CIVIL,2013)
0	CHIN KIAN SENG	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
61999	CHIN SIEW CHOO	B.E.HONS.(UTP) (CIVIL,2006)
61975	CHONG HUI SZE	B.E.HONS.(MALAYA) (CIVIL,2012)
64594	CHOONG PAK LIM	B.E.HONS.(UTM)(CIVIL, 2011)
61932	CHUA CHIEN MING	B.E.HONS.(KINGSTON) (CIVIL,2011) M.SC.(SURREY) (STRUCTURAL,2013)
61945	DOMINCIE ANAK WINSTON BALE	B.E.HONS.(UNIMAS) (CIVIL,2006)
0	DZULKARNINE BIN ABDUL GHANI	B.E.HONS.(UTHM) (CIVIL,2013)
61966	EIMAN SHAHIRAN BIN ELLIAS	B.E.(SYDNEY)(CIVIL,2013)
0	ELISA AZRA BT ZULKEPLI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	EMILIA SYAIFUZA BT.ABD HALIM	B.E.HONS.(UTHM) (CIVIL,2013)
0	FARAH SOFHIA BT MOHD ZIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	FATIMAH BT BELUHI @ ALWIE	B.E.HONS.(UTHM) (CIVIL,2013)
0	FAUZIAH BINTI MOHD ABDUL WAHID	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	FAZHERAWATI BINTI NORDIN	B.E.HONS.(UTHM) (CIVIL,2013)
64546	GOH LI PHIN	B.E.HONS.(CURTIN)(CIVIL & CONSTRUCTION, 2009)
61920	GOH POI HUNG	B.E.HONS.(UNIMAS) (CIVIL,2009)
62154	GOH WEN ZHONG	M.E. & B.E.HONS. (LEEDS)(CIVIL & STRUCTURAL,2012)
0	HAFIZ BIN MOHD KHANAFI	B.E.HONS.(KUiTTHO) (CIVIL,205) M.E.(UTHM)(CIVIL,2013)
0	HAFIZAH ASMAA BINTI MOHAMAD HALMI	B.E.HONS.(UTHM) (CIVIL,2013)
0	HALIMATUN AKMAR BINTI NASURUDDIN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	HALINA BINTI HAMID	M.E.HONS.(UTHM) (CIVIL,2013)
0	HAMNEE BINTI MOD ZAIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	HARISHANKAR A/L RAJASEKARAN	B.E.HONS.(UTHM) (CIVIL,2013)
62057	HARTINI BINTI KASMIN	B.E.HONS.(UTM) (CIVIL,1999)
0	HAZWANI BT MOHD GHAZALI	B.E.HONS.(UTHM) (CIVIL,2013)
0	HELMIUKASYAH B. MOHAMED	B.E.HONS.(UTHM) (CIVIL,2013)
61924	HENG INN CHEN	B.E.HONS.(UNITEN) (CIVIL,2004)
0	HOO LEK SING	B.E.HONS.(UTHM) (CIVIL,2013)
64597	HOW KAH CHOONG	B.E.HONS.(UTAR (CIVIL, 2011)
0	IKHWAN HAWARIY B MOHD ROZLAN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	IMRAN BIN ILIYAS AHMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	INTAN LIYANA BINTI MD LATIFI	B.E.HONS.(UTHM) (CIVIL,2013)
0	INTAN SYAZANA BINTI SULAIMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	ISMAAINI BINTI ISMAIL	B.E.HONS.(UTHM) (CIVIL,2013)
0	IVOR TAN KIAN JOO	B.E.HONS.(UTHM) (CIVIL,2013)
0	IZAIDAH BINTI ADNAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	IZZAT IZZUDDIN BIN ZULKEPLI	B.E.HONS.(UTHM) (CIVIL,2013)
0	JABBAR SHEQ BIN MOHD NASIR	B.E.HONS.(UTHM) (CIVIL,2013)
0	JAMAATUN ADAWIYAH BINTI KAMARUDDIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	JULIA BINTI SUHAIMI	B.E.HONS.(UTHM) (CIVIL,2013)
0	KHAIRIAH NUR BINTI SHARIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	KHAIRUL NAZMI BIN ABDUL LATIB	B.E.HONS.(UTHM) (CIVIL,2013)
0	KONG YU LOONG	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
62161	KWANG KIM LUP	B.E.HONS.(UTAR) (CIVIL,2013)
61887	LAI SIAW PIN, JAMES	M.E.HONS.(NOTTINGHAM) (CIVIL,2011)
64573	LAU KOK TSEN	M.E.HONS.(UNI. OF LONDON)(CIVIL & ENVIRONMENTAL,1998) P.HD.(UNI. OF LONDON) (CIVIL, 2002)
0	LAW LEH KHING	B.E.HONS.(UTHM) (CIVIL,2013)
62055	LAW SOON GUAN	B.E.HONS.(SALFORD) (CIVIL,2004)
61947	LEE HENG ZHI	B.E.HONS.(UNITEN) (CIVIL,2008)
0	LEE KAH WAI	B.E.HONS.(UTHM) (CIVIL,2013)
0	LEE WENG LOK	B.E.HONS.(UTHM) (CIVIL,2013)
62181	LIEW SU FUAN	B.E.HONS.(UNITEN) (CIVIL,2004) M.SC. (PORTSMOUTH) (CIVIL ENGINEERING PRACTISE,2005)
61914	LIM CHEE HOWE, LUCAS	B.E.HONS.(UNIMAS) (CIVIL,2009)
0	LIM TONG PENG	B.E.HONS.(UTHM) (CIVIL,2013)
0	LINA MARIANA BINTI KHALID	B.E.HONS.(UTHM) (CIVIL,2013)
64596	LIONEL TESSENSHON	B.E.HONS.(UTM) (CIVIL, 2007)
0	LOKE WAI KITT	B.E.HONS.(UTHM) (CIVIL,2013)
0	LOW TECK LOON	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	LOY HUI TING	B.E.HONS.(UTHM) (CIVIL,2013)
0	LYDIA KRISTEN BINTI EDWARD MONGUDAL	M.E.HONS.(UTHM) (CIVIL,2013)
0	MAFLIZA BINTI MAHADI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MAISARAH BINTI MOHD ISA	B.E.HONS.(UTHM) (CIVIL,2013)
0	MARKLINE MANNIE	B.E.HONS.(UTM) (CIVIL,2001) M.E.(UTHM) (CIVIL,2013)
0	MARNI BINTI CHE MAHMUD	B.E.HONS.(UTHM) (CIVIL,2013)
0	MASHITAH BINTI AHMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	MASRULAINI RAMLAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MAZAITUL NISYA BT SUHAIMI	B.E.HONS.(UTHM) (CIVIL,2013)
62165	MICHELLE CHUA YEE WEN	B.E.HONS.(TASMANIA) (CIIVL,2010)
62038	MOH WEI REN	B.E.HONS.(NEWCASTLE) (CIVIL,2013)
0	MOHAMAD AZIM BIN MOHAMMAD AZMI	B.E.HONS.(UTHM) (CIVIL,2013)
62177	MOHAMAD AZIZUDDIN BIN MD DAUD	B.E.HONS.(UITM) (CIVIL,2009)
0	MOHAMAD AZLAN BIN RASDI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMAD AZRIE MUSTAPHA	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMAD FADZLI BIN MOHD SARIB	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMAD FAIZ BIN MAT NAWAWI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMAD FAZRIN BIN MOHAMAD FAUZI	B.E.HONS.(UTHM) (CIVIL,2013)
61938	MOHAMAD FIRDAUS BIN PASRO RADZI	B.E.HONS.(UTM) (CIVIL,2011)
0	MOHAMAD HAFIFI HAFIZ BIN MOHD ALI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMAD IKRAM BIN MOHAMED KHAIR	B.E.HONS.(UTHM) (CIVIL,2013)
64566	MOHAMAD KHALID BIN ALI	B.E.HONS.(UITM) (CIVIL, 2007)
0	MOHAMAD WAZIR SHAFIX BIN OSMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMAD ZAIDI BIN JAMAL	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHAMAD ZULFADHLI BIN DOLHAN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHAMED ANVARDEEN BIN MOHAMED KASSIM	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMED NOR FAKHRI BIN IBRAHIM	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHAMMAD ASYRAFF BIN ABDULLAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHAMMAD IZZAT AMIR BIN ABDUL HAMID	B.E.HONS.(UTHM) (CIVIL,2013)

KEAHLIAN

0	MOHD AFIZI BIN MOHD GHAZALI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHD AMRAN BIN ARSHAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD AZARUDIN BIN MAT YASIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD AZIZI BIN SULAIMAN	B.E.HONS.(UTM) (CIVIL,2005) M.E.(UTHM) (CIVIL,2013)
62046	MOHD AZMAN BIN MOHD NOOR	B.E.HONS.(UTHM) (CIVIL,2010)
0	MOHD AZMI HAFIZULLAH BIN MOHD RASID	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHD AZREE BIN SHAMSUDDIN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHD DZUL-IKHWAN BIN MOHD KHALID	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD EZWAN BIN ILIAS	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD FAHMI BIN SAIDI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD FAIRUZ BIN MOHAMED YUSOP	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD FAIZ BIN MOHAMED	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD FAIZAL BIN MOHD FAUZI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
62010	MOHD HAFIZ BIN A. MANAP	B.E.HONS.(USM) (CIVIL,2008)
64551	MOHD HANAFI BIN MOHD YAACOB	B.E.HONS.(UTM) (CIVIL, 2013)
0	MOHD HELMY SHAH BIN RAMLI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD HILMY BIN MAT SALLEH	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD HISHAM AZWANI BIN CHE HUSIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD HUZAIRI BIN MOHD BAHAR	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD IZUMUDDIN BIN JAMIAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD KAMIL BIN MAHIAN @ NORDIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD KHAIR IKHWAN BIN MOHD NOOR IHSAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD KHAIRUL SYAFIQ BIN ABD TALIB	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHD NASRUL NIZAM BIN MOHD YAHAYA	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD NAZRI BIN MUSTAPHA	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD QAYYUM ASHRAF BIN MOHD SHUKOR	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHD RAZIF BIN ROSLAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD RIZALMAN BIN HAMZAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD SAIFUL BIN SOAIB	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MOHD SOFIE B SUPIAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOHD TAUFIQ SYAKIRIN BIN MOHD RIDZA	B.E.HONS.(UTHM) (CIVIL,2013)
62033	MOHD ZAID BIN MOHAMMADUN	B.E.HONS.(USM) (CIVIL,2006)
61946	MOHD ZIZI BIN SEMAN @ OTHMAN	B.E.HONS.(UTM) (CIVIL,2003)
61968	MOHD ZUBAIR ANSARI BIN SAMSUL	B.E.HONS.(UiTM) (CIVIL,2011)
0	MOHD ZULFAHMI BIN WAHAB	B.E.HONS.(UTHM) (CIVIL,2013)
0	MOPIUS BIN MAJUNGKI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMAD FAHMI BIN ABD RASHID	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMAD FIRDAURS BIN ABDULLAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMAD IZDHAM BIN NOOR AZLAN	B.E.HONS.(UTHM) (CIVIL,2013)
61919	MUHAMAD NORSYAFIQ BIN MUHAMAD NAZRI	B.E.HONS.(UiTM) (CIVIL,2010)
0	MUHAMAD SHAFIZAN BIN SHAFIEE	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMAD TAUFIK@ ADAM BIN ABD RASHID	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMAD THOHA BIN ADNAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD AFIQ BIN TAJUL URUS	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD ALIFF BIN NOR AZMI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD AZLY B.MOHAMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD AZRI BIN FAZIL	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MUHAMMAD FARIDZAL BIN MD YUSUFF	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD FIRDAUS BIN A RAHMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD FIRDAUS BIN AHMAD ZUHAIDI	B.E.HONS.(UTHM) (CIVIL,2013)
61936	MUHAMMAD HAFEEZ BIN HASHIM	B.E.HONS.(UMP) (CIVIL,2011)
62162	MUHAMMAD HAFIZ BIN ABD. RAHIMAN	B.E.HONS.(UTM) (CIVIL,2012)
0	MUHAMMAD HAFIZ BIN NASIR	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MUHAMMAD HAIQAL AZLI BIN SAZALI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD HASBULLAH BIN MOHD SAFIAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD HELMY BIN SAADON	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	MUHAMMAD IBRAHIM BIN ZABRI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD IZZAT BIN SULAIMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD IZZULFAHMI BIN AFANDI	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD NAZIRUL MUBIN BIN MOHTAR	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD NIZAMUDDIN BIN MAZLAN	B.E.HONS.(UTHM) (CIVIL,2013)
62037	MUHAMMAD ROGHAIZAT BIN GHAZALI	B.E.HONS.(UTM) (CIVIL,2011)
0	MUHAMMAD SAFWAN BIN ZAMMANI	B.E.HONS.(UTHM) (CIVIL,2013)
62004	MUHAMMAD SAIFULDIN BIN ZAKARIA	B.E.HONS.(UITM) (CIVIL,2008)
0	MUHAMMAD SUFFIAN BIN MOHAMAD NOR	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD SYAZWI BIN SHAFIE	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD TAJUDIN BIN YUHANIS	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD YUSRI BIN ISA	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD YUSRI BIN MOHD YUNUS	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD ZAIDI BIN ALLIAS	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHAMMAD ZUL FAIZ BIN MUHAMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUHD ZUHAIRI BIN IBRAHIM	B.E.HONS.(UTHM) (CIVIL,2013)
0	MUNIRAH BINTI GHAZALI	B.E.HONS.(UTHM) (CIVIL,2013)
0	NABILA SYAZWANIE BINTI KAMALUDIN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	NADZIRAH BINTI ROSLAN	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	NADZLIA BINTI LARY	B.E.HONS.(UTHM) (CIVIL,2013)
0	NANG AFIFA BINTI LONG MUDA	B.E.HONS.(UTHM) (CIVIL,2013)
0	NATASHA NADIA BINTI ABDUL SHUKOR	B.E.HONS.(UTHM) (CIVIL,2013)
0	NAWIR BIN BALO	B.E.HONS.(UTHM) (CIVIL,2013)
0	NAZURAH BINTI HASSAN	B.E.HONS.(UTHM) (CIVIL,2013)
62160	NAZWAN BIN AZMAN	B.E.HONS.(UTM) (CIVIL,2012)
0	NAZZRUL KHAIRIE BIN KHALID	B.E.HONS.(UTHM) (CIVIL,2013)
0	NG CHERN SIONG	B.E.HONS.(UTHM) (CIVIL,2013)
61902	NG JUN HONG	B.E.HONS.(UNITEN) (CIVIL,2011)
62000	NGOH FEI PHING	B.E.HONS.(UNIMAS) (CIVIL,2009)
0	NIK MUHAMMAD HAZDREEN B. NIK RUSELI	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOOR AZIMA BINTI AZAM	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOOR AZIRAH BINTI ABD AZIZ	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOOR HAFIFA BINTI NGADI	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOOR HANISAH BINTI KAMSHAH	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	NOOR HIDAYAH BINTI OTHMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOOR MAHIRAN BINTI MAMAT	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	NOOR MUIEZZAH BT MD RADZI	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOOR SHAHELA AZUANI BINTI ISMAIL	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOORSINA REHAN BINTI NAZIR	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR ASMIZAR BINTI ARIFFIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR ASYIRA BINTI SHAHBUDIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR ASYURAH BINTI RAMLI	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR ATHIRAH BINTI MOHAMAD ATAU SIDEK	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR AZILA BINTI DAUD	B.E.HONS.(UTHM) (CIVIL,2013)
62054	NOR AZLINA BINTI AHMAD	B.E.HONS.(UiTM) (CIVIL,2002)
0	NOR FATIHAH BT OSMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR HAZLINDA BINTI ZAKARIA	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOR IZATI BINTI AZIZ	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORAIDAWATI BINTI NORDIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORAKMAR BINTI DULAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORASHIRA BINTI JAMIL	B.E.HONS.(UTHM) (CIVIL,2013)
64599	NORASYIKIN BINTI AMIRUDDIN	B.E.HONS.(UTM) (CIVIL, 2006)
0	NORATHIRAH BINTI ABDULLAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORBAZIELA BINTI MOHAMMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORBIHA ASSILA BTE AHMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORFAZLIS BINTI MUSA	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORHAFIZAH BINTI ISMAIL	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORHALIZA BINTI HARUN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORHAMIDAH BINTI NGATIMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORHANIM BINTI MOKHTAR	B.E.HONS.(UTHM) (CIVIL,2013)
61984	NORHASNIZAH BINTI HASBI	B.E.HONS.(UKM)(CIVIL & STRUCTURAL,2006)
0	NORHAYATI BINTI KHUZAIMAH	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORHIDAWATI BINTI YUSOP	B.E.HONS.(UTHM) (CIVIL,2013)
62056	NORIDAH BINTI MOHAMAD	B.SC.(PACIFIC) (CIVIL,1987)
0	NORLIZAWANA BINTI MAASOM	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORSHAKINA BINTI SAMSUDDIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORSHARINA BINTI ABDUL RAHMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NORSHAZWANA BINTI ABDULLAH	B.E.HONS.(UTHM) (CIVIL,2013)
62163	NORSHAZWINA BINTI JOHARI	B.E.HONS.(UTM) (CIVIL,2012)
0	NORUL SHAFIENA BINTI MOHAMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	NOZAIHAN BIN AHMAD	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR AFNI SYAFINAZ BINTI BUDIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR AIN BT ABD RAHMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR AISAH BINTI MOHD YASIN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR AISYAH BT CHE SIDID	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR ATIKAH BT HASSAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR AZIAN BINTI MOHD ZAHARI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	NUR FADILAH BINTI ABDUL RAHMAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR FAIRUZA BINTI SABRI	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR FAIZAH BINTI M.ROSLI	B.E.HONS.(UTHM)(CIVIL & ENVIRONMENTAL,2013)
0	NUR FARHANA BINTI MUHAMMAD SYAMS BASKARAN	B.E.HONS.(UTHM) (CIVIL,2013)
0	NUR HAFIZAH BINTI MOHAMED	B.E.HONS.(UTHM) (CIVIL,2013)

Note: *Remaining list of the "ADMISSION TO THE GRADE OF GRADUATE", "ADMISSION TO THE GRADE OF INCORPORATED MEMBER" and "ADMISSION TO THE GRADE OF ASSOCIATE MEMBER" would be published in the February 2014 issue. For the list of approved "ADMISSION TO THE GRADE OF STUDENT", please refer to IEM web portal at http://www.myiem.org.my.*

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