DIMENSION PUBLISHING SDN. BHD. (449732-T)
Unit No. 3A-10, Block F
Phileo Damansara 1, 9 Jalan 16/11
Off Jalan Damansara, 46350 Petaling Jaya
Selangor Darul Ehsan
Tel : (603) 7955 5335 Fax : (603) 7955 5773
Email : info@dimensionpublishing.com.my

Chairman
ROBERT MEBRUER

Publisher
PATRICK LEUNG
pat@dimensionpublishing.com.my

Editor
RIDWIN G. CANDIAH
editor@dimensionpublishing.com.my

General Sales Manager
JESSIE LEE
jessie@dimensionpublishing.com.my

Senior Advertising Executive
HASNIZAM BIN MOHAMAD
nizam@dimensionpublishing.com.my

Senior Advertising Executive
CHRISTHY WONG
christhy@dimensionpublishing.com.my

Advertising Executive
NATALIE CHUA HOOI ENG
natalie@dimensionpublishing.com.my

Graphic Designer
EVELYN LIM
NORA VADINA BT AHMAD HILMI
art@dimensionpublishing.com.my

Accounts Executive
SHIRLEY THAM
admin@dimensionpublishing.com.my

Accounts Assistant
SHAREENAWATI BT HARON

For advertisement placements and subscriptions, please contact:
DIMENSION PUBLISHING SDN. BHD.

BULETIN IEM

Jurutera Monthly Circulation: 15,000 copies

READER'S CONTRIBUTION INVITED
We invite members and others to submit comments and articles for publication in the Bulletin.

Please send your contribution to the
Chief Editor,
The Institution of Engineers, Malaysia
Bangunan Ingenieur, Lots 60 & 62,
Jalan 52/4, Peti Surat 223 (Jalan Sultan),
46720 Petaling Jaya, Selangor.
Tel: 03-7968 4001/2
E-mail: pub@iem.org.my (Nurul)
IEM Home Page: http://www.iem.org.my

Printed by : HjL PRINT ENTERPRISE (Co. No. 14 56681-X)
No. 20, Jalan PBS 14/8
Taman Perindustrian Bukit Serdang
43300 Seri Kembangan, Selangor Darul Ehsan, Malaysia
Tel/Fax: 603-8945 6472

CONTENTS

At the Pitstop. Change of tyre and refuelling for the Sauber Petronas Formula One race car.

Cover photograph courtesy of Petronas Motosports

Disasters After Disasters – Natural Or Man-Made?

By : Ir. Prof. Abang Abdullah bin Abang Ali, IEM President

The recent Tsunami disaster involving many countries in this region was indeed a wake up call to those who seem oblivious to impending disasters around them and to the suffering of fellow human beings on this blessed earth. It was a stark reminder that we can be just seconds or inches away from disaster whoever and wherever we are; sunbathing happily on the beach or safely tucked away in the apparent safety of our homes.

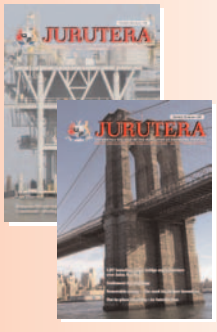
Yes, the weather has gone somewhat haywire. Floods and snow in the hot and dry Middle-Eastern desert and heat waves in the cold north are not unknown nowadays. Mudslides and landslides are becoming commonplace, even in peaceful Malaysia. And the joke that I regularly tell my students in their structural design class is during my time, I could effectively ignore wind loading in my building design but with all the *maksiat* (vice) in our society nowadays, the winds can uproot huge trees and lift houses; thereby making their design more difficult. And we have not considered the earthquakes and tsunamis.

Yet we keep on talking about global warming in various international forums without showing much enthusiasm in mitigating it. It is the richest nations that remain the culprits. We cut down trees at will to satisfy our greed for timber, making barren lands out of virgin forests. We clog up and pollute beautiful streams and rivers without due regard to the wildlife depending on the water bodies. We dam up and impound huge stretches of ecologically sensitive areas. And we introduce imbalances in a perfectly balanced natural ecology and geology.

As a result, the sea is rising, drowning whole villages during rainy seasons in many low-lying areas. The joke that the Philippines has a thousand islands and more at low tide may not be told anymore in the future when these extra islands disappear from the face of the earth. The deserts are growing, shrinking arable lands for future generations. And pollution is everywhere, a symbol of our greed as a human race.

Is this the price we are willing to pay to satisfy our material wants? Destroying the only earth we have. And we engineers are often called "destroyers of the environment".

The time has come for us to wake up from our slumber. We should be sensitive to acts that destroy our environment. The materials we use, the approach to design and construction, the products we manufacture, the process or systems we select, must respect and support efforts towards sustainability. And we should quickly respond to disasters, natural or man-made and offer our assistance, particularly in reconstruction and rehabilitation efforts. As highly educated professionals, we can make the difference. We can then face God who created this blessed earth with a clear conscience. ■



Announcement

The IEM Standing Committee on Publications is sending out letters to student members to ask whether they would like to receive this bulletin (JURUTERA) monthly. At the moment, JURUTERA is not distributed to student members. If you are a student member and you have not received a letter to this effect, please go to IEM's website at http://www.iem.org.my/ and look under 'Publications' for more information.

ERRATA

In the January 2005 issue of Jurutera, the photo of the author for the article titled **"Mining and Quarrying in Malaysia: The Industry and Education"** is incorrect.

The correct photo of the author, Ir. Dr. Mior Termizi bin Mohd Yusof, is at left. We regret the error.

JURUTERA

Number 3 March 2005
IEM Registered on 1st May 1959

THE INSTITUTION OF ENGINEERS, MALAYSIA
Bangunan Ingenieur, Lots 60 & 62, Jalan 52/4, P.O. Box 223,
(Jalan Sultan) 46720 Petaling Jaya, Selangor.
Tel: 03-7968 4001/4002 Fax: 03-7957 7678
E-mail: sec@iem.org.my Homepage: http://www.iem.org.my

Moments in Time

By: Sdr. K.H. Man, Bulletin Editor

Those defining moments. The struggles throughout the years. The battles fought, won, and lost. The laughter and the tears. The moments of exultation and the moments of gloom. An organisation's foundation might be in its constitution and in dry legal prose, but its spirit and passion surely lies within those who have served in the past and in the present. Documents like the constitution are well taken care of; the same cannot be said for those moments in time that are the memories and experiences of people. These moments are fragile; as time passes, some will be lost forever, ceasing to exist. A single memory might not mean much but taken together, the memories and experiences of an organisation embodied in its members is precious, a resource whose value is incalculable that should be cared for and nurtured. If an organism, whether living or abstract, can be defined by the information that it has amassed, then to lose part of the information is to lose a part of itself.

As each year goes by, the need to preserve memories and experiences in a mature organisation like IEM increases. Human beings, after all, do not last forever. Large organisations have historians and actively tries to preserve their history and heritage. Oral histories are recorded, and personal papers of historical interest are donated by members for archiving. The moments may not be perfectly captured, but such steps, inadequate as they are, are the best we humans can do for now.

The Standing Committee on Publications has been running a Book Project Subcommittee in the past few months. Many details have yet to be worked out, but one of the things we will definitely need are those IEM moments – those memories and experiences that are a part of you and me. Immaterial of what we are trying to publish, I think it's time to do a better job preserving the history and heritage of IEM. In essence, the Standing Committee on Publications deals with information, and we should capture as much meaningful information as we can. For example, although we print many articles and reports in this bulletin, we are a bit short of personal memories and experiences. Like chipmunks, it's time we started collecting more of those precious acorns.

We would like to hear from those who were there at the beginning; those who have been there for the Institution over the years; those who have sweat blood and tears for their fellow engineers. We do not have much resources to go around accumulating material for now, but I hope that this message in a small way is a start. As we march forward, let us not forget the past, and let us safeguard our heritage and always remember that we bear upon our shoulders the fruits of the labour of a great many individuals, past and present. ■

Motorsports in Malaysia – Malaysia's involvement through Petronas

By: R.G. Candiah

Petronas' involvement in motorsports was initially an exercise to put Malaysia and the oil and gas company on the world map. However, what was meant as a branding and globalisation exercise has become a passion for the company.

According to Rosman Roslan, Senior Manager of Petronas Motorsports, motorsports not only complements the globalisation agenda of Petronas (Petronas is present in 35 countries currently) but also acts as an avenue to research in technology.

"This is a window to peek into the future of automotive technology as Formula 1 is a sport built on technology. Being an oil and gas company, we should be closely related to the auto industry and F1 acts as a platform for us to develop our capabilities in this area," he said.

Roslan said that engineers played a very important role in motorsports. "In motorsports, when you have a racing event, you are given a regulation or regulations which set the engineering parameters – what you can do and what you cannot do with your vehicle and engine. The responsibility of the engineer is basically to stretch this limit and boundary so that they remain inside the regulation but yet have the advantage over the other competitors," he added.

"Thus, there is continuous improvement. You have a set of boundaries but you need to figure out how to improve your vehicle's performance within that parameter," he said adding that there was much research and development by engineers in motorsports that was not known to the public.

Apart from getting better performance, the engineers obtain knowledge in new areas during research and development. "The engineers are bound to find out new things, new innovations and this will later be applied to auto technology in general," he said.

According to Roslan, many inventions in current road cars originate from motorsports. For instance, the Tiptronic gearbox was invented with the view of saving time for the race car driver. It takes several seconds to shift the gear using the traditional clutch and every second is vital in motorsports.

"The job of the engineer is to make sure the car performs better than that of the competitor, thus they invented the semi-automatic gearbox and Tiptronic systems which enable the driver to change gear in a split of a second and it is located on the steering column," he said adding that there are several cars on the road today having that function.

The 5 Malaysian Engineers based in Sauber Petronas Engineering, Hinwil, Switzerland. From left to right: Kamarulzaman Ahmad - Electronics Engineer, Shaharudin Mustapha - Suspension / Chassis, Ahmad Izhan Ismail - Electronics Engineer, Mohd. Ruhaidi Abdul Rashid -Calculations and Mohd. Irwan Ismail - Composite Engineer

Another example where technology from motorsports has been applied to consumer cars is the size of the engine. Sizes of engines are getting smaller whilst delivering more horse power (bhp) and torque. This is the result of research and development from motorsports as in a race car, the engine has to be small for weight purposes whilst giving out maximum performance. "Before the oil crisis, American cars for instance, used to be huge, consuming a lot of fuel," Roslan said adding that motorsport technology has enabled car manufacturers to reduce the physical size of the cars as the engines were getting smaller.

"We don't need large engines. F1 engines deliver 850bhp from a mere 3 litre unit. Who knows, in the future, such technologies can be applied in the automotive sector," he said.

Roslan went on the explain that the Anti Lock Braking System or better known as ABS also originated from motorsports to prevent the race car driver from skidding the vehicle. This technology is now in many cars.

Petronas Sauber F1 Team

In 1996, Sauber Petronas Engineering was established as a joint-venture with the prominent racing team Sauber of Switzerland. Sauber has practically become a synonym for Swiss motor racing and has over 35 years of experience in motorsports. Hinwil, Switzerland, is home to Sauber's highly sophisticated racing car factory

Kamarulzaman Ahmad and Ahmad Izhan Ismail.

Crowd overlooking a Sauber Petronas Formula One race car

featuring the whole gamut of state-of-the-art technology and equipment. This is where the high-tech racers which have been competing for the FIA Formula 1 World Championship are built since 1993.

The joint venture company enabled Malaysian engineers to go through programs designed to transfer this technology to Malaysia.

The first project was to develop a passenger car engine in 1997. The team completed the project in 18 months and in November 1998, the engine, named *EQ1e* was unveiled. It was a 2 litre engine delivering 200bhp. The engine can be construed as the first Malaysian car engine ever produced.

"It is not just the knowledge acquired from building the engine that was important, it was the fact that we broke the psychological barrier that 'we could not do it because it was too high tech,'" he said.

The company produced several units that are placed in the Marshall cars of the Petronas Malaysian Grand Prix. There are no plans for commercialisation as yet.

"When Petronas went into F1, it was initially for branding. However, when we saw the technology involved, we realised that this is a research laboratory in itself for the future of the automotive industry. By capitalising on this, we can develop our capabilities in high tech engineering in Malaysia," Roslan added.

He said that by coming up with such an engine, the engineers even obtained the relevant knowledge to improve on Petronas lubricants as they were aware of what was demanded from engines of the future.

"We have a group of engineers directly involved in the F1 operations in the factory in Switzerland and at the circuit. They contribute to the preparation and design of the car. There are currently 300 people working in the Sauber Petronas plant. In Malaysia there is a team of more than 50 engineers who have undergone the technology transfer program in Hinwil since 1997.

Engineers Role to Accommodate FIA Regulations

Motorsport engineers have a difficult task of extending the life of an engine. The world renowned body that regulates motorsports globally, the Federation Internationalle De L'Automobile (FIA) is mainly concerned about safety and also about reducing the cost of a race. Before 2004, a race team could have a qualifying engine and a race engine and they could change engines any time they wanted to.

Teams with lots of money, for example top teams, had qualifying engines designed to last very short periods, roughly about 100 kilometres before it burns but give top notch performance.

"During the race, we will race about 300 km. Big teams with lots of resources have engines that last only 400 to 500 km but with the aim of getting top notch performance. Smaller teams unfortunately do not have this luxury and there is a disparity," he said.

In 2004, the FIA regulation on engines changed. The FIA said that teams were only allowed to have one engine for one weekend.

"Here the engineers have to look into the engine to extend their lifespan to about 700 km to 800 km for the Friday practice, Saturday qualifying and Sunday race. These are all the parameters set by the FIA and engineers have the difficult task of extending the life of an engine but yet maintaining performance," he added.

In 2005, the FIA said that to further reduce cost, engines must last for two races. Thus, instead of a 700 km life-span, engineers have to now double that to1400km. "This is not an easy task as you must change the materials of the engine and yet maintain the weight and performance," he said.

The task given to engineers to solve such a problem is tremendous. "Imagine the knowledge obtained from attempting to extend the life of a race engine that revs at 19,000 rpm to double its life. One day, such knowledge will be extended to road cars. Roads cars will be able to rev at, say 12,000 rpm, and yet have a reasonably long life span," he added.

Maintenance and Modification of Race Cars

Within the parameters set by the FIA, there are a lot of modifications and changes to the body of the car. Though they may be small changes, they have significant results as demanded by different circuits.

There are circuits that require high down force and some, low down force. "Here the wind tunnel plays a very important role. In the Monza circuit for instance, there are lots of straights but few corners, and here there is no need for a high down force. Instead top speed is important. Thus the body kit of the car has to be modified to cater for the Monza circuit. In contrast, the Monaco circuit requires a high down force because the circuit has many corners and is twisting," he said.

Modification of vehicles is ongoing but the engineer has the responsibility of monitoring the calendar and preparing for each circuit.

"They have the data in the system and know what the circuit is like. They will simulate this in the wind tunnel to make the necessary modifications," he added.

The race cars are maintained regularly to ensure that all parts and material strength are kept at optimum

Petronas Motorsports regularly conduct roadshows and demonstrations nationwide for those unable to go to Sepang

levels and there is no compromise in quality. Every single aspect from composite strength to the drivers' seating comfort is tested before every race.

Culture and History

According to Roslan, the Sauber Petronas team is at par with top notch teams in terms of knowledge but Malaysia is still new to motorsports and the industry is still growing.

"In terms of knowledge, we are equal, however, experience and exposure wise, we are still growing," he said.

Roslan goes on to explain that the home of motorsports in the United Kingdom and the community there has grown with the industry over a long period of time.

"Malaysia is different as we did not go through the industrial revo-lution. The British did and have designed, developed and produced cars for over 100 years. From there, motor sports started. The British have grown up with motorsports and the industry around them. Our community is just being exposed and it will take a while before the motorsports industry in Malaysia develops to be at par with that of European countries," he said.

Future Challenges

Roslan said that for a mere 10 years in the motorsports industry, Malaysia has achieved a lot. Sauber Petronas recently built its own wind tunnel and it is rated as one of the best in the world. (See the following Feature in this issue.)

"With our own wind tunnel, our expectations are high. We hope we can get better results, however, we must also be practical, as our team do not have the resources as what the top teams have," he added.

He said to improve in F1, a team will need unlimited resources and to turn the resources into performance.

"A team like Ferrari can afford to use a wind tunnel up to 8,000 hours per annum. That is almost 360 days with the remaining days used for maintenance work. For us, we are using our own wind tunnel around 3,000 to 4,000 hours a year," he added.

Roslan expresses confidence that the Sauber Petronas engineering team will come up with better solutions using minimal resources. "In the short term, we will try to get into the top notch group and in the long term, we want to keep up with the exciting new technologies motorsports exposes us to," he added. ■

Ultra-Modern Wind Tunnel by Sauber Petronas

By: R.G. Candiah

Sauber Petronas has recently put a completely new, ultra-modern wind tunnel into operation. Regarding factors such as wind speeds, the size of the test section and the models, the dimensions of the Rolling Road, and the Model Motion System as well as data acquisition technology, the Sauber facility compares favourably with any of the existing Formula 1 wind tunnels.

Generally speaking, the outside of a wind tunnel does not offer a particularly attractive sight. This does not apply to the facility in Hinwil, however, with its design that includes a deliberate focus on overall aesthetics. In addition to boasting impressive dimensions (65-metre length, 50-metre width, 17-metre height, 63,000 cubic metres of construction volume), a glass façade aims to convey the unique character of the building that combines its industrial purpose with that of a facility for special events.

Although presenting the exterior impression of a homogenous hall, the facility actually comprises two clearly separated elements. These are the wind tunnel hall itself and a multi-storey wing that accommodates work areas, a platform for special events and an exhibition of selected Sauber racing cars. The two sections are separated by a glass wall that visually preserves the relation between them, while effectively keeping out the noise emanating from the wind tunnel. Not for technical reasons, as might be suspected, but for achieving a strong visual impact, the central axis of the wind tunnel tube is located more than 8 metres above ground. Except for the test section, which is embedded in a concrete construction, the steel elements of the circuit appear to be "floating" inside the hall.

The wind tunnel itself features the most advanced technology currently available. Based on the ideas of Sauber's project engineers, the facility was designed and developed by two leading specialist firms, TLT Turbo GmbH, Germany, and MTS Systems Corporation, USA. Both companies have extensive experience in building facilities of this type. MTS, based in Eden Prairie near Minneapolis, who are the supplier of the Rolling Road (a steel belt simulating the relative motion between the road and the vehicle) and the Model Motion System (suspension and control of the model), are the number one supplier of mechanical testing and simulation systems. As the third supplier for the wind tunnel project, Sauber selected the UK firm KineticaRT Ltd. to develop the data analysis and Main Control System software.

The wind tunnel is of a closed-circuit design. The total length of the steel tube is 141 metres, and the largest tube diameter is 9.4 metres. Including the fan housing, the weight of all the steel elements, welded or bolted together at the construction site, amounts to 480 tons. The single 16-stage axial fan with carbon rotor blades weighs 66 tons, including the motor and housing. When operating under full load, the power consumption of the system amounts to 3000 kW. This enables wind speeds of up to 300 kph to be reached in the test section. In order to minimise the transmission of vibrations to the building, the axial fan is mounted on a solid concrete foundation via a vibration damper and is only joined to the rest of the wind tunnel by flexible membranes.

The core element of any wind tunnel is the test section where the models under test are exposed to air flow and measurements are made. In order to expand the testing capabilities beyond 60-percent scale models to road cars, up to and including the size of vans, the test section is unusually large. It has a 15-square-metre cross-section and a particularly long Rolling Road.

In order to simulate side-slip conditions up to a maximum angle of 10 degrees, the entire rolling road platform can be rotated. It is fitted with a steel belt which simulates the relative motion between the vehicle and the road as well as the rotating wheels. The moving steel belt reaches the same velocity as the air stream that is up to 300 kph. Located underneath the moving belt are load cells, which are used to measure the wheel lift during tests.

Supercomputer for Computational Fluid Dynamics

On another note, Sauber Petronas has also launched a new supercomputer for CFD calculations. "Albert", as the machine is known, is one of the most powerful supercomputers in Formula 1 as well as the automotive industry as a whole. The supercomputer was built by the Swiss company DALCO and has a total of 530 AMD Opteron processors installed in high-density cooling enclosures supplied by American Power Conversion (APC). The software is provided by a company called Fluent.

CFD (Computational Fluid Dynamics) serves to analyse and design aerodynamic components and is an important complement to wind tunnel work. Aerodynamics has been steadily gaining importance in recent years, accounting for roughly three quarters of the performance of a Formula 1 car today.

Sauber Petronas has been working with a supercomputer for years. However, the growing complexity of the tasks has drastically raised the demands made on computing power. Hence, the new supercomputer is nearly 30 times more powerful than the one previously used.

This enormous power reduces computing times considerably as well as enabling much more complex tasks to be solved. Altogether, the new Sauber supercomputer comprises 530 AMD Opteron processors in a cluster architecture with dual nodes installed in high-density cooling enclosures. These enclosures are self-contained, closed loop systems that utilise chilled water to cool up to 15kW per rack. The supercomputer comprises a total of ten racks, each having a width of one metre, a depth of 1.20 metres and a height of 2.30 metres, resulting in a total width of ten metres and an impressive weight of 18 tons.

The supercomputer can achieve a peak performance of 2.3 Tflops and is equipped with 1 TB RAM and 11 TB of storage. To illustrate the point for non-computer experts, this means that "Albert" is capable of performing 2,300,000,000,000 computing operations per second.

To achieve the same computing performance, the entire population of the city of Zurich would have to multiply two eight-digit figures every four seconds for a whole year. The machine

has over 1,085,440 megabytes of physical memory and over 10,880 gigabytes of hard drive storage.

The virtually unlimited technical possibilities of the Sauber supercomputer are used for analysis in the field of aerodynamics. CFD serves to analyse and design aerodynamic components for the Formula 1 race car on the computer, using numerical grid models that used to be defined by a maximum of 50 million cells. With the new supercomputer, it will be possible to further refine these models, thus improving the quality of the results significantly. The shorter computing times will allow a lot more variants to be evaluated than before.

In addition, more complex driving situations can be simulated to further improve the results. CFD plays a particularly critical role in the development of front, rear and auxiliary wings as well as being a vital tool for thermal analysis and brake cooling development.

Computational Fluid Dynamics does not compete with but rather complements the work in the wind tunnel. For example, during the development of a new front wing, up to 100 variants are evaluated two-dimensionally before roughly half a dozen of them are analysed in three-dimensional form. The most promising versions are subsequently built for the 60-percent scale model and tested in the wind tunnel. CFD thus enables particularly efficient use of the facility.

Technical Specifications of the Wind Tunnel

Building
Length 65 m
Width 50 m
Height 17 m
Gross floor area 7,450 m^2
Construction volume 63,000 m^3

Wind tunnel

Test models
Model sizes 60% scale
Full-size up to and incl. van size

Test Section concept
closed/slotted walls

Wind Tunnel concept closed circuit with axial fan
Cross-section of test section 15 m^2
Wind speed up to 300 kph

Air Circuit
Total length 141 m
Total weight of steel elements approx. 480 t

Fan
Power consumption under full load 3,000 kW
Weight (total) approx. 66 t

Rolling Road system
Belt Speed up to 300 kph
Turn Table position adjustment range ±10° yaw

How Do You Spell "Speleology"?

By: Sdr. Leong Sek Kai

Continuing our series on what engineers do with their spare time, we bring you one member's account of his recent caving adventure. "Caving itself was only half the fun!" says our writer, Sdr. Leong, who is Engineering Manager at Simpro Engineering Sdn. Bhd., and a Malaysian Nature Society member.

Due to my hectic schedule, I rarely get more than a few days off at a time. So, when I saw that the Cave Group of the Malaysian Nature Society (MNS) was organising a 5-day trip to explore caves in Perlis during the "Deepa-Raya" holidays, I signed up.

Participants met for a briefing a week before the trip itself. The organisers probably wanted to eliminate anyone with a phobia of the dark and enclosed spaces, but all 15 of us looked like we were ready to tackle any cave-dwelling monster and we stayed.

As we would start our journey on Deepavali Day itself, and we were joining the mad 'balik kampong' rush, it was agreed that we had to set off at 4 a.m. for an expected 10-hour drive. I did think to myself then... "So early? What have I let myself in for?"

As it turned out, the drive was quite pleasant despite the heavy traffic. The stop in Ipoh for Dim Sum along with copious amounts of Chinese tea was refreshing.

We arrived well ahead of schedule in Perlis. Somehow, I had the impression that Kaki Bukit, the staging point of our explorations, was a two-shack town, but as it turned out, it had 5,000 inhabitants, and we had five coffee shops to choose from to take our meals, not to mention one that served probably the best and biggest "dai bau" (dumpling) in the whole of Malaysia.

The school in Kaki Bukit, which was to be our home for five days, brought nostalgic memories. The classroom I slept in, with six other like-minded adventurers, was surprisingly clean and was only missing a few panes of glass from the windows, unlike in my old school.

With a bit of group effort and modifications to the classroom doors (a bit of engineering to make them lockable), we were quickly settled in. By nightfall, the organisers had got us motivated enough to climb up a nearby watchtower to gaze at the tops of forests – lit gently by a near full moon – stretching right to the Thai border.

Novices that we were, we quickly found out that our equipment needed adjusting. My engineering skills were not wasted – as we had invested in construction-grade hard hats instead of expensive caving helmets, I helped 'retrofit' them so the headlamps could be secured onto them.

The next morning, the real action started. I did some caving before, so that part did not worry me. But the thought of crawling through flooded caves did make me worry a bit. I made the mistake of reading an article by some cavers that had gone into Gua Wang Ulu and had nearly got trapped when the water level in the cave they were exploring in suddenly started rising. We found out later that one of the organisers had gotten into a similar situation himself. Thankfully, he didn't recount his tale until after our caving was over!

The first cave was Gua Baba – the entrance to this was literally a hole in the ground. With some trepidation, we went down this hole one by one. Once inside, the hole opened out into a tunnel that led into the mines. We got our first taste of the watery domain as we slipped into a shallow pool to cross into the mine proper.

It was certainly an interesting experience, wading through ankle- to chin-deep water (it was only chin deep because we had life vests on!) I guess each of us had our fears and challenges, from overcoming the fear of darkness, to getting used to muddy conditions and to surviving leech bites.

We found that the only true test of the caving equipment, especially the lights, was to take it through a cave like we did. Countless so-called waterproof torches were not, and long-life batteries of a certain brand were certainly very short-lived!

We also learnt about conservation of energy sources very rapidly. When we first started into the cave, everyone had his or her lights full on. By the time we stopped for lunch, many were keeping their lamps off unless absolutely necessary. Spare batteries deep inside a dark cave are very, very marketable items! Name your price…

Two caves (actually three and a half, Gua Wang Burma, Gua Kelam 2, Gua Kelam showcave and an aborted attempt at Gua Wang Mu) and two days later, we had gotten a real taste of what being inside a water cave was about – especially if you had accidentally swallowed some water whilst swimming in them!

The only negative thing about exploring water caves? The washing and drying of clothes and equipment after all the fun! But the best part about the experience? Each time, whenever I emerged from the dark passages and finally saw daylight, I felt good. After all, we had been to the depths of the mines where few had ventured in the past 30 years. ■

For more details about caving and how to join MNS, the reader is invited to visit: www.mns.org.my/selangor/cavegroup/pcecaver/index.htm

The World Federation of Engineering Organizations/ WFEO
Fédération Mondiale des Organisations d'Ingénieurs/ FMOI

The Shanghai Declaration on Engineering and The Sustainable Future

World Engineers' Convention, Shanghai, 5 November 2004

PREAMBLE

Three thousand engineers from 70 countries and regions came together for the World Engineers' Convention on November 2-6, 2004. WEC2004 was sponsored by the World Federation of Engineering Organisations (WFEO) and co-sponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO), and organized by the Chinese Association for Science and Technology (CAST), Chinese Academy of Engineering (CAE), and Shanghai Municipal Government. The theme of WEC2004 was "Engineers Shape The Sustainable Future". Many important issues related to this theme were addressed in the plenary and five parallel sessions of the Convention and the virtual fora associated with WEC2004.

PROCLAMATION

Engineering and technology are vitally important in addressing poverty reduction, sustainable development and the other UN Millennium Development Goals, and need to be recognized as such. We, the participants at WEC2004, proclaim the following:

The Challenge

1. The Situation

While having made encouraging progress in economic and other respects, the world today is facing many severe challenges. The environment continues to deteriorate, natural and man-made disasters are more frequent, some natural resource uses approach critical points, and the gaps between the rich and the poor, between developed and developing nations, continue to widen. All these factors are a major threat to global prosperity, security, stability and sustainable development.

The Mission

2. The Engineering Community

The bounden duty of engineers is to build a better life for society. To this end, engineers should dedicate themselves to developing a better world together with the public and private sectors, non-governmental and intergovernmental organizations, through the application of knowledge to convert resources into products and services. In this process, engineers should be aware of the need to achieve a balance between resource use and the needs of future generations, maintaining the environment and ecosystems to promote sustainable development. We need to develop goals and measurable indicators towards these goals.

3. Governments

Governments need to recognize and reinforce the role of engineering in social and economic development, addressing basic human needs and poverty reduction, bridging the "knowledge divide" and promoting intercultural dialogue, cooperation and conflict resolution. Governments also need to promote public and private support for engineering education and capacity building. This is most important in developing public understanding and the application of engineering and technology in all countries.

4. International Organisations

Non-governmental organisations, such as WFEO, and inter-government organisations, such as UNESCO, can and should play vital roles in promoting the development and application of engineering to bridge the divide between countries. They also play important role in supporting and promoting international cooperation in engineering and technology, particularly between developed and developing countries.

Responsibility and Commitment

5. Sustainability

Engineers should take greater responsibility for shaping the sustainable future. Engineers should also create and apply technology to minimize the waste of resources, reduce pollution and protect the human health and well-being and the ecological environment.

6. Ethics and Codes of Conduct

The principles of honesty, equity, freedom from bribery, corruption and fraud, on which engineering codes are based, should be emphasized. High standards in all aspects of engineering practice should be maintained worldwide, and ongoing debate about engineering ethics should be strongly fostered towards the aim of adoption of codes of conduct by all engineers and engineering bodies.

7. Interdisciplinarity

Engineers should be clearly aware of the importance of interdisciplinary cooperation. We need to promote cooperation within the profession and also with natural and social scientists and the public in the creation and application of knowledge for sustainable development.

8. Education and Capacity Building

Innovation and creation in engineering are of crucial importance. We need to promote human and institutional capacity building. Curricular and pedagogical reform in engineering education and continuous professional development to encompass wider social and ethical concerns are needed. This will enhance the attractiveness of engineering to young people. We need to promote and support young engineers – they are our future.

9. Women and Gender Issues

Women are frequently constrained from reaching their full potential. Only when women and men realize their potential, will the development of human society realize its full potential. Hence, promoting the participation of women and addressing gender issues in engineering is crucial for the sustainability of the engineering community.

10. International Cooperation

There are excessive disparities between people and countries. This can lead to increasing insecurity and conflict. International cooperation in engineering facilitates the exchange of knowledge and promotes technological applications for health, wealth and well-being, poverty reduction and the culture of peace.

CALL TO ACTION

We, the participants at the World Engineers' Convention 2004, commit ourselves in this Shanghai Declaration on Engineering and Sustainable Future and issue a call. We call on engineers, engineering organizations, governments and international bodies to acknowledge and adopt the actions stated in this declaration. We consider that this Declaration gives practical expression and impetus to a commitment to engineering that can serve as a strategic guide for partnership between all stakeholders in engineering for our sustainable future.

World Engineers Convention 2004 Shanghai – More Than a Technical Experience

By: Ir. Dr Wong Koon Yuin, FIEM, P.Eng., FIEAust., C.P. Eng., RPEQ, MACEM

"Why don't you attend the World Engineers Convention (WEC) in Shanghai," asked Adrian, the Treasurer of the Malaysian Chapter of The Institution of Engineers, Australia (SIEAMM). "Dato' Pang (the Chairman) suggested that you represent SIEAMM." Shanghai! I have never been to Shanghai. The only thing I knew about Shanghai was from Hong Kong's TVB series "The Bund". I cannot disappoint SIEAMM by turning down such an assignment.

I contacted IEM to find out which travel agent was arranging their tour. I then contacted the agent, whose response was "Sori-lah, you too late! No more seat. Ai-yah, why you come so late one-ah? You only give problem lah." What can I say? In simple language it means bye-bye and don't disturb me. I have to look for alternative arrangements. I WILL NOT GIVE UP. I can fly by MAS instead of China Airlines and join the ground tour in Shanghai. I can leave a day later and the local tour guide can pick me up. That seems simple enough. So I handed in my passport, one passport size photograph (for the visa), paid all the fees and was told to collect my ticket and passport four working days later.

There is definitely a difference in how engineers calculate time from the rest of humanity. I submitted my passport on a Monday morning (before 10am) and 4 working days, by my calculation, is Thursday. No, the rest of humanity ignores the day you submit and adds 4 days, making it a Friday. Not only on Friday but Friday afternoon. "Just to be safe," said the tour agent. Since I am flying on the following Monday morning, I thought it was cutting it a bit thin because embassies work 5 days a week and if I cannot get my passport back by Friday, I will have to miss the flight! So on Thursday afternoon, I called the tour agent only to be told, "Ai Yah, Mr Wong, told you oledi lah, Friday afternoon after 4.30. Now only Thursday, why you call?" I apologized for the intrusion.

I got my passport back on Friday after 4.30pm and so early on the Monday morning (on 1 November), I made my way to KLIA. Now, being a descendent of Cantonese migrants, my Mandarin is about as good as the general population's Tamil. But I have been watching a lot of movies on Astro Channel 39 and Channel 34 and I thought that this should suffice and put me in a good position to handle the language problem. I can understand when Mandarin is spoken to me. It's the reciprocating part that worries me. Admittedly, my spoken Mandarin can be confusing (for the listener that is) but I am sure that I can get by when combined with other forms of facial and body expressions. It may take a bit of time to make the other side understand my intentions, but what the heck, language is only ONE form of communication.

I arrived in Pudong airport (about 50 km from Shanghai) after a 5 hour flight. After clearing immigration and customs, I looked for the tour guide who is supposed to pick me up. There were two other friends on a separate tour with me, arriving on the same flight. We waited, and waited…….. and 45 minutes later made eye contact with a guy holding up a piece of paper with some Chinese characters. He told us he was to pick up five passengers from "Mar Lai See Yah". After a couple of mobile calls to the Shanghainese tour agent, he confirmed that we (three of us) were part of the right package. We then left Pudong airport. What about the other two passengers? "Never mind, they can make their own way, NOT MY FAULT" was his reply. Under this situa-tion the safest thing for self preservation is to keep quiet.

My first impression of Shanghai is that it is an ultra modern city, at least in the Pudong area. There are many skyscrapers some with international fame such as the Jiang Mei building which once vied for the world's tallest building title, and the Shanghai Telecommunication tower. Also, not many cities can boast a Maglev (a magnetic levitation train) which travels at a top speed of 431km/h. This is half the flight speed of MAS to Shanghai and more than twice the speed of the Shinkansen, the bullet train in Japan. I saw the Maglev on the way out from Pudong airport and by the time I say see…….. it was gone. Seeing all these, it is difficult to believe China has a communist regime for government.

As an engineer, I was fascinated to observe how the design and construction of the Maglev track handle the tilt and the curvature. This was done very elegantly using strategically located tilted cross beams of varying sections. This seems easy when one looks at it after construction. But planning and design is needed to account for the 3-dimensional curvature along the alignment. And at such high speeds, the construction tolerance must have been very small. There are many elevated highways all over Shanghai but most construction seems to be of post-tensioned, cast in-situ box girders, unlike ours where most beams are of pre-tensioned and pre-cast type. Highways in Shanghai do not generally have the emergency lane like we do in Malaysia and designated rest and stop areas are very few. This can be a safety problem when cars stop at the side because the driver or passengers wanted to pee.

After about an hour of driving, we finally arrived at the hotel, Xin Kian Fu, in the old part of Shanghai. Now, ANY Chinese of Cantonese decent will not forget this name. The name sounds like 'Sun Kow Fu', a crude phrase in Cantonese meaning "Suffering". Over the next few days of my stay, the hotel truly lived up to the name.

In the old part of Shanghai, one can see many old houses. These were generally 2 to 3 storeys and most in a somewhat dilapidated condition. Not only will one see the contrast between the ultra modern part of Shanghai and the old Shanghai, one can also smell the contrast. Stinking beancurd, a favourite snack on a stick, is sold in street stalls around old Shanghai. Its reputation of stink is not without basis. To me, the closest thing to it is the smell of an open pit lavatory. The smell lingers on for a long time. The locals say they do not smell the stink and will look for the smelliest ones when buying!

Across the hotel are a couple of small eateries and a hairdresser salon that doubles up as a massage parlour. Talk about entrepreneurship and capitalism at

work in China; one country two systems. One shop two businesses!

As a Malaysian of Chinese descent, I cannot help but feel sad and sorry to see many of the things that we consider mostly things of past. People in Shanghai spit at their convenience everywhere and drive recklessly. The most important piece of equipment in the car is the horn, not the brakes because the driver sounds the horn continuously and expects the rest to make way. There are umpteen bicycles and electric scooters on the streets. People jump queue without apology and throw rubbish indiscriminately. Life can be very tough in Shanghai. Undoubtedly, there are many super rich people in Shanghai. There are Mercedes models that I do not know even existed. S1000 class is common. For the majority, poverty is very evident. Daily survival is a main priority for most.

In a pasar malam type set-ting of Xiang Yang city, one sees all types of clothing, fake watches and video games for sale at bargain prices, that is, one has to bargain hard. You offer no more than 20 percent of the vendor's asking price. All around were security personnel, indicating that things can be rough and petty crimes are common. In the more affluent shopping and commercial areas like the Nanjing street mall, there are also many people who tout. They can pick out a tourist easily. They offer fortune telling, massage services (any style and type) and beg for money (usually with a very sad tale). After a while you realize the similarity in story line of the beggars. There must be a training school for them to be so consistent.

The WEC was held at the Shanghai International Convention Centre with a reception hall big enough to cater for up to 5000 people. More than 3000 registered for this convention. Participants have to pass through metal detectors and all bags were scanned each time participants entered the building. Even watches have to be taken off. If one has false metal teeth or wore braces it is safer to declare them or risk embarrassment. It is definitely an unpleasant experience to have a security guard looking into your mouth! In the building, participants are required to wear their name tag around their neck. Security was tight.

Almost all participants attended the opening reception, although it is unclear whether it is the lure of the opening speeches or the banquet. Like anything formal in China, things are done to perfection. Food was in abundance. The food was a very welcome change after two days of eating Shanghainese cooking, which is in general very oily and salty. During the first two days, I survived on soya bean drinks and pancakes. Later I introduced the shop which serves these near our hotel to other IEM members. I knew exactly where they were nightly after that.

On the second evening of the convention, a cultural performance was held. All traditional Chinese instruments were featured. Soprano singing, cultural dances, traditional music and acrobatic performances lasted about two hours. Now, I am not one who will normally sit for hours to listen to cultural music. But for this event, I sat through the entire performance. It gave me an interesting insight into Chinese musical culture. I was particularly fascinated by the Er Hu, a simple string instrument played with a bow across a few strings. Every Er Hu has a piece of snake skin about 5 inches diameter – python skin mostly. Many pythons have indeed contributed to the advancement of this style of classical Chinese music.

I attended the session presentation of WFEO and UNESCO. The current President of WFEO is a Malaysian, Dato' Lee Yee Cheong. His presentation outlined the aspiration and objectives of the conference's theme of sustainable development, and the role WFEO can play in this area. In reality, many of the problems resulting from modern development were already identified and some even have well advanced solution schemes. The issue is a unified holistic implementation of a solution scheme on a global scale. The Kyoto Protocol, for example, is only a small step aimed at controlling emissions of greenhouse gases. Yet, even this protocol has met many obstacles, including the refusal of the United States of America to ratify it. There is concern amongst some countries, especially developed ones, that they cannot meet the target emission indices set in the time period without implementation of costly technologies or seriously cutting back production. Perhaps the global economic race is the real issue. The technical excuse is just to mask the economic concerns.

I extended my stay by two days to visit Wuxi at the invitation of an old university friend who has done very well in China (no, he is not an engineer.) He had sent a car to pick me up from Shanghai. The 120km journey took about two and half hours. Even on a Saturday, it is difficult to escape the traffic chaos. The main highway was tolled. But there was no 'Touch and Go' system. The queue was about a kilometer long each time we have to pass a toll.

On the return from Wuxi to Shanghai to catch the flight home, I decided to take the train. There are two classes of train travel here, the 'soft' class and the 'normal' class. The soft class is akin to the first class. For the times I needed to travel, all tickets for the soft class were sold out. So I opted to try the normal class. It turned out to be quite an experience for me. The seats are numbered (so no one can displace you) and it is air-conditioned. The top speed is about 120km/h. The journey normally takes about 105 minutes, allowing for some stops.

All the things you see about train travel in Chinese movies are true. People carry chickens, televisions, dried food and cartons and cartons of goods as part of their luggage. They push and jostle their way up the train. Tempers fly and verbal exchanges are quite common. On this trip I witnessed a train guard physically kicking a passenger! On the train, people sell all sorts of things, from finger food and drinks to packed mixed rice, to toys and socks. Yes, socks! And the salesman has to do some hard selling to show the quality of his product. The train is a mobile shopping complex and many petty traders make their living aboard in this manner.

There are a few things that I will probably remember well about Shanghai. No, it is not the Convention. I will probably forget many things about the Convention. To me, every conference is similar. They all introduce great ideas for the advancement of mankind. I will also probably forget the food or even the stinking smell of the fermented beancurd. But, I will remember the spitting people do around Shanghai. I will also remember the very chaotic traffic system and the many people on the streets peddling petty services. And the beggars, I will remember them well.

When I returned, my friends asked how I had enjoyed the trip and did I find Shanghai interesting. I told them that I have been to the past and the future at the same time. I had a look into the future from the aspiration and courage of the Chinese people and I had a look into the past of a root that I did not know. ■

Evolution of Concrete Technology – The New Challenge

By: Dr. VOO Yen Lei, BEng (Civil), PhD (Struct.)

INTRODUCTION

In 12 million BC, it is believed that a natural deposit of cement compounds was formed from the reactions between limestone and oil shale during spontaneous combustion (Shaeffer, 1992). In 3,000 BC, the Egyptians used lime and gypsum mortar as a binding agent for building the Pyramids and the Chinese used cementitious materials in the Great Wall of China. It is believed that in about the second century BC, the first use of cementitious binding agent was used in southern Italy. The Romans used volcanic sand called pozzuolana in their cement where it was first found near Pozzuoli in the bay of Naples. One of the most well known masterpieces by the Romans using ancient concrete is the Pantheon. Probably due to the lack of availability of similar pozzuolans throughout the world, this type of concrete was not used elsewhere and stone and brick masonry continued to be the dominant construction materials for many centuries.

The modern use of concrete can be traced back to John Smeaton who, born in 1724, is famous for his work on the Eddystone Lighthouse in Cornwall, England, which he had been commissioned to rebuild in 1756. Smeaton used interlocking courses of masonry bound with a pozzolanic mortar. In his later work, he added aggregate to the mix and built Ramsgate Harbour, Perth and Coldstream Bridges and the Forth and Clyde Ship Canals (Skempton, 1982). In the early 1850s, the use of reinforcing steel was introduced by Jean-Louis Lambot in his boats (Shaeffer, 1992). With the use of reinforcing, a new building form, the thin shell, was developed. In 1889 the first concrete reinforced bridge was built, Alvord Lake Bridge in the USA.

Basic cement tests were standardised in the early 1900s. In 1904, Ingalls building in USA was the first mounted concrete skyscraper. In 1916, the Portland Cement Association was founded. A year later, the US Bureau of Standards and the American Society for Testing Materials established a standard formula for Portland cement.

In 1922, the tallest concrete building of the time was built, the Medical Arts Building (70 metres high, Omaha, USA). Eugene Freyssinet successfully developed prestressed concrete in the mid 1930s. In 1935, the first major concrete dams, Hoover Dam and Grand Coulee Dam were built (Shaeffer, 1992).

Interest in advanced cement-based materials is not solely because of their increased strength but also because of their generally high-performance characteristics.

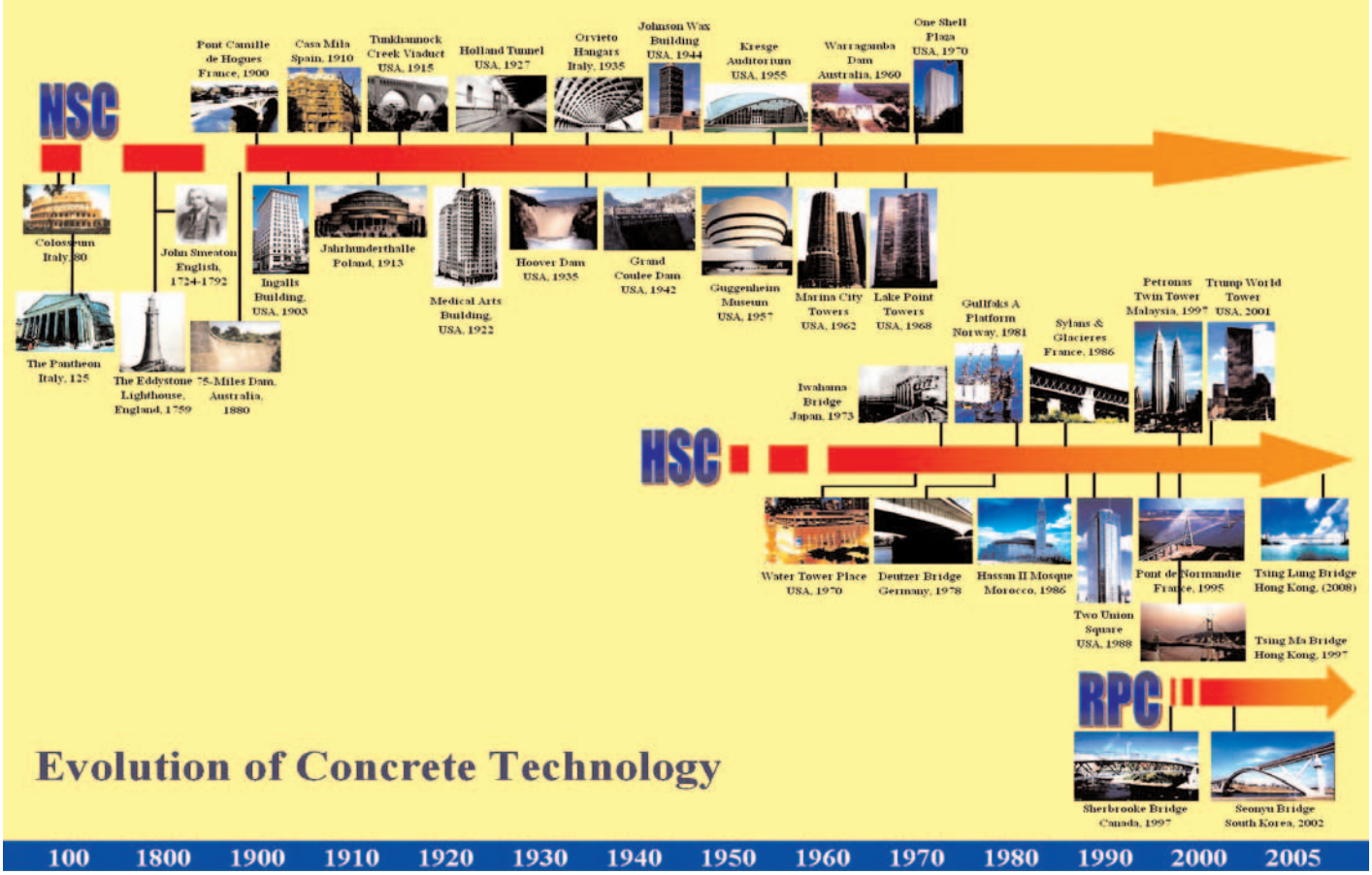


Figure 1 : Evolution of concrete technology (Voo 2004)

The earliest use of high performance concrete (HPC) can be traced to the 1950s and in the time since there has been numerous projects that have used HPC in their construction. In 1973, Water Tower Place reached 260 metres with concrete strengths as high as 60 MPa (Shaeffer, 1992).

In the following two to three decades, high performance concrete has been widely used in bridges and high rise buildings such as Two Union Square (USA), Petronas Twin Tower (Kuala Lumpur, Malaysia), Tsing Ma Bridge (Hong Kong) and Trump World Tower (USA) but to list a few.

In the mid-1990s, ultra-high performance cementitious mortar known as reactive powder concrete (RPC) was developed with concrete strengths over 200 MPa. In 1997, the world's first RPC filled steel tube composite foot-bridge was constructed at Sherbrooke in Canada and in 2002 the world's first fully RPC footbridge spanning 120 metres was constructed in Seoul, South Korea (Deem, 2002).

To date, a project is being developed by VSL Prestressing (Aust.) for the world's first RPC highway traffic bridge to be constructed at Shepherds Gully Creek in NSW, Australia (Cavill and Chirgwin, 2003). A schematic drawing showing the development of concrete through to RPC is provided in Figure 1.

REACTIVE POWDER CONCRETE

Reactive powder concrete (RPC) is an ultra-high strength, low porosity cementitious material with high cement and silica fume contents, low water-binder ratios and uses a new generation of superplasticizer to enhance workability (see Figure 2). Reactive powder concrete may also incorporate large quantities of steel or synthetic fibres giving enhanced ductility and high temperature performance. Unlike conventional concrete, reactive powder concrete contains no coarse aggregate and the fine aggregate is replaced by fine sand and crushed quartz with particle sizes not greater than 600 mm.

Reactive powder concrete was firstly developed by the French. Bouygues Construction (in France) with Richard and Cheyrezy (1994, 1995) have reported the mechanical properties of RPC and the results showed RPC demonstrated compressive strengths greater than 200 MPa and a modulus of rupture of 25-50 MPa.

Since the development of this ultra-high strength cementitious material, many experimental investigations/research have been conducted on the durability of this material (Roux et al., 1996). According to Roux et al. (1996) the durability of RPC can be defined by measuring the porosity, air permeability, water absorption, diffusion and migration of chloride ions, accelerated carbonation, resistance to reinforcement

Figure 2: Mixing of reactive powder concrete with high workability

corrosion, and resistance to mechanical abrasion. The results of Roux et al. (1996) show that the excellent durability characteristics of RPC make it a revolutionary material with, potentially, a significant increase in the life expectancy of structures constructed using RPC (demonstrated in Table 1).

Table 1 – Performance characteristics comparison of RPC to HPC (Cavill, 2000)

Durability Indicator	RPC Vs HPC
Total porosity	4 to 5 times lower
Microporosity	10 to 30 times lower
Permeability	50 times lower
Water absorption	50 times lower
Chlorine ions diffusion	25 times lower
Electrical Resistance	4 to 17 times greater
Abrasion Resistance	2 to 3 times greater

Today, much research has been undertaken or is being undertaken in many European countries (e.g. France, Canada, Australia, UK, etc.) to study and investigate the potential use of fibre reinforced RPC as construction and building material, especially in the field of precast product and bridge engineering.

To date, the University of New South Wales (Australia) has tested seven large-scale prestressed steel FR-RPC girders without conventional stirrup in the web (Voo, 2004, Voo et al., 2004). The experimental data gives evidence how conventional shear reinforcement can be replaced by steel FR-RPC in a prestressed girder. The experimental program were conducted in the heavy structural laboratory of the UNSW as shown in Figure 3.

BENEFITS & APPLICATIONS

The characteristics of RPC make it a unique material with possibilities for use in a wide range of structural and non-structural applications due to its superior strength and corrosion protection capabilities in aggressive environments (Richard and Cheyrezy, 1995, Roux et al., 1996). Enormous benefits have been reported for the application of RPC. For instance,

(a)

(b)

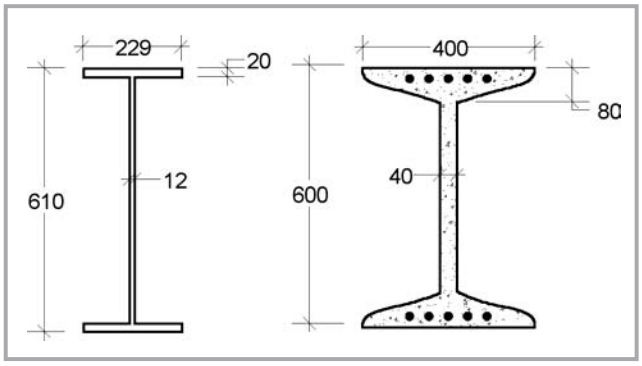
Figure 3 (a): A photo of the heavy structural laboratory of the UNSW and (b) a photo shows the FR-RPC girder in the testing rig.

Richard (1996) and Gilbert et al. (2000) suggested with its superior ductility and tension failure mechanism, fibre reinforced RPC can be used to resist all but direct primary tensile stresses or localised shear. This may eliminate the need for supplemental shear and other auxiliary reinforcing steel.

From the point of view of construction management, the construction time and labour costs may also be significantly decreased; which is important in the century of high labour costs in many countries. The inclusion of conventional stirrups in reinforced concrete beams and structures require relatively high labour input and supervision and the replacement of stirrups with fibres may reduce the fabrication cost. Also, with this new material, thinner or irregular shaped sections, such as architectural panels, are possible due to the absence of conventional reinforcement.

Gilbert et al. (2000) showed that FR-RPC has the potential to compete structurally with steel using prestressed RPC beams such as those shown in Figure 4.

From the perspective of the bridge industry, Gilbert et al. (2000) show how a RPC box girder may perform in place of a constructed concrete Super T bridge (Figure 5a) for Georges River Bridge, NSW, Australia. The existing deck consisted of seven simply supported, pretensioned, Super T box girder sections placed side by



Weight = 125 kg/m
Area = 0.016 m²
Steel 610UB

Weight = 167 kg/m
Area = 0.0636 m²
RPC 600UB

Figure 4: Comparison of equivalent RPC beam sections and structural steel (Gilbert et al., 2000), dimensions in mm.

side and spanning 35 m with a 175 mm thick in-situ reinforced concrete deck placed over the 75 mm thick top flange of the girder. The RPC box girder, shown in Figure 3b, has been designed to perform the same task but the RPC girder requires no conventional transverse reinforcement for shear. As the girder is prestressed both longitudinally and transversely, no in-situ deck is required. The longitudinal prestressing requirement for both girders is similar. Furthermore, the weight of the RPC bridge superstructure is approximately 60% of the Super T girder and deck slab.

Reactive powder concrete is well known as a durable material. Its low and non-interconnected porosity minimises mass transfer making penetration of liquid, gas, or radioactive elements nearly non-existent. This increased durability and abrasion resistance over conventional and high strength concrete makes RPC ideal for the storage of nuclear waste or other hazardous materials (Richard and Cheyrezy, 1995).

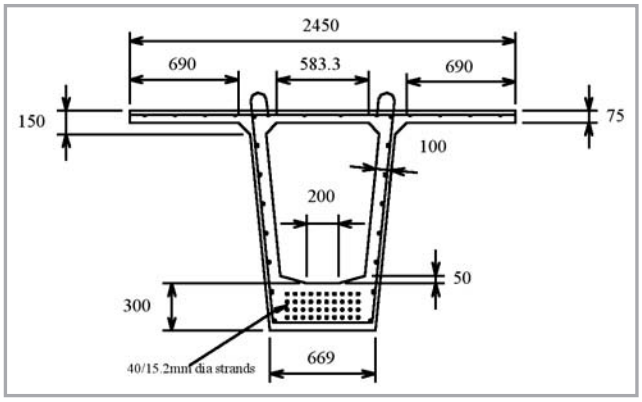
From the point of view of structural design, regarding long-term behaviour, RPC exhibits low creep and shrinkage properties and has remarkable properties that allow the elimination of most of the design considerations linked to time-dependent strains (Richard and Cheyrezy, 1995).

Three completed projects using RPC, Sherbrooke footbridge (Canada), Seonyu footbridge (South Korea) and Sakata Mirai Pedestrian Bridge (Japan) and an on going project, Shepherds Gully Creek, Australia, highlight the potential use of RPC in the application to civil infrastructure.

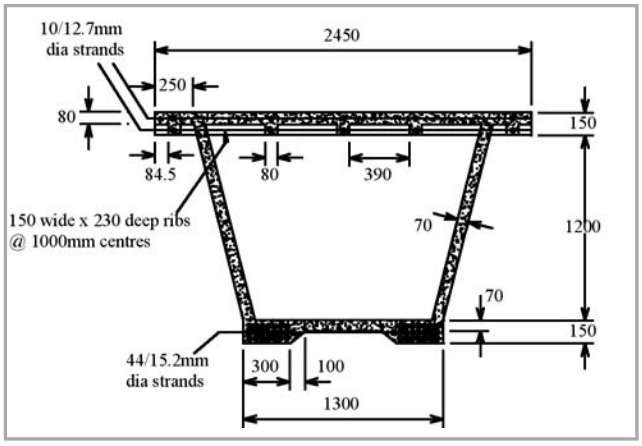
The first major structure to use RPC200 was the 60-metre single span Sherbrooke Pedestrian Bridge crossing the river of Magog in Sherbrooke, Province of Quebec, Canada. The walkway deck, which serves as the top chord to the truss, consists of 3.3 metres wide by 30 mm thick RPC slab. The web members, which slope in both directions, are of a composite design involving RPC placed in thin-walled stainless steel tubing having compressive strengths up to 350 MPa. The success of this structure dawned a new era in design methodology of concrete structures with no conventional reinforcing steel used for any part of the superstructure (Lachemi et al., 1998).

Figure 6 shows the Seonyu Footbridge in Seoul, South Korea and constructed in April 2002 using RPC. The structure connects the city of Seoul to Seonyu Island on the Han River. Constructed by Bouygues Construction, the bridge consists of an arch with a 120 metre span supporting a 30 mm thick RPC deck. According to Bouygues Construction (Deem, 2002), the structure required only about half of the amount of material that would have been used with traditional concrete construction, yet provides equivalent load-bearing and strength properties.

An ongoing project on the world's first RPC highway traffic bridge is under construction by VSL Prestressing at the Shepherd's Gully Greek at NSW, Australia. The road bridge is to comprise four traffic lanes plus a footway. The superstructure of the bridge will comprise 16 precast pretensioned steel FR-RPC beams without any conventional stirrup in the web region and the beam is singly spanning 15 metres. The total width of the bridge is 21 metres. The success of this bridge project will not only challenge the existing design methodology of concrete structures but also give a sign that the use of ultra-high strength concrete as long life construction/precast material is about to begin.



(a)



(b)

Figure 5: (a) Existing and (b) alternative RPC girder sections for Georges River Bridge, New South Wales, Australia (Gilbert et al., 2000).

Figure 6: Seonyu Footbridge on the Han River, Seoul, South Korea.

REFERENCES

Cavill, B., 2000. "Prestressed Concrete without Conventional Reinforcement," *Proceedings of the 19th Biennial Conference of the Concrete Institute of Australia*, Sydney, Australia, 5-7 May, pp: 230-238.

Cavill, B., and Chirgwin, G., 2003. "The Worlds First RPC Road Bridge at Shepherds Gully Creek, NSW," *21st Biennial Conference of the Concrete Institute of Australia (CIA)*, July, pp: 89-98.

Deem, S., 2002. "Concrete Attraction-Something New on the French Menu-Concrete", source at **www.popularmechanics.com/science/research/2002/6/concrete/print.phtml.**

Gilbert, R.I., Gowripalan, N., and Cavill, B., 2000. "On the Design of Precast, Prestressed Reactive Powder Concrete (Ductal) Girders," *Proceedings of 4th Austroads Bridge Engineering Conference*, Adelaide, Australia, Nov. 30 - Dec 1, Vol. 3, pp: 313-324.

Lachemi, M., Bastien, J., Adeline, R., Ballivy, G., and A_tchin, P.C., 1998. "Monitoring of the World's First Reactive Powder Concrete Bridge," *5th International Conference on Short and Medium Span Bridges*, Calgary, Alberta, Canada, July, 10 pp.

Richard, P., 1996. "Reactive Powder Concrete: A New Ultra-High-Strength Cementitious Material," *4th International Symposium on Utilization of High Strength/High Performance Concrete*, Paris, Editors: F. de Larrard and R. Lacroix, Press de l'Ecole Naturale des Ponts et Chaussées, Vol. 3, pp: 1343-1349.

Richard, P., and Cheyrezy, M., 1995. "Composition of Reactive Powder Concretes," *Cement and Concrete Research*, Vol. 25, No. 7, pp: 1501-1511.

Richard, P., and Cheyrezy, M.H., 1994. "Reactive Powder Concretes with High Ductility and 200-800 MPa Compressive Strength," *ACI*, SP-144(24), San Francisco, CA, pp: 507-518.

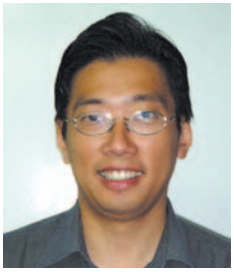
Roux, N., Andrade, C., and Sanjuan, M.A., 1996. "Experimental Study of Durability of Reactive Powder Concretes," *Journal of Materials in Civil Engineering*, Vol. 8, No. 1, February, pp: 1-6.

Shaeffer, R.E., 1992. "Reinforced Concrete: Preliminary Design for Architects and Builders," *McGraw-Hill*, 196 pp.

Skempton, A.W., 1982. "John Smeaton, FRS," *American Society of Civil Engineering*, December, 291 pp.

Voo, Y. L., 2004. "An Investigation into the Behaviour of Prestressed Reactive Powder Concrete Girders Subject to Non-Flexural Actions," *PhD Thesis*, School of Civil and Environmental Engineering, The University of New South Wales, Sydney, Australia.

Voo, Y. L., Foster, S. J., and Gilbert, R. I., 2004. "Shear Strength of 160 MPa-Fibre Reinforced Reactive Powder Concrete Girders without Stirrups," Asean Australian, Engineering Congress 2004.



Talk on Design and Construction of Sub-structure for 102 Storey Tower in Hong Kong

Reported by: Ir. Yee Yew Weng, Geotechnical Engineering Technical Division

The proposed mega tower at Kowloon station when completed will be the tallest building in Hong Kong. The foundation work for the structure has recently been completed. It comprised a large raft foundation measuring 76m in diameter within a 1.5m thick diaphragm wall. The diaphragm wall and 240 barrettes within it extend to about 60m below the raft and has been shaft grouted to provide sufficient geotechnical capacity to support the very large load from the 102 storey building. The design and construction of the basement excavation was particularly challenging as they entail the excavation of a 26m deep basement with no internal props whilst ensuring that movement is minimised adjacent to a running MRT tunnel about 3m distance away.

The talk, attended by 90 members, was presented by Dr Jack Pappin (Ove Arup & Partners, Hong Kong) on August 17, 2004, who covered various design issues, construction methods and performance evaluation. Dr Pappin explained that the foundation design was unique as it required understanding of the behaviour of deep barrettes in large group action. The design criteria specified settlement of less than 75mm and distortion of 1:1000. FEM analyses were carried out which showed that the loads in the central barrettes are essentially carried almost completely to the toe. The design also allowed for geotechnical failure of the outer barrettes under extreme wind loading.

Construction work employed state-of-the-art equipment. The 1.5m thick diaphragm wall and 1.5 × 2.8m barrettes were formed using hydrofraise with real time verticality monitoring. A scraping tool was introduced into the excavated panel to remove much of the bentonite "cake" formed on the wall of the panel. After concreting, the barrette shaft was shaft grouted by means of tube-a-manchette valves fixed on the steel cage. Real time grout take volume, pressure and flow were monitored using the SINNUS monitoring system.

A few barrettes were load tested which showed that the ultimate shaft friction in the alluvium clay and completely decomposed granite satisfy the relation f_{su} = 6N with a limiting friction of 170kPa and f_{su} = 2.4N with a limiting friction of 145kPa, respectively (where N = SPT blow-count in blows/ft). The strut-free diaphragm walls performed admirably with monitored lateral movement of less than 15mm.

Dr Pappin also noted that the excavation was careful not to cause ground water lowering to the surrounding which will lead to ground and building subsidence. The walls were taken to sufficient depth and further, water pumping tests were carried out prior to excavation. ■

"The State Of The Art Of Jet Grouting Technique"

Reported by: Ir. Neoh Cheng Aik, Geotechnical Engineering Technical Division

A talk on "The State of the Art of Jet Grouting Technique" was delivered in Hall A of IEM on 21 October 2003 by Mr. Stefan Toth, expert advisor to Keller Group based in Singapore. About 20 members attended the interesting, informative and enlightening talk. Jet grouting originated in Japan in 70s and the technology has been introduced in Europe more than 20 years ago. The scope of the talk includes development of jet grouting technique and its applications based on the recently published European Standard EN12716.

Jet grouting is a process of applying hydraulic erosion, erosion based on a ground improvement system used to create insitu cemented soil called Soilcrete. In the jet grouting process, soil is eroded by the collision of a high speed fluid with the soil. The kinetic energy of the fluid, the unit volume of Soilcrete and the soil strength and type all play important roles in the process of ground improvement.

Generally, jet grouting techniques can be classified into 3 main systems, depending on the number of fluids which are injected into the subsoil. The three systems are defined as single, double and triple fluid system or method (see Fig 1).

For the single fluid system, the grout is injected into the soil with high pressure (300 to 450 bars). This energy causes the erosion of the ground and the replacement and mixing of grout with the soil. The double fluid system is a two-phase internal rod system. Water is used for eroding the subsoil and the grout is then injected with low pressure through a second nozzle. Alternatively an air-coated grouting jet is used to erode and mix the soil. With this system greater size or diameter of Soilcrete can be created. In cohesive soils the double system is more effective than the single system. The triple fluid system uses an air-coated water jet and grout is induced with lower pressure through a second nozzle. Grout, air and water are pumped through different lines to monitor. This triple system is more sophisticated and effective system for cohesive soils and produces higher quality and larger diameters because it separates the erosion process from the grouting process.

The size, diameter or geometry of Soilcrete created by jet grouting depends on:-

- dynamic pressure (velocity of the fluid, air shroud, nozzle focus and conditions)
- injection volume rate
- erosion time (rotation speed, lift speed, etc.)

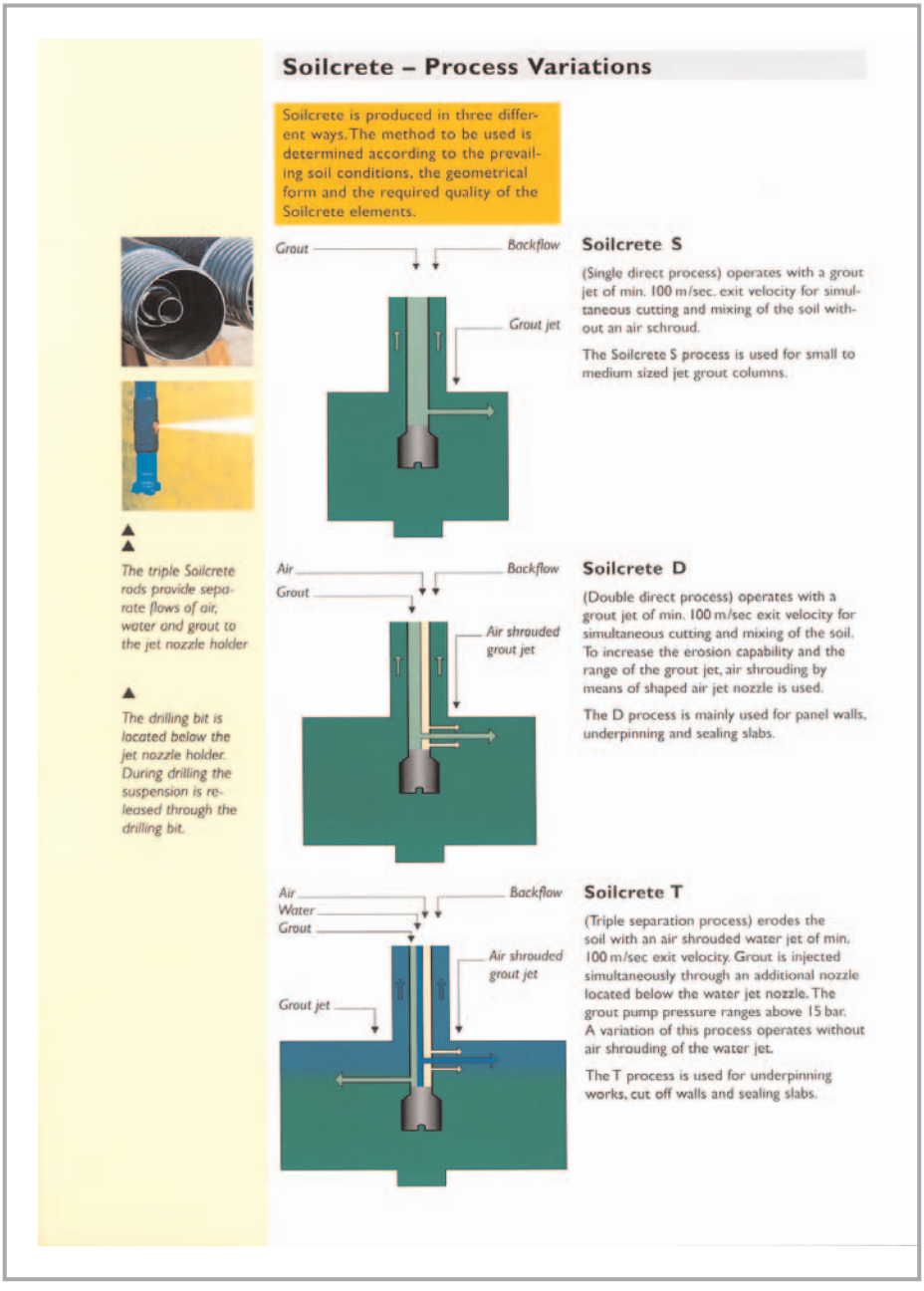


Figure 1: Jet Grouting System

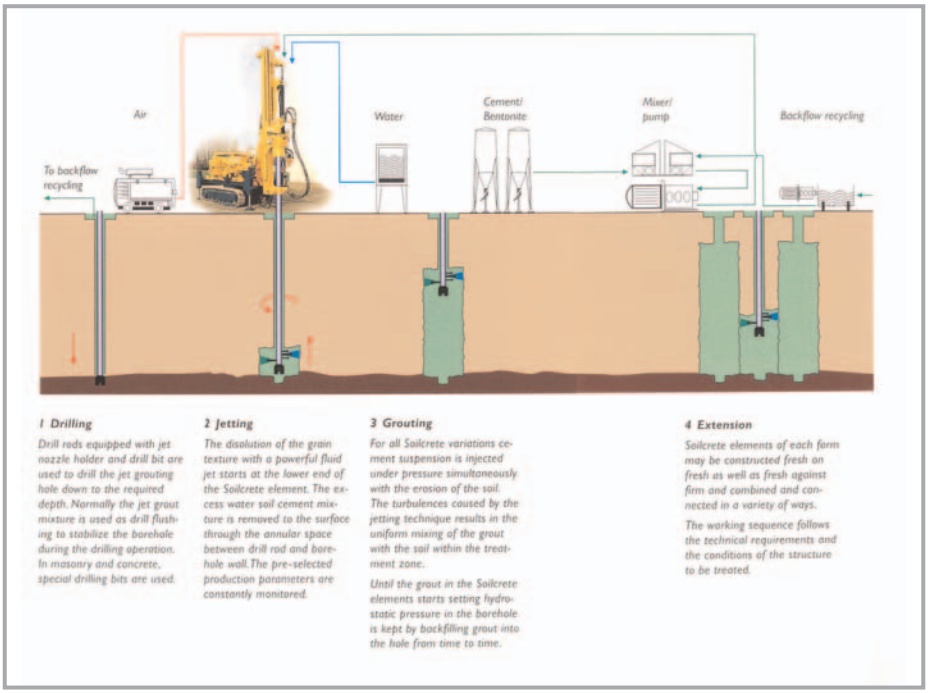


Figure 2: Jet Grouting Sequence of Works

Figure 3: Jet Grouting Applications

- soil strength and plasticity (soil type, shear strength, etc.)

Mr. Stefan Toth also explained the jet grouting process, equipment, materials and properties of Soilcrete. Fig 2 shows the Jet Grouting Process and sequence of works.

Factors that can affect the strength of Soilcrete are:-

- Soilcrete geometry (usually around 1.6m to 2.0m diameter)
- grout design, cement content and additives
- soil type and chemistry
- jet grouting method and equipment
- installation procedures
- sequence of work

Due to the inherent variability in the strength of Soilcrete, it is reasonable to aim to achieve 2 to 3 times the design strength from field samples (normally have USC = 1 to 2 N/mm^2 for clay and 3-4 N/mm^2 for sand.)

The result of jet grouting treatment of soil is a cemented soil body shaped as a column (generally) or other shape for settlement reduction, reduction of risk of liquefaction or as impervious barriers. Some common applications of jet grouting are shown in Fig 3.

Mr. Stefan Toth also illustrated and explained several case histories about the design and construction of jet grouting. Mr. Stefan Toth also replied and clarified several questions about the applications of jet grouting.

In conclusion, Mr. Stefan Toth remarked that jet grouting technique has advanced tremendously in the past few years after extensive research in many research institutions in Europe and USA. Jet grouting is a very powerful, innovative and useful ground improvement technique and has great potential to solve many difficult or unsolved problems in geotechnical engineering.

The talk was ended at about 6.30 pm with thanks from the floor in the usual way. ■

Talk On "European Installation Bus System"

Reported by: Ir. Mohd. Sobri bin Saleh, ITSIG

A talk on the European Installation Bus (EIB) system was held at Bangunan Ingenieur in Petaling Jaya on 7 June 2004. It was presented by En. Dahari bin Mat Siran, the Engineering Manager of Hager Engineering Sdn Bhd, a company that specialises in electrical and control systems for home and building installations. The talk was attended by fifteen participants.

En. Dahari started with an introduction of the EIB system, an open bus system for decentralised electrical control systems. EIB standardisations and certifications are managed by EIB Association (EIBA), based in Brussels, Belgium, which was founded in 1990 by 15 electro-technical and building management industry leaders with the aim to promote the system in the international market and as a standard system for home and building system applications. However, in April 1999, EIBA together with two other European associations, namely BatiBUS Club International (BatiBUS) and European Home System Association (EHSA) merged to form the Konnex Association (KNX) with the principal aim of promoting KNX, a single open communication protocol as the standard for home and building electronic systems. Details about Konnex's protocols etc. are available at the following URL: http://www.konnex.org.

The functional methods of EIB are based on the Open Systems Interconnection (OSI) model, the most commonly used reference model for data communications.

It is an open system concept whereby different companies are able to develop their own products based on EIB specifications. Presently there are over 110 different companies manufacturing EIB devices which share a common protocol system. For example, EIB devices manufactured by Hager can communicate with those of Merten, ABB, Gira, Siemens, etc. This is made possible because their communication modules built in bus couplers (explained in a later paragraph) follow EIB specifications. EIB has been certified by Technical Committee 247 of Comité Européen de Normalisation Electrotechnique, European committee (CENELEC TC247).

The basic components of a functional EIB system are two-core bus cabling, a power supply unit (+6/-4 29Vdc-640mA) with the option of a 12Vdc totally sealed battery backup, input modules, output modules, and, in many cases, controllers. Bus cable specifications are: twisted pair 0.8 mm^2 operating at 9,600 bits per second, having an execution speed of 20ms and can be used for both the signal and power. Tested to 4kV insulation level, the bus cable (see Figure 1) in conduit can be laid in parallel with power cables.

The smallest functional EIB unit is the line which comprises four segments, each capable of supporting up to 64 devices, thereby allowing a maximum of 256 devices to be connected. A larger area (zone) can be created with a maximum of 16 lines. The configuration can be further expanded into a network of up to 16 areas, thereby being able to accommodate a maximum of 65,536 end devices or bus users.

A binary input module is used for detecting or measuring input signals such as dry contacts, 240Vac, 24Vdc, 0~10Vdc, etc., which are then transmitted over the bus to interrogate or activate actuators, dimmers, heater valves, etc. Figure 2 shows a typical application where command inputs can be used to send orders for the outputs to act accordingly. Whilst an input switch can be programmed to give the command to turn ON and OFF a group of outputs, an actuator can be configured to receive signals from several groups of inputs. Lighting, shutter and heater actuators can be individually controlled by different switches, as required. But the three different actuators, as shown in the diagram, can also be programmed to operate simultaneously with a command switch.

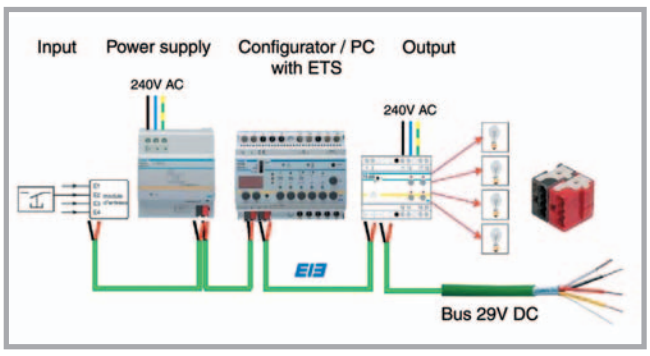


Diagram 1: Basic components of an EIB System.

Ir. Osman presenting a gift to En. Dahari

A twisted pair communications end device consists of a bus coupler unit (BCU) and an application module. The BCU is a communications module made up of a transceiver and a processor, which contains a micro-controller with ROM, RAM, EEPROM, ADC, PWM and serial interfaces. It represents the universal link between the application (e.g. switch or sensor) and the communications system and acts as the electrical contact between the applications and the bus. Common types of application modules are touch sensors, temperature sensors, brightness sensors, motion detectors, presence detectors, infra-red sensors, RF receivers, etc.

Monitoring and control of the fieldbus system can be established with the use central stations (PCs) connected to the fieldbus through a gateway, LAN switch and ISDN line. While viewing and control can be set up through a connection to a LAN switch, downloading of EIB Tool Software (ETS) (and configuration of inputs and output links, parameters, etc.) to field devices is done from a PC via an RS232 or USB/EIB interface connected to the bus (see Figure 3).

With the combined support of all EIB product manufacturers at present, EIB can be easily applied to existingor new installations, whereas proprietary systems are limited in terms of interoperability and product range. Available EIB products and applications include:

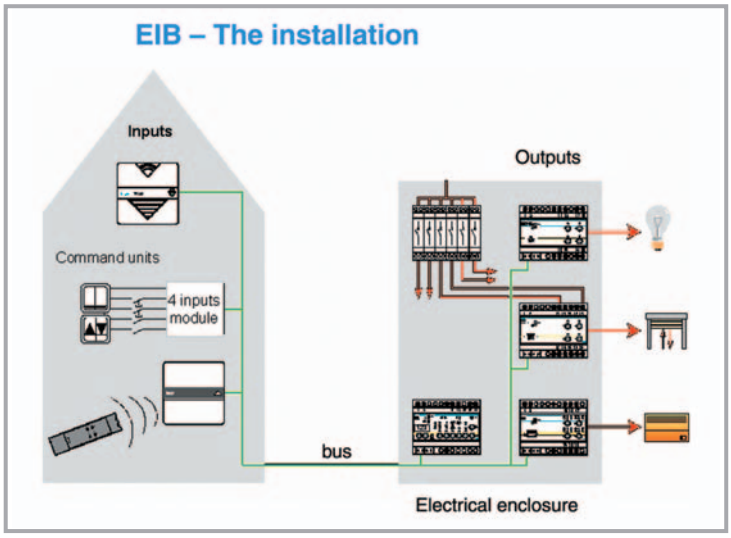


Diagram 2: Typical bus linking inputs and outputs

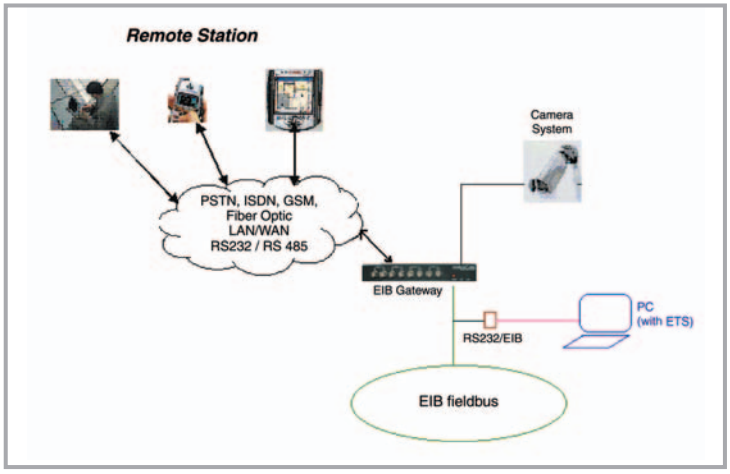


Diagram 3: Typical integrated control and monitoring system via an EIB gateway

- Automation of building installation systems (e.g. mechanical, electrical, security, etc.)
- Remotely monitor, control, and perform data acquisition, visualisation and fault alarm notification of a system from anywhere (e.g. residential home, commercial building, hospitals, etc.)
- Future-home system
- Integrated energy management system
- Intelligent intruder alarm system
- Intelligent fire and security detection system
- CCTV surveillance control system
- Intelligent hotel guestroom management system
- Audio and audio apartment intercom system
- Lighting control management system
- Motor control centre management system
- Air-conditioning management system

Responding to a question from the audience on the acceptance of EIB in Malaysia, the speaker said that it has been well implemented in many private bungalows but not in commercial buildings as the *open system* concept has not been fully understood. In the Asian region, however, it is already establishing itself as the leading technology in building automation and control.

At the end of the talk, a live simulation of a simple EIB system including configuration of group addressing was demonstrated by a Hager system engineer.

As a token of appreciation for giving the talk, the Chairman of the Information Technology Special Interest Group (ITSIG), Ir. Osman Khan, presented a gift to En. Dahari Mat Siran. ■

Fourteenth Professor Chin Fung Kee Memorial Lecture

Reported by: Ir. Dr Ooi Teik Aun, Organising Chairman

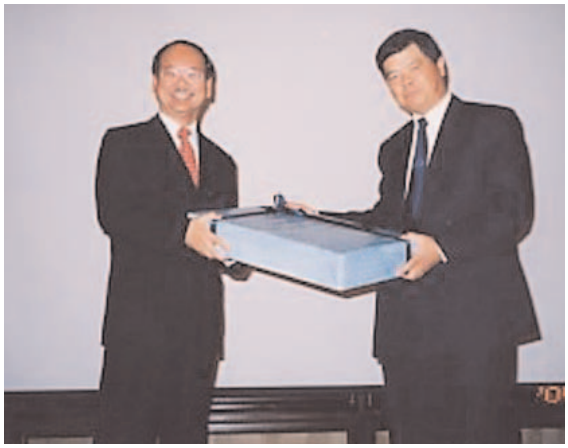
The 14th Professor Chin Fung Kee Memorial Lecture-cum-Lunch, jointly organised by The Institution of Engineers, Malaysia and Engineering Alumni Association of The University of Malaya, was held on Saturday, 2 October 2004 at the Sheraton Subang Hotel, Selangor Darul Ehsan. The lecture-cum-lunch was well attended by 300 participants.

The lecture entitled "Kuala Lumpur: Re-Engineering A Flooded Confluence" was delivered by Y.Bhg. Datuk Ir. Haji Keizrul bin Abdullah, Ketua Pengarah, Jabatan Pengairan dan Saliran, Malaysia.

The lecture highlighted the KL flooding problems and its causes, and traced the engineers' effort to contain it, utilising both structural and non-structural measures, and culminating in the present works under the Stormwater Management and Road Tunnel (SMART), a dual-purpose tunnel to handle both flood and traffic flows. This dual-purpose tunnel is the first of its kind in the world.

Kuala Lumpur or KL as it is more fondly called was founded in the late 19th century as a tin mining settlement at the muddy confluence of the Klang and the Gombak Rivers. A century later it had become the nation's largest city, its capital and the heart of commerce and business. The transformation of KL into an ultra modern metropolis as it is today has not been without its trials and challenges. The rapid development of the last three decades has brought with it urban congestion, traffic gridlock and devastating bouts of flooding that have turned a muddy confluence (*kuala lumpur*) into a flooded confluence (*kuala banjir*).

KL is situated in the mid upper reaches of the 120 km long Klang River which drains a catchment of some 1,288 sq. km. The river originates in the state of Selangor, flows through the Federal Territory of KL before re-entering Selangor where it meanders through gently rolling lands and a flat coastal plain and finally discharges into the Straits of Malacca. Situated in a flood plain, KL has experienced a number of major flood events with the worst recorded being the flood of 1926.

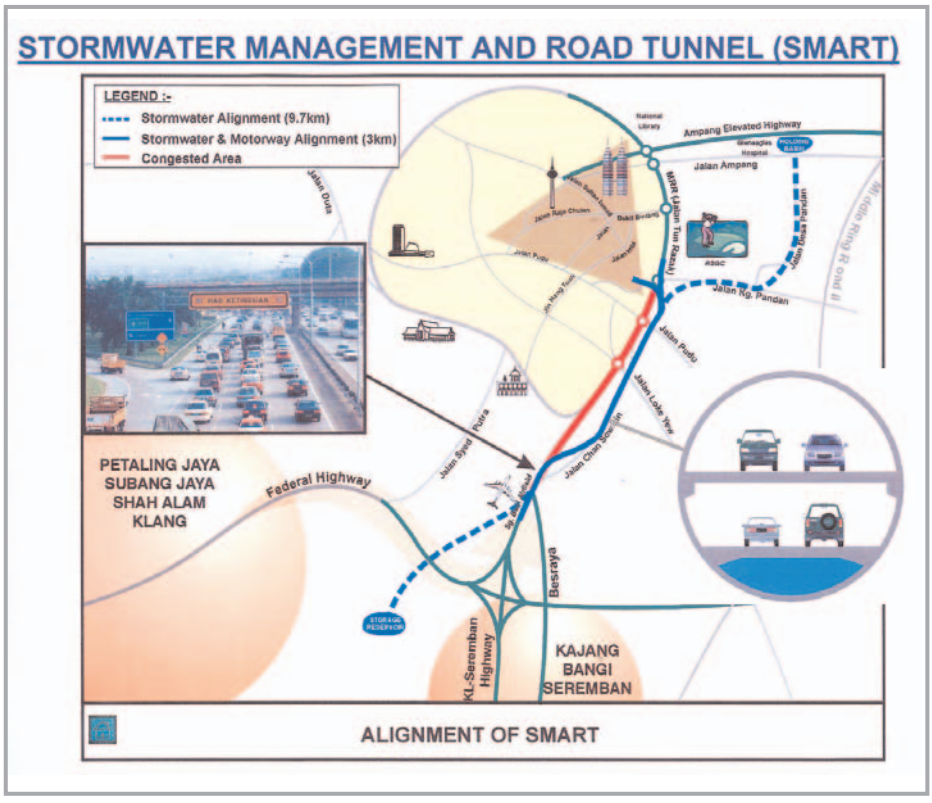


Prof Ow (right) presenting a token of appreciation to Datuk Keizrul

However, it was only after the disastrous flood of 1971 that efforts were initiated to resolve the flood problem.

By the mid 1970s, a flood mitigation Master Plan had been developed which incorporated a number of engineering options including upstream storage; ponding and pumped drainage; and improving the drainage capacity of the Klang River and its major tributaries. A decade later, this plan had been enlarged to cover the whole Klang Valley and modified to take into consideration the Government's decision to cancel the proposed Gombak Dam. During the 1990s, the pace of development increased with more green areas being urbanised and this resulted in a three-fold increase in the annual discharge of the Klang River at the city centre. Entering the millennium, flooding of the city has become an annual event.

The ongoing works under the Kuala Lumpur Flood Mitigation Project is designed to reduce the occurrence of floods in the city. However, to be effective in the long term, the proposed program of structural works must be combined with the implementation of Integrated River Basin Management measures. The appropriate non-structural flood mitigation measures including land-use planning and development controls in floodplain areas have to be looked into seriously. If these measures are not implemented, then the community will in one way or the other end up paying for a higher cost in future flood mitigation works. ■



Facelift For Old Folks And Children Home

Reported by: Sdr. W.L.Cheng

Activity	:	**Facelift Work for PKWTWP (Persatuan Kebajikan Warga Tua dan Kanak-kanak Wilayah Persekutuan).**
Date	:	**2 November to 5 December 2004**
Organised by	:	**Social & Community Portfolio, G&S.**
Organising Committee	:	**Sdr. Cheng Wei Loon (Leader), Sdr. Ho Wee Leong, Sdr. Bernard Tan, Sdr. Ivan Tan, Sdri. Cheong Sze Yin.**

Construct a high-rise condominium? That's easy for engineers. If we can do that for the better-off people, why not provide a better quality of life for the less fortunate?

Project kick-off

Engineers in action

The G&S has taken the initiative and recently embarked on a project to improve the living condition of the Persatuan Kebajikan Warga Tua dan Kanak-kanak Wilayah Persekutuan (PKWTWP). PKWTWP is a shelter home for the neglected and homeless old folks and children located at Kepong, Kuala Lumpur.

G&S has constructed awning at the front of the house, replaced doors, repaired floor parquet tiles, replaced toilet cisterns and plumbing, repaired electrical fittings, and painted. The members and volunteers spent their off-day to complete the painting and repair works themselves on 7 November 2004 and 28 November 2004.

In conjunction with the project, G&S organised a lunch with the folks and children of the home on 5 December 2004. We were honoured to have Y.B. Datuk Dr. M. Kayveas and IEM Deputy President, Ir. Prof. Dr. Ow Chee Sheng

Drawing contest

Datuk Dr. M. Kayveas: "Good job!"

Show them we care

Thank you G&S!

to grace the event. Both Datuk Dr. M. Kayveas and Ir. Prof. Dr. Ow commended G&S young engineers on their committed effort in community service. Datuk Dr. M. Kayveas said, "I'm impressed by your commitments to help the needy, to give them the better quality of life. Your effort has helped to lessen the constraints of voluntary organisations in sheltering the less fortunate in our society."

In the morning, G&S held a drawing contest for the children. The children had fun and showed their drawing creativity. Datuk Dr. M. Kayveas presented souvenirs from IEM G&S to sponsors and volunteers of the project and to the drawing contest winners.

The highlight of the day is the launching of the brand new G&S banner with the theme ***"Show Them We Care"***. This is a symbol of G&S commitment to community service.

The greatest reward for us G&S through this project, is the smile and appreciation from the children and old folks. Come on engineers, be part of our community service team!

Another milestone for the hip, happening and **CARING** young engineers.

The G&S team would like to record our appreciation to the following sponsors: **Bluescope Lysaght (M) Sdn. Bhd., Sungai Besi Contruction Sdn. Bhd., Kitacon Sdn. Bhd., Pagoda Steel Works, Giant Ace Sdn. Bhd., Jurusanwa Enterprise Sdn. Bhd. & Pumpen Engineering Sdn. Bhd.** ■

For more information about IEM G&S community service projects, please e-mail **iemgs@yahoo.com**

Site Visit To Bakun Hydroelectric Project, Sarawak (10-12 September 2004)

Reported by: Ir. Zainal Abidin bin Othman, Water Resources Technical Division

As in any other hydro construction site visits I have conducted before, the technical visit to the Bakun Hydroelectric project which is under construction in Sarawak certainly lived up to my expectations.

Upon arrival with a group of seven other IEM members, my curious anticipation and enthusiasm were deflated when after waiting for some time at the arrival hall of the Bintulu airport, no one came to receive us as arranged. After a few phone calls, we piled into three four-wheel-drive vehicles and were on our way to the Bakun site some 150km away.

Upon arrival after a journey of almost three hours, we checked in at the Bakun Resort located within the project site. The dam site is located on the Balui river which forms the upper course of the Rajang river, upstream of Belaga town in the Kapit Division of Sarawak.

After lunch at a restaurant near the Resort, we were briefed by the Chief Resident Engineer, Mr. Tan Chuan Ngan of Sarawak Hidro Sdn Bhd (SHSB). SHSB is a wholly-owned subsidiary of the Ministry of Finance Incorporated, the developer of the Bakun Hydroelectric Project. The Bakun Project comprised a Concrete Face Rockfill Dam 205m high, eight power tunnels each 8.0m in diameter, 8 x 300MW (2400MW) power generating units housed in a surface power station, and a gated spillway with a discharge capacity of 15,000m^3/s. The upstream coffer dam (70m high) and the three diversion tunnels each 12m in diameter and approximately 1.4km long are completed and in operation. The diversion tunnels were completed in April 2001 while the upstream cofferdam was completed in June 2002.

According to the construction programme, the first unit (300 MW) is scheduled to be commissioned in July 2007 and the other seven units will follow subsequently. The reservoir impoundment is planned to commence in early 2007 and upon impounding, an area of 696km^2 will be submerged.

Apart from our group, the local Councillor and his staff were also present at the briefing and there were good exchanges and discussions on the project from all parties. The briefing ended rather late and there was a heavy thunderstorm as well which was quite unusual at this time of the year. We were quite worried about the rain continuing to the following morning as we were scheduled to go for the site visit.

Even though it was drizzling the following morning, the sun finally showed up later in the morning when we started our site visit. Our first stop was the outlet of the diversion tunnel which was flowing at full capacity after the rain throughout the night. Then we proceeded to the inlet of the massive diversion tunnel and saw the river flow level lapping the crown of the tunnels. We were informed that the river has on a few occasions swollen to full potential reaching a further 10 meters, submerging the diversion intake and causing spectacular water jet discharges at the outlets.

Next, we were driven to the crest of the completed upstream auxiliary cofferdam and had a good view of the dam foundation and construction of the Bakun dam. Placing of rocks from the downstream toe of the dam and excavation along the spillway on the left abutment went on steadily. Our next stop was the left abutment of the dam at a crest level of 235m asl (above sea level.)

The next highlight of the visit was the walk through the adit tunnel which accesses the eight power tunnels.

BAKUN HYDROELECTRIC PROJECT TECHNICAL DATA

RESERVOIR		
Maximum Operating Level	:	228m asl
Minimum Operating Water Level	:	195m asl
Surface Area at Maximum Operating Level	:	695km^2
Catchment Area	:	14,750km^2
Volume at Maximum Operational Level	:	44 x 10^9 m^3
Perimeter	:	Approx. 2,000km
RIVER DIVERSION WORKS		
Length of Diversion Tunnel T1 (riverside)	:	1,337m
Length of Diversion Tunnel T2 (riverside)	:	1,429m
Length of Diversion Tunnel T3 (mountainside)	:	1,520m
Internal Diameter of Diversion Tunnel	:	12m
Height of Auxiliary Cofferdam	:	70m (104m asl)
Height of Integrated Cofferdam	:	91m (121m asl)
Height of Downstream Cofferdam	:	30m (64.5m asl)
DAM (CONCRETE FACE ROCKFILL DAM – CFRD)		
Height	:	205.0m
Crest Level	:	235.0m asl
Crest Length	:	814.0m
Parapet Wall Elevation	:	236.5m asl
Volume of Rock Fill	:	Approx.16.0 million m^3
Surface Slope (upstream)	:	1V:1.40H
Surface Slope (downstream)	:	1V:1.52H
POWER TUNNEL		
No. of Tunnels	:	8
Type of Lining	:	Concrete and Steel
Internal Diameter of Tunnel	:	Concrete Lining – 8.5m
	:	Steel Liner – 7.0m (max.int.design pressure=2.6Mpa. max.ext.design pressure=0.6Mpa)
Length of Tunnel	:	Approx.av.597m
SPILLWAY		
Type	:	Open chute with gated weir
Elevation of Weir	:	209m asl
Length of Chute	:	Approx. 608m
Width of Chute	:	50m
No. of Gates	:	4
Discharge Capacity (PMF)	:	15,000m^3/s
Reservoir Surcharge (PMF)	:	4.6m
POWERHOUSE		
Type	:	Surface
No. of Turbines	:	8
Type of Turbine	:	Vertical Axis Francis
Rated Turbine Flow	:	208m^3/s
Rated Generator Capacity	:	8 x 300MW = 2400MW

It was unfortunate for our ladies colleagues that the superstition of not allowing females to enter the tunnels during construction is being enforced. However with the help of digital cameras, they did not miss anything apart from the noisy and dusty walk through the tunnels. The tunnels are constructed using the traditional drill and blast technique.

The visit ended around lunch time when we headed for the restaurant before taking a boat ride to Belaga, the nearest town downstream of the Bakun dam.

The boat ride to Belaga which is about 37km downstream of the dam site took about 1 hour. Belaga has been serving the needs of the communities along the Balui river before the resettlement of the population due to the construction of the Bakun dam. It is a rather sleepy town with little business activity. We spent about an hour exploring the town and we also talked to the local communities.

On the way back, we stopped at one of the long houses and had a good appreciation of the Orang Ulu lifestyle. We were received by the Chief of the Community and were treated with afternoon tea.

The boat ride was interesting and there were anxious moments when the boatman had to steer the boat through turbulence and mini rapids. We reached the Bakun site late in the evening and feeling tired and hungry.

It was early on the third day when we said our farewells to the CRE and his staff. On the way to Bintulu we stopped at Kg. Asap which was built for the affected communities. It is about 30km from the Bakun site and is a well-planned resettlement scheme. As it was on a Sunday, the market and the town centre were rather busy.

After the three day visit, we left for Kuala Lumpur with fond memories of the people we met, the Bakun site construction challenges, and the hospitality extended to us by the officers of SHSB. ■

Visit to Sungai Selangor Water Supply Scheme Phase 3

Reported by: Ir. Marlinda binti Abd. Malek, Water Resources Technical Division

The Water Resources Technical Division, of The Institution of Engineers, Malaysia (IEM) organised a technical visit to the Sungai Selangor Water Supply Scheme Phase 3 in Kuala Selangor on 10 April 2004. 28 participants attended the one-day visit.

IEM members participating in the Sg. Selangor Water Supply Scheme Phase 3, Kuala Selangor visit.

Background

Syarikat Pengeluar Air Sungai Selangor Sdn. Bhd. (SPLASH) is the concessionaire appointed by the state government of Selangor to develop the Sungai Selangor Phase 3 Water Supply Scheme (SSP3) on a Build, Operate and Transfer (BOT) basis.

The main components of the scheme are the construction of the Kuala Kubu Baru Dam, the realignment of the Kuala Kubu Baru–Frasers Hill Road and the construction of the Rasa and Bukit Badong Water Treatment Plants.

Upon completion, SPLASH is required to operate the dam and treatment plants for the duration of the 30-year concession, commencing from January 2000. Under the scheme, SPLASH recovers its investment from Perbadanan Urus Air Selangor (PUAS) through a fixed capital charge and a variable supply charge based on the volume of water supplied in bulk to PUAS.

Bukit Badong Phase 3 Water Treatment Plant

The Bukit Badong Water Treatment Plant is located at Mile 28, Jalan Ijok–Sg. Buloh, Ijok which is about 7km from the town of Batang Berjuntai in the district of Kuala Selangor. The plant is built in 2 stages. Stage 1 with a capacity of 400MLD was completed in December 2003 and started supplying water in bulk to PUAS since then. Stage 2 construction started in March 2003 and will be completed in July 2005, adding another 400MLD to its capacity. The total capacity for both stages is 800MLD, catering to the water demand in Shah Alam, Klang and part of Kuala Lumpur.

The Bukit Badong Water Treatment Plant employs a conventional treatment process consisting of aeration, clarification, filtration and disinfection. The plant consists of 8 main buildings, namely the administration building, filter control building, chemical building, store, workshop, chlorine building, treated water pump house and generator building. A total of 40 quarters are provided for the 50 employees and their families.

The Kuala Kubu Baru Dam

The Kuala Kubu Baru regulating dam completed in July 2003 is an earth core rock-filled embankment dam of 110m height and 750m crest length, giving a total storage of 235 million m^3. The catchment area is 197km^2, while the impounded area is just 6km^2. This makes the dam the highest in terms of storage in relation to the area that needs to be flooded. The dam provides a yield of 1100MLD which is sufficient for the Rasa and Bukit Badong Water Treatment Plants located downstream. ■

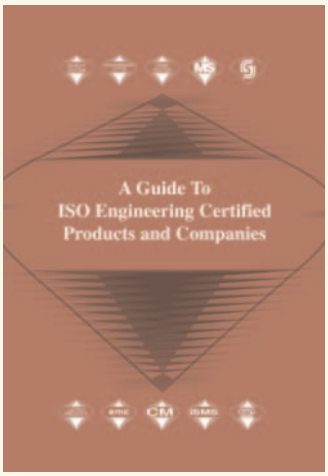
A Guide To ISO Engineering Certified Products And Companies

Dimension Publishing - the publisher of The Institution of Engineers, Malaysia (IEM) - is proud to bring you the brand newly launched A Guide To Engineering Certified Products And Companies publication. This publication will be focusing on the country's leading engineering companies and organisations that have acquired the prestigious International Organisation for Standardisation (ISO) certifications for either their respective services or products, or for both.

It is designed to specifically focus on ISO accomplishments and achievements by Malaysia's leading companies providing or producing engineering-related products, systems, automation, consultation, and other engineering-based services.

Companies featured in this unique publication encompass a wide-ranging field of engineering sectors, including manufacturers, developers, integrators, planners, designers, and many more. More importantly, they are all innovators who have been verified by the international standards authority for their industry-leading techniques, ideas and business applications.

For more information, please call us at:
DIMENSION PUBLISHING SDN BHD
Unit No. 3A-10, Block F,
Phileo Damansara 1, 9 Jalan 16/11,
46350 Petaling Jaya, Selangor.
Tel: 603-7955 5335
Fax: 603-7955 5773
Email : info@dimensionpublishing.com.my



Talk On AOTD Experience In Pilot Plant Operations

Reported by : Mr. Parthiban Siwayanan, AOTD, Malaysian Palm Oil Board

The Advanced Oleochemical Technology Division (AOTD), formerly known as AOTC, is a newly-formed division in Malaysian Palm Oil Board (MPOB). The division was established on 18 May 2004. Any new laboratory-scale process or technology developed by AOTD researchers that has the potential to be commercialized will be scaled up into pilot plant production.

Laboratory findings have confirmed that when palm oil and its products are epoxidized, they react with polyhydric alcohols to yield polyols. These polyols are used to produce polyurethanes for various applications. In view of the promising development, the laboratory scale process of palm-based polyol was upgraded into complete pilot plant production. A pilot plant capable of producing 800 kg polyols per batch was erected in 1999. It was designed by considering the overall view of various functions involved in unit operations. Several technical problems were encountered during the pilot plant commissioning stage and were rectified after a series of modification works. Currently the pilot plant is fully operational. Numerous batches of polyol has since been produced.

Pilot Plant Processes and Unit Operations

There are eight unit operations involved in the process, comprising three reactors (R1, R2 and R3), one settling tank (S1) and four storage tanks (T1, T2, T3 and T4). The processing stages and their respective unit operations are shown in Figure 1.

Three main reactions are involved in the pilot plant production of polyol:

- Reaction between glacial acetic acid and hydrogen peroxide to produce peracetic acid in R1.
- Reaction between palm oil and in-situ formed peracetic acid in R2.
- Reaction between dried epoxidized palm oil and polyhydric alcohol in R3.

Construction Materials

All the vessels used for the entire process are made of either stainless steel 316 or 316L. Other equipment besides the vessels (e.g. pumps, pipe works, valves and ancillary items) are also made of stainless steel. The gaskets and seals are made of either PTFE or PVDF.

The internal surfaces of the three vessels involved in service with hydrogen peroxide and peracetic acid were initially polished with a rotating abrasive disc to give 240 grit roughness before being subjected to chemical treatment. Polishing treatment was also made on other equipment to ensure cleanliness and stability of the contact surfaces to avoid excessive decomposition of hydrogen peroxide and peracetic acid. The four-step chemical treatment involves detergent cleaning, pickling, passivation and conditioning.

Chemical Treatment

The first detergent washing process was applied to remove extraneous materials from the metal surfaces to ensure that they do not adversely affect the process and also to give proper foundation for subsequent chemical treatment. Detergents containing no alkalis or abrasives were used.

The second pickling process was to remove metals, metal oxides or weld scales from the surfaces at the start of a treatment exercise. It effectively exposed inclusions of foreign bodies. Commercially available pickling paste was used.

The third passivation process involved treatment using a nitric acid solution, which rendered the metal surfaces less likely to decompose hydrogen peroxide. It also protected these metals from corrosion.

The final conditioning process improved the compatibility of the surfaces through prolonged contact with diluted hydrogen peroxide.

Process Safety of Polyol Pilot Plant

Reactor R1: Production of Peracetic Acid

The first stage of the process is an oxidation reaction between glacial acetic acid and hydrogen peroxide from which the product is a peracetic acid solution. R1 is a jacketed vessel equipped with heating and cooling systems and an agitator.

The minimum concentration of hydrogen peroxide that can cause explosion when mixed with organic compounds is 44%. Keeping the overall composition of hydrogen peroxide in R1 below 20% ensures that the composition cannot enter the explosive limits. The reaction temperature is maintained below 45°C. If the temperature exceeds 45°C, cooling is applied immediately. This is necessary to avoid the operation from exceeding the self-accelerating decomposition temperature of peracetic acid, which is above 55°C.

For safety reasons, R1 is equipped with a temperature alarm system. The alarm is set at 5°C above the operating temperature. Incorrect reactor conditions or the presence of unusual amounts of decomposition catalysts may result in temperature exceeding the self-accelerating decom-position temperature. When this happens, peracetic acid emits acrid smoke and toxic fumes of carbon monoxide and carbon dioxide. The oxygen liberated by decomposition could result in an

oxygen-enriched atmosphere, which can lead to fire and/or explosion risks.

R1 is also equipped with an exhaust ventilation system. This allows adequate ventilation to permit gases and vapours to escape to the atmosphere during reaction and in case of serious decomposition. This system prevents pressure from building up in R1. The surrounding air is drawn into R1 through an inlet nozzle. The gases and vapours mix intimately in air and these airborne mixtures are carried through the polyethylene pipes before being emitted to the atmosphere.

Reactor R2: Epoxidation of Palm Oil and Spent Acid Removal

Crude palm oil is melted in T3 before being allowed to enter R2, which is a jacketed vessel equipped with a heat exchanger and an agitator.

The epoxidation reaction in R2 is highly exothermic and could break the epoxide rings if the temperature exceeds 90°C. The temperature of R2 can be efficiently controlled below 70°C with the heat exchanger. An experienced operator who is well aware of the temperature increase profile should carry out the dosing of peracetic acid.

For safety reasons, R2 is equipped with an exhaust ventilation system to prevent pressure build-up. For additional safety in case of emergencies, an emergency relief system is fitted to carry the liquid into a collection tank.

The spent acids are separated from the product (epoxidized palm oil) in R2. A transparent plastic hose is used to transfer the aqueous spent acids into a fully vented HDPE container. This is to prevent pressure build-up in the container due to decom-position of the remaining hydrogen

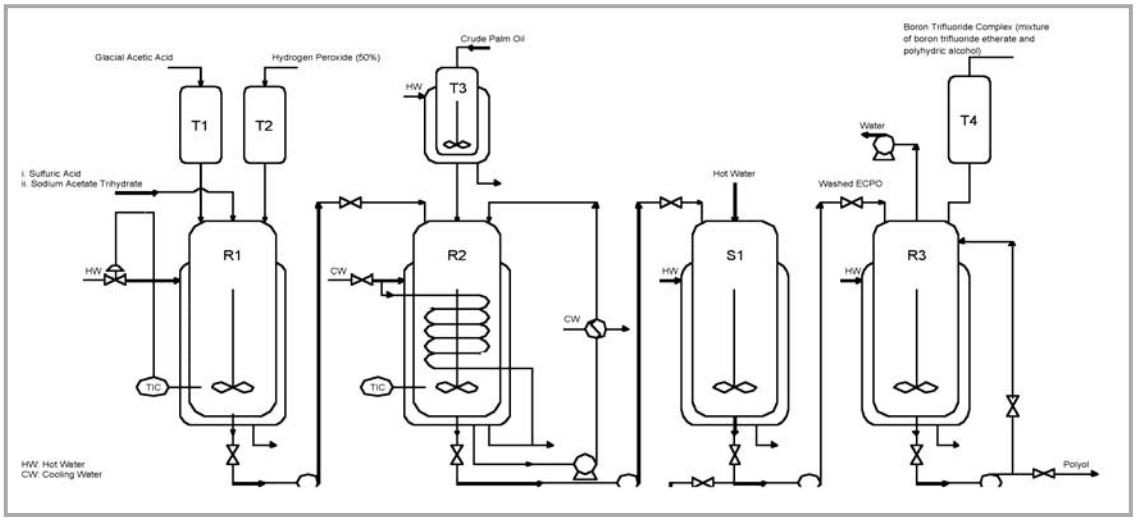


Figure 1 : Process flow chart of Polyol Production

peroxide and peracetic acid in the spent acids. The spent acids are further diluted with water before being discharged into the drain.

Reactor R3: Drying of Epoxidized Palm Oil and Production of Polyols

The wet epoxidized palm oil is dried in R3, a jacketed vessel equipped with vacuum, cooling and heating systems and an agitator. R3 is operated under vacuum to remove the water present in the oil phase of wet epoxidized palm oil. The vacuum is released after the drying process by allowing nitrogen gas to enter R3 (nitrogen blanketing.)

For the production of polyol, it is necessary to premix polyhydric alcohol and boron trifluoride etherate in a vessel to form a complex mixture before being poured into T4. The vessel is fitted with a vent that is connected to an exhaust ventilation system in order to eliminate ether, which is highly flammable. The epoxidized palm oil reacts with polyhydric alcohol in the presence of boron trifluoride to produce polyol.

As part of the safety measures to counter the exothermic reaction in R3, the temperature is controlled below 90°C by cooling, to prevent polyol from polymerizing. A small portion of water is added to the polyol at the end of the reaction to deactivate the remaining boron trifluoride.

Conclusion

The process and safety aspects of the palm based polyol pilot plant encompass the processing steps involved in the production, design of the unit operations and operation procedures. Effective engineering controls and operating practices are essential in the pilot plant production in order to ensure the process to be completely safe and clear of danger. ■

A Half Day Seminar on "Innovations in Pump Installation, Maintenance and Energy Savings"

Reported by: Ir. Gary Lim Eng Hwa, Deputy Chairman, Building Services Technical Division

A half-day seminar on "Innovations in Pump Installation, Maintenance and Energy Savings" was conducted by "Mr. Jim Laidler, International Sales Manager" of S A Armstrong Ltd. on 7 August 2004, in conjunction with the Building Services Technical Division (BSTD) 2004 AGM chaired by Ir. Yeo Boon Kah, Chairman of BSTD.

The seminar touched on the technology of Vertical In Line (VIL) pumps which can result in energy and space savings. The first VIL pump was developed in 1921 by United Pumps for use in the oil industry. Today, VIL pumps cater for the general industry with flows exceeding 10,000 usgpm at 180 feet of head.

The VIL pump system was compared to conventional base mounted pump systems and the speaker highlighted various benefits of using a VIL pump system. However, to maximise the benefits, a VIL pump system should be introduced at the design stage whilst retrofitting existing systems may still yield benefits depending on the extent of the exercise. Pictures of actual installation of both systems were shown to highlight the benefits of VIL pump systems. Figure 1 shows an installed VIL pump.

For a single pump arrangement comparison, these benefits were discussed:

- space saving because the pump is mounted along the pipeline above the ground level;
- saving in installation costs by doing away with base plinth, grouting and pump alignment;
- saving on the number of accessories like flexible connectors;
- able to expedite piping installation without the presence of physical pumps by providing a pre-determined space for the VIL pump;
- easy of maintenance of the pump because the access is from the top without affecting the pipeline. Impeller trimming and balancing is critical to optimise pump performance and energy saving hence good access to the impeller makes the job easier. Less parts in the installation equate to lesser frequency of parts change. It can also imply lesser friction losses along the pipeline which equates to lesser energy cost;
- vibration-free operation without the need to carry out pump alignment all the 3 planes.

For a multi-pump arrangement comparison, these benefits were discussed:

- pipeline saving because of shorter length of pipes;
- shorter pipes means lesser pipe friction losses, hence energy savings.

From the pictures presented, it is clearly shown that head space is critical for a VIL pump installation because lifting equipment like a chain block or even an electrical hoist (for large multi-pump installations) should be erected in order to lift the motor and impeller out of the casing. There should be a clear path out of the maze of pipelines in a large installation. In this respect, retrofitting any conventional base mounted pumps to VIL pumps will have to take this factor into consideration. ■

Figure 1: An installed VIL pump

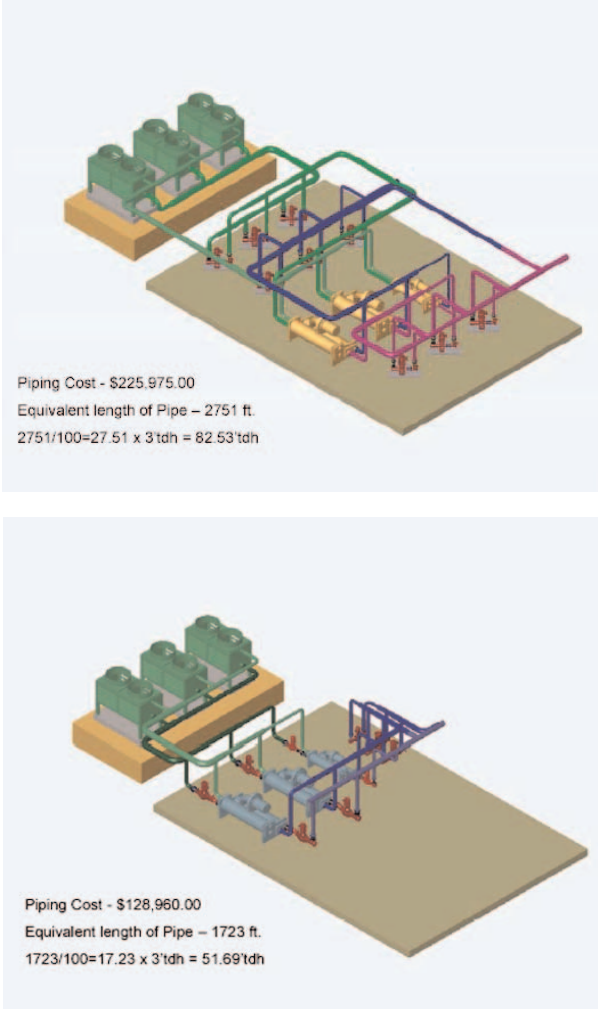


Figure 2: Multi-pump comparison showing space and cost savings

The Art Of Happiness

By: Sdri. Elaine Koh

A writer once said "deaths in magnitude is incomprehensible to the human mind that it becomes a statistic." Even when I see before and after pictures of Aceh, bloated bodies floating in rivers and sufferings of the people in the Tsunami-hit disaster areas, I am not able to fully comprehend the magnitude of the disaster. Of course there is a deep sense of sadness and my prayers are offered to those affected by this disaster. But ashamedly, I am incapable of empathising. Empathy is the capability of a person to put himself or herself in the sufferer's shoes. How can I when all my life I have been sheltered in this safe little cocoon of mine. When I have never had a whiff of a rotting corpse nor had to go hungry in my life. When my daily whining would have to be the cramp on my left foot caused by that daily jam (so I should get an auto!) or that my butt has gone lumpy from that piece of chocolate cake.

I am currently reading Dalai Lama's thoughts on the art of happiness. It gives food for thought. The wise one says that pleasure is not always the same as happiness. Does that ring a bell? Pleasure is only fleeting, derived from the new car or the new dress I am wearing today. But does it make you happy? Of course being in that nice car makes the traffic jam more bearable and really, it does give you the cool edge ala Brad Pitt but I've seen families piled into Kancils happily chatting away (not that I'm advocating overloading a car at that.) My happy childhood memories are of picnics by the beach with my parents over a bucket of KFC or playing in my grandmother's backyard with her pots and pans. It's also the smile on the face of a child I tutored when he finally could write his alphabets. Of course having nice clothes and all those little comforts in life are very good. But there would always be something better to desire for, to upgrade to.

The reason I joined IEM G&S, as unglamorous as it may sound, was because a friend bugged me to death to join. But what made me stay? Maybe it was because there is an effort to add that human element to the engineer in their community projects. Admittedly, they are baby steps compared to some other NGOs like Mercy Malaysia. But still, I guess baby steps are better than none. The volunteers in IEM G&S have full time jobs, and some, like me, work 6 days a week. Sundays are our only day off and believe me, when you work 6 days a week, Sundays become precious. You get selfish the way you spend it. So really, I understand if you can't come out to help. But you can still help in other ways. You can help donate building materials, clothes; you can volunteer your technical skills; you can create awareness by writing or help spread the word around to others who have the time. In fact, if you still don't know how to help out, just drop us a line and we'll find something for you to do.

I am at that point in life where I am taking a step back and reflecting where I am going next. The new year is always a time when we sit back and take stock of our lives. This disaster, at a time like this, made me give thanks for what I have already been blessed. And because I have been so blessed, have I ever given anything back in return? Have I been an instrument of His love? Have you?

For more info on our hip and happening young engineers, visit http://www.iem.org.my/external/g&s/ or e-mail us at iemgs@yahoo.com ■

Announcement:
IEM G&S is currently working on its mammoth issue of the Annual scheduled out in May 2005. So if you're an engineer itching for a say, or just have an inexplicable wish to see your name emblazoned in print, buzz me.