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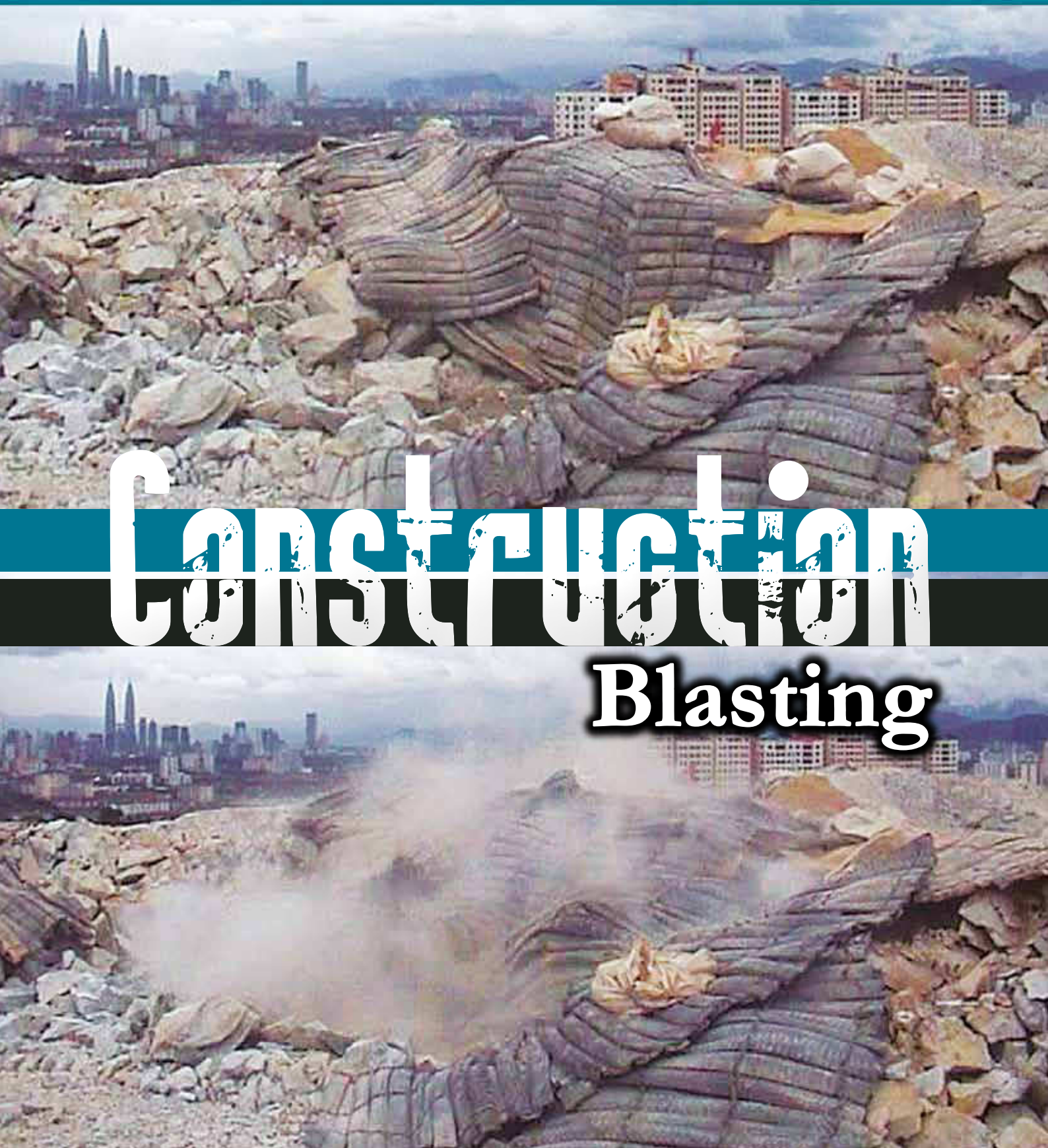

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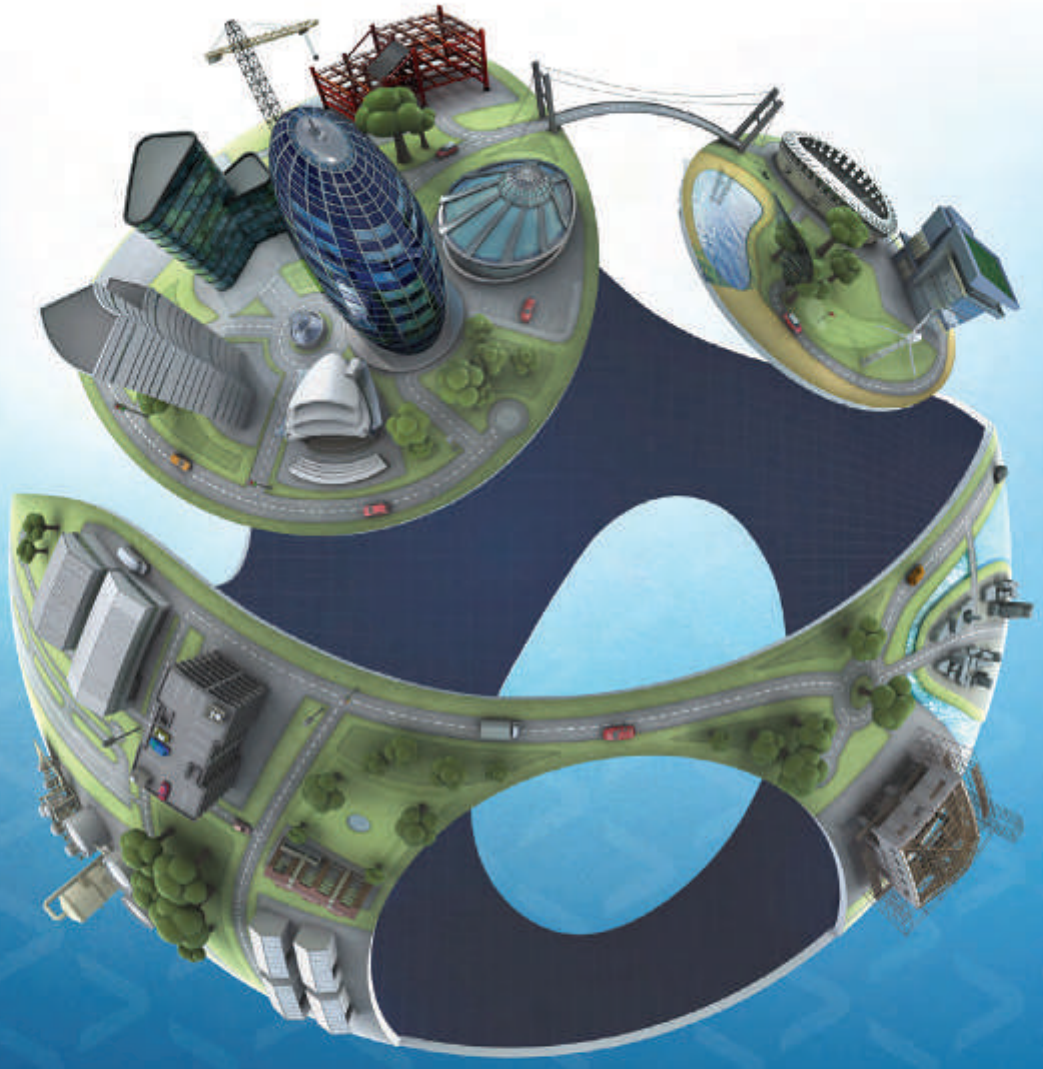

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Getting Paid to Blow Things Up to Smithereens

by ***Ir. Ahmad Rafidi Mohayiddin***
Chairman of the Oil, Gas and Mining Technical Division of IEM

A few years ago, I had the opportunity to visit an open pit gold mine in Pahang and got myself enlightened on the work of a mining engineer. Growing up, the closest link I had to mining was reading about Malaysia being once a premier producer of tin in the world. I also remember sighting this one presumably abandoned tin dredge along the trunk road when my father used to drive the family on the occasional family trips to Kuala Lumpur.

Nowadays, many engineers in the traditional mining industry have adapted to the current needs. The specialized few who are trained in handling explosives are often in high demand. They are present when their expertise is sought after especially where major rock breaking and blasting requirements in quarrying, construction or tunneling works are needed. Lest we forget, the extraction of oil and gas from the earth depth is also a form of mining activity. Explosive is used for borehole casing perforation or for stimulation of wells to improve production.

In this issue of JURUTERA, we pay tribute to the selected men and women of the mining industry who have found their niche in current times. Specifically, to the engineers who make a living blowing things up, literally. We will hear views from the authority and from a prominent industry player on aspects of explosive use in construction blasting and its safety. We will also look at the competency and certification requirements for a blasting engineer in today's context and whether the competencies and the legislations have progressed concurrently to keep up with the nature and demand of the country's development.

I hope readers will find this issue of JURUTERA enriching in bringing to light features on blasting, a subject that is of interest to many but is seldom explored. Hopefully, the more we know about it the better we become especially in making sure that the activity is regulated in the safest way for the public at large. One thing for sure is the need to have more Malaysian engineers to be trained and certified as blasting professionals.

Lastly, on behalf of the IEM's Oil, Gas and Mining Technical Division, I would also like to wish all our readers a Happy New Year 2015. Happy reading!. ■

Ir. Ahmad Rafidi Mohayiddin is a Mechanical Engineer by training and is presently employed at one of the world's largest liquefied natural gas (LNG) production facilities at a single location. He has been in the oil and gas industry for close to 20 years. He is the current session Chairman of the Oil, Gas and Mining Technical Division of IEM.

Construction Blasting:

From The Perspective of REHDA Malaysia

by Putri Zanina

Dato' Soam Heng Choon is the Deputy President of the Real Estate and Housing Developers Association (REHDA), He is also the Deputy Chief Executive Officer and Deputy Managing Director of IJM Corporation Berhad

IN construction work, blasting hard materials such as rocks and boulders at construction sites sometimes cannot be avoided.

"If we can avoid it, we will," says Dato' Soam Heng Choon, the Deputy President of the Real Estate and Housing Developers Association, also known as REHDA Malaysia or in short, REHDA. The association is the national representative body of real estate and housing developers in Malaysia.

Dato' Soam adds: "One of the effects of blasting work is the increase in cost of construction. Blasting of hard materials is not only costly but is also time consuming. There are also other concerns, such as the levels of dust, noise, vibration and structural damage caused by blasting works."

The public, he continues, will raise these concerns as well. "That's why when developers buy land, they try to avoid sites with rocky structures which require blasting to level the land. But sometimes, underground hard materials are only discovered much later when drilling and other construction works have begun."

"When this happens, the first hurdle that we need to go through is to ask these questions: Is blasting necessary and is it acceptable? If blasting needs to be done, noise, vibration and dust cannot be avoided," says Dato' Soam who is the Deputy Chief Executive Officer and Deputy Managing Director of public listed IJM Corporation Berhad, one of Malaysia's leading construction groups.

> **"One of the effects of blasting work is the increase in cost of construction. Blasting of hard materials is not only costly, but is also time consuming. There are also other concerns, such as the levels of pollution from dust, noise, vibration, structural damage and environmental destruction... The adverse effects of construction blasting can be mitigated."**

The 55-year-old, a civil engineer by profession, is also the Chief Executive Officer and Managing Director of IJM Land Berhad, the Managing Director of RB Land Sdn. Bhd. and IJM Properties Sdn. Bhd. and a director of ERMS Berhad as well as a trustee of Construction Research Institute of Malaysia (CREAM). He served the Ministry of Works for a decade before joining the private sector. He has extensive experience in construction and property development.

He says: "Land is becoming more scarce and expensive. In many cities, flat land is almost all gone. For example, in Penang – there are the sea and the hills. When we have to develop land here, we have only two ways to go. Either we reclaim the sea or we cut the hills. Both may result in a lot of environmental destruction and the public will make a lot of noise. But Penang has clear-cut guidelines – land above 250 feet cannot be developed, below that height, we can."

"If rocky areas have to be developed, rock blasting comes into play. Noise, dust, pollution, vibration or structural damage on some of things cannot be avoided if we want to have more areas developed. There will always be public complaints and these are we have to deal with." It is in this respect that collaboration with the local authorities becomes crucial for developers to mitigate all potential problems of construction blasting.

Dato' Soam stresses that the adverse effects of construction blasting can be mitigated.

"We take all the precautions based on advice by consultants, including civil and mining consulting engineers. But not all site inspections automatically require blasting as this depends on certain criteria such as the size and volume of rocks at the site. If blasting

> **"REHDA is now the biggest non-governmental organisation for property development in Malaysia."**

works must be done, then a mining consulting engineer (blasting consultant) will come in to assess the site and its surroundings and recommend the suitable blasting design and method," he explains.

ROCK BLASTING TECHNIQUES

Rock blasting using explosives is one of the techniques to excavate, break down or remove rocks. It is the most often used technique in mining, quarrying and civil engineering works such as construction of roads and dams. Beside rock blasting, other available techniques include chemical cracking blasting or gas pressure pyrotechnics, bolder blasting technique and hydraulic machine splitting technique. Dato' Soam mentions that controlled blasting using explosives is more efficient and cost-effective. It is also a faster technique to break rocks found at construction sites compared to other techniques. The amount and type of explosives needed depend on the size, quantity and nature of rocks at the site.

"Blasting becomes a harder choice when we have to build in brown areas, where there is development and residential areas around. To break down rocks near built-up and densely populated areas with houses and other buildings around, we will consider controlled blasting as it can be conducted safely according to the blast design and it is more effective compared to other rock cracking/splitting techniques."

The process of determining whether or not rock blasting is practical is usually complex particularly when the risks are high. The risks involve, among others, the safety of workers and the public, the impact on surrounding structures and the environment as well as engaging the qualified people (licensed shotfirer) to carry out the blasting work. Developers usually engage the services of mining consultant to assess the feasibility of carrying out controlled blasting technique to facilitate and minimise the risks resulting from construction blasting.

Dato' Soam says trial blasting is first conducted on a small scale before the actual blasting. This may be done in many stages – from small to large scale.

"The different stages are very expensive and time consuming, and we may not even get the desired result such as the ideal surface for building. But if it is something we have to do, then we will do it after taking all the necessary steps and precautions," he adds.

PROCEDURES AND GUIDELINES

Before construction work begins, all developers must submit their development plan and get it approved by the local authority. The process planning permission, building plans and endorsement of land development applications have been facilitated with the setting up of one-stop centres (OSCs) which come under the purview of the Ministry of Housing and Local Government. The OSC is directly responsible to the head of the local authority while the OSC Secretariat is headed by a Town Planner and supported by Technical Officers from planning, architecture and engineering fields.

"The local authorities have mapped out which areas can or cannot be developed, so when we submit our development plans, we have to take this into consideration. For geologically sensitive areas, there are geological maps to guide the local authorities in giving development planning permission. Some of the local authorities are quite well versed already so they can advise us accordingly," says Dato' Soam, adding that the geology varies from area to area so the local authorities operating in geologically sensitive areas would be more exposed to the needs of collaborating with the Minerals and Geoscience Department (Jabatan Mineral dan Geosains or JMG).

"If massive blasting has to be done, these local authorities will consult with JMG. However, only the local authorities hold the power to issue stop work order to developers in cases involving serious problems or public complaints," he says.

JMG, which comes under the Ministry of Natural Resources and Environment, covers the usage and safety procedures concerning mining and quarrying. Although the JMG's roles do not encompass construction, its involvement in this field is always sought by the local authorities in terms of getting the proper advice and expertise concerning blasting works at construction sites of development projects. Some of the local authorities particularly those operating in geologically sensitive areas have put this as a requirement stipulated by their OSCs in processing and approving development planning proposals.

"JMG's advice can include trial blasting before the actual blasting is carried out under the supervision of blasting consultants. We also need to get the approval of the Police before carrying out site blasting using explosives," he says. The use of explosives comes under the Explosives Act 1957. The Police needs to ascertain that all persons who handle explosives for construction purposes do not have criminal records. This is enforced by the Police for security reasons.

If new development projects are located near houses or other existing development, developers and contractors will first engage structural engineers to conduct independent dilapidation surveys on the existing structures so as to determine their condition and identify if these have any structural damage. The surveys are done before the start of any construction work, even those that do not involve blasting. The surveys are necessary in order to mitigate any problem, such as house owners' complaints of structural damage after the construction work has begun. Slope conditions for hillside development are also assessed and work will be carried out based on the engineers' estimation and recommendations.

Dato' Soam reiterates that REHDA members are advised to comply with the proper procedures. "We know that our members also work out the best and intensive methods when it comes to carrying out blasting works. Their approach involves getting the most effective results on a case to case basis, based on the advice of their consultants and professional assessments. We do not base on fixed distances to carry out blasting."

JMG's blasting work guidelines stipulate the safe distances or minimum distances to observe for blasting works. "Whether far or near is not the solution," argues Dato' Soam. "The effectiveness of controlled blasting does not depend on keeping to distances alone. The blasting guidelines can be further improved, such as determining the acceptable levels of noise, vibration and dust as

well as achieving the desired results."

"There are mitigation measures to reduce/control noise and vibration from exceeding the limits, for example. The technical aspects can be worked out and more appropriate guidelines can be developed," he says.

Dato' Soam also thinks that it would be onerous to regulate based on distances as the characteristics of sites, including the quantity and nature of rocks vary from place to place.

"REHDA's stand is that there should not be blanket regulations for blasting works. These should instead be assessed on a case to case basis and carried out with expert consultations. Before carrying out rock blasting in sensitive areas, our members are encouraged to get the advice and help of JMG," he says.

However, not all developers and contractors know that JMG offers such services. As such, he suggests that JMG increases awareness on this aspect of its services and conducts discussions with the industry players and other local authorities.

"REHDA encourages our members who encounter rocks at their construction sites to consult JMG and ask the department to assist them and make work better so as to help reduce problems with the public and other stakeholders. Together they can articulate problems especially concerning the public. We at REHDA want this as well."

He says REHDA is open to the idea of collaborating with JMG and the Institution of Engineers, Malaysia (IEM) to develop standard procedures or guidelines for blasting works.

"In undertaking development projects, REHDA members engage the services of engineers – civil, mining and other fields – and these engineers are members of IEM as well. So it is appropriate for IEM, which is multi-discipline – from mining and quarrying to construction – to come out with the guidelines to mitigate some of the problems encountered in development projects."

Dato' Soam recognises the suitability for IEM to initiate the development of proper guidelines for blasting works. He says REHDA also meets regularly with IEM as well as with other relevant associations, including Malaysian Institute of Architects, Master Builders Association, the Royal Institution of Surveyors, Malaysia and the Association of Valuers, Property Managers, Estate Agents and Property Consultants in the Private Sector, Malaysia, which together with REHDA and IEM are all members of the Building Industry Presidential Council (BIPC).

"All the relevant sectors are therefore involved and this is good. We discuss and deliberate on issues affecting our industry. Since the Government does not clearly assign a department to monitor the issue of construction blasting, which now falls under the local authority, all of us can play a role. We can be proactive in helping to come out with the guidelines through IEM," he says.

"Having guidelines is now preferred over developing standards for construction blasting. Problems associated with blasting do not have one fixed solution, therefore what REHDA needs more are guidelines on which blasting methods to use rather than standards."

"Now it is okay for the local authorities to act as the government agency to control, monitor and issue approval as well as stop-work order for construction blasting. We can't have many parties to issue stop-work order. Let the local authorities have the power to do so. But it is also good to get JMG into the system to provide advice when necessary," he says.

PRACTICAL COURSES

Dato' Soam says REHDA has its own institute where relevant courses are conducted for its members.

"We can also get our practitioners to conduct a series of courses for IEM and JMG. Other relevant parties can also get involved. We can talk about the dos and don'ts of developing in rocky areas, as well as provide information on who you can go to for help and what to do in case anything happens at blasting sites," he says, adding that the courses will impart practical ways of getting things done.

"We will touch on things that you don't learn in engineering schools," he says with a smile.

Dato' Soam says courses can also be held at the premises of IEM. "While REHDA can conduct courses on the dos and don'ts for both engineers and non-engineers, IEM can focus on training the engineers."

The REHDA Institute in Kelana Jaya is equipped with a big auditorium and training rooms. The Institute is housed within the premises of Wisma REHDA which was officially opened by the Prime Minister, Y.A.B. Dato' Sri Mohd. Najib Tun Abdul Razak, on 6th November 2014.

REHDA MALAYSIA

Dato' Soam says REHDA was formed 44 years ago on 21st May 1970.

"Our membership then was only 13 but as at 30th September 2014, it has grown to 1,023 members. REHDA is now the biggest non-governmental organisation for property development in Malaysia."

The association has 11 branches: Johor, Malacca, Negeri Sembilan, Perak, Penang, Kedah/Perlis, Kelantan, Pahang, Terengganu, Selangor and Wilayah Persekutuan. In East Malaysia, the Sabah Housing and Real Estate Developers Association and the Sarawak Housing and Real Estate Developers Association represent the interests of their members. However, under an agreement signed on 26th June 1999, both associations and REHDA Malaysia have formed a Malaysian Developers' Council which provides a platform for consultation and closer relationship amongst the three associations.

Membership is open to all real estate and development companies in Malaysia. Dato' Soam says membership is on voluntary basis. "There's no compulsion. So our membership may increase or decrease from time to time as some companies close down and some withdraw while new ones may join in. We have also just amended our Articles of Association to allow subsidiaries of member companies to become our affiliate members. The number is fluid now but affiliate members are coming in."

REHDA promotes and co-ordinates throughout the country the development of land and construction of buildings for residential, commercial, industrial, tourism and other related purpose by its members. Its activities are also geared towards contributing to the economic development of the country. In addition, the association promotes measures aimed at securing improvements pertaining to the techniques and methods of the development of land and construction of buildings in the country.

"REHDA sits on many relevant Government bodies and are involved in the study of issues and problems arising from the development of land and construction of buildings. We propose solutions to the Government through the relevant ministries,

departments and agencies in dealing with problems," he says. At the same time, REHDA protects the legitimate interests of its members by bringing up and articulating issues and problems and discussing these with the relevant authorities in finding solutions. The issues are varied but matters raised primarily concern policy, finance, legislation, technical standards and administrative procedures, which affect the development of land and construction of buildings.

The supreme authority of the association is vested in the Delegates' Conference, consisting of branch delegates and members of the National Council. The National Council manages the affairs of the association. The Elected National Council members form the executive Committee (EXCO) which is established to execute the functions of the National Council. The National Delegates' Conference is held every two years. ■

Occupational Safety and Health in The Construction Sector

Ir. Mohtar bin Musri, M.Sc (Eng) Work Design and Ergonomics and B.Sc (Hons) Mechanical Engineering Director General of the Department of Occupational Safety and Health (DOSH)
Ir. Mohtar oversees the overall planning and the implementation of the core activities of DOSH – enforcement, standard setting and promotional activities. He has served DOSH since the last 15 years. He received the Johan Mahkota Wilayah (JMW) award in 2013; the Kesatria Mangku Negara (KMN) in 2010; and the Excellence Service Awards in 1994, 1997 and 2006. He is a member of the Board of Directors, Board of Engineers Malaysia and a professional Engineer registered with the Board of Engineers Malaysia. He is also the Lead Auditor for Occupational Safety and Health Management System (NIOSH Certification); a member of the Road Transport Consultative Council, the Ministry of Transport; a member of SIRIM Bhd's Certification Panel; a member of TC 159-Technical Committee on Ergonomics, SIRIM Bhd; a member of the Malaysian Standards and Accreditation Council (MSAC); a member of the National Accreditation Council (MYNAC); and a member of the Institution of Engineers, Malaysia.

Q: Please explain the role of DOSH in the construction sector particularly in areas where hill slope development is required, and a new development is surrounded by an already developed residential area especially one located less than 500 metres away. What is the potential impact/disturbance to the public and to the safety of structures?

A: The institution and role of DOSH as the main administrator and enforcer of occupational safety and health (OSH) in the country are well established by the provisions of the Occupational Safety and Health Act (OSHA) 1994 and the Factories and Machinery Act (FMA) 1967. Under these two main statutes, the occupational safety, health and welfare of workers and the public are enshrined, with DOSH essentially being the guardian and custodian.

The Factories and Machinery (Building Operations and Works of Engineering Construction) (Safety) (BOWECS) Regulations 1986 is a construction-specific law made under FMA 1967 which addresses workplace safety and health issues particular to the construction industry. Thus, the role of DOSH as the premier safety enforcer for the construction industry has also already been well entrenched even before the advent of OSHA 1994, i.e. when DOSH was still called the Factories and Machinery Department (FMD).

The BOWECS Regulations are also supplemented by several supporting industry guidelines such as Guidelines for Public Safety and Health at Construction Sites 2007; Guidelines for the Prevention of Falls at Workplaces 2007; Guidelines on Trenching for Construction Safety 2000; and Guidelines on Occupational Safety and Health in Tunnel Construction 1998.

BOWEC 1986 provides safety provisions on excavation work; material handling, storage, use and disposal; piling; and blasting and use of explosives. These provisions are further clarified in the guidelines. BOWEC 1986 also covers the safety aspects of any work activity defined in FMA 1967 as a 'building operation' and a 'work of engineering construction', in any situation or terrain, including construction activity involving hill slope development as well as new development within an area surrounded by an already developed residential area.

For example, the Regulations include provisions on protection of the public, dissemination of information to the public and stability of the adjacent structures during construction activities. However, there is not specific provision under DOSH's jurisdiction dedicated solely and exclusively either to construction work involving hill slopes or new development within an area surrounded by an already developed residential area, at whatever distance. Nevertheless, in such a case where a complaint is made to DOSH by any person or organisation regarding the impact of a new construction activity, DOSH will conduct an investigation and take appropriate action.

Q: Are there any regulations or safety procedures on construction blasting?

A: Yes, of course. The overall legal framework for the use of explosives in any activity is regulated by the Explosives Act 1957 and the Explosives Rules 1923, which are enforced for security reasons by the Royal Malaysian Police. A construction contractor must first obtain a Police permit before proceeding with blasting work. The contractor also needs an earthwork plan approval, which covers processes and procedures regarding blasting work, from the Local Authority, as required under the Street, Drainage and Building Act (SDBA) 1974.

The scope of workplace and workplace-related safety and health is still under the jurisdiction of DOSH. Therefore, if any effects of blasting work have a reasonable possibility of reaching a level where they could seriously impact any member of the nearby public in terms of health or safety, e.g. extremely high intensity noise capable of causing acute ear injury, medium level noise capable of causing noise-induced hearing loss (NIHL) over a prolonged period of exposure, or extremely powerful vibration that could endanger the integrity of a building's structure or component and thereby the safety of its occupants, then the relevant provisions of FMA 1967 or OSHA 1994 or any regulation under them could be brought to bear, even if their focus is mainly for the protection of employees. Two good examples would be the Factories and Machinery (Noise Exposure) Regulations 1989 to protect against possible NIHL, and the Factories and Machinery (BOWECS) Regulations 1986 to control the generation and spreading of dusts and gases.

The only available detailed technical safety aspects of blasting and safe use of explosives at construction sites are outlined in Part XV of BOWEC 1986, enforced by DOSH, which describe specific measures or prohibitions to be complied with regarding: (1) handling of explosives; (2) smoking and open lights/flames; (3) opening of explosives packages; (4) drilling of holes; (5) retrieving of cartridge wrappers; (6) loading of holes near other operations; (7) loading and tamping procedure; (8) warning before blasting; (9) return to the blast area; (10) misfires; (11) precaution before blasting; and (12) operation during thunderstorm. These are now supported further by the Guidelines for Public Safety and Health at Construction Sites 2007.

Q: Will DOSH consider a more comprehensive law under OSHA on blasting at construction sites to cover competency training, issuing of competency certificate etc. to include blasting work in tunnelling, highway construction and other specialised blasting work, especially at or near sensitive structures and where people stay?

A: At the moment, this has not yet been considered. The current provisions for safety in blasting work as already existing in the BOWECS Regulations are believed to be adequate. But if such a need arises in future, then DOSH will look into it.

Q: There has been a growing number of media reports regarding complaints from members of the public affected by construction site blasting. Since blasting is a safety issue, does DOSH handle the complaints highlighted?

A: Yes. Every complaint made to DOSH is investigated. Any complaint on construction-related activities is usually directed to the nearest DOSH state or regional office. The findings of the investigation are conveyed to the contractor involved, and, where appropriate, corrective action requested.

For example, a complaint was made recently to DOSH Wilayah Persekutuan KL & Putrajaya by a group representing nearby residents regarding the frequent occurrence of vibration and alleged fracture in building structure, purportedly as a result of rock blasting activity by a major construction contractor carrying out construction work about 400 metres away from their homes in Precinct 6, Putrajaya.

An investigation was duly done by staff from the Investigation Section of DOSH WP KL & Putrajaya. The investigation showed that the complaint arose as a result of the impact of earthworks, namely surface levelling, piling and rock blasting, being carried out by a sub-contractor. It was also determined that the rock blasting works were performed for a limited period in the daytime, i.e. between 12 noon and 2 p.m., and that the works were about 60% done and needed another two months to be completed. The blasting works had also been approved by the Royal Malaysian Police, and the Police permit was renewed every two months based on the exact blasting site for which approval was sought. However, the site was not registered with DOSH WP KL & Putrajaya.

DOSH WP KL & Putrajaya had then issued a Notice of Improvement (NOI) to the main contractor for the offence of not giving a written notification of a 'building operation'. It also served a Notice of Prohibition (NOP) for all blasting activity, prohibiting all blasting work until the site owner/developer, i.e. Perbadanan Putrajaya, had undertaken a study to determine the exact cause of fracture in building structure and ensured that the proper control measures have been taken by the main contractor.

Q: Is there any government department checking/evaluating blasting design/techniques/proposals and supervising blasting works?

A: Yes. In general, the use of explosives is mainly controlled by the Royal Malaysian Police through the Explosives Act 1957, more for the purpose of public security, rather than workplace safety.

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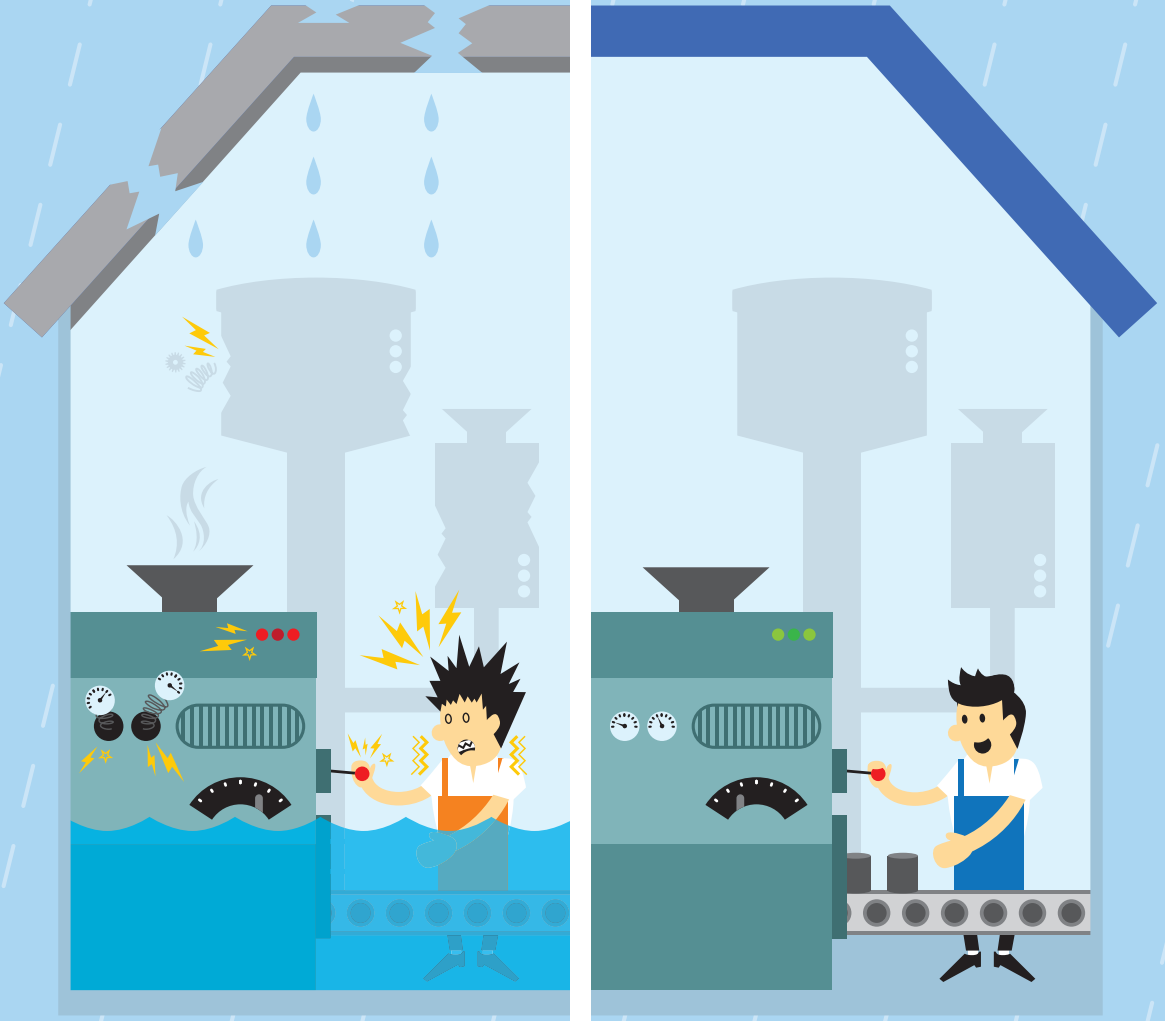

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DOSH is the main agency supervising and overseeing, albeit indirectly, via the main contractor, all blasting activity in terms of OSH at a construction site. The major legislated requirements for safety in blasting and use of explosives at construction sites are as outlined in Part XV, i.e. Regulations 135 to 146, of BOWEC 1986 and certain relevant provisions of OSHA 1994, e.g. the all encompassing Section 15 (1), to oblige the contractor to conform to certain extra general duties as an employer. The impact of preventive measures undertaken is also in fact effectively extended to everybody living or working in the vicinity, whether or not they are employees at the worksite. A committee is now reviewing BOWEC 1986 with the aim of having necessary amendments and additions, including in the aspects of blasting and the use of explosives.

Q: How does the agency ensure that blasting work at a construction site is being carried out by a qualified person? Who is considered a competent/qualified person for blasting work? What is DOSH's policy on this?

A: Regulation 135 of BOWEC 1986 specifically states that :

"Explosives shall not be handled or used except in accordance with the manufacturer's instructions, if any, and under the immediate control of a designated person who has the training, knowledge or experience in the field of transporting, storing, handling, and use of explosives. Such a person shall be required to furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting to be carried out and he shall have adequate knowledge of the dangers connected with their use; and steps shall be taken to see that, when a charge is fired, all persons are in positions in which, so far as can reasonably be anticipated, they are not exposed to risk of injury from the explosion or from flying materials."

In relation to the above, the term 'designated person' has been explicitly defined in the same Regulations to mean "a competent person appointed by an employer to carry out any supervision or inspection or to perform any task or duty prescribed by these (i.e. BOWEC) Regulations". From the way this definition has been framed, the appointment of the 'designated person' currently needs only be made at the level of the employer without any direct control being exerted at the level of DOSH. But if there is a future need for this, DOSH will look into it.

Current practice at the industry level, at least where the bigger contractors are concerned, is that the blasting 'designated person' appointed by the contractor has to be someone holding a Shotfirer's Certificate issued by the Department of Minerals and Geoscience (Jabatan Mineral dan Geosains Malaysia – JMG). To obtain this certificate, a candidate is required to attend a training course conducted by approved training provider, and to pass the relevant theoretical and practical examinations at JMG. A candidate shotfirer must also pass security screening by the Police before he can obtain certification. However, the shotfirer's certification is applicable only for blasting works in mines and quarries. Hence, additional training syllabus needs to be incorporated, especially in preparing the safe system of work for construction blasting.

Q: Residents' objections have forced several feasible construction blasting proposals to be cancelled. These objections can delay or jeopardise the implementation of infrastructure/development projects. What is your opinion on this?

A: Safe blasting can be achieved by having a safe system of work for blasting. The system documentation can be used for public consultation. If the safe system of work is complete, and the public can be convinced that they will not be subjected to unreasonable risk of harm to them and their family, then the public would have no valid reason to object to blasting work. Early public consultation or engagement is likely the key to gaining public approval. The safe system of work for blasting must be communicated properly, understood by all interested and affected parties and implemented correctly. This will help convince the public of the contractor's seriousness and commitment toward protecting their safety. If someone has concerns about potential risks to his own or his family's safety and health, or his property etc., the best thing to do is to engage him in a positive way, present him with adequate and correct information, convince him that adequate safety controls will be in place, and get his buy-in, rather than seeing him as a threat and reacting to him in an adversarial or confrontational way.

Q8: Is DOSH willing to assist IEM in preparing a position paper on construction blasting?

A: In principle, DOSH remains open to any form of co-operation or collaboration with industry, as long as it does not compromise DOSH's own objectives and roles. ■

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Developing Blasting Professionals

by Ir. Hj. Look Keman bin Sahari

INTRODUCTION

Long ago, when mines and quarries were located far away from towns and villages, it was very difficult to get qualified blasting jobs and as such, there was no requirement to test the competency of those who want to be a shotfirer.

In fact the test done on request from the Police was simply an interview by the Inspector of Mines (Department of Mines) with a standard list of 10 questions which the interviewer himself had to study before conducting the interview. The prospective shotfirer did not have to undergo any specific training in blasting; he just needed to be brave enough to handle explosives and learn the trade from the explosives supplier.

Many shortfirers had experience in the military engineers unit and had done blasting work in the development of rural roads. Only a few brave men would want to do this dirty blasting job. The educated (engineers included) thought the job was not only filthy but also dangerous as they had to handle explosives.

At that time, accident rates were probably quite high and the quarry industry was not under the control of any government department. However, after a few high profile quarry accidents happened in early 1990s, the Perak State Authority decided to take action.

The Perak Quarry Rules was introduced and subsequently adopted by many other States. The objectives of Quarry Rules were to regulate quarry operations and to ensure quarries operated according to safety and environmental requirements.

However, blasting work at the construction site did not come under the Quarry Rules unless there was crushing activity done at the construction site.

Until today, there is still no single department with the clear authority to handle blasting work at construction sites, including tunnelling work. Technically and legally there is a government department that has the authority but not the expertise and there is a government department that has the knowledge and some expertise, but not the authority to regulate the construction blasting work.

This must be addressed to ensure there is proper development of blasting professionals and accreditation to ensure recognition, not only at local level but also international level. This is especially important now with the open or free movement of professionals as practised and accepted in the country.

Certification by the authorities is a requirement for this recognition. The Malaysian Shotfirer's Certificate, which is actually designed for shotfirers, is recognised by our neighbouring countries for tunnel blasting work even though syllabus-wise, it is designed mainly for blasting work at quarries. The blasting industry needs to know which government department should issue the competency certificate for this particular job.

Many shotfirers here work as construction blasters and blasting workers in tunnels even though they are not trained for it. If the sites are far from residential areas, it may not be that important but if these are near residential areas, factories and buildings that have sensitive structures, then it becomes a big issue. High ground vibration, airblast and flyrocks are common public complaints. These may result in damages to nearby structures and people may get injured or killed by flyrocks.

Training of Shotfirer

THE NEED FOR BLASTING

With the country's population growing, there is the need to build new homes, highways, offices, hotels, shopping centres, airport facilities etc to cater to an increasingly sophisticated and educated people. All these require the levelling of hilly areas, removal of rock deep in the ground to create a firm foundation for high rise structures, excavation of ponds and water channels in hard rock etc.

In Kuala Lumpur right now, the MRT project requires excavation works to build underground stations and tunnels for train tracks. Then there are others such as the Pahang-Selangor water transfer project which requires tunnelling by using Tunnel Boring Machine (TBM) and Drill & Blast methods and a tunnelling project for hydropower that's on-going in Cameron Highlands, Terengganu and Kedah. The contractors hire shotfirers with Competency Certificates issued by the Mineral & Geoscience Department (JMG).

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Underground Tunnel

This is an open-ended certificate designed for blasting at quarries in early 1990s and little has changed since. Foreign blasting engineers have to teach the shotfirers on the job, the Drill & Blast techniques for tunnelling work. Perhaps after so many tunnelling projects have been completed, we may now have many qualified Drill & Blast engineers since there is always the requirement to train local engineers and technical staff in tunnelling work.

Blasting with explosives is the cheapest and fastest method to break rock from the rock mass. No doubt there are other alternative means of breaking rock such as using chemicals like expansive cement, pyrotechnic materials, rock breakers etc but not only are these very slow and difficult to use on a large scale but they will also cause inconvenience to the public for a long period.

Instead of just a few week, alternative methods, for instance rock breakers, may take much longer and the public may be subjected to extreme noise, flyrocks (shorter distance) etc. For softer rock and extremely hard rock, blasting is the most effective means to break the rock. Chemicals and pyrotechnics material do not work well with softer rock.

Even in urban areas where there are many structures that need protection from potential problems caused by blasting work, blasting can be done and indeed, has been carried out safely. Examples of these locations are Sogo, UNIKL, Damansara, Star City and the area near Puduraya bus station. At the time of these projects, I was the evaluating officer from the Authority.

However, because of the need to ensure the safety of the public and the structures around it, the cost of blasting will be quite high. Twenty years ago, the cost of blasting in city centres was anywhere between RM50 and RM80 per cubic metre. But it was still cheaper than using breakers or wrecking ball because of the time factor and inconvenience to the public.

Contractors need to hire experienced, competent blasting engineers and shotfirers or someone with the necessary expertise in explosive engineering and experience in related application. For the time being, the only avenue to learn explosive engineering is to join the military Ordnance Corp or work as a demolition expert in the Engineers Corp. However, retraining in the use of commercial explosive is still required.

The months of training in the military should give them an added advantage over the short one-week training course for shotfirers. Normally, engineers in the commercial world are users of explosives but very few actually learn about the explosives, apart from the essential properties that they need to know in order to select suitable explosives for their needs. There is almost a total reliance on the explosives manufacturer and technical advisors to help the blasters choose suitable explosives for any particular use.

In the Kuala Lumpur MRT project for example, even though TBMS are used, Drill & Blast method is still needed to build underground space for stations, space for utilities, shaft for ventilation and access tunnels during emergencies.

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Construction Site

Since tunnelling works are carried out at shallow depths, there is a need to take special precautions to ensure minimum disturbance and that the structure above is not damaged in any way. Any ground settlement which may cause instability to the foundation of the building above must be avoided at all costs. Monitoring must be carried out at every blast to ensure compliance with the requirements of the authorities and to protect the project proponent in case of litigation or claims of alleged damage from blasting work.

In hilly areas where rocks are encountered, blasting is required to prepare a platform for houses, road, channel for drainage, sewerage, pond and pre-splitting work for stable slope. Extreme precaution must be taken during blasting work to ensure minimum vibration effect to nearby structures and to prevent flyrocks.

The issue of flyrocks has been highlighted quite often in the newspapers, particularly when people are injured or even killed. Any such incident may result in blasting work being suspended for months pending investigation and this can cause project delays.

BLASTING PROFESSIONAL AND THE LAW

The requirement of shotfirers or blasters on mining land is clearly stated in State Mining Enactment. It is also a requirement where State Quarry Rules is enforced. However, such requirements are not compulsory on other lands and depend on the conditions imposed by local authorities when approving the development plan (DP).

Of late, most local authorities (such as Selangor, Perak and Penang) require the submission to JMG of the blasting work proposal at construction sites for technical evaluation before the earthwork permit approval is granted and this includes the employment of a competent shotfirer and blasting consultant.

If the use of explosives is considered a safety issue, then DOSH (Department of Occupational Safety and Health) should be the overseeing authority. At present there is no regulation under current OSHA (Occupational Safety and Health Act 1994) on the use of explosives at construction sites or other specialised applications such as tunnelling, underwater blasting or demolition.

As far as the Police Department is concerned, the only requirement, besides security vetting, is that the applicant must have a valid Shotfirer Certificate issued by JMG or the Police before he is issued a permit to buy explosives. How the explosives are used, however, will be decided by the shotfirer and this depends on his competency and experience. There is no requirement for the shotfirer to provide proof of experience or certification that he has indeed attended a training course in a particular application and so, can ensure operational safety.

The absence of regulation for blasting at construction sites or any other special application makes it difficult for the evaluating officer or approval authority to evaluate the proposal for such work or the competency of the blaster. Furthermore, the current trend of "cut and paste" proposals by consultants who have no understanding of blasting work, provide little confidence to the authority and the public whether the proposed method is practical or not. The absence of the requirement for competent people under any regulation also makes it difficult for any institution to introduce related professional development courses for blasting professionals. It is very expensive to attend any course overseas or a conference, seminar or workshop and then return home to disseminate the knowledge.

As long as the current low level of competency is considered sufficient for blasting contractors to operate without the need to attend a Continuous Professional Development (CPD) programme and they can renew their Shotfirer Certificate easily, there is no incentive for them to attend regular training. If the authority which issues the Competency Certificate requires the holders to attend a Professional Development Course, that would ensure they have up-to-date knowledge.

Even though there are many tunnelling projects in the country and there are provisions in the contract of work to train local people, there is no programme for training a blasting engineer. A course in Blasting Technology is offered by a local university but the industry has yet to take advantage of this.

Under the current Malaysian Explosives Act 1967 (Explosives Rules 1923), the Police has the authority to issue the permit and licence to remove and purchase explosives, as long as the applicant has security clearance and a valid Shotfirer Certificate.

The shotfirer can blast anywhere as stated on the application form and he is not required to give a method statement. The blasting contractor may be required by local authorities to refer to other departments such as JMG for evaluation if the site is considered a very sensitive area. The local authority may also intervene if there is the risk of disturbance or danger to the public.

There is also a small provision in Part XV (Blasting and Use of Explosives Regulation 135-146) of the Factory and Machinery Act but few are aware of its existence.

DISTURBANCES AND DANGER FROM BLASTING WORK

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disturbance can actually be mitigated and reduced to a manageable level that will not cause damage to any structure. Blasting work can be carried out safely to within a few metres from a public structure if done properly.

Monitoring must be carried out to ensure compliance within the safe and practical limit as imposed by the authorities.

There are standards and guidelines used in USA, Australia or Europe which can be used as references guidelines. However, there is the need to standardise operational conditions to avoid confusion and to make it easier for the blasting professional to plan the work.

The Malaysian Department of Environment (DOE), for example, has adopted the German Standard DIN 4750 as the standard for vibration. The Australian Standard AS 2187 (Explosives Storage, Transport and Use) is probably more comprehensive for blasting work. To reduce confusion and the cost of blasting application, it would be better to develop a Malaysian Standard for blasting work, with inputs by representatives from the authorities and the industry.

TRAINING AND DEVELOPMENT

Blasting Technology is taught at undergraduate level to those studying mining engineering and, in Malaysia, to those who take the undergraduate degree in Mineral Resources Engineering. However, it is tailored for surface mining and quarrying application.

The Shotfirer Course is currently conducted by the Institute of Quarrying Malaysia, trice a year with a syllabus approved by JMG. The certificate is issued when the applicant passes the theoretical and practical examinations. Sometimes, explosives companies conduct blasting courses on topics specific to their clients. IEM too has also conducted several one-day short courses on "Blasting At Construction Sites".

However with the fast development in blasting technology, syllabus updating on a regular basis is essential. Seminars, conferences or workshops where blasters can learn the latest techniques must be held on regular basis. Attending professional development programmes continuously is essential to ensure safety of blasting operation. The authorities need to work together with the industry to develop Standard Operating Procedures, Code of Practice and Guidelines.

With the adoption of free movement of professionals, the issuance of competencies certificates as proof of expertise is now essential. Other than the general Shotfirer Certificate, there is now a need for specialised certificates for applications such as construction blasting, tunnelling, demolition, blast monitoring etc. The responsibility for issuing these can be entrusted to departments such as DOSH, JMG or even CIDB (Construction Industry Development Board). The departments with legal authority on construction safety, such as DOSH and CIDB, can work together with the departments with technical expertise such as JMG.

Foreign experts would be invited as consultants to impart their knowledge to the local professionals in areas where we are lacking and, in the longer term, we should be able to offer our expertise overseas.

CONCLUSION

Competent blasting professionals are people with a specialist expertise and there are very few of them presently. Even among engineers, few are actually interested to become blasting professionals because it is considered a dangerous job and the remuneration is not very satisfactory. Under current law and practices, it is not required to hire them unless the situation is critical. Thus, there is no incentive for them to improve their technical expertise for a job that comes along only once in a while.

With population growth, there is an acute need to develop new areas for residential and industrial purposes, including high rises. There is now a need to do blasting work in sensitive areas such as hill slopes, constructions near residential areas and tunnelling under existing structures. All these require special expertise.

Advancement in Explosives Technology also means blasting professionals must continuously improve and update their knowledge. Blasting regulations for construction and special applications need to be formulated to ensure that the right people do the job. This will ensure the safety of workers as well as protection of the public and structures. Blasting professionals must attend regular Continuous Professional Development Programmes in related subjects to ensure their knowledge is up to date.

Development of the Code Of Practice and the issuance of Guidelines On Blasting Work by both the industry and the authorities as allowed under OSHA should be encouraged. The standardisation in application procedures will also reduce cost and time. This will also make it easier for training providers to design courses for the industry.

In this Internet era, it is very easy to obtain samples of Standards, Code Of Practice and Guidelines from overseas. These can be modified to suit local requirements. Developing local blasting professionals is crucial to achieve a safe blasting industry and to instil confidence in the public.

It is also essential to develop expertise within the authorities which would be evaluating proposals from the industry and issuing approvals with practical operational conditions. ■

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IEM DIARY OF EVENTS

Title: Evening Talk on River of Life Programme : The Challenges in Improving the Water Quality of the Klang River

15th December 2014
Organised by : Technical Division – Water Resources
Time : 5.30 p.m. – 7.30 p.m.
CPD/PDP: : 0

Title: 1 Day Workshop on Super Memory For Engineers – Tools For Continuous Improvement & Effective Planning

18th December 2014
Organised by : IEM Women Engineer Section
Time : 9.00 a.m. – 5.00 p.m.
CPD/PDP: : 6

Title: Talk on Renewable Energy Current Status & Further Development of Feed-In Tariff

18th December 2014
Organised by : Consulting Engineering Special Interest Group
Time : 5.30 p.m. – 7.30 p.m.
CPD/PDP: : 2

Title: Talk on Search Engine Optimization

19th December 2014
Organised by : Information and Communications Technology Special Interest Group
Time : 5.30 p.m. – 7.30 p.m.
CPD/PDP: : 2

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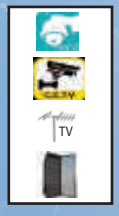

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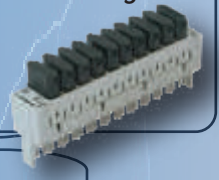

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ROLE OF PIPING ENGINEERING IN O&G INDUSTRY

by Engr. Puvanesan Mariappan

INTRODUCTION

Piping engineering plays a very important role in the oil and gas industry. Piping is crucial for transporting fluid from one point to another, commonly in process plants and offshore topsides. There are many aspects to piping and it can be a daunting and time consuming task to understand how everything fits together.

Piping engineering applies the principals of mathematics, physics and chemistry for design purposes. This design covers assurance for pressure integrity, flow rates, pressure drops and useful life under corrosion. Piping engineering covers three main categories: Material engineering, stress analysis and layout engineering.

THE BASICS

a) Pipe/Tube

The term "piping" refers to a system of pipe, fittings, flanges, valves, bolts, gaskets and other inline components which make up the entire system. Pipes are manufactured to a nominal pipe size (NPS) in which the outside diameter (OD) of a given nominal size remains constant. Any changes in wall thickness will be reflected in the inside diameter (ID). Pipe wall thicknesses are specified by schedule.

Pipes are manufactured in three basic forms – cast, welded and seamless. Cast pipe is available in four different types: White iron, malleable iron, grey iron and ductile iron. Welded pipe is manufactured by furnace welding or by fusion welding and seamless pipe is made of using various extrusion and mandrel mill methods. There are also two forging processes used in the manufacture of large diameter (10-30 ins) pipe with heavy wall thickness (1.5-4 ins).

The difference between a pipe and a tube is that the nominal dimensions of pipes are based on the inside pipe diameter and the nominal dimensions of tubes are based on the actual outside diameter. For an example the actual outside diameter of 1¼" pipe is 1.660" and on the other hand 1¼" tube has a true 1.25" outside diameter.

Photo 1: Pipe Manufacturing Process

b) Pipe Fittings

Fittings permit a change in direction of piping, a change in diameter of pipe or a branch to be made from the main run of pipe. They are formed from plate or pipe, machined from forged blanks, cast or moulded from plastics. Examples of fittings are elbow, tee, reducing elbow, bends, reducer/expander, swage and mitered elbow. Among the more widely used materials are ductile/cast iron, malleable iron, brass, copper, cast steel, forged steel and wrought steel.

c) Joints

The methods used widely to join pipes are butt welded joints, socket welded joints, screwed joints, flange joints and bolted quick couplings.

i. Welded & Screwed Joints

Lines NPS 2 and larger are usually butt-welded, this being the most economic leak proof way of jointing larger diameter piping. Lines NPS 1½ and smaller are usually either screwed or socket-welded.

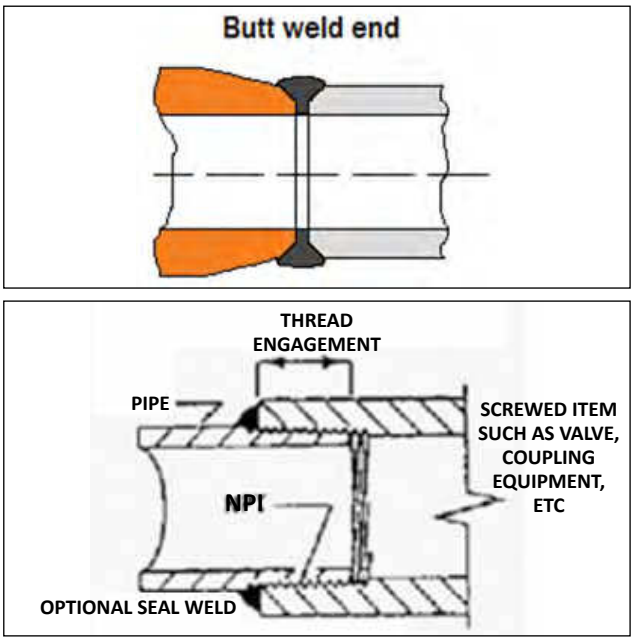

Photo 2: Welded & Screwed Joints

ii. Socket Welded Joints

Socket welding is used for lines for smaller sizes, but unlike screwed joints, socket welded joints has advantage that absence of leaking is assured. This is a valuable factor

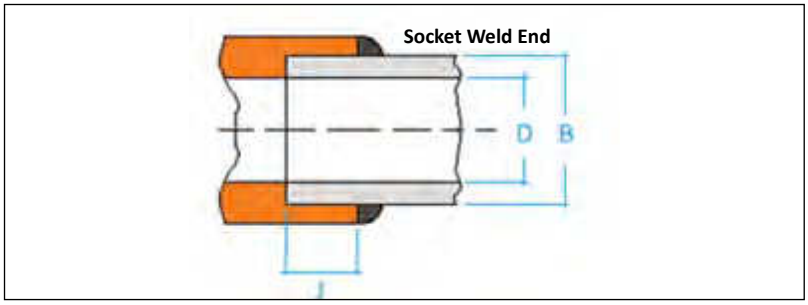

Photo 3: Socket Welded Joints

when flammable, toxic or radioactive fluids are being conveyed, the use of socket welded joints is not restricted to such fluid.

iii. Flange Joints

Pipe flanges are used to mechanically connect pipe sections to other pipe sections, inline components and equipment. Flanges also allow pipe to be assembled and disassembled without cutting or welding, which eliminates the need for those two operations when dismantling is required. The most common codes are ASME B16.5 and ASME B16.47 for larger diameter steel flanges (NPS 26 through NPS 60). The types of pipe to flange connections include the following:

- Threaded – Threaded flanges need not be welded
- Socket weld – Commonly used for small pipe sizes
- Slip on weld – Offers an initial lower cost
- Lapped joint – Yield savings in material
- Weld neck – Highly capable for many uses
- Blind flange – Commonly used to cap off piping ends.

Photo 4: Flange Joints

iv. Bolted Quick Couplings

A connection of this type may be suitable for either permanent or temporary use, depending on the joint and gasket and service conditions. Piping can be built rapidly with them and they are especially useful for making repairs to lines, for constructing short run process installations such as pilot plants and for process modifications.

Photo 5: Bolted Quick Couplings

DESIGN

a) Specs and Guidelines

Piping design is the job of configuring the physical aspects of pipe and components in an effort to conform with piping and instrumentation diagrams

(P&IDs), fluid service requirements, associated material specifications, equipment-data sheets and current good manufacturing practices (GMP) while meeting owner's expectations. One of the first activities the piping engineer will be involved with is development of piping specifications (specs) and guidelines on design and construction. Piping specifications, as an overview, should provide essential material detail for design, procurement and fabrication. Pipe spec describes the physical characteristics and specific material attributes of pipe, fittings and manual valves necessary to the needs of both design and procurement personnel. A piping specification should contain only components and information that would typically be used from job to job. That would include the following:

- Pressure and temperature limit of the specification
- Limiting factor for pressure and temperature
- Pipe material
- Fitting, flange and gasket type, rating and material
- Bolt and nut type and material
- Manual valves, grouped by type
- Notes
- Branch chart matrix with corrosion allowance

a) Pipe Stress Analysis

The purpose of piping analysis is to ensure the structural integrity from breakage or gross deformation by performing code stress break. The other purpose is to maintain the system operability to ensure profitability. The following shows the compliance list to the pipe stress analysis:

- Modes of failures
- Pipe behaviour
- Code compliance
- Theory of failure

Pipe stress design criteria is the basic document required for doing the pipe stress analysis for a particular project and it varies/changes based on the project requirement from one project to the other. There are two types of stresses which are primary and secondary stresses/loads.

Primary stresses are caused by imposed loading and are necessary to satisfy the equilibrium between internal and external forces and moments of the piping system. Secondary stresses caused due to restraining of the displacement. The displacements can be either due to thermal expansion or by outwardly imposed restraints – thermal displacement, imposed anchor movement, settlement and vibration. Different type of stresses in a pipe:

- Longitudinal/axial Stress (SL)
- Circumferential Stress (Hoop Stress SH)
- Radial Stress (SR)
- Shear Stress (t)
- Bending Stress (Sb)
- Torsional Stress (St)

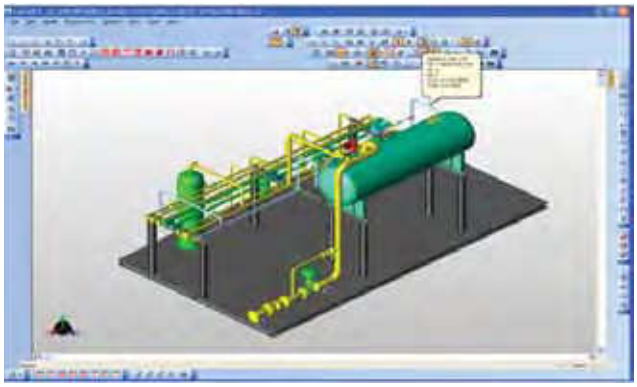

Photo 6: Flexibility Analysis

Flexibility is the measurement in a piping system to absorb the thermal expansion. It is the most basic and important function of piping stress analysis. Flexibility within a piping system can include the addition of loops, bends and improving anchoring method. Stress Intensification Factor (SIF) at every bend and tee influence the outcome of the results. The outcome of the flexibility analysis is:

- To produce a piping layout that will not cause excessive stresses or excessive end reactions
- To achieve a layout which is not stiff
- It is also not desirable to make the system unnecessarily more flexible because this requires excess materials, thus increasing cost
- To eliminate lengthy pipes with many bends (drops) which will increase pressure drop.

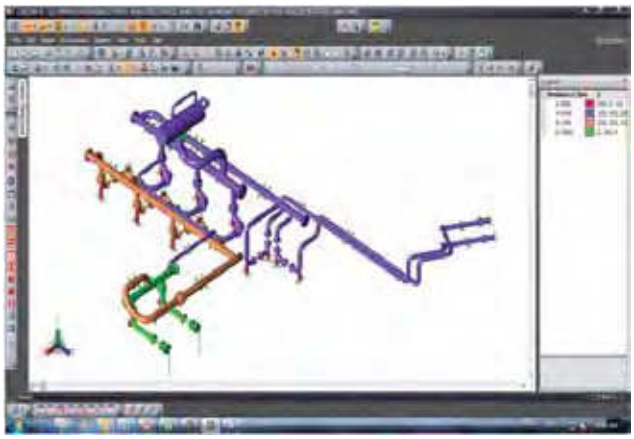

Photo 7: Stress Analysis

b) Layout Engineering

Piping design and equipment arrangement are interrelated subjects that cannot be well taught in colleges. Most good designers learned their profession through a combination of academic and practical work. Field and design office plus a little shop experience is good preparation for designing or teaching. This topic is very broad-based and relies on a sound mechanical engineering background coupled with lots of common sense. The use of previous designs and drawings is a good way to learn and improve on current designs.

The cost, complexity and safety of process operation and maintenance are highly dependent on site location

and layout. Building inherent safety into a site generally reduces both the cost and complexity. Siting and layout are among the earliest steps in design and can be quite costly to modify once the site is constructed. Optimum siting and layout will minimise material and construction costs, but more importantly, will minimise the risk of losses throughout the site's life cycle.

Proper planning is an important activity performed by the piping designer in the early stages of a project. Space conservation and a symmetric piping arrangement are achieved when all the systems are evaluated in the preliminary stages of design. This study will become the final design. It is important to consider the cost of the piping material at this time for the expensive line. These lines should be kept as short as possible, while maintaining proper piping flexibility even if this requires changing the equipment arrangement.

Detail design should not start until planning studies are completed. Putting engineering work hours on details that are subject to change pending the completion of the planning study is not recommended.

Piping layout then becomes a matter of designing dimensioned routings from one point to another point with the branches, valves, piping specialities and instrumentation as indicated on the P&ID. This statement, however, is an oversimplification of the process, since many other factors must be considered, such as interference, piping flexibility, material costs, pipe supports, operation and maintenance and safety and construction requirements.

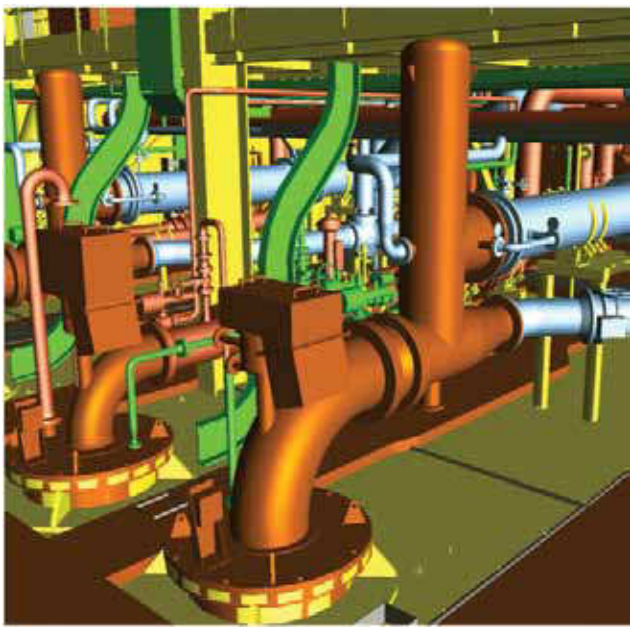

Photo 8: PDMS Layout Design

INSTALLATION AND MAINTENANCE

The installation of a pipe follows its fabrication and is very frequently a part of it. The installation of a pipe can be accomplished in the following four primary ways, or combinations thereof:

a) Field Fabricate and Install:

In this method, pipe is fabricated onsite, either in place or in segments, at onsite field-fabrication area and then erected. Efficiency, quality and safety must be factored in when considering field fabrication.

b) Shop Fabricate and Field Erected:

Generally speaking, shop fabrication refers to any pipe, fittings and components that are assembled by welding into spools assemblies at the fabricator's facility. The spools are then labelled with an identifier and transported to the job site for installation.

Photo 9: Pipe Fabrication

c) Skid Fabrication, Assembly and Installation:

A skid fabrication is a pre-packaged assembly that may contain all or some of the following that make up an operating system: Vessels, rotating equipment, piping, automation components, operator interfaces, instrumentation, gauges, electrical panels, wiring and connectors, frameworks, supports, inline piping components and insulation. A single process or utility system may fit onto one skid or, depending on size restraints, may comprise multiple skids.

d) Modular Construction:

A module can refer to pre-fabricated units that actually form the structure of a facility as each is installed. Or the units may be smaller sub-assemblies that, when combined, make up a complete process or utility system.

After years of operation, many of the initial design specifications may change, such as operating temperatures, pressures, and flow rates. All components of the piping system should be periodically maintained to see that they are adequate for their current service.

Most of the piping and fittings have anti-corrosion protection (painting being the most common method). However, over a period of several years in corrosive environments particularly, there may be sufficient corrosion to compromise the ability of a part to perform its intended function. Corrosion occurs fairly slowly and frequently starts in crevices where it is not easily detected for some time unless a definite effort is made to search for it.

Photo 10: Corrosion In Piping And Fittings

Operation engineers should check for signs of damage that may have occurred since installation. If any is found, the seriousness of the damage must be assessed, and a decision as to whether to repair or replace is warranted.

CONCLUSION

This article attempts to cover a brief range of subtopics on piping engineering in order to provide a basic broad understanding of some key points, without going into great detail on any specific topic. It is hoped that readers will dig deeper into this subject matter to discover and learn some of the more finite points of what has been discussed in this article. ■

Engr. Puvanesan Mariappan obtained his B. Eng (Hons) Mechanical from Multimedia University, Malaysia (2007) and MBA from Victoria University, Australia (2011). He is attached with Aker Solutions as a piping engineer. In IEM, Engr. Puvanesan Mariappan is currently the co-opted member of The Young Engineers Section (YES) and Oil, Gas & Mining Technical Division (OGMTD).

IEM DIARY OF EVENTS

Title: "Impact of Leadership and Teambuilding in Project Management"

3rd January 2015

Organised by : Project Management Technical Division
Time : 9.00 a.m. – 11.00 a.m.
CPD/PDP: : 2

Title: Talk on Recent Development in The Vacuum Preloading Method and Its Application for Soft Soil Improvement

5th January 2014

Organised by : Geotechnical Engineering Technical Division
Time : 5.30 a.m. – 7.30 p.m.
CPD/PDP: : 2

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Rainwater Harvesting Systems In Malaysia




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

THE first thing that comes to mind is the benefits of rainwater harvesting, which has been hailed as one of the solutions to combat the annual water crisis. According to research carried out by the National Hydraulic Research Institute of Malaysia (NAHRIM) at Taman Wangsa Melawati, Kuala Lumpur, use of rainwater for domestic non-potable purposes is 34% of the total monthly household water use (Shaaban and Huang, 2007).

Rainwater is an inexpensive, on-site supply of water which can be used for outdoor, non-potable uses with little, if any treatment required or, with appropriately higher levels of treatment, for a variety of uses that include potable supply.

As cited by Garrison et. al. (2011), rainwater harvesting can also reduce the runoff or excess water that would otherwise contribute to storm water flows, a leading cause of water pollution and urban flooding.

NAHRIM's study on rainwater utilisation systems as an on-site flash flood control system (on-site detention) in Taman Wangsa Melawati showed that the system could reduce peak runoff by 10-20%. Another study (2010), carried out on a regional scale in the Sungei Damansara catchment area, indicated that flooded areas could be reduced by 35-50%, in proportion with the volume of rainwater storage provided for every building.

Rooftop containment also has the potential to improve water quality in urban areas by preventing excess stormwater (often filled with sewage, toxins and chemicals from sidewalks and streets) from washing into rivers, streams and beaches. In fact, the US EPA views urban runoff as "one of the greatest threats to water quality in the country" and a leading cause of surface water pollution (Garrison *et. al*, 2011). The reduction of water pollution will subsequently reduce the load for water treatment in water treatment plants.

PROVISIONS OF POLICY AND REGULATIONS

The drought and water supply crisis (1998) in the Klang Valley saw a surge of interest in rainwater harvesting. In May 1998, the Ministry Of Housing And Local Government (MHLG) expressed interest for houses to be designed to include facilities for collecting rainwater. In June the following year, MHLG produced a guideline on "Installing Rainwater Collection And Utilisation Systems".

In March 2007, the National Water Resources Council (NWRC) approved the extension for the application of rainwater harvesting system which was to be included in the "Guideline and Regulation of Building Planning" and Uniform Building By-Law (1984) by Ministry of Housing and Local Government (KPKT). This by-law encourages the use of rainwater harvesting systems in existing government and public buildings.

In November 2007, the Cabinet agreed to make installation of rainwater harvesting systems mandatory in new developments. The National Council for Local Government approved a regulation in Uniform Building By-Law for rainwater harvesting system in May 2011. The following November, the Uniform Building By-Law (UKBS 1984 (Amendment 2011) was officially gazetted by KPKT which required new semi-detached houses, bungalows and government buildings to install a rainwater harvesting system.

The amended Uniform Building By-Law is an important milestone and achievement to ensure rainwater harvesting systems are widely used as a first step towards sustainable water resources management.

To date, only four States (Johor, Selangor, Perak and Kelantan and the Federal Territory of Kuala Lumpur) have officially gazetted the by-law through their Local Government Authority.

R&D CASE STUDIES

NAHRIM embarked on research and development of rainwater harvesting in 2001, and had carried out a number of projects. In all of these, Tangki NAHRIM Simulation Software was used to estimate the optimum size of rainwater tank, amount of rainwater captured, total rainwater volume delivered, reliability of the system and storage efficiency.

Here, we highlight some projects that have been conducted and are currently pursued.

- **Masjid Bukit Indah, Ampang**

At the request of the mosque committee, the rainwater project was carried out in 2003 with the objective of utilising rainwater as an alternative water supply for toilet flushing. An underground rainwater storage tank of polyethylene modules was constructed under the car park, with a total volume of 60m^3. The reliability of the system is about 80% and estimated water saving per month is 100m^3.

- **National Zoo, Ulu Klang**

At the request of the National Zoo and in collaboration with DID, NAHRIM initiated the rainwater project at the National Zoo in 2008. The aims were to use rainwater as an

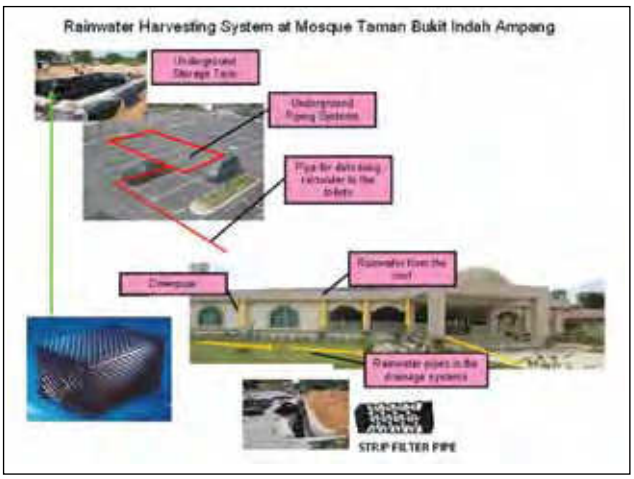

Photo 1: Schematic Arrangement of the Rainwater Harvesting System at Masjid Bukit Rendah

alternative water supply for two hippopotamus ponds and for flushing in public toilets. The system is designed to store a total volume of 366m^3 and the reliability of the system is about 70%. The average monthly rainwater consumptions for the ponds and toilet flushing are 271m^3 and 35m^3 respectively.

The rainwater is used to replace river water for the hippopotamus ponds, so there is no direct saving in the water bill. However about RM250 a year is saved from using rainwater for toilet flushing.

- **NAHRIM**

Currently there are two rainwater harvesting systems installed in NAHRIM at its Office Complex (2010) and the Hydraulic & Instrumentation Laboratory (2011). The rainwater system in the administration building is used for toilet flushing and landscaping, while at the laboratory, it is used as the main water supply for physical modelling activities.

In the Office Complex, the system is designed to store a total volume of 20m^3 of rainwater. From Tangki NAHRIM's

Photo 2: Components of the Rainwater Harvesting System at the National Zoo for Hippo Ponds and Toilet Flushing

Photo 3: The Layout Plan of Rainwater Harvesting System for NAHRIM Office Complex

simulation, the reliability of the system is about 93%. Based on water bills, the average monthly rate of treated water conservation is 156m^3 or 7%. In a year, NAHRIM is able to save about RM3,000 in water bills.

As for the Hydraulic & Instrumentation Laboratory where physical modelling activities require a huge amount of water, the system is designed according to the concept of rainwater harvesting and reusing the harvested rainwater repeatedly and optimally. With a total storage volume of approximately 3,700m^3, savings add up to about 10,527 m^3 or RM17,000 per year (Hamzah, 2011).

- **Rumah Panjang Bair, Betong, Sarawak**

The rainwater harvesting system was constructed for the long house community to use rainwater to supplement the existing supply of river water, mainly for general cleaning. For the first phase in 2010, each household unit (24 units in total) was equipped with a 2m^3 stainless steel tank. The system was designed for a 21-day supply monthly. However the system managed to supply rainwater for 25 days or 83% reliability. The total average monthly rainwater consumption is 25m^3.

Research and upgrading works are currently in progress to improve the system with the aim of increasing the supply duration up to 30 days and for potable use too. The upgraded system will utilise a new roof catchment of 480m^2 and three additional tanks of 5m^3 each. One of these will be specifically intended for potable water supply. A sophisticated filtration system will be installed and monitored to treat rainwater for direct consumption.

- **Rain Gardens at NAHRIM**

Two rain gardens were constructed and continuously monitored in the NAHRIM compound in 2011. The system is built in an existing streetscape area to treat road surface runoff before being discharged to the drainage systems. The main objectives are:

a) Stormwater quality improvement via filtration by vegetation and media
b) Stormwater quantity control via underground storage and
c) Reusing the water for watering the plants.

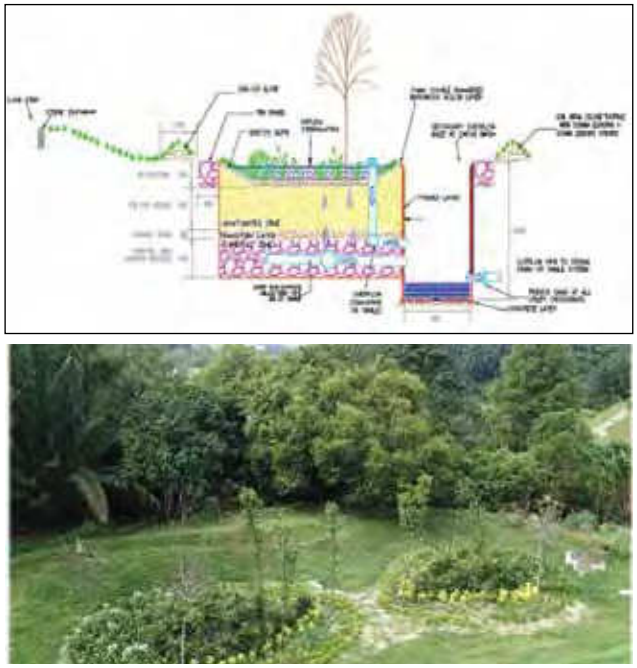

Photo 5: The Cross Section and Side View of Rain Garden 2 at NAHRIM

From NAHRIM's simulations, the system is able to reduce the peak discharge up to 80%, and meet the target of annual load reduction of Total Suspended Solid (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) of 40%, 30% and 30% respectively.

- **Design for Rainwater Harvesting System at the Ministry of Natural Resources and Environment (NRE)**

NAHRIM was requested to carry out a rainwater harvesting project at NRE building to utilise rainwater as an alternative water resource for toilet flushing (at ground level) and water feature. The system is designed to store an estimated 20m^3 of rainwater in a stainless steel tank in the basement. The total estimated water demand is about 2m^3/d, which in turn will provide 480m^3 of treated water and save RM770 in water bill annually. The design has been completed and submitted to NRE whilst the construction is estimated to begin this year.

WAY FORWARD

Going forward, steps must be taken to encourage the use and practice of rainwater harvesting. A few economic instruments such as rebates, education and raising awareness, guidelines and restrictions in availability of piped water can be introduced and implemented to encourage the practice of rainwater harvesting (*Osman et. al, 2007*).

The implementation of rainwater harvesting systems as stipulated in the amended Uniform Building By-Law 2011 is vital. Other States should follow in the footsteps of Perak, Selangor, Johor, Kelantan and the Federal Territory of Kuala Lumpur in gazetting the amended by-law.

Promoting the benefits and importance of rainwater harvesting and utilisation through campaigns by government agencies and the media is important to encourage the public to install rainwater harvesting systems.

We can also incorporate rainwater harvesting in the school education curriculum as an early awareness programme.

On a much larger scale, the concept of multipurpose rainwater management in cities can be a proactive and alternative solution to flooding and water supply issues. An example is South Korea's Rain Cities programmes such as the Seoul City Rainwater Management and the Star City Rainwater Harvesting System Project (Han, 2007). The Star City project, for example, has taken the "No Regret Approach" which is not only useful for efficient on-site

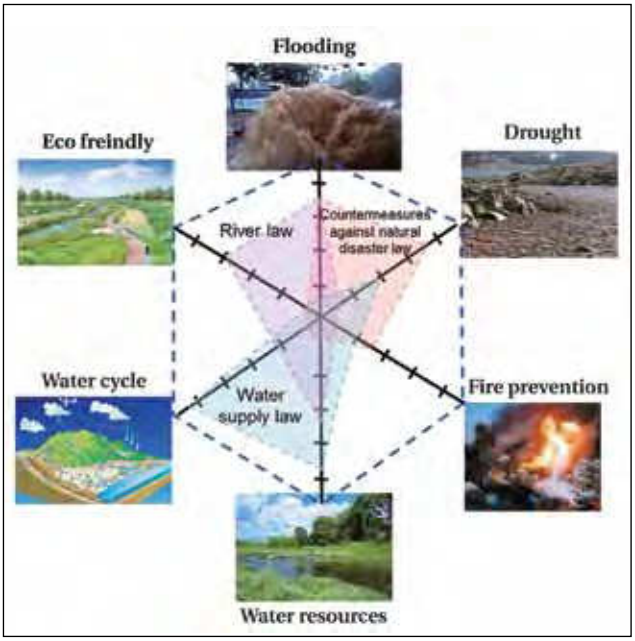

Photo 6: Concept of Multipurpose Rainwater Management Utilized in Korea (Han, 2013)

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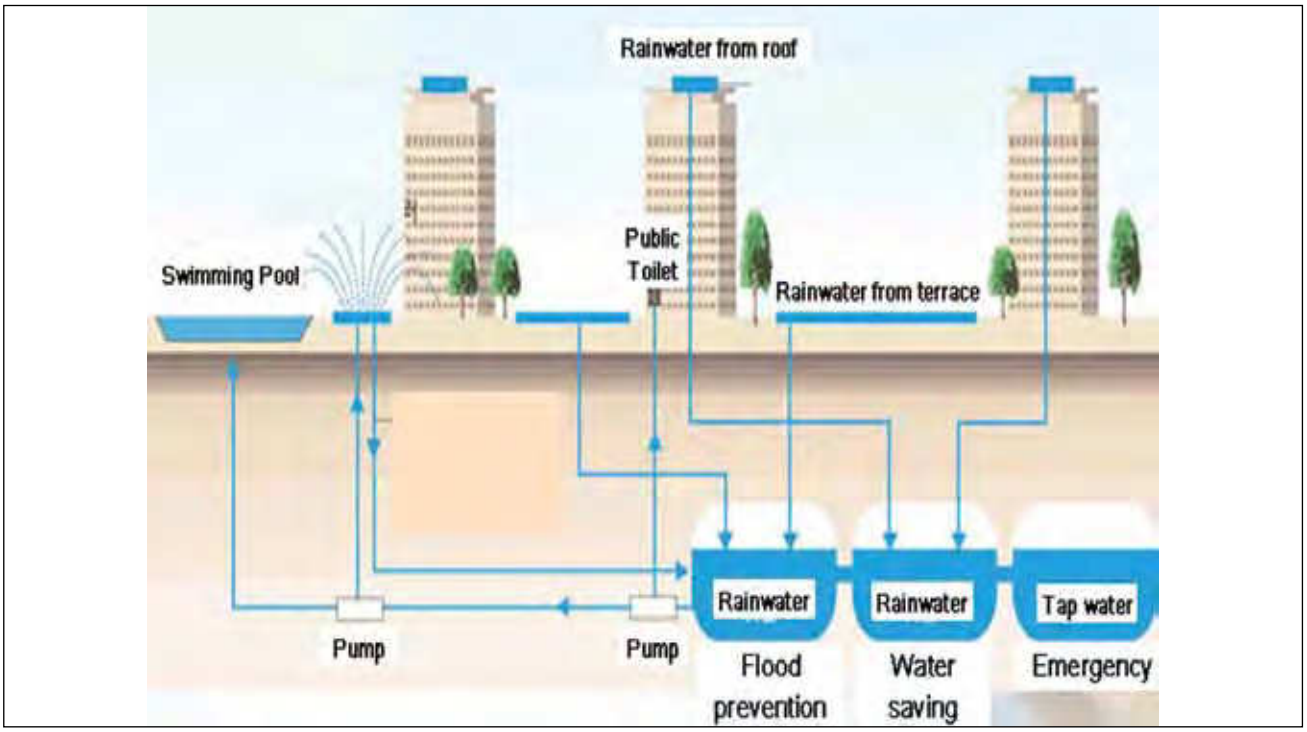

Photo 7: Overview of Star City Rainwater Storage and Management System (Han, 2007)

flash flood control, drought management, firefighting and landscaping but also for climate change adaptation and mitigation (reduction of greenhouse gases via reduction in energy use).

At the same time, R&D to utilise rainwater for drinking and potable consumption should be explored and enhanced. The use of low impact development strategies which include permeable pavements, detention and retention ponds, rain gardens, green roof, green wall and water features together with rainwater harvesting systems will not just improve the health of urban environment (e.g. reducing water pollution and urban heat islands) but also provide storage facilities for conjunctive water supply.

However, such large-scale implementation of Rain Cities programmes needs serious efforts and comprehensive plans by both the public and private sectors. ■

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Goh Yee Cai is a research officer in the Water Resources and Climate Change Research Centre, NAHRIM.

Some Computational Fluid Dynamics (CFD) Applications In Marine Technology

by Prof. Dr Adi Maimun bin Abdul Malik

INTRODUCTION

Computational fluid dynamics, commonly known as CFD, is the use of numerical methods through different algorithms to solve the physics of flow. CFD can also be interpreted as techniques solving Euler, RANSE (Reynolds Averaged Navier-Stokes Equations) or Navier-Stokes equations, using field methods.

In most hydrodynamic problems, calculating global pressures and fluid velocity components in a 3-dimensional space surrounding the submerged portion of the marine structure of interest is necessary to understand the nature of fluid structure interaction, a prerequisite to optimise the design. These calculations can be done by CFD, which has become a research field in the late 1960s and, over the years, its use has increased in terms of handling complex design, turbulence flow modelling and free surface modelling due to the availability of strong computational resources and a number of powerful commercial CFD software.

This potent technique has become extremely significant for the marine industry as most of the towing tests commonly performed to study the effect of fluid on structure, are time consuming and painstaking. CFD can be a viable alternative to those tests. It can be used to optimise the design of a ship hull, offshore structures and the propeller. It can also be used to study complex hydrodynamic phenomenon such as vortex induced vibration (VIV) or Vortex induced motion (VIM). Recently, the Marine Technology Centre of Universiti Teknologi Malaysia (UTM) used CFD in a number of research projects. This paper highlights some of the interesting works that are being studied.

CFD APPLICATIONS

Suitable mesh, appropriate turbulence model and strong computational resources are tricky issues to be considered before using CFD. Meshing is a discrete representation of the geometry that is involved in the problem. Basically, it assigns cells or smaller regions over which the flow is solved. Several parts of the mesh are grouped into regions where boundary conditions may be applied to solve the problem. Generating good quality mesh demands considerable experience. Unstructured mesh is of great interest in hydrodynamics community as a relatively straight forward approach compared to the structural mesh. However, the unstructured mesh also presents the difficulties to attain good resolution in certain cases, especially when the free surface is involved. Photo 1 is an example of meshing is depicted.

Using appropriate turbulence model is another important issue. Unsatisfactory results are often blamed on turbulence

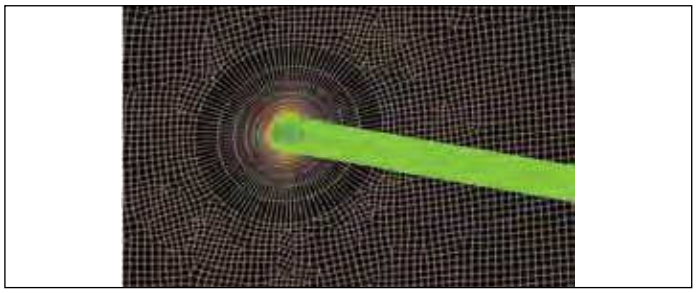

Photo 1: Grid details near boundary layer of a circular cylinder [1]

modelling. For most applications, the standard k-ε or k-ω turbulence models are adequate. In order to predict secondary flows better, more sophisticated models are needed such as the shear-stress model (SST). The SST k-ω turbulence model is a two-equation eddy-viscosity model which, by and large, is considered very effective in case of adverse pressure gradients and separating flow. The shear stress transport (SST) formulation combines the two formulas k-ε and k-ω.

For studying complex cases like VIV where flow separation is evident (see Photo 2), large eddy-simulation (LES) or detached eddy simulation (DES) should be used. DES (Detached Eddy Simulation) combine LES and RANS by treating the boundary layer with RANS and capturing the outer detached eddies with LES. The cost scaling of the method becomes favourable since LES is not applied to resolution of the relatively smaller-structures that populate the boundary layer.

Computational time required for CFD simulation can be reduced significantly by using more powerful computers. Each simulation of in this project is run on a shared-memory type machine with 4 processors (speed of 3.6 GHz) and a total of 32 GB DDR3 RAM at 1600 MHz speed.

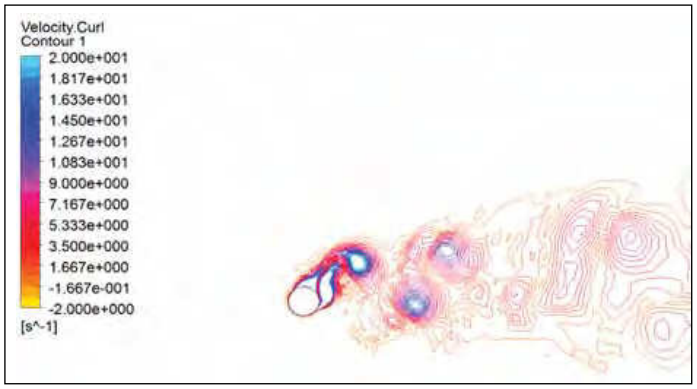

Photo 2: Nature of fluid effect on cylinder, successfully obtained by using DES model [2]

Wake Wash Analysis for Semi-SWATH Vehicle

This study deals with the wave profile around a semi-SWATH hull (Photo 3) that is an important aspect to be analysed in predicting wake wash. Experimental work may not give an accurate wave pattern due to environmental condition. Better wave profile can be obtained by using CFD. Pattern of wave amplitude of hull depends on the pressure distribution around hull. Similar pattern with wave profile at same Froude number (Photo 4) shows that pressure distribution contributes to wave pattern around hull [3].

Hull Resistance of LNG Carrier

The computational domains in the study of LNG carrier were carried out with structural mesh approach for better quality meshes

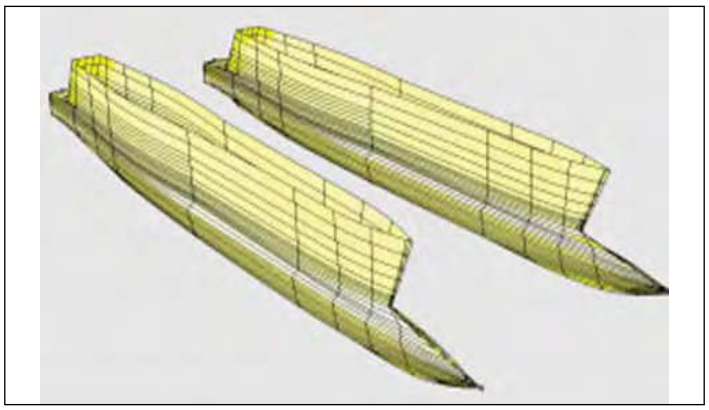

Photo 3: Isometric view for Semi-SWATH model (hull)

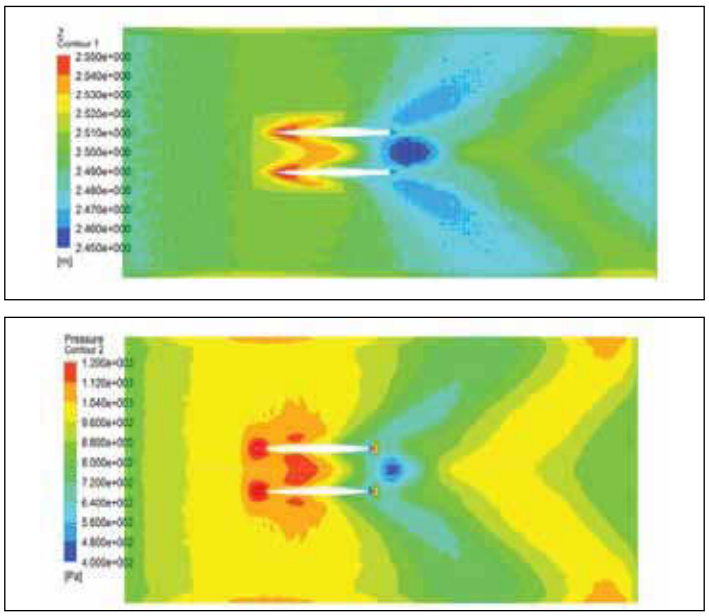

Photo 4: Wave profile and pressure distribution of Semi-SWATH (catamaran mode) at Froude number 0.68 [3]

in the simulation. Simulations were run on a work station with 4 processors (speed of 3.6 GHz) and computing time for each case require approximately 30 hours. The limiting streamlines and wave characteristics (see Photo 5) of LNG carrier were also investigated.

Overall predicted results agreed well with experimental data and validation of the results according to standard procedure adopted by the International Towing Tank Conference (Photo 6). This study shows the feasibility of CFD in practical prediction of resistance characteristics.

Propeller Performance

This study focuses on a marine propeller's performance and characteristics in open water condition. The hydrodynamic values such as thrust (Kt) and torque (Kq) coefficients and the other selected values are measured in this numerical research work. The scheme and computational domain of open water condition are shown in Photos 7 and 8, respectively [4].

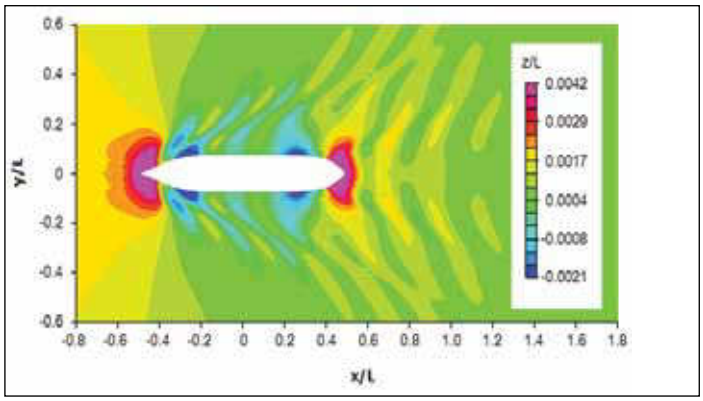

Photo 5: Wave profile LNG carrier at Froude No. 0.2

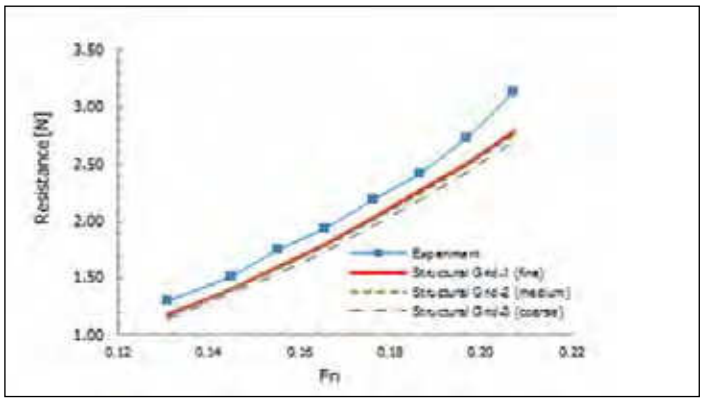

Photo 6: Resistance results bet. CFD and Experiment

Photo 9 shows various Advance Coefficient (J) values obtained by keeping a same revolutions but varying the flow speed. Photo 10 shows the distribution of pressure coefficient on the face surface of one blade at the radial section r/R = 0.80.

The results from the numerical simulation of full scale propeller in open and restricted water based on RANS equation are compared with the model test results. The trends of results with varying Advance Coefficient (J) are well predicted. It should be

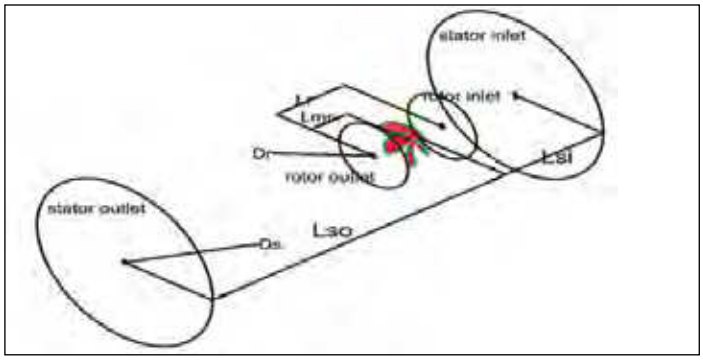

Photo 7: scheme of computational domain

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Photo 8: Rotational and Stationary domain

noted that KQ and Kt are generally slightly overpredicted. The maximum hydrodynamic propeller efficiency is found at J = 0.84 and J = 0.87 for open water and restricted water, respectively [5].

Multi-Purpose Amphibious Vehicle Resistance and Flow Streamlines

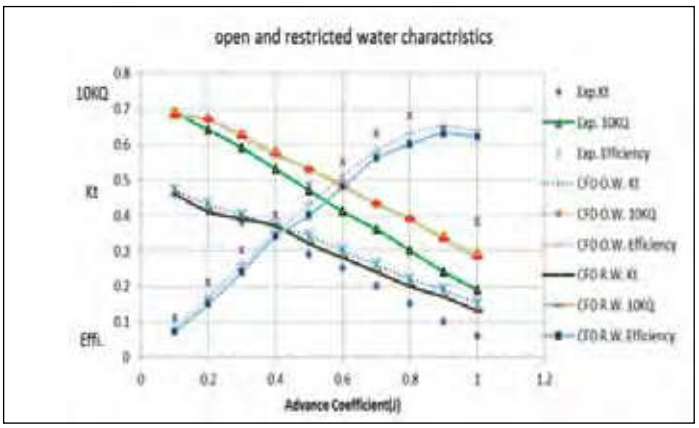

Photo 9: Open and Restricted water diagram of propeller performance at full scale

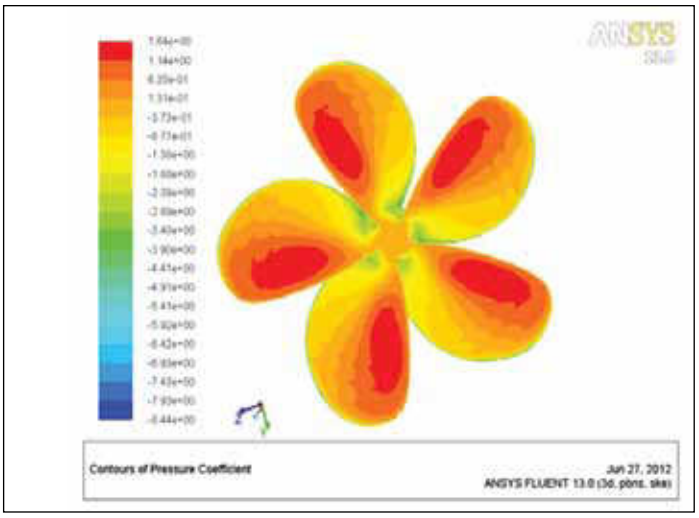

Photo 10: Contours of pressure coefficient on face surface

The practical application of CFD for predicting the flow pattern around a Multi-purpose Amphibious Vehicle (MAV) hull (Photo 11) has made much progress in the last decade. The research work investigates the performance of three different designs of bow shapes and the best design is chosen in based on the minimum resistance for several forward speeds [6]. Photo 12 shows the computational domain and Photo 13 shows the pressure contour around the hull.

Photo 11: MAV in 3D view

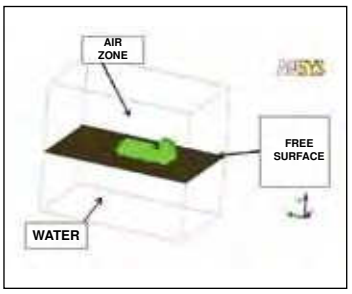

Photo 12: Computational domain

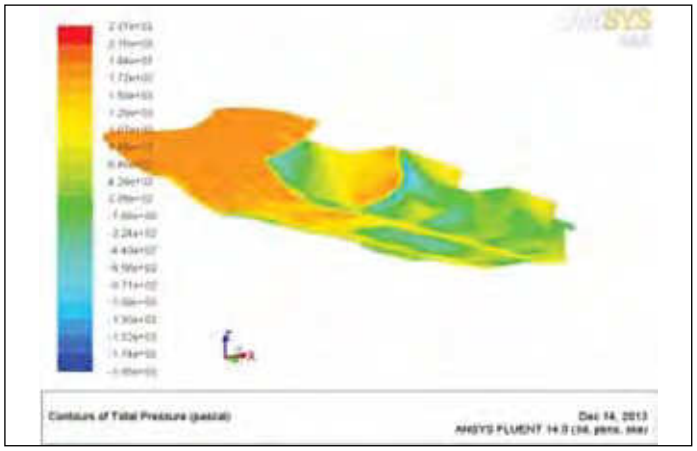

Photo 13: Pressure distribution round U-shape of bow hull

Vertical Axis Current Turbine (VACT) Design

Industrial development, population growth and the greenhouse effect have made renewable energy a necessity rather than a choice. Design of efficient Vertical Axis Current Turbine (VACT) (Photo 14) can be effective in terms of being a potent source of renewable energy. This research work includes CFD simulations (Photo 15 & 16), parametric study and experimental work. It is important that the numerical simulations are conducted first to reduce the time required for finding the best possible ways to optimise the four-bladed vertical axis current turbine rotor [7].

CONCLUSION

Some recent researches on hydrodynamics and marine technology where CFD has been used, are briefly discussed in this paper. CFD is able to generate data sets for subsequent fast evaluation in design and operation. As computer hardware continues to become more and more powerful and highly parallel computing environments become more affordable, CFD can be a strong tool to solve various hydrodynamic problems essential for design optimisation. In marine technology higher demands from CFD come in various forms such as:

- Transient simulations (URANS (= unsteady RANS), DES and LES) to obtain more accurate results.
- Prediction of pressure fluctuation.
- Solving fluid-structure-interaction problem such as VIV ,VIM, slamming, sloshing
- Simulation of interaction (ship + ship, ship + bank, etc.).
- Design optimisation of complex geometry such as propeller, turbine with all geometrical details, etc.

Even though numerous powerful CFD software are available, how quickly problems can be solved depends on the engineer.

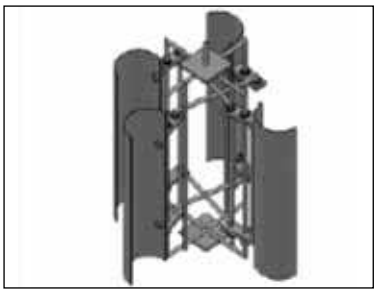

Photo 14: VACT design

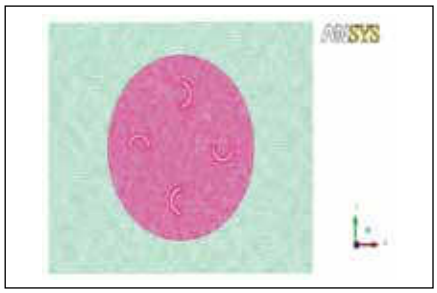

Photo 15: Computational domain

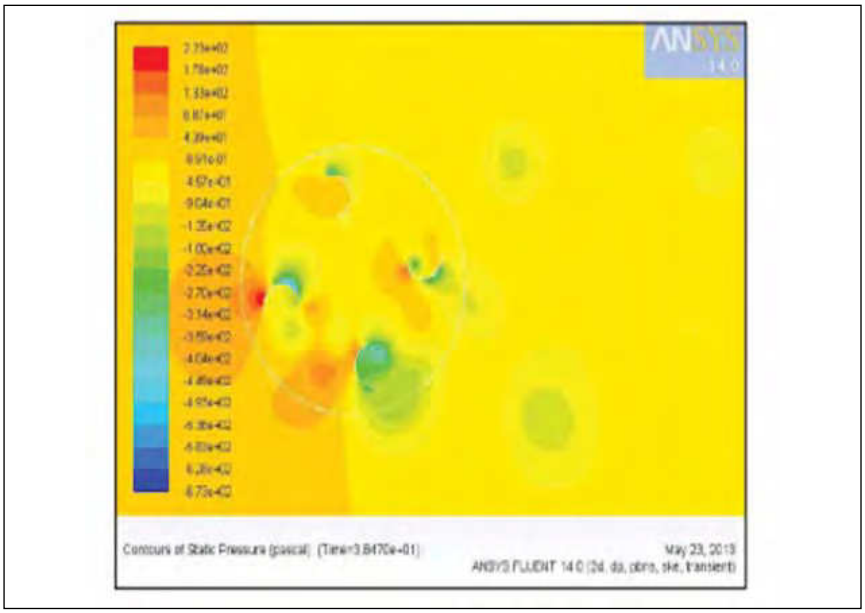

Photo 16: Static pressure contour

From this aspect, it is essential for marine technology experts today to be familiar with the know-how in using CFD tools. ■

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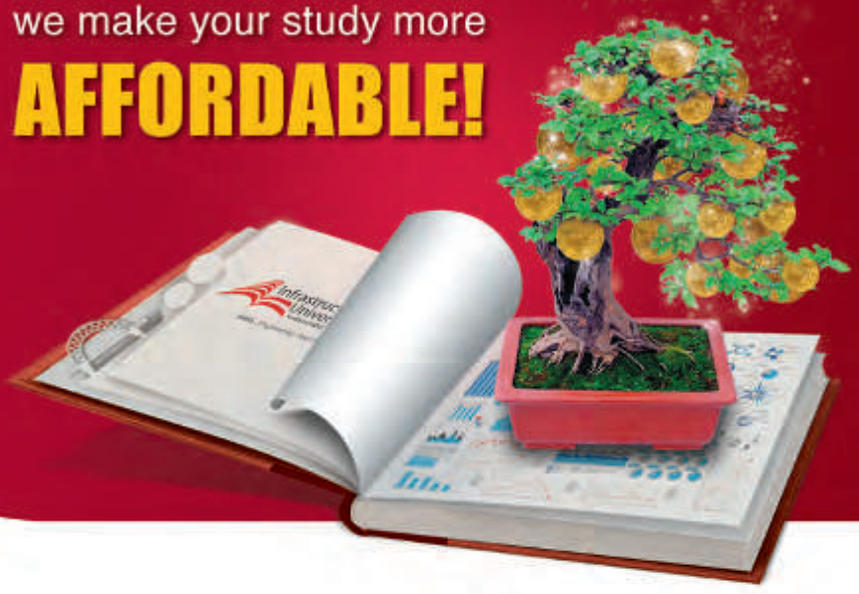

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Talk on "Aboveground Atmospheric Hydrocarbon Storage Tanks Maintenance for Lifespan Expansion"

by Engr. Shazlan Rahman

OIL, GAS AND MINING ENGINEERING TECHNICAL DIVISION

ON 14 June 2014, IEM's Oil, Gas and Mining Engineering Technical Division (OGMTD) organised a talk on Aboveground Atmospheric Hydrocarbon Storage Tanks Maintenance for Lifespan Expansion by Ir. Alzakri Ekhwan from Petronas. It was attended by about 30 engineers.

The aim of the talk was to explain the online and offline repair works that can be carried out to extend the lifespan of the hydrocarbon storage tanks.

Ir. Alzakri started by explaining a typical structural arrangement of an aboveground atmospheric hydrocarbon storage tanks. This usually comprises a large steel cylindrical wall with a floating pontoon roof.

Photo 1 : Ir. Alzakri Ekhwan gave his presentation

When the tank is in operation, routine inspections may reveal some defects to these structures. The defects can be repaired either online or offline.

Online repair is carried out when the tank is still in operation.

Offline repair is carried out after the tank is shut down for the planned maintenance work.

The defects are first assessed for the risk towards structural failure. If it is low risk, these would be repaired offline during the next maintenance shutdown. If it is found to be high risk, online repair would be carried out immediately.

Ir. Alzakri then highlighted some online repairs that have been carried out on the storage tanks such as a puncture on the floating pontoon roof is repaired by using high density polyethylene (HDPE) balls, a damaged flexible hose that acts as the drain for the pontoon roof is repaired by using

Photo 2 : Ir. Alzakri Ekhwan received a token of appreciation from Ir. Lee Cheng Quan, the session chairman

rubber plug and holes in the storage tank wall are repaired by using wire mesh and ceramic paint.

He also highlightlighted some offline repairs such as desludging the storage tank by using the crude oil method, replacing part of the tank wall, especially at the location that is repeatedly scraped by the pontoon roof, and replacing the roof drain with a flexible hose type joint system.

Online repairs usually act as a temporary solution. Follow-up permanent repair works are usually carried out during the tank maintenance shutdown.

Ir. Alazakri's vast experience in design, fabrication, inspection, construction and maintenance of hydrocarbon storage tank made his presentation very informative and interesting. This was followed by a lively question and answer session. ■

Engr. Shazlan Rahman is a corporate member of the Institution of Civil Engineers UK (MICE) and a chartered engineer with the Engineering Council UK (CEng). He is currently working with Aker Solutions, and has experience in structural design and integrity management of offshore structures. He is a committee member of the IEM Oil, Gas and Mining Engineering Technical Division.

IEM COUNCIL ELECTIONS 2015/2016

NOTICE ON NOMINATION PAPERS FOR COUNCIL ELECTION SESSION 2015/2016

A notice inviting nominations for the Election of Council Members for Session 2015/2016 will be posted on the IEM Notice Board and IEM website by **24 November 2014** for the information of all Corporate Members of IEM. Following the close of nominations on **27 December 2014**, the election exercise will proceed. All Corporate Members residing overseas are requested to take note of the requirements of the By law, Section 5.11, as shown below.

The voting paper shall, not less than twenty-eight (28) clear days before the date of the Annual General Meeting be sent by post to all Corporate Members residing in Malaysia and to any other Corporate Members who may in writing request to have the paper forwarded to him. The voting paper shall be returned to the Honorary Secretary in a sealed envelope so as to reach him by a specified date not less than seven (7) days before the Annual General Meeting.

Voting papers will be posted out by **26 February 2015**.

Corporate Members residing outside Malaysia, who wish to receive voting papers, are advised to write to the Honorary Secretary on or before **2 January 2015**.

Thank you.

Election Officer, IEM

Major Issues on Drilling Engineering

by Ir. Razak Yakob

OIL, GAS AND MINING ENGINEERING TECHNICAL DIVISION

Photo 1 : Ir. Razak Yakob gave his presentation

REALISING the importance of drilling engineering, the IEM Oil, Gas and Mining Engineering Technical Division (OGMTD) organised a talk titled Drilling Engineering: What Is It?

Drilling engineering is a sub-discipline of Petroleum Engineering in oil and gas field development.

The talk, held on 13th September, 2014, attracted over 80 participants which proved that many engineers are interested to learn and understand another sub-discipline.

The talk, chaired by Ir. Tengku Fadziliaton, was presented by Ir. Razak Yakob, an independent consultant with 18 years' experience as a drilling engineer operator with ExxonMobil, Talisman and Petronas Carigali as well as contractors like Halliburton.

The aim of the talk was to provide a basic understanding of drilling engineering. It was also intended to be a preamble session for a 1-day course on 20th September, 2014, titled Drilling Engineering Overview.

The talk focused on four major issues: Definition, Organisation, Work and Specialties.

In the Definition section, Ir. Razak gave an introduction of the major responsibilities and work areas and further explained the other sub-disciplines under Petroleum Engineering such as Reservoir Engineering, Petrophysic, Production Technology, Petroleum Economics, Subsurface Engineering and others.

Photo 2 : Audience participation during the session

Photo 3 : Token of appreciation for Ir. Razak Yakob

He then went on to Organisation, covering essential topics to help understand the general petroleum industry, such as an introduction to Drilling Project Management Team structure, Life of Field, Project Cost Components and Well Design Process.

In the Work section, Ir. Razak talked about some of the work components of a drilling engineer, highlighting four items: Well Trajectory, Blowout Prevention, Casing & Completion Design and Wellhead & Christmas trees.

In the Specialties section, he focused on two areas: Drilling Rigs and Drilling Technologies.

Throughout the session, the audience was encouraged to ask questions to ensure that everyone understood the presentation. And ask questions they did, even on topics that were not covered by the talk, such as deep water equipment components and technologies.

The session ended with the customary presentation of a memento to the speaker by the session chairperson. ■

Ir. Razak Yakob graduated from the Colorado School of Mines in the United States with a degree in Petroleum Engineering and a minor in Mechanical Design in 1996. He has18 years of working experience in various roles, in the Drilling sector of the oil and gas industry. He previously worked with ExxonMobil, Halliburton, Talisman, and Petronas Carigali.

He is currently an Independent Drilling Consultant providing services in the Tanjong Baram Small Field Risk Service Contract Project for EnQuest.

IEM DIARY OF EVENTS

Title: Seminar on "Alternative Dispute Resolution in Construction Industry

15th December 2014

Organised by : Project Management Technical Division
Time : 9.00 a.m. – 5.30 p.m.
CPD/PDP: : 7

Title: One Day Short Course On Urban Drainage Modelling For Design

16th December 2014

Organised by : Water Resources Technical Division
Time : 9.00 a.m. – 5.00 p.m.
CPD/PDP: : 0

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

Talk on Challenges In Machining Of Composite Materials

by Ir. Chew Weng Yuen

ENGINEERING EDUCATION TECHNICAL DIVISION

THE Engineering Education Technical Division organised a talk titled Challenges In Machining Of Composite Materials on 28th August, 2014 at Wisma IEM.

The talk was delivered by Ir. Dr Mohd. Khairol Anuar bin Mohd Ariffin, Associate Professor and Head of Department of Mechanical and Manufacturing Engineering, Universiti Putra Malaysia.

The evening talk was attended by 23 participants and Ir. Dr Mohd. Khairol Anuar started with a brief overview of what constituted composite material, the fabrication of composite material, the machining of composite material, and the challenges in machining the composite material.

He then proceeded to talk on the special characteristics of composite materials or composites in short. He said the main advantage of a modern composite is that it is light and strong. Since it has a very high strength to weight ratio, composite such as the carbon fibre reinforced plastic (CFRP) is widely used in the motoring and aerospace industries.

A video to illustrate various composite fabrication processes was then shown. The manual lay-up, the wet lay-up, and the autoclave moulding processes were clearly illustrated and explained.

The manual lay-up process involves the application of resin and reinforcement by hand onto a suitable mould surface. The resulting laminate is then allowed to cure in place without further treatment. The wet lay-up on the hand is a moulding process that combines layers of reinforced fibre with liquid resin to create a high quality laminate.

It involves the positioning of reinforcement material into or against a mould in layers which are then impregnated with liquid resin either with a brush or roller, to ensure a good wet-out of the reinforcement material until the reinforcement thickness is achieved. The composite is then cured at room temperature, or under heat depending on the selection of the resin system.

Autoclave moulding is an advanced composite process that produces denser, void free mouldings because higher heat and pressure are used for curing. This process is widely used in the aerospace industry to fabricate high strength to weight ratio parts from pre-impregnated high strength fibres for aircraft.

Ir. Dr Mohd Khairol Anuar also briefly mentioned that there are currently several types of composite in the industry namely the polymer matrix composite (i.e. fibre glass, CFRP, and kevlar), the particulate reinforced composite, metal matrix composite, natural composite, and ceramic matrix composite.

As for the challenges encountered when machining composites, Ir. Dr Mohd. Khairol Anuar said composites are not homogenous materials. For example, CFRP, the main composite in aircraft parts, consists of a plastic matrix with carbon fibre reinforcement that during machining, may melt from

too much heat, while the carbon fibres do not cut well because they fracture instead of shearing smoothly. Also, CFRP structures are built up of layers of material that can easily splinter or delaminate during machining and by the time the composite structure is ready for machining, it has become such a valuable part that the cost of scrapping may be enormous.

The various types of machining process for composites, namely drilling, milling, and trimming, were then briefly described.

Ir. Dr Mohd. Khairol Anuar showed participants a sample of a CFRP/aluminium laminate composite. He is currently researching on its machining process at the university. He told participants that since the sample was non-ferrous, a diamond coated cutting tool was used for the process. He emphasised that during the milling operation, one must consider the optimum spindle speed, the depth of cut, and the feed rate in order to obtain the most economical milling process. The effect on the finished part was also of importance especially the surface finishing. Other considerations included tool wear, cutting strategy and the vibration/stiffness effect. He also discussed numerical control and tool path optimisation.

Lastly, a video of the experimental milling process carried out by Ir. Dr Mohd. Khairul Anuar and his researchers at the university was shown. An active discussion followed, with questions raised by the participants. ■

Ir. Chew Weng Yuen is a committee member of the Engineering Education Technical Division of IEM. He is currently the Deputy General Manager of Forefront Tiara Sdn. Bhd., a property development company.

IEM DIARY OF EVENTS

Title: One-Day Course On "Non-Destructive Testing (NDT)"

20th December 2014

Organised by : Mechanical Engineering Technical Division
Time : 9.00 a.m. – 5.00 p.m.
CPD/PDP: : 6

Title: Talk On Palm Oil Mill Power Generation

10th January 2015

Organised by : Water Resources Technical Division
Time : 9.00 a.m. – 11.00 a.m.
CPD/PDP: : 2

Title: 16th AFETD Annual General Meeting

10th January 2015

Organised by : Agricultural and Food Engineering Technical Division
Time : 11.00 a.m. – 1.00 p.m.
CPD/PDP: : 2

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

Back To Primary school

ENGINEERING EDUCATION TECHNICAL DIVISION

by Ir. Prof. Dr Dominic Foo Chwan Yee

IN recent years, I have been giving talks in schools on Career Prospects In Engineering. These talks are mostly meant for upper secondary school students in the science stream.

In September 2014, I had arranged with a primary school in Port Dickson, SJK Chung Hua, to deliver a similar talk.

I was initially sceptical. Would such a talk attract students of such a young age?

To my surprise, the 160 Standard Six students (accompanied by the headmaster and some teachers) actively participated in the talk.

I started by asking the students if they could point out where we'd find engineers in the small town of Port Dickson. They correctly pointed out the few important corporations such as the power plant and the two oil refineries, all of which are not too far from the school.

Then I asked how many of them would like to be an engineer when they grow up. A few hands shot up.

I then introduced them to some famous engineers in the world. These included chemical engineering graduate Roberto Goizueta (former chairman and chief executive of Coca-Cola), aeronautical engineering graduate Neil Armstrong (first astronaut to walk on the moon), chemical engineering graduate Andrew Grove (founder of Intel) and civil engineering graduate Datuk Ir. Dr Wee Ka Siong (Minister in Prime Minister Department).

They all broke into hearty laughter when they saw a picture of actor Rowan Atkinson (a.k.a. Mr. Bean) who is an electrical engineering graduate!

Next, I explained to the students that there are a few major branches of engineering, i.e. chemical engineering, civil engineering, mechanical engineering and electrical and electronics engineering.

Instead of going into the details of what each engineering discipline can contribute (as I normally do during talks to secondary school students), I decided to make use of various real life examples to enhance the understanding of the students.

For instance, I told them that the laser point that I was holding was designed by electronic engineers and produced by mechanical engineers.

Another example was the clothes we wear. I told them about fabric that came from petroleum that was explored by petroleum engineers, refined by chemical engineers and made by mechanical engineers.

I also briefly touched on the role of the Board Of Engineers Malaysia (BEM) and the Institution of Engineers Malaysia (IEM).

For the last part of the talk, I showed them photographs of my travelling. The students were very excited to see my pictures taken at the Great Wall of China, the Egyptian pyramid, the windmill of Netherlands and many more! I explained to them that engineers

Photo 1 : Ir. Prof. Dr Dominic Foo Chwan Yee talking to the Standard Six students about Career Prospects in Engineering

Photo 2 : Students listening attentively in the career talk

Photo 3 :The school headmaster handed a souvenir to Ir. Prof. Foo.

do travel around the world due to the nature of their work. I, for example, travel to attend conferences as well as give talks and workshops in all continents of the world.

The students were a lively bunch. To my surprise, they were curious about how much an engineer earned (a question I would expect from secondary school students), so I showed them charts based on an IEM survey conducted some years back. Another interesting question was whether I brought my family along on my travels (my answer was "sometimes").

At the end of the talk, I asked again how many of them would like to be engineers. This time, I definitely saw many more hands going up! ■

Ir. Professor Dr Dominic Foo is the Professor of Process Design and Integration at the University of Nottingham Malaysia Campus. He is the 2012/13 and 2013/14 sessions chairman for the Chemical Engineering Technical Division (CETD). Ir. Prof. Dr Foo also serves the editorial board of Process Safety & Environmental Protection (Transactions of the Institution of Chemical Engineers UK - IChemE), IEM Journal and Chemical Engineering Transactions. He is the winners of the 2009 IChemE Innovator of the Year Award, 2010 IEM Young Engineer Award, Outstanding Young Malaysian Award 2012 and the 2013 SCEJ (Society of Chemical Engineers, Japan) Award for Outstanding Asian Researcher and Engineer.

PRESS STATEMENT

Stop The Excessive Land Clearing at Cameron Highlands to Prevent Flash Floods and Landslides

The Institution of Engineers, Malaysia (IEM) is concerned over the recent flash floods and landslides that occurred in Ringlet and Bertam Valley, Cameron Highlands on 5th and 7th November 2014 which claimed five lives and damaged a lot of property.

As pointed out by the relevant authority, the root cause of such massive flooding which has been occurring quite frequently in recent years is the excessive land clearing in Cameron Highlands; mainly for agricultural purpose. The uncontrolled extensive land clearing has resulted in tremendous amount of soil erosion which in turn caused the Ringlet Lakes and both the Ringlet River as well as Bertam River to be heavily silted. The indiscriminate dumping of rubbish such as plastic sheets used by the farmers is another contributing factor that chokes the drains and rivers. In the event of heavy rain, both the Ringlet and Bertam River would not be able to cater for the huge amount of stormwater, hence causing the muddy rivers to overflow and flood the banks and the surrounding low lying areas.

IEM welcomes the Government initiative in taking the necessary structural flood mitigation measures such as deepening and widening of the rivers. But the time has come to put an immediate freeze on excessive land clearing in the highlands where the terrain is steep. Any further opening up of the highlands will definitely aggravate the problem of soil erosion and increase the risk of flooding. The long term solution lies in the control of land use and the relevant authorities must be serious in tackling the root cause.

For areas that have already been cleared, the authorities should ensure that the land owners or operators take the necessary measures to reduce soil erosion. Plastic 'houses' which have been used extensively by farmers to shelter their vegetable farms should have proper water retention facilities so that when it rains, some of the water flowing to the rivers can be controlled and held back at source.

There must be an integrated approach to solve the recurrent flooding and landslide problem which should include controlled land use and land clearing, the application of best agricultural management practices, the relocation of squatters along river reserves, the appropriate flood mitigation measures and the necessary flood forecasting and warning system. In order to prevent further loss of lives, it is important to formulate the Cameron Highlands Disaster Prevention Master Plan urgently. IEM is willing to assist the Government with the necessary technical advice in the preparation of such a master plan.

IEM wishes to extend our sympathies and condolences to the families of the flood victims in Ringlet and the Bertam Valley, Cameron Highlands. ■

Dato' Ir. Lim Chow Hock
President
Dated 8 November 2014

The IEM PRESS STATEMENT was submitted to all the medias on 8 Nov 2014 and published by the following Media :-

[1] New Straits Times (NST) – Letters – "Freezing land clearing will help" (Newsprint + Online Version) NST Online (11 Nov 2014) http://www.nst.com.my/node/51683

[2] The Sun (Sun) – Letters – " Freeze clearing of hilly land" (Newsprint + Online Version) The Sun Online (10 Nov 2014) http://www.thesundaily.my/node/280640

[3] The Malay Mail Online (Online Version Only) –" Stop the excessive land clearing at Cameron Highlands – IEM" (10 Nov 2014) http://www.themalaymailonline.com/what-you-think/article/stop-the-excessive-land-clearing-at-cameron-highlands-iem

[4] Free Malaysia Today (Online News Portal) – "Halt land clearing in Cameron, says IEM" (10 Nov 2014) The Institution of Engineers offers its help in drawing up a master plan to prevent disasters. http://www.freemalaysiatoday.com/category/nation/2014/11/10/halt-land-clearing-in-cameron-says-iem/

[5] The Malaysian Insider (Online News Portal) – "Stop the excessive land clearing at Cameron Highlands – Lim Chow Hock" (8 Nov 2014) http://www.themalaysianinsider.com/sideviews/article/stop-the-excessive-land-clearing-at-cameron-highlands-lim-chow-hock

SIEMENS

Introduction to Model Predictive Control from an Application Perspective

Dr Otmar Lorenz, Dr Ing B.M Pfeiffer and Ir. Johnson Tan Shiew Sun

Abstract - Innovative automation solutions, such as model predictive control (MPC) promise to increase plant throughput, improve operability and energy efficiency, reduce downtime and operating man-power as well as stabilize operations and increase maintenance intervals. In industrial practice MPC is the most common advanced control technology. During the last years many applications are realized in the process industries such as chemical/ petrochemical plants, oil refineries, metals, minerals, paper, glass, cement, food and beverages industry [1, 2].

This article illustrates fundamentals, different approaches of implementation and application examples from a practical perspective. It provides an introductory overview and orientation for users in the process industry.

I. INTRODUCTION AND MOTIVATION

MODEL predictive control is an advanced method of process control characterized by using a dynamic model of the process not only in controller design phase but explicitly use the model in run-time control operation for prediction of future process behavior. These predictions are used to control process units dynamically at optimum steady-state targets [4]. In practice linear empirical models are frequently used, obtained from observed process behavior by plant step test and system identification. Model predictive controllers mostly include multiple independent variables, constraint handling and on-line optimization.

Model predictive controllers are applied to plants with characteristics such as large time delays, numerous constraints, process interactions, inverse response or other difficult process dynamics, high production volume, competing control objectives, day/night or seasonal variation. You can apply them if you need to operate the process close to constraints, to track optimization targets or to transition smoothly from one set of targets to another. In refinery and petrochemical industry MPC is already a standard control technology (Fig. 1). The solutions are highly multivariable and based on "full-blown MPC" software packages (e.g. DMC+, INCA) using linear process models [3,4,5]. In this industry the MPC solutions are mainly offered by software tool suppliers as turn-key solutions, running on standard PC outside the distributed control system (DCS).

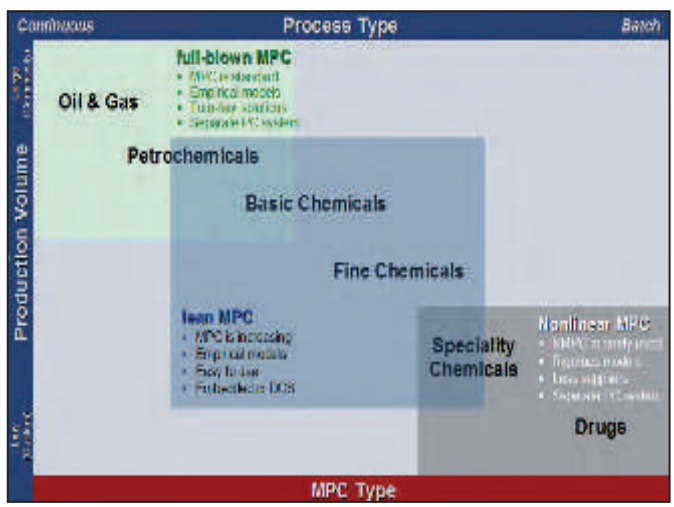

Figure 1: Types of MPC and fields of application

Many MPC applications such as binary distillation columns, chemical reactors, drying or burning processes are lean applications, often found from petrochemical up to fine chemical industry. For these applications lean MPC functions embedded in the DCS are offered by several distributed control system suppliers (Fig. 2).

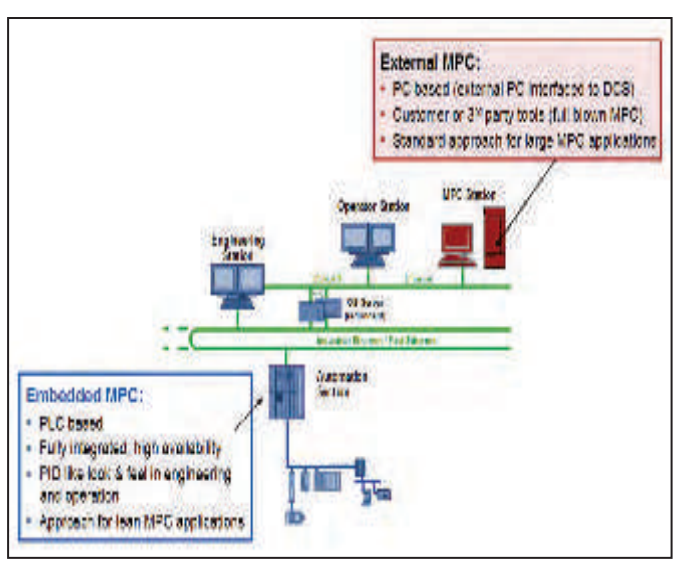

Figure 2: Implementation variants for MPC

Lean MPC in general based on linear process models. They are embedded in the DCS with high availability and the same look and feel in engineering and operation as familiar DCS functions like PID control. They are more easy in implementation and life cycle maintenance for DCS engineers with a basic control engineering background. Furthermore pre-built engineering templates for typical plant units, such as distillation column, fluidized bed dryer or continuous stirred tank reactor support the application of lean MPC. These templates cover preconfigured CFCs (Continuous Function Charts, instances of process tag types), SFCs (Sequential Function Charts), and OS screens (HMI screens on the operator station) (Fig. 3).

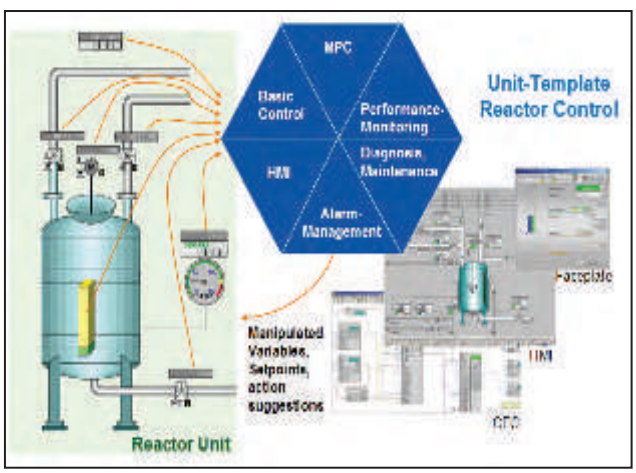

Figure 3: Unit oriented solution template for MPC (Example: SIMATIC PCS 7 by Siemens)

For transient processes like batch and semi-batch processes, mainly found in specialty chemical industry, there exist MPC algorithms with nonlinear models (NMPC). Today, general-purpose commercial NMPC software packages are hardly available, and nonlinear MPC solutions are implemented individually in a project-specific way, actually only in a few chemical plants so far.

II. ESSENTIALS AND FUNDAMENTALS

The size of an MPC application for example "2x2x1" is described by the number of controlled variables (CV; n=2), manipulated variables (MV; m=2) and disturbance variables (DV; o=1). In general MPC are used as supervisory controllers providing set points for slave control loops (cascade structure; Fig. 4). The main advantage of this structure is exploiting the benefits of PID control (e.g. system linearization by PID flow controller in combination with non-linear valve behavior) and the reduced engineering effort for integration in the DCS project by keeping the basic control structure. Only in a view cases the MPC outputs are directly linked to actuators like valves or drives.

The inputs of MPC are measured process variables, measured disturbances and reference trajectories (set points). In case not all controlled variable can be measured or only sporadic lab samples are available (e.g. product quality parameters like melt flow rate, density, concentration, particle size), a soft sensor is used additionally. A soft sensor replaces a real sensor by a piece of software that calculates the desired variable from other variables that can be easily measured.

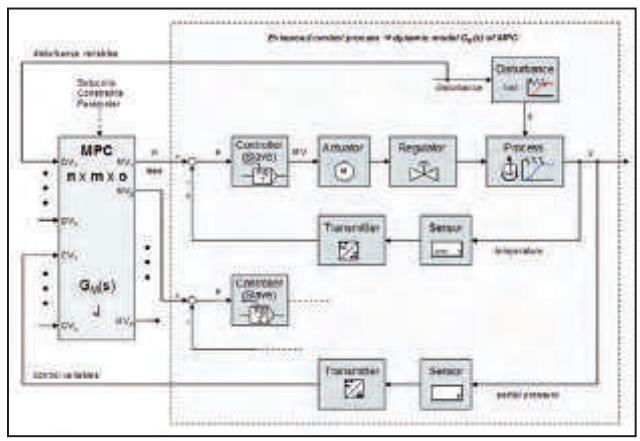

Figure 4: Integration of MPC into automation hierarchy in cascade control structure

The principle of model predictive control is shown in Fig. 5. Based on an explicit process model $G_M(s)$ and measurements obtained in the past (Time ≤ k), the controller predicts the future responses of the process (controlled variables) over a prediction horizon n_P. If all MVs are kept constant at their actual value at time k the prediction is called "future without control" or "free response".

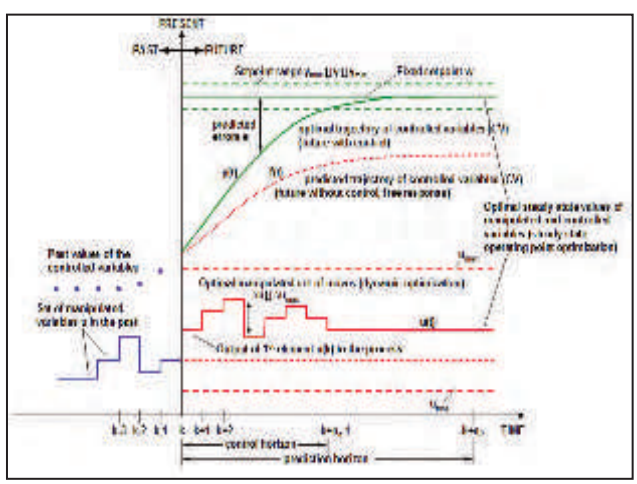

Figure 5: Illustration of MPC principle in time-domain

The impacts of measurable disturbance variables are already considered in "future without control". Moreover, the controller can "test" (simulate) what will be the future impact of different strategies to manipulate the process using the available MVs (inside the control horizon n_C). At each control interval an optimization algorithm is applied to find the best sequence of future manipulated variable adjustments (optimal manipulated set of moves Δu) in order to get the optimal trajectory of controlled variables ("future with control"). This approach is similar to a chess computer: different combinations of future moves are "virtually played" and evaluated according to their effects.

There are a lot of degrees of freedom in the formulation of the optimization setup: future control deviation, CV constraints and future MV moves are included in the performance index while MV limitations are hard constraints. Economic targets can also be considered in the performance index J.

The optimization problem is solved for the whole prediction horizon online at each sampling step but only the first move in the optimal sequence is then sent to the process (1st element u(k) of MV moves). At the next sample, the time horizon is shifted and the complete optimization is re-started ("moving horizon principle"). In other words: the control problem is formulated as an optimization problem and solved as an optimization problem. The typical performance index J looks like:

$$\min_{\Delta\bar{u}(k)} \left\{ J = \sum_{i=1}^{n_P} r_i \left[w(k+i) - \hat{y}(k+i|k) \right]^2 + \sum_{i=0}^{n_C-1} q_i \left[\Delta u(k+i) \right]^2 \right\}$$

w contains the time series of future set points, y contains the time series of future CVs (inside the prediction horizon), Δu contains the time series of future MV moves (inside the control horizon). One of the important reasons for the popularity of MPC is the easy tuning of the basic parameters n_P, n_C, r, q. If the weightings q_i are increased, the controller moves its manipulated variables more cautiously resulting in a slower but more robust control action. Using the control weighting factors r_i, the relative significance of the individual controlled variables can be specified. A higher weighting (priority) for a controlled variable means that this one moves more quickly towards the set point w and remains more accurately at the set point in steady state if it is not possible to achieve all set points precisely. Important requirements for control design are good set point tracking, sufficient disturbance rejection and robustness against model mismatch.

III. PRACTICAL EXAMPLES

Typically the application of MPC starts with a process analysis and benefit potential estimation, followed by plant tests, model identification, controller design and implementation. A short selection of MPC application examples are listed below.

Distillation is the most important separating process in the process industry. It is a thermal separating process used on a liquid mixture for separating different substances (soluble in each other) by means of their different relative evaporation and different boiling points. Some typical applications for distillation are the production of alcohol and the distilling of crude oil in a refinery. Basically, a distinction is made between batch distillation and continuous distillation (e.g. rectification, extractive or reactive distillation). During rectification (counter flow distillation), a multi-component mixture is separated into at least two streams. The low boiling components D (distillate, tops) are drawn off at the head of the rectification column and the heavy boiling components B (bottoms) are drawn off at the bottom. There are at least five different variants for controlling distillation columns via one single temperature, because using conventional single-input single-output control the product quality (temperature) can be controlled either at the top or at the bottom of the column, but not at both due to the strong thermodynamic interactions in the distillation column [5]. By routine application of a multivariable controller that has two controlled variables and two manipulated variables, almost all of the columns that were previously operated according to one of the five conventional control patterns can now, for the first time, be equipped with the same standardized automation structure, which includes a complete quality control: Control of head and bottom temperature via reflux ratio and amount of heating steam. In an individual case, the user can specify which controlled variable is particularly important to him by prioritizing the optimization criteria of the predictive controller. Figure 6 shows the simplified instrumentation diagram.

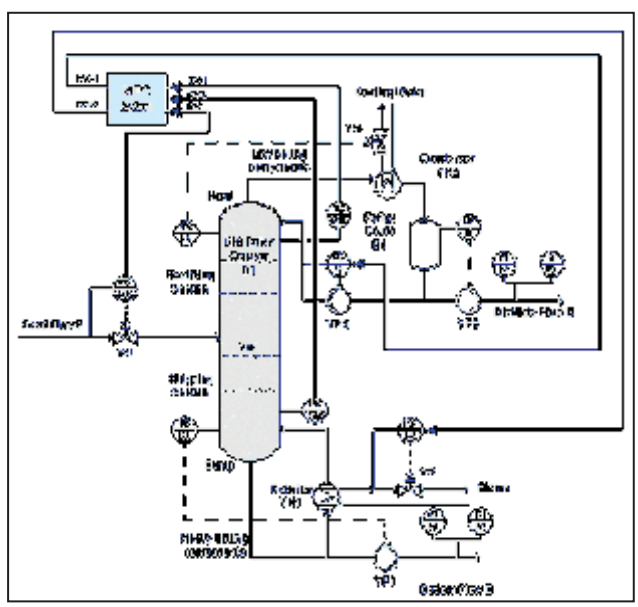

Figure 6: Distillation column with 2x2x1 MPC

A plant operator is running the distillation column typically quite far away from any limits (compressor capacity, pressure, temperature head/bottom, valve positions, etc.) in order to have enough space for counter actions. In this manner he will minimize risk of shutdown. However in order to reach maximal economic benefit (good separation at maximal throughput and minimal energy consumption) the plant should be running in an optimal operating point. Normally the optimum will be at the constraints of the plant. In order to enable an optimal operation the first step is tuning of basic control loops for well-defined and fast reaction (compare Fig. 4: slave control loops are part of the process dynamics for the master controller). The second step is to design an MPC in order to reduce process variations and run closer to the optimal operating point. In the present distillation column example this can be reached by a 2x2x1 MPC structure.

- CV-1 : Temperature head
- CV-2 : Temperature bottom
- MV-1 : Reflux
- MV-2 : Reboiler steam flow
- DV : Feed flow F

In the distillation column there are strong interactions between the controlled variables temperature head/ bottom (CV-1, CV-2). This means that moving one MV will affect both CVs. If you induce more heat at column bottom this will not only increase bottom temperature, but also head temperature. If you increase reflux, this will not only reduce head temperature, but also bottom temperature, because of the cold reflux fluid dripping downwards in counterflow to the hot steam ascending in the column. The feed F into the column strongly affects both CVs and appears as disturbance variable DV. The feed composition is also a disturbance, but it cannot be considered as disturbance variable because in general it is not measured.

The present distillation example is based on separation of a chemical mixture into C5 – and C6-parts with main specification in distillate flow D. It is using the "ModPreCon" function block in the advanced process library (APL) of distributed control system SIMATIC PCS 7 (Fig. 7). It is a linear MPC algorithm, derived from the famous DMC (Dynamic Matrix Control) [10]. For model identification the "MPC-Configurator" was used. This is a user friendly engineering tool for DCS engineers, similar to a PID tuning wizard. Based on plant test data the process model and tuning parameter can be calculated automatically. For the operator station the corresponding familiar faceplates are provided without any effort.

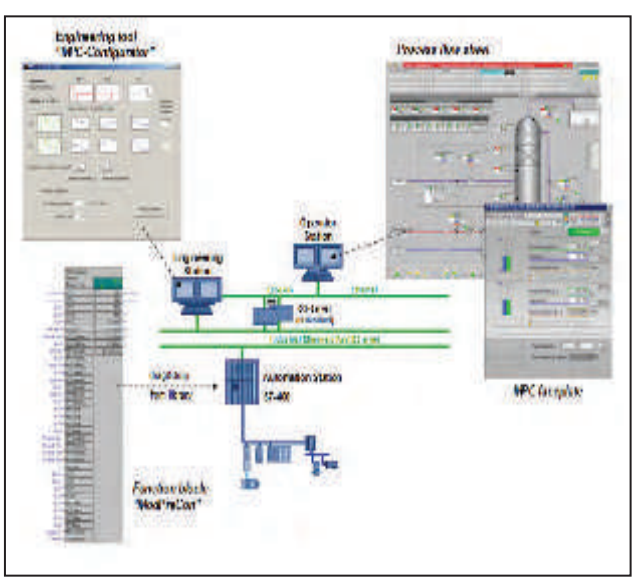

Figure 7: Implementation of embedded MPC within DCS

The applied MPC is able to increase the quality of the distillate D in the production plant (green) in comparison to PID control (black) (Fig. 8). Almost 90 percent of the product is now within specification range.

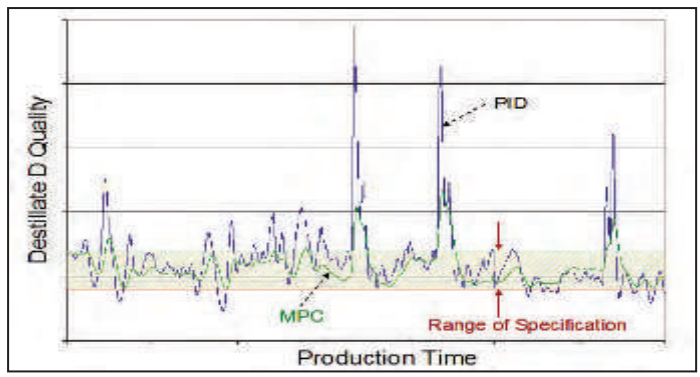

Figure 8: Distillate Quality: PID control versus MPC

The next application example for model predictive control shows the residue desulfurization catalyst evaluation [6]. To effectively achieve an **isothermal** status inside the **reactor**, model predictive control has been applied for regulating its multiple heaters cooperatively. In this application, 5 PID slave controllers used for heater control at a pilot reactor are cascaded with an MPC master controller. Instead of indirect manual setting of heater set-points applied in conventional method, MPC regulates 6 internal temperatures simultaneously to keep temperatures constant (isotherm) $TE_{l,n}(t)$ and achieve target average bed temperature (ABT) as desired (Fig. 9).

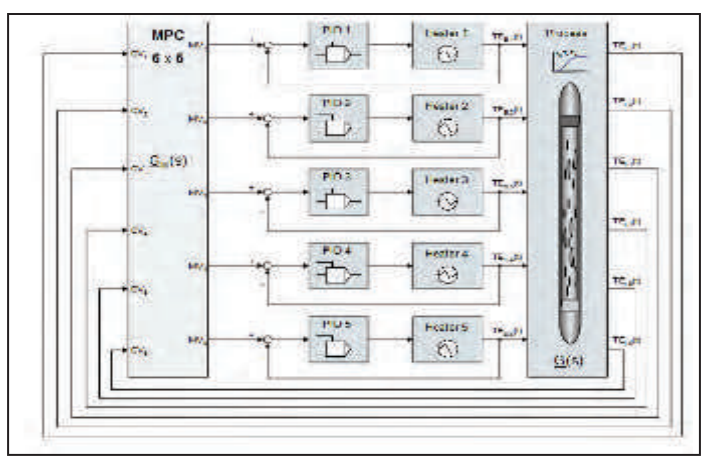

Figure 9: MPC for thermal control of a pilot reactor

The trend of average bed temperature in pilot reactor is shown in Fig. 10. The advantage of MPC is visible in error reduction (mean-value +0.38 → -0.01). Besides stabilizing isotherm of reactor, the number of manual interventions could be significantly reduced.

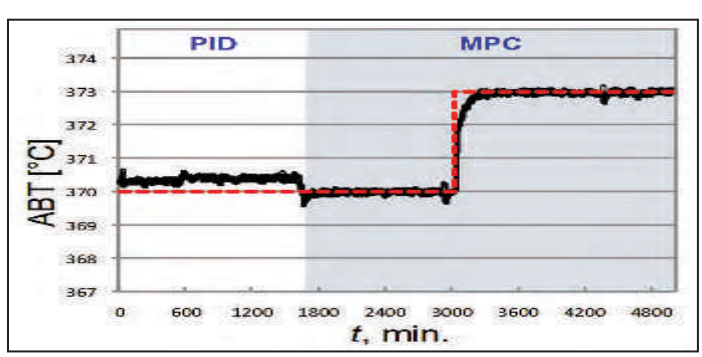

Figure 10: Average Bed Temperature (ABT) reactor control

Another example refers to a single-stage **fluidized bed dryer** for HDPE powder (High Density Poly Ethylene). Wet polymer powder is mixed turbulently in the hot air flow directed upwards. This way the raw material is dried with high heat and moisture transfer coefficients (Fig.11). The wet powder is provided via a rotary feeder at the top end of the dryer. The feed mass flow is controlled by FIC312 via manipulation of rotary feeder speed. Fresh inlet air is provided by a compressor and heated by hot steam in a heat exchanger. Hot air mass flow is controlled by FIC313 via manipulation of compressor speed. Hot air temperature is controlled by TIC315 via a slave controller FIC314 and manipulation of the in the steam pipe. The dry powder leaves the fluidized bed reactor at the bottom end, where residual moisture QI317 and temperature TI316 of the dry powder are measured.

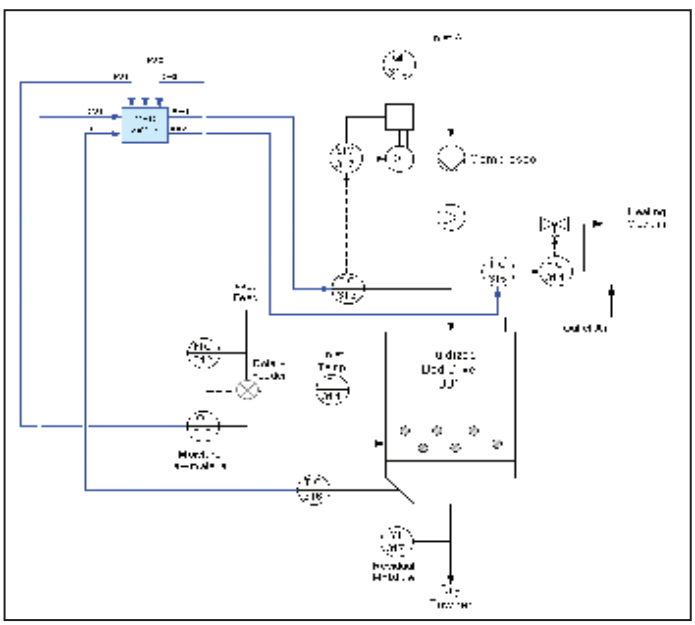

Figure 11: MPC applied to fluidized bed dryer

The existing basic automation of the dryer will be extended by a supervisory MPC quality controller. The controlled variables are residual moisture (CV-1) and temperature (CV-2) of the dry powder. The manipulated variables are mass flow rate (MV-1) and temperature (MV-2) of the inlet air. The measureable disturbance variables are moisture of the wet powder (QI318=DV-1) to be dried, moisture of the inlet air (QI319=DV-2) and through put (FIC312.MV=DV-3). Including economic optimization of operation point the profit of plant operation is based on minimizing energy consumption and increasing product moisture up to the optimization constraints.

IV. SUMMARY

Although many MPC applications have been realized in the past years, it is still estimated that the overall percentage of control systems in the process industry using MPC is not more than 1-5 % [8,9]. Typical reasons for this low percentage are missing quantification of the benefit, missing personal skills, low management attention or missing acceptance of the technology [4,9]. Nevertheless the trend to use MPC as key technology for production efficiency in process industry is increasing. The role of the operators is moving from routine operation to monitoring and opti-mizing the process. In [7] there is an estimation that in a large chemical industry complex 50 new model based control applications are added every year. The trend is also influenced by the high potential for lean MPC [9]. These kind of small and medium sized appli-cations become more attractive, because the starting price is reduced significantly and the tools are more user friendly and better manageable in maintenance for DCS engineers. Within SIMATIC PCS 7 for example, MPC is part of the advanced process library (APL) which is a standard feature of any PCS 7 engineering system. The cost overhead of licensing and supporting advanced techniques is, thereby, avoided.

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Defence Towers

by Ir. Chin Mee Poon
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WHEN my wife and I backpacked through the trans-Caucasian countries of Georgia, Azerbaijan and Armenia recently, we went deep into the Greater Caucasus mountain range on four occasions and were greatly impressed by the many defence towers we saw there.

The Greater Caucasus mountain range stretches 1,200km from the eastern bank of Black Sea in an east-southeast direction, all the way to the Caspian Sea, separating Russia and Europe in the north from those 3 countries and Asia in the south.

Of the 4 regions up in the Greater Caucasus that we visited, Svaneti in the north-western part of Georgia had the most number of defence towers.

These are known as koshki in the local language and it is estimated that there are about 175 of them scattered in the villages in the region, with the highest concentration in the town of Mestia and the villages of Ushguli. It is also believed that most were originally built between the 9th and 13th centuries. Mestia is situated at an altitude of 1,400m and has a population of less than 3,000 people, spread over more than 10 neighbourhoods. On the other hand, Ushguli is 700m higher in the topmost reaches of the Enguri Valley beneath the snow-covered massif of Mt. Shkhara, Georgia's highest peak. It is actually made up of 4 hamlets close to one another, with a total population of less than 300. With more than 30 ancient Svan towers, Ushguli was admitted to UNESCO's World Heritage List in 1996.

The defence towers, built of stones, were mostly to protect the villagers against invading bandits and rival villagers. Inter-village feuds were rife in the olden days. Some towers were even built as status symbols for their owners. Typically 4-5 storeys high, they look very much like the towers I have seen in San Gimignano in Tuscany, Italy, and in the Tibetan villages in Danba, Sichuan Province, China, where they are known as diaolou.

Similar structures in far-flung parts of the world point to one thing: When faced with a similar problem, men in different situations often come up with a similar solution. ■

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

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Note: *This is a continuation of the list which was first published on page 48 of the November 2014 issue.*

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66860	MOHAMMAD ZAKUAN B. RAMLAN	4TH YEAR(UTHM)(CIVIL)
66861	MOHD ADIB B. ABDUL WAHAB	4TH YEAR(UTHM)(CIVIL)
67804	MOHD AL-RASHID B. KUSRIN	2ND YEAR(UITM)(CIVIL)
68098	MOHD AMIR AZIZI B. KASIN	1ST YEAR(UTHM)(CIVIL)
68099	MOHD AMIRUL HAKIM B. MOHD ZAILANI	1ST YEAR(UTHM)(CIVIL)
66937	MOHD ARIEF B. MOHAMED	4TH YEAR(UTHM)(CIVIL)
68601	MOHD ASYRAF B. ISMAIL	2ND YEAR(UITM)(CIVIL)
68695	MOHD AZIZUL NADRI B. AWANG	1ST YEAR(UTM)(CIVIL)
66862	MOHD AZLAN B. SAMSUDDIN SAH	4TH YEAR(UTHM)(CIVIL)
68747	MOHD AZRUL B. NAZENI @ NAZRI	1ST YEAR(UTHM)(CIVIL
68616	MOHD FAIZ B. MOHD TAHIR	2ND YEAR(UITM)(CIVIL)
67805	MOHD FAREEZ B. HANAFI	2ND YEAR(UITM)(CIVIL)
70978	MOHD FATEHAH BIN ABDUL LATIF	1ST YEAR(UTP)(CIVIL)
66863	MOHD FAZRIE B. RAKMAT	4TH YEAR(UTHM)(CIVIL)
70962	MOHD FUAD BIN SAMSUDIN	4TH YEAR(UTM)(CIVIL)
66864	MOHD HAZIQ NIZMAN B. HALED	4TH YEAR(UTHM)(CIVIL)
66865	MOHD IDHAM B. MOHD NAJID	4TH YEAR(UTHM)(CIVIL)
66866	MOHD IZZAT HELMI B. MAHDI @ MAHADI	4TH YEAR(UTHM)(CIVIL)
67806	MOHD LOKMAN NUR HAKIM B. HAZAHARI	2ND YEAR(UITM)(CIVIL)
68100	MOHD NAZREEN B. MOHAMMAD ZAKI	1ST YEAR(UTHM)(CIVIL)
68748	MOHD NOR AZLAN B. MOHD ASERI	1ST YEAR(UTHM)(CIVIL
66938	MOHD ROFLI B. JOHARI	4TH YEAR(UTHM)(CIVIL)
68749	MOHD RUZAINI B. ABD JALIL	1ST YEAR(UTHM)(CIVIL
68101	MOHD SHAFIQ B. MOHD ROSLI	1ST YEAR(UTHM)(CIVIL)
66939	MOHD SHAFIQ B. MOHD SHUKRI	4TH YEAR(UTHM)(CIVIL)
66867	MOHD SHAFIQ B. SHAMSUDIN	4TH YEAR(UTHM)(CIVIL)
67807	MOHD SHAHIRAN B. JAMIL	2ND YEAR(UITM)(CIVIL)

66868	MOHD SHAHRUL RIDZWAN B. OTHMAN	4TH YEAR(UTHM)(CIVIL)
68617	MOHD SHARILL SYARNIZAN B. MOHD RAZALI	2ND YEAR(UITM)(CIVIL)
68750	MOHD SHAWAL B. ALIAS	1ST YEAR(UTHM)(CIVIL
68751	MOHD SHAZWAN B. SULAIMAN	1ST YEAR(UTHM)(CIVIL
66940	MOHD SUFIYAN B. JUPERI	4TH YEAR(UTHM)(CIVIL)
68696	MOHD SUHAYMI B. JUMADIL	1ST YEAR(UTM)(CIVIL)
68102	MOHD TAUFIK CHIA	1ST YEAR(UTHM)(CIVIL)
68697	MOHD TAUFIQ B. MOHAMAD	1ST YEAR(UTM)(CIVIL)
66869	MOHD YUSRI B. MOHD YUSOFF	4TH YEAR(UTHM)(CIVIL)
66941	MOHD ZAIME B. MAT NOR	4TH YEAR(UTHM)(CIVIL)
66942	MOHD ZARI B. MUSA	4TH YEAR(UTHM)(CIVIL)
67808	MOHD ZHAFIR B. CHE SAKRI	2ND YEAR(UITM)(CIVIL)
68103	MOHD ZUL AZMI B. AHMAD MAHYUDIN	1ST YEAR(UTHM)(CIVIL)
66870	MOHD ZULHILMI B. ABDUL HALIM	4TH YEAR(UTHM)(CIVIL)
68752	MOHDHAZEEQ ADHAHUDDINSA B. MOHD SOBRI	1ST YEAR(UTHM)(CIVIL
70961	MUHAMAD ADIB BIN AHMAD	4TH YEAR(UTM)(CIVIL)
67809	MUHAMAD AFIQ B. MOHD YUSOFF	2ND YEAR(UITM)(CIVIL)
68753	MUHAMAD FAQRUL HISHAM B. MOHD ZULKIFELI	1ST YEAR(UTHM)(CIVIL
68104	MUHAMAD FIRDAUS B. IBERHIM	1ST YEAR(UTHM)(CIVIL)
68105	MUHAMAD HAZRUL BADRUL B. NORDIN	1ST YEAR(UTHM)(CIVIL)
68754	MUHAMAD IQBAL B. MD NASIR	1ST YEAR(UTHM)(CIVIL
68618	MUHAMAD IZZUDDIN B. ZAINAL	2ND YEAR(UITM)(CIVIL)
68755	MUHAMAD RIDZUAN B. ALI	1ST YEAR(UTHM)(CIVIL
66871	MUHAMAD ROSSAIRI B. RUSLAN	4TH YEAR(UTHM)(CIVIL)
68106	MUHAMAD SAUFI B. AHMAD NASIR	1ST YEAR(UTHM)(CIVIL)
68756	MUHAMAD SHAFIZAINI B. SHAFIEE	1ST YEAR(UTHM)(CIVIL
68619	MUHAMAD YUSUF B. SUID	2ND YEAR(UITM)(CIVIL)
68757	MUHAMMAD AFIF B. JAMAL ABD. NASIR	1ST YEAR(UTHM)(CIVIL
70960	MUHAMMAD AFNAN B ABDULLAH	4TH YEAR(UTM)(CIVIL)
68107	MUHAMMAD AIZAT B. BAKER	1ST YEAR(UTHM)(CIVIL)
70976	MUHAMMAD ALIF BIN MUHD HASBI	1ST YEAR(UTP)(CIVIL)
67810	MUHAMMAD AMINUDDIN B. ABDUL RAHMAN	2ND YEAR(UITM)(CIVIL)
68066	MUHAMMAD ARIFF ADLAN B. PUAD	2ND YEAR(UITM)(CIVIL)
66872	MUHAMMAD ASSA'DI MUZAMMIL B. ISMAIL	4TH YEAR(UTHM)(CIVIL)
67811	MUHAMMAD ASYRAF B. ROSSLAN	2ND YEAR(UITM)(CIVIL)
67812	MUHAMMAD AZFAR B. MOKTAR	2ND YEAR(UITM)(CIVIL)
66873	MUHAMMAD AZLIN B. SUDIN	4TH YEAR(UTHM)(CIVIL)
67813	MUHAMMAD DARULNAIM B. CHE DOLLAH	2ND YEAR(UITM)(CIVIL)
66874	MUHAMMAD FADHIL B. ABDLLAH	4TH YEAR(UTHM)(CIVIL)
68620	MUHAMMAD FADZIL B. MOHD TAHIR	2ND YEAR(UITM)(CIVIL)
68758	MUHAMMAD FAHMI B. NOOR IZHAR	1ST YEAR(UTHM)(CIVIL
66875	MUHAMMAD FAISAL B. MD ALI	4TH YEAR(UTHM)(CIVIL)
68621	MUHAMMAD FAIZ B. ISMAIL	2ND YEAR(UITM)(CIVIL)
68759	MUHAMMAD FA'IZ B. MOHD FUAT	1ST YEAR(UTHM)(CIVIL
68760	MUHAMMAD FAIZ B. RAHMAT	1ST YEAR(UTHM)(CIVIL
68622	MUHAMMAD FAKHRUDDIN B. IDRIS	2ND YEAR(UITM)(CIVIL)
67814	MUHAMMAD FAQRUL RADZI B. ZAINAL RASHID	2ND YEAR(UITM)(CIVIL)
68032	MUHAMMAD FAREED B. MOHD ALUI	4TH YEAR(UTHM)(CIVIL)
68108	MUHAMMAD FARHAN B. HASSAN	1ST YEAR(UTHM)(CIVIL)
70959	MUHAMMAD FARID BIN CHE DERAMAN	4TH YEAR(UTM)(CIVIL)
67815	MUHAMMAD FITRI B. MAT YASIN	2ND YEAR(UITM)(CIVIL)
67816	MUHAMMAD HAFIZ B. MAHASSAN	2ND YEAR(UITM)(CIVIL)
68762	MUHAMMAD HAFIZ B. MUHAMAD SAFWAN SELVAM	1ST YEAR(UTHM)(CIVIL
66877	MUHAMMAD HAFIZ B. SALBI	4TH YEAR(UTHM)(CIVIL)
68763	MUHAMMAD HAFIZ FIRDAUS B. BORHAN	1ST YEAR(UTHM)(CIVIL
68764	MUHAMMAD HAFIZUDDIN B. ANIS	1ST YEAR(UTHM)(CIVIL
68765	MUHAMMAD HAKIM B. MOHD ZIN	1ST YEAR(UTHM)(CIVIL
67817	MUHAMMAD HAMIZ B. NORDIN	2ND YEAR(UITM)(CIVIL)
68109	MUHAMMAD HAMZAH B. AWANG	1ST YEAR(UTHM)(CIVIL)
67818	MUHAMMAD HARITH IMRAN B. MOHAMMAD NOH	2ND YEAR(UITM)(CIVIL)
67819	MUHAMMAD HASROL NIZAM B. ABDUL KARIM	2ND YEAR(UITM)(CIVIL)
70958	MUHAMMAD HAZIM BIN MOHAMAD	4TH YEAR(UTM)(CIVIL)
68110	MUHAMMAD HAZIQ B. ABDUL RAHMAN	1ST YEAR(UTHM)(CIVIL)
68111	MUHAMMAD HILMAN B. ADNAN	1ST YEAR(UTHM)(CIVIL)
70937	MUHAMMAD HUZAIL BIN HASSAN	4TH YEAR(UTM)(CIVIL)
66943	MUHAMMAD HUZAIRE B. HUSIN	4TH YEAR(UTHM)(CIVIL)
68766	MUHAMMAD IKHWAN NAZIF B. ZAMLEE	1ST YEAR(UTHM)(CIVIL
66878	MUHAMMAD IRFAN AFIFI B. ROSMANI	4TH YEAR(UTHM)(CIVIL)
68112	MUHAMMAD KAMAL UBAIDILLAH B. KAMARUDIN	1ST YEAR(UTHM)(CIVIL)
68113	MUHAMMAD KHAIRUL AMIRIN B. ADNAN	1ST YEAR(UTHM)(CIVIL)
68767	MUHAMMAD KHUZAIMY B. KAMARUL HALIM	1ST YEAR(UTHM)(CIVIL
67820	MUHAMMAD LUTHFI B. FAUZAM	2ND YEAR(UITM)(CIVIL)
67821	MUHAMMAD MUTAWAKKIL B. ILIAS @ ISMAIL	2ND YEAR(UITM)(CIVIL)
68114	MUHAMMAD MUZZAMMIL B. MUSTAFA	1ST YEAR(UTHM)(CIVIL)
68768	MUHAMMAD NAJMUL MUSYAROFF B. MUSTAKIM	1ST YEAR(UTHM)(CIVIL
66944	MUHAMMAD NIZAMUDDIN B. SAMADI	4TH YEAR(UTHM)(CIVIL)
67822	MUHAMMAD NUR HANIF B. ISMAIL	2ND YEAR(UITM)(CIVIL)
68769	MUHAMMAD SASZUAN B. MOHD SULAIMAN	1ST YEAR(UTHM)(CIVIL
70957	MUHAMMAD SAZLLY NAZREEN BIN MAH MOOR	4TH YEAR(UTM)(CIVIL)
68770	MUHAMMAD SHAFWAN B. SABAN	1ST YEAR(UTHM)(CIVIL
67823	MUHAMMAD SHUKRI B. DAMANHURI	2ND YEAR(UITM)(CIVIL)
66879	MUHAMMAD SHUKRI B. SAHARIN	4TH YEAR(UTHM)(CIVIL)
68115	MUHAMMAD SHUQUR B. ABU BAKAR	1ST YEAR(UTHM)(CIVIL)
68771	MUHAMMAD SYAFIQ B. MOHAMAD NOR	1ST YEAR(UTHM)(CIVIL
68624	MUHAMMAD SYAHIR B. ROSLAM	2ND YEAR(UITM)(CIVIL)
68772	MUHAMMAD SYAHRIF AZHAR B. JAAFAR	1ST YEAR(UTHM)(CIVIL
67824	MUHAMMAD USMAN B. NORDIN	2ND YEAR(UITM)(CIVIL)
68773	MUHAMMAD ZAID B. MOHAMAD SAHIDE	1ST YEAR(UTHM)(CIVIL
68774	MUHAMMAD ZAKI B. BACHOK	1ST YEAR(UTHM)(CIVIL
68775	MUHAMMAD ZAKIRUDDIN B. ZABIDI	1ST YEAR(UTHM)(CIVIL
66880	MUHAMMAD ZAMIRUL FAIQ B. MOHD YUNUS	4TH YEAR(UTHM)(CIVIL)
68776	MUHAMMAD ZARRIN B. AHYER	1ST YEAR(UTHM)(CIVIL
66881	NABILA BT. ZAKARIA	4TH YEAR(UTHM)(CIVIL)
66945	NABILA NAJWA BT. AZMI	4TH YEAR(UTHM)(CIVIL)
68116	NABILAHRAIHAN BT. ABDUL HALIM	1ST YEAR(UTHM)(CIVIL)
70956	NADIA AINI BINTI HASHIM	4TH YEAR(UTM)(CIVIL)
68777	NADIA AZWA BT. RAMLI	1ST YEAR(UTHM)(CIVIL
66882	NADIA BT. KARIYA	4TH YEAR(UTHM)(CIVIL)
68778	NADIAH BT. JAMALUDIN	1ST YEAR(UTHM)(CIVIL
68033	NADIAH FADIRA BT. MARZUKI	4TH YEAR(UTHM)(CIVIL)
67825	NADZIRA IRUANIE BT. AHMAD TARMIDZI	2ND YEAR(UITM)(CIVIL)
66883	NAFHAH NABIHAH BT. MOHAMED NAWI	4TH YEAR(UTHM)(CIVIL)
66992	NATASHA AMIERA BT. MOHD ZULKIFLY	1ST YEAR(USM)(CIVIL)
67826	NATASHA ZUREENA BT. ARABI	2ND YEAR(UITM)(CIVIL)
66993	NAZATUL AMIRA BT. ABU SAFIAN	1ST YEAR(USM)(CIVIL)
70955	NAZIRAH BINTI AHMAD SHUKRI	4TH YEAR(UTM)(CIVIL)
68698	NAZLIAH @ LIAH BT. NASIR	1ST YEAR(UTM)(CIVIL)
66946	NAZLIDATUL ASHIKEN BT. ADNAN	4TH YEAR(UTHM)(CIVIL)
68625	NAZRUL HANAFI B. MUHAMMAD NIDZAM	2ND YEAR(UITM)(CIVIL)
70954	NAZRY BIN AZILLAH	4TH YEAR(UTM)(CIVIL)
67827	NELSON ANAK ARMY	2ND YEAR(UITM)(CIVIL)
68779	NG ENG CHUNG	1ST YEAR(UTHM)(CIVIL
68117	NG PEI LING	1ST YEAR(UTHM)(CIVIL)
67828	NIK FAZLEEN BT. NIK ZULKEFLI	2ND YEAR(UITM)(CIVIL)
66947	NIK MASNIRA BT. NIK MAT SABRI	4TH YEAR(UTHM)(CIVIL)
68626	NIK MOHD NAIM B. NIK SIN	2ND YEAR(UITM)(CIVIL)
67829	NIK NURAIN AMIRA BT. NIK ABD HANAL	2ND YEAR(UITM)(CIVIL)
68118	NOOR ADEEBA HANIS BT. MOHD NO ZALBIAN	1ST YEAR(UTHM)(CIVIL)
68119	NOOR ASNI BT. MAT SARI	1ST YEAR(UTHM)(CIVIL)
66884	NOOR ATIQAH BT. MOHD YUNUS	4TH YEAR(UTHM)(CIVIL)
66948	NOOR AZILA BT. BAHARIN	4TH YEAR(UTHM)(CIVIL)
68780	NOOR AZYYATI BT. IDRIS	1ST YEAR(UTHM)(CIVIL
70953	NOOR FARAHIN BT MEOR HAMDAN	4TH YEAR(UTM)(CIVIL)
68120	NOOR HAZARINA BT. MOHAMED HUSSAIN	1ST YEAR(UTHM)(CIVIL)
66885	NOOR IDIRAH BT. RAHMAT	4TH YEAR(UTHM)(CIVIL)
66886	NOOR ISLAMIZAM BT. ISMAIL	4TH YEAR(UTHM)(CIVIL)
66949	NOOR LIYANA BT. AHMAD KHASHAIRI	4TH YEAR(UTHM)(CIVIL)
70952	NOOR MIMIE HAFIZA BINTI AB KADIR	4TH YEAR(UTM)(CIVIL)
66950	NOOR SYAZWANI BT. AB HALIM	4TH YEAR(UTHM)(CIVIL)
68034	NOOR SYAZWANI BT. ZAINUDIN	4TH YEAR(UTHM)(CIVIL)
68627	NOORASYIFIN BT. JAMIL	2ND YEAR(UITM)(CIVIL)
66887	NOORATIKAH BT. MOHD ASNAN	4TH YEAR(UTHM)(CIVIL)
67830	NOORSYALILI BT. ROSLY	2ND YEAR(UITM)(CIVIL)
68121	NOR ADLINA BT. SAMSUDIN	1ST YEAR(UTHM)(CIVIL)
68035	NOR ADNIN BT. ABU MANSOR	4TH YEAR(UTHM)(CIVIL)
66994	NOR AMELIA BT. ADHA	1ST YEAR(USM)(CIVIL)
68781	NOR AMIRAH BT. SAHARAN	1ST YEAR(UTHM)(CIVIL
66888	NOR A'TIKAH BT. MOHD YUSOP	4TH YEAR(UTHM)(CIVIL)
66995	NOR AZLIN BT. ALI @ IBRAHIM	1ST YEAR(USM)(CIVIL)
66951	NOR AZRIN BT. MOHD ZAINUDIN	4TH YEAR(UTHM)(CIVIL)
67831	NOR DIYANA BT. YOUB	2ND YEAR(UITM)(CIVIL)
68036	NOR FADZILAH BT. PAHAZRI	4TH YEAR(UTHM)(CIVIL)
66952	NOR FAIZAH BT. MUSA	4TH YEAR(UTHM)(CIVIL)
67832	NOR FATIHAH BT. MOHD FAUZI	2ND YEAR(UITM)(CIVIL)
68037	NOR FAZILAH BT. MOHD ZAKI	4TH YEAR(UTHM)(CIVIL)
68038	NOR HASLIZA BT. HASSIM	4TH YEAR(UTHM)(CIVIL)

66889	NOR RAHAYU BT. RASIDI	4TH YEAR(UTHM)(CIVIL)
68039	NOR RAIHAN BT. MOHD TAMIN	4TH YEAR(UTHM)(CIVIL)
68782	NOR SAHIZAN BT. HARUN	1ST YEAR(UTHM)(CIVIL
67833	NOR SHAFIQAH BT. MOHD MOHSIN	2ND YEAR(UITM)(CIVIL)
70951	NOR ZUHAIRAH BINTI REDHOUAN	4TH YEAR(UTM)(CIVIL)
66996	NORADILA BT. MARZUKI	1ST YEAR(USM)(CIVIL)
68783	NORAFIFI BT. ZAKARIA	1ST YEAR(UTHM)(CIVIL
66953	NORAIZA BT. ISMAIL	4TH YEAR(UTHM)(CIVIL)
68784	NORASHIKIN BT. MOHD ZUL	1ST YEAR(UTHM)(CIVIL
70950	NORASMIRA BINTI JAMALUDIN	4TH YEAR(UTM)(CIVIL)
68785	NORASYIKIN BT. KHAMIS	1ST YEAR(UTHM)(CIVIL
66997	NORAZILAH BT. MOHAMED PAID	1ST YEAR(USM)(CIVIL)
66890	NORDIANA BT. AZEHA	4TH YEAR(UTHM)(CIVIL)
70949	NOREMI BINTI MUZTABA	4TH YEAR(UTM)(CIVIL)
67834	NORFARAH AIN BT. ROSLAN	2ND YEAR(UITM)(CIVIL)
66891	NORHALIZA BT. WAHAB	4TH YEAR(UTHM)(CIVIL)
66954	NORHANIS BT. IDRIS	4TH YEAR(UTHM)(CIVIL)
68786	NORHASHIMA BT. ALIMIN	1ST YEAR(UTHM)(CIVIL
68787	NORLAILI BT. RUSTAM	1ST YEAR(UTHM)(CIVIL
67835	NORLIANA BT. MOHAMAD NOOR	2ND YEAR(UITM)(CIVIL)
66892	NORLIANA BT. SUIB	4TH YEAR(UTHM)(CIVIL)
70948	NORMAIZATULAKMAR BINTI RAHMAT	4TH YEAR(UTM)(CIVIL)
66893	NORMALAHIDA BT. JAMIRAN	4TH YEAR(UTHM)(CIVIL)
68122	NORMARLIANA BT. ZULKIFLEE	1ST YEAR(UTHM)(CIVIL)
68699	NOROHAIDAEZAWATI BT. MOHD NOR	1ST YEAR(UTM)(CIVIL)
66894	NORSUHADAH BT. HAMZAH	4TH YEAR(UTHM)(CIVIL)
66895	NORSYAFIKA NAZUWA BT. MHD RAMLI	4TH YEAR(UTHM)(CIVIL)
68123	NORSYAZWANI HASSAN BASRI	1ST YEAR(UTHM)(CIVIL)
68124	NORZAMILA BT. MOKHTAR	1ST YEAR(UTHM)(CIVIL)
66896	NUR ADEELA BT. RUSLAN	4TH YEAR(UTHM)(CIVIL)
66897	NUR ADILAH BT. HASHIM	4TH YEAR(UTHM)(CIVIL)
68788	NUR AFIQAH BT. ABD HAMID	1ST YEAR(UTHM)(CIVIL
67836	NUR AISHAH BT. ATAN HASHIM	2ND YEAR(UITM)(CIVIL)
68125	NUR AISYAH BT. ARLIS	1ST YEAR(UTHM)(CIVIL)
66998	NUR AISYAH FARHANAH BT. SALLEH	1ST YEAR(USM)(CIVIL)
70947	NUR AIZA SHUHADA BINTI KAMARUDIN	4TH YEAR(UTM)(CIVIL)
67837	NUR ALIA BT. JAILANI	2ND YEAR(UITM)(CIVIL)
66955	NUR AMALINA BT. MOHAMAD	4TH YEAR(UTHM)(CIVIL)
68789	NUR AMIRAH BT. MOHD NASIR	1ST YEAR(UTHM)(CIVIL
68126	NUR AQMA IZURIN BT. RAHMAT	1ST YEAR(UTHM)(CIVIL)
67838	NUR ARLINA BT. CHE ABDULLAH	2ND YEAR(UITM)(CIVIL)
68790	NUR ASSHEEKIH BT. ZAINAL KARIM	1ST YEAR(UTHM)(CIVIL
67839	NUR ATHIRAH BT. HASSAN	2ND YEAR(UITM)(CIVIL)
68040	NUR ATHIRAH BT. MOHAMAD	4TH YEAR(UTHM)(CIVIL)
68127	NUR ATIKAH BT. MOHD ZINAL	1ST YEAR(UTHM)(CIVIL)
70946	NUR 'ATIQAH BINTI JAMAL	4TH YEAR(UTM)(CIVIL)
67840	NUR ATIQAH BT. MOHD NOOR	2ND YEAR(UITM)(CIVIL)
67841	NUR DIANA BT. SHAFIE	2ND YEAR(UITM)(CIVIL)
67842	NUR DIYANA BT. MAZLAN	2ND YEAR(UITM)(CIVIL)
68128	NUR FADZILAH BT. MASRUDIN	1ST YEAR(UTHM)(CIVIL)
66898	NUR FAEEZA BT. ABDUL RAHMAN	4TH YEAR(UTHM)(CIVIL)
68129	NUR FAJEEHA NAJWA BT. AHAMAD	1ST YEAR(UTHM)(CIVIL)
66999	NUR FARAH SHAHIRAH BT. BESENUN	1ST YEAR(USM)(CIVIL)
67843	NUR FARAHANI BT. MD DESA	2ND YEAR(UITM)(CIVIL)
66899	NUR FARAHDINA BT. ABD RAHIM	4TH YEAR(UTHM)(CIVIL)
68130	NUR FARHANA BT. CHE ROS	1ST YEAR(UTHM)(CIVIL)
68041	NUR FARRINA BT. JOHARI	4TH YEAR(UTHM)(CIVIL)
66900	NUR FATHANAH BT. ZAKARIA	4TH YEAR(UTHM)(CIVIL)
68131	NUR FATHIN NADIAH BT. MOHD NOH	1ST YEAR(UTHM)(CIVIL)
68602	NUR FATIHAH BT. JOHNNY	2ND YEAR(UITM)(CIVIL)
68132	NUR FATIHAH BT. LATIF	1ST YEAR(UTHM)(CIVIL)
70936	NUR FATIN BINTI FAIRUZ	4TH YEAR(UTM)(CIVIL)
67000	NUR FATIN BT. MUSTAFA	1ST YEAR(USM)(CIVIL)
68133	NUR HAIDA SHAHIRA BT. RAZAK	1ST YEAR(UTHM)(CIVIL)
66901	NUR HANIFAH BT. MOHD NOH	4TH YEAR(UTHM)(CIVIL)
67844	NUR HAZIQAH AFIEFAH BT. ZULKIFLEE	2ND YEAR(UITM)(CIVIL)
67845	NUR HAZWANI BT. ABD AZIZ	2ND YEAR(UITM)(CIVIL)
68042	NUR HIDAYAH BT. HAMZAH	4TH YEAR(UTHM)(CIVIL)
68628	NUR HISYAM B. TAJUL AURUS	2ND YEAR(UITM)(CIVIL)
67846	NUR IYLIA HIDAYAH BT. FAHMI	2ND YEAR(UITM)(CIVIL)
66956	NUR IZAWANI BT. MOHAMED YUSOFF	4TH YEAR(UTHM)(CIVIL)
67847	NUR IZIATI BT. MAZMI	2ND YEAR(UITM)(CIVIL)
67848	NUR IZZATI BT. MOHD RUDZI	2ND YEAR(UITM)(CIVIL)
68043	NUR LAILA BT. RAHMAD	4TH YEAR(UTHM)(CIVIL)
67849	NUR LIYANA BT. ISMAIL	2ND YEAR(UITM)(CIVIL)
67850	NUR NADIA BT. MOHAMAD YA'AKUP	2ND YEAR(UITM)(CIVIL)
68134	NUR NADIRA BT. RUSLAN	1ST YEAR(UTHM)(CIVIL)
68791	NUR NAZIHAH BT. NUR RAHILMAN	1ST YEAR(UTHM)(CIVIL
66902	NUR RASHIDAH BT. AHMAD RASHIDI	4TH YEAR(UTHM)(CIVIL)
68792	NUR RASYIDAH BT. NORDIN	1ST YEAR(UTHM)(CIVIL
67851	NUR SALIMAH BT. SALIM @ MUSA	2ND YEAR(UITM)(CIVIL)
68135	NUR SHAFIQAH BT. NORHISAM	1ST YEAR(UTHM)(CIVIL)
70945	NUR SHOFIAH BINTI ABDUL RAHIM	4TH YEAR(UTM)(CIVIL)
67852	NUR SYAFIQAH BT. ABDUL RAIF	2ND YEAR(UITM)(CIVIL)
68044	NUR SYAFIQAH SHAZIRA BT. MOHD SHUKOR	4TH YEAR(UTHM)(CIVIL)
67853	NUR SYAHRAIN NABILA BT. ATAN	2ND YEAR(UITM)(CIVIL)
68793	NUR SYAZWANI BT. ABD ALIM	1ST YEAR(UTHM)(CIVIL
68136	NUR ZAHIRAH BT. ABD JABAR	1ST YEAR(UTHM)(CIVIL)
68794	NUR ZAKIAH BT. HASAN	1ST YEAR(UTHM)(CIVIL
68795	NUR ZULAIKA BT. MAT HAMIZI	1ST YEAR(UTHM)(CIVIL
68137	NURASYIKKIN BT. AZIZ JAAFAR	1ST YEAR(UTHM)(CIVIL)
66903	NURAZIRA BT. ABD AZIZ	4TH YEAR(UTHM)(CIVIL)
67854	NURAZLIN BT. IBRAHIM	2ND YEAR(UITM)(CIVIL)
67855	NURDIYANA BT. RADUAN	2ND YEAR(UITM)(CIVIL)
68138	NURFARHANI BT. JOUHARI	1ST YEAR(UTHM)(CIVIL)
67856	NURHANIS BT. NOOR AZHAR	2ND YEAR(UITM)(CIVIL)
66957	NURHASLINDA BT. ABDUL RAHMAN	4TH YEAR(UTHM)(CIVIL)
68139	NURHAZWANI BT. MOHAMAD	1ST YEAR(UTHM)(CIVIL)
66904	NURHAZWANI BT. MOHD SALLEH	4TH YEAR(UTHM)(CIVIL)
68796	NURHIDAYAH BT. ABDUL BASIR	1ST YEAR(UTHM)(CIVIL
68797	NURIN AMALINA BT. ZAINAL ABIDIN	1ST YEAR(UTHM)(CIVIL
67857	NURLIANA BT. HASSAN	2ND YEAR(UITM)(CIVIL)
67858	NURLISA AINA BT. ZAIDY	2ND YEAR(UITM)(CIVIL)
67859	NURRUL NABILAH BT. KAMARUDIN	2ND YEAR(UITM)(CIVIL)
66905	NURSHIMA BT. ROSDI	4TH YEAR(UTHM)(CIVIL)
70944	NURUL AFIDAHTUL AZUA BINTI ROSLI	4TH YEAR(UTM)(CIVIL)
67860	NURUL AKMA BT. NGAH	2ND YEAR(UITM)(CIVIL)
66958	NURUL AKMA BT. SALIMI	4TH YEAR(UTHM)(CIVIL)
68140	NURUL ALIA DIANA BT. MOHD ZIM	1ST YEAR(UTHM)(CIVIL)
68141	NURUL AMIRA BT. MD NORDIN	1ST YEAR(UTHM)(CIVIL)
68142	NURUL ASHIKIN BT. SUHAINI	1ST YEAR(UTHM)(CIVIL)
68798	NURUL ASILAH BT. A. GHANI	1ST YEAR(UTHM)(CIVIL
67861	NURUL ASYIKIN BT. MOHMAD ASRI	2ND YEAR(UITM)(CIVIL)
67862	NURUL ASYIQIN BT. ABD AZIZ	2ND YEAR(UITM)(CIVIL)
68143	NURUL ATIQAH BT. NIZAM	1ST YEAR(UTHM)(CIVIL)
68799	NURUL ATIQAH BT. NORDIN	1ST YEAR(UTHM)(CIVIL
66959	NURUL AZIMAH BT. AHMAD	4TH YEAR(UTHM)(CIVIL)
66960	NURUL DIYANA BT. MAT NOR	4TH YEAR(UTHM)(CIVIL)
68800	NURUL FAHADA BT. MOHAMMAD NAJIB	1ST YEAR(UTHM)(CIVIL
68144	NURUL FARAH AIN ZAHIRAH BT. ZAIDI	1ST YEAR(UTHM)(CIVIL)
68801	NURUL FARAHIYAH BT. MOHD PAUZI	1ST YEAR(UTHM)(CIVIL
67863	NURUL FAREHAN BT. IBRAHIM	2ND YEAR(UITM)(CIVIL)
68145	NURUL FATINA BT. MD SALI	1ST YEAR(UTHM)(CIVIL)
68802	NURUL FATINNABILAH BT. NOOR AZMI	1ST YEAR(UTHM)(CIVIL
68700	NURUL HAFIZAH BT. AG JALUDIN	1ST YEAR(UTM)(CIVIL)
68629	NURUL HAFIZAH BT. MOHD HARUN	2ND YEAR(UITM)(CIVIL)
67864	NURUL HAFIZZA BT. JOHNNY	2ND YEAR(UITM)(CIVIL)
66906	NURUL IZZATI BT. BAHARI	4TH YEAR(UTHM)(CIVIL)
67001	NURUL JANNAH BT. ISMAIL	1ST YEAR(USM)(CIVIL)
66907	NURUL JANNAH IZZATI BT. MAH HASSAN	4TH YEAR(UTHM)(CIVIL)
66908	NURUL KHALISAH BT. MAHTAR	4TH YEAR(UTHM)(CIVIL)
67865	NURUL NADIAH BT. JAAFAR	2ND YEAR(UITM)(CIVIL)
66909	NURUL NADIAH BT. MOHAMMAD	4TH YEAR(UTHM)(CIVIL)
66910	NURUL SAHIDA BT. ABD RAHIM	4TH YEAR(UTHM)(CIVIL)
67866	NURUL SYAFIKA BT. NOR RIZAN	2ND YEAR(UITM)(CIVIL)
67867	NURUL WAJIHAH BT. ABAS ZAHARI	2ND YEAR(UITM)(CIVIL)
68146	NURULAIN BT. OTHMAN	1ST YEAR(UTHM)(CIVIL)
68147	NURULFARAH AMIRAH BT. ZAINAL	1ST YEAR(UTHM)(CIVIL)
67002	NURULYASARAH BT. MOHD YUNUS	1ST YEAR(USM)(CIVIL)
67003	PAVANITHAN A/L NATHAN	1ST YEAR(USM)(CIVIL)
67004	POON JING LIN	1ST YEAR(USM)(CIVIL)
68148	PRIYADATCHINI A/P KARUNAKARAN	1ST YEAR(UTHM)(CIVIL)
68149	PUTERI NATASYA BT. MAZENAN	1ST YEAR(UTHM)(CIVIL)
68150	PUTERI NUR HANIS BT. MEGAT ZAINOL BADRI	1ST YEAR(UTHM)(CIVIL)
70943	PUTERI SYAFIQAH BINTI A. AZIZ	4TH YEAR(UTM)(CIVIL)
68803	PUTRI NUR FARAH IZZATI BT. NORAZAM	1ST YEAR(UTHM)(CIVIL
68804	RAFIQAH BT. ABD RAHMAN	1ST YEAR(UTHM)(CIVIL
68701	RAIMI B. RAHIM	1ST YEAR(UTM)(CIVIL)
68805	RAJA NOR HIDAYAH BT. RAJA IBRAHIM	1ST YEAR(UTHM)(CIVIL
68151	RAJA SUHAIDA BT. RAJA MOHAMED DOL	1ST YEAR(UTHM)(CIVIL)
66911	RIZUWAN AB RAHMAN	4TH YEAR(UTHM)(CIVIL)
66912	RIZWAN ISMARA B. ISMAIL	4TH YEAR(UTHM)(CIVIL)
66913	ROHAIDA BT. RAZALI	4TH YEAR(UTHM)(CIVIL)
66961	ROSFAZLINIE BT. MOHAMED SANUSI	4TH YEAR(UTHM)(CIVIL)
66914	ROSFAZREEN AZWANA BT. ROTHMAN	4TH YEAR(UTHM)(CIVIL)
66915	ROSMAWANIE BT. MOHD RADZUAN	4TH YEAR(UTHM)(CIVIL)

Note: *Remaining list would be published in the January 2015 issue. For the list of approved "ADMISSION TO THE GRADE OF STUDENT", please refer to IEM web portal at http://www.myiem.org.my.*

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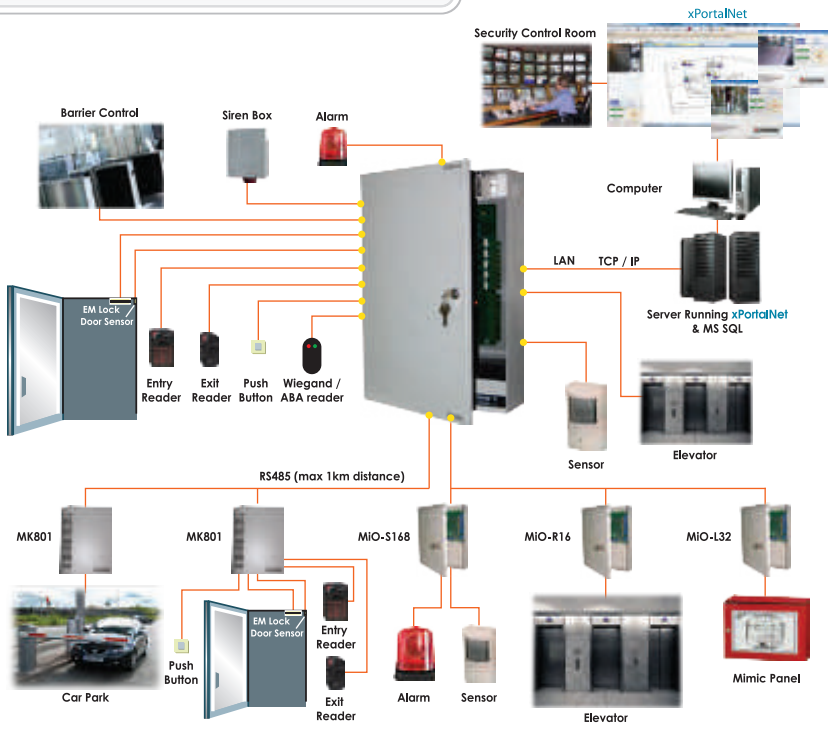

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