**DIMENSION PUBLISHING SDN. BHD.** (449732-T)
Unit No. 3A-10, Block F
Phileo Damansara 1, 9 Jalan 16/11
Off Jalan Damansara, 46350 Petaling Jaya
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E-mail: pub@iem.org.my (Nurul)
IEM Home Page: http://www.iem.org.my



*Printed by :*
PRO PRESS PAPER PRODUCT (M) SDN BHD (652542-X)
21-23, Jalan PBS 14/9,
Taman Perindustrian Bukit Serdang,
43300 Sri Kembangan, Selangor.
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*Cover photograph courtesy of Ir. Yee Yew Weng*

# Perpetual Relay, from Now to Then

Wow, it is the usual time in every month for the publishing of Jurutera, the monthly IEM Bulletin. The new team of the Standing Committee on Publications has just been appointed. With Ir. Prof. Dr Ruslan bin Hassan as our Chairman, we will give our best endeavor to inform members of any significant changes or events as timely as possible, adhere to the regular publications of the IEM Journal, Jurutera; the monthly IEM Bulletin and any other publications as well as contributing towards the continual improvement of the IEM Library.

Members of the IEM present at the 46th Annual General Meeting on 16 April 2005 witnessed the changing of guards from the President, Deputy President, 7 Vice Presidents, Honorary Secretary and Honorary Treasurer to the IEM Council Members. As in any relay team where one runner of each respective team, after completing his or her lap, would pass on the baton to his or her immediate successive counterpart who will soldier on to continue the race. This has been the pattern and it is hoped that the perpetual cycle will continue for the promising future of the IEM. Actually to give it the proper perspective, it is analogous to the flag bearer, where if one respective flag bearer falters or falls, there should immediately be another member to voluntarily take over the flag and soldier on. The culture of "esprit de corps" should be nurtured among all the IEM members in order to hold the IEM flag high up perpetually.

The IEM's main objective has been to promote the science of engineering in Malaysia both locally and abroad. The immediate two past president, Ir. Dr Gue See Sew and Ir. Prof. Abang Abdullah bin Abang Ali, have given their best shot at the reinventing of the image of Engineers in particular and the engineering profession at large. The new session IEM President, Ir. Prof. Dr Ow Chee Sheng, in his President Address has announced his Road Map for the Way Forward. So it is up to all of us as IEM members to close ranks, stay united and give whatever support and commitment we can offer to make all the effort worthwhile towards achieving the objective.

With the old saying that "Heavy is the Head that wears the crown" as a guide, to be able to deliver, IEM needs both good leaders and supportive and committed members. It is of utmost importance that contribution from all the members towards the IEM in whatever forms that may be. This could either be in the sacrifice of valuable time to help in the various committees, or contribute towards IEM publications in the form of articles and photographs of historical interest and as referees to vet articles or in any other form that one may see fit and beneficial towards making the IEM active and alive with a purpose.

We know that members have a lot of stories to tell, a lot of experiences to share, photographs of interesting events, and a lot of updates on the latest advance of engineering in your respective field or discipline. To make the IEM successful as a learned society, we hope to receive more contributions such as articles to make IEM publications something for readers to look forward to each and every publication.

We appeal to all members to pledge in helping to make IEM as our beloved and respected Institution. To love it and nurture it so that it will continuously grow towards achieving its objectives. Charity always begin at home. If we, the IEM own members, do not respect it and love it then how could we convince others who are from the outside to respect IEM and ourselves who are its members?

Before penning off, we wish to thank for all our forerunners for their invaluable contributions and we hope to emulate their untiring efforts for continuous improvement to make IEM better in all respects. ■

**Ir. Mah Soo**
*The new Editor of Jurutera,*
*the monthly IEM Bulletin*

## Errata

In the June 2005 issue of JURUTERA, the image was erroneously duplicated for the article **"Wastewater Treatment for the Recycled Pulp and Paper Industry"**.

The correct image is at the right. We regret any inconvenience caused due to this error.

*Figure 6 : MMF and Secondary Clarifier*

JURUTERA

Number 6 June 2005
IEM Registered on 1st May 1959



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# Geotechnical Engineering

*By: Ir. Tan Yean Chin*

Public awareness on the importance of geotechnical engineering in development and the role of geotechnical engineers have increased since the catastrophic collapse of Block 1 of the Highland Towers Condominium in December 1993 which killed 48 people. Generally, geotechnical engineers are civil engineers by qualification and whose daily work involves planning and interpreting subsurface investigation (S.I.), and the analysis, design and/or supervision of foundations, excavation, slopes, embankment, ground treatment and any other civil engineering works that rest on ground.

With the recent awareness of the difficulties and risks involved in buildings on hill-sites, a more systematic control of hill-site development is taking shape in the public and private sectors. IEM has taken a lead role to publish in Year 2001 a position paper titled "Mitigating the Risk of Landslide on Hill-Site Development," which proposed to the Government a systematic way to regulate both existing and proposed new hill-site developments. This year IEM has also launched a poster for "Routine Slope Maintenance Works" to promote the awareness to the public on the importance of maintenance of slopes. Despite the many slopes failures that have occurred, there is still a common **misconception** among the public and engineers that as long as the slopes that are still standing (no failure yet) these slopes are safe in the long term. Engineers designing soil cut slopes should remember that the most critical condition for cut slopes is in the long term when pore water pressures in the slopes somehow reach equilibrium. To date, the design of slopes in Malaysia mainly follows the "Geotechnical Manual for Slopes" published by the Geotechnical Engineering Office of Hong Kong with some modifications to suit local conditions. The Geotechnical Engineering Technical Division of IEM has taken the initiative to form a task force to formulate an IEM guidelines/manual for slopes, to be used for hill-site development in Malaysia. The intention of the guidelines is to provide engineers with clear "do's" and "don'ts" in the design and construction of slopes.

Other than slopes, the practice of geotechnical engineering in other fields such as soft ground engineering, ground treatment, reclamation of ex-mining ponds, deep excavation and foundation design and construction, etc., has led to many innovations in the last 30 years. Many of the achievements and failures related to geotechnical works in Malaysia were recorded and published in the proceedings of the 1st Malaysian Geotechnical Conference in March 2004. One of the most obvious advancement in geotechnical analysis and design is the use of sophisticated numerical methods, especially Finite Element Method (FEM) software to solve complicated geotechnical problems especially those involving soil-structure interaction. This trend will definitely benefit the industry overall; however, the user should be wary that the reliability of the results obtained from computer analyses rely solely on the correctness of the input parameters, the modelling technique, limitations of the software and also the capability of the user to properly interpret the results. Therefore the user should always remember the word "GIGO" (Garbage In = Garbage Out).

The Geotechnical Technical Engineering Technical Division will continue to organise useful courses, seminars and talks to share geotechnical engineering knowledge with fellow engineers that would subsequently lead to safe, construction-friendly and cost-effective geotechnical works. ■

# Karstic Features of Kuala Lumpur Limestone

**By: Ir. Tan Siow Meng, Simon**

## 1. Introduction

Kuala Lumpur Limestone is well known for its highly erratic karstic features. With the exception of Batu Caves, exposures of Kuala Lumpur Limestone are mainly found in tin mining areas. Such exposures seldom exist today after the closure of the tin mines. Ex-tin mining lands are covered with remnants of highly heterogeneous nature from slime to sand.

If the underlying karstic limestone bedrock is overlooked or not dealt with appropriately, it will pose great uncertainties and difficulties in foundation construction. In less fortunate cases, adjacent properties are affected or the buildings suffer damages or failures after their completion.

## 2. Geology of Kuala Lumpur Area

Published geological maps of Kuala Lumpur area show that Kuala Lumpur Limestone Formation dominates the majority area of KL. A geological section through KL is shown in Figure 1. The limestone is estimated to be about 1,850m thick, overlying graphitic schist known as Hawthornden Schist. The top of the sequence is Kenny Hill formation which occupies the heartland of KL including areas at KLCC and Bukit Bintang.

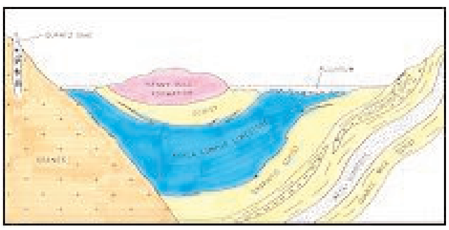

*Figure 1: Geological section through Kuala Lumpur (Yeap 1986)*

According to Gobbett & Hutchison (1973), Kuala Lumpur Limestone is "Upper Silurian marble, finely crystalline grey to cream, thickly bedded, variably dolomitic rock. Banded marble, saccharoidal dolomite, and pure calcitic limestone also occur".

## 3. Tin Mining Activities

Tin mining activities in Kuala Lumpur started in 1857 when the first mine was operated in Ampang. Tin mining was rampant in the past and concentrated in the limestone area of Kuala Lumpur as shown in Figure 2. Note that most information concerning the tin mining industry of Selangor before the Second World War was lost or destroyed during the war (Yin 1986), and as a result, it has not been possible to have a complete and accurate record of all the mining areas.

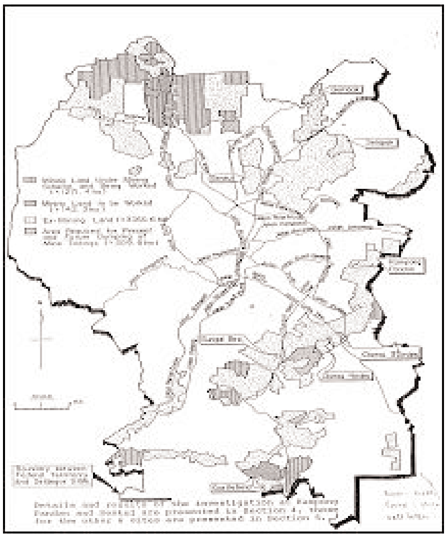

*Figure 2: Ex-tin mining area in Kuala Lumpur (GSM unpublished)*

Most tin mine tenures expired in the early 80s. The common mining method was open cast and gravel pump. This method involved excavation by big machines such as bucket wheels and 'navies'. At confined places, such as potholes and pinnacles, the sediments were first broken by water jet and washed down to a pool which was then pumped to flow down along a sluice built on a tall wooden framework called 'palong' (Figure 3), thus concentrating the heavy minerals including the tin ore cassiterite (Ayob 1965).

*Figure 3: Palong in an opencast tin mine in Segambut (Gobbett 1973)*

The mining activities left behind numerous ponds and remnants mainly consisting of sand and clay slime, forming a highly heterogeneous overburden materials over the limestone as illustrated in Figure 4.

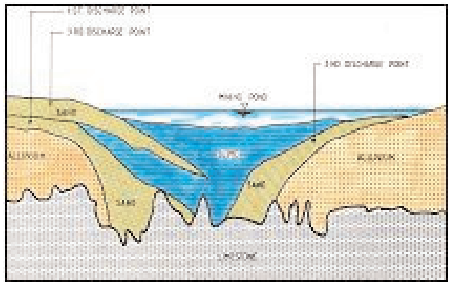

*Figure 4: Tin mining remnant of heterogeneous nature (Chan & Hong 1986)*

## 4. Karstic Features

### 4.1 Development of Karsts

Karst topography in limestone is formed by a chemical dissolution process when groundwater circulates through the limestone as illustrated in Figure 5. Carbon dioxide from the atmosphere is fixed or converted in the soil in an aqueous state and combined with rainwater to form carbonic acid, which readily dissolves carbonate rocks. Karstic features develop from a self-accelerating process of water flow along well-defined pathways such as bedding planes, joints and faults. As the water percolates downward under the force of gravity, it dissolves and enlarges the pathways. Enlargement

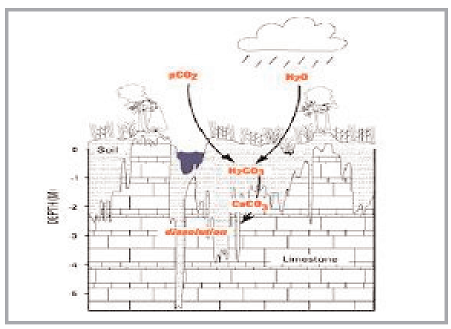

*Figure 5: Process of limestone dissolution (UCGS 2000)*

of a pathway allows more water flow which increases the dissolution rate. As the enlarged pathway transmits more water, it pirates drainage from the surrounding rock mass. Over time, this process results in very jagged appearance, sometimes dissect vertically and deeply into the rock terrain as seen in Figure 6.

*Figure 6: Originally flat limestone plateau dissected deeply by dissolution (Ch'ng 1984)*

Water will continue to percolate downward until it reaches the water table, below which all pore space is occupied by water. Since the rock is saturated with water, water flow slows down and so does the dissolution rate. The water table fluctuates up and down as a result of seasonal change and creates a zone of preferential dissolution along the zone of fluctuation. Over time, this process creates solution channels.

The development of subsurface karstic topography over limestone terrain is classified in five types as illustrated in Figure 7 by Yin (1986).

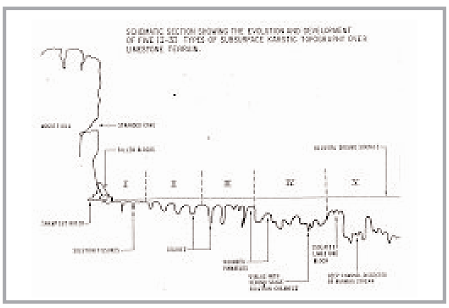

*Figure 7: Evolution and development of limestone karst (Yin 1986)*

### 4.2 Rate of Limestone Dissolution

The dissolution of limestone is a very slow process compared to the human life span. The dissolution rate is expressed in ka (one thousand year).

Tens of thousands of years is considered a reasonable time in Kaufmann's (2004) dissolution kinetics model for limestone conduit deve-lopment. Sowers (1996) quotes the rock surface denudation rates compiled by Jennings (1983) and White (1988) vary from 5mm to 200mm per ka. The maximum rate of 200mm per ka is expected for tropic climate with an annual rainfall of 3000mm.

The literature review by Fatihah & Yeap (2002) shows limestone denudation rates of 15 to 100 mm/ka in different parts of the world except Williams (1966) obtained values range from 3-6300mm/ka in Ireland.

Local research on the topic is limited. Fatihah & Yeap (2002) conducted a research on the limestone dissolution rates in the Kinta and Lenggong valleys. They left limestone samples in running streams, stagnant pond water and subaerial condition. The estimated limestone denudation rates for the three cases were 369mm/ka, 224mm/ka and 134mm/ka respectively. Exposing the limestone samples in running streams, stagnant pond water and subaerial condition is analogous of various conditions that may be experienced by limestone.

According to Sowers (1996), the collapses of limestone cavern roofs should be very rare although many limestone caverns have experienced some roof collapse in the geological past. This is due to the very slow rate of dissolution in limestone. Moreover, the roof of a cave is not dissolved aggressively unless the groundwater flow is full.

### 4.3 Limestone Bedrock Profile

As shown in Figure 1, limestone usually occurs at shallow depths of a few metres to less than 25m except in areas covered by the thick Kenny Hill formation where the limestone is encountered as deep as 200m such as at the Petronas Twin Towers (Azam *et. al.* 1996).

Note that Cliff-like drops in limestone profile were encountered at the sites of Petronas Twin Towers (Azam et. al. 1996), Pan Pacific Hotel (Mitchell, 1986) and Bistari Condominium (Hewitt & Gue 1996). The difference in bedrock levels varies from 70m to more than 100m within the sites. Yeap (1986) attributes such abrupt rock profile to fault zone and contact zone between limestone and other formations.

### 4.4 Steep Depressions, Potholes and Deep Cut Solution Features

On a flat limestone terrain, steep depressions can occur. Such a feature was encountered in a deep excavation at a site near the junction of Jalan Cheras/Jalan Chan Sow Lin. The depression was about 27m deep.

Potholes as shown in Figure 8 were exposed at an excavation site near Kg. Pandan Round-about. The biggest pothole measured 11m in dia-meter and 8m deep. Another pothole was suspected 150m away as detected by boreholes supplemented by Mackintosh probing tests. The potholes at Sg. Besi Tin Mines observed by Ayob (1965) were as big as 10m in diameter and 25m deep. Simi-lar features are described as 'well like holes' by Yeap (1986). Their sizes vary from 30m to 200m in diameter!

*Figure 8: A pothole*

Deep dissections as shown in Figure 6 are common features.

It is not surprising that pile lengths vary significantly in limestone area.

### 4.5 Solution Channels and Cavities

It is unlikely that cavities exist in isolation in limestone. They are part of the solution channel system. Their encounters by soil investigation bore-holes are commonly reported as 'cavities' locally.

Based on the author's experience, the vertical dimension of cavities encoun-tered by boreholes is seldom greater than 3m, similar to observations by Ting (1986). Cavities are usually partially filled or without in-fill. The in-fills are usually slimy, having low N values when Standard Penetration Tests (SPT) are conducted on them.

Large forms of solution channels are found typically in dense non-porous limestone which is thick-bedded and well-jointed (Gobbett 1965). Soft porous and poorly jointed limestone does not provide a favourable environment because groundwater flow is not concentrated into particular channels. The cross-sections of small limestone solution channels are more of arch as in Figure 9 (b) to (f) rather than flat roof which is

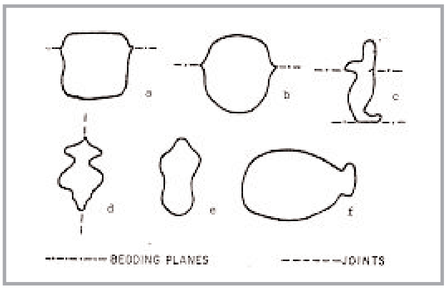


*Figure 9: Typical cross sections of small cave passages (Wilford 1964)*

less stable as in Figure 9 (a) based on observation of Wilford (1964) for small cave passages in Peninsular and East Malaysia.

Due to vertically developed karsts as described earlier, it is possible that a borehole drills through a limestone overhang before it re-enters the rock below. This rock free section can be misinterpreted as a cavity and a fairly big one! The materials from the rock free section usually show properties similar to materials of the overburden soils above the limestone bedrock.

The largest cavity encountered by the author was 13m (refers to vertical dimension hereafter) as revealed by a borehole. The site is located on the western side of Jalan Sentul/ Lebuhraya Karak junction. The site occupies an area of 7.6 ha where a total of 38 boreholes were carried out. Another 5.2m cavity was encountered in another borehole 40m away from the afore-mentioned one.

### *4.6 Sinkholes*

Sinkhole refers to a depression on the ground surface caused by dissolution of the limestone near the surface or the collapse of an underground cave.

There were a number of sinkhole incidents in Kuala Lumpur and the surrounding areas. The most recent ones occurred near Jalan Cheras (Sin Chew Daily 2004) and at Jalan Tun Razak (China Press 2004), suspected linked to an on going tunnel excavation. In 1995, a sinkhole measuring 3m diameter and 1.5m deep occurred at Jalan Lidcole (Figure 10). The associated ground depression was 20m by 25m in size (GESB 1995). The incident coincided with borehole drilling in the vicinity and there were construction activities involving piling and excavation more than 150m away. GESB 1995 also quotes a ground depression at Jalan P. Ramlee in 1993 which was 10 times the size of that at Jalan Lidcole. It coincided with bored piling activities in the locality. A sinkhole at Datuk Keramat was recorded in the geological map by GSM (1995).

*Figure 10: A sinkhole at Jalan Lidcole (GESB 1995)*

Ch'ng (1984) lists a few sinkhole incidents as reported in the newspapers: In 1968, 9 people were killed due to the collapse of a block of low-cost flat at Jalan Raja Laut believed to be due to failure of foundation on weak limestone bedrock; In 1981, 24 houses on an ex-mining land were demolished due to sinking and cracks at Taman Seri Serdang; In 1983, a sinkhole at KL-Seremban Highway near UPM caused a partial closure of the highway; In 1983, 16 units of PKNS houses on ex-mining land were demolished due to significant foundation settlement; In 1984, 10 units of double-storey houses in Taman Cheras Indah were seriously damaged due to sinkholes.

Sinkholes have also occurred in Jinjang and Kepong. In Kuala Lumpur, a 10m diameter sinkhole developed suddenly at the building site during pile driving for the Campbell Shopping Centre in 1972 (Chan & Hong 1986). Sinkhole risks associated with bored piling work are highlighted in Bauer (2004).

Almost all sinkholes are triggered by construction activities. The main triggering factors are lowering of groundwater table, loss of fines through groundwater seepage, imposing of additional loads and vibrations. In some occasions, it is due to direct punching of cavity cover by borehole or piling activities.

Locations where overburdens are thin are more susceptible to occurrences of sinkholes due to lack of 'buffer' and 'bridging effect'. For the recent sinkholes occurred near Jalan Tun Razak and Jalan Cheras, the overburden was around 3.5m thick and holes were created. Where overburden thickness increased to about 10m, there were ground depressions but no hole was formed. The incident occurred after frequent rainfalls over a short period of time. There was lack of direct evidence of groundwater table lowering. The nearest excavation was some 175m away. Rainwater was suspected to cause extra groundwater flow that encouraged migration of fines in the soil into solution channels.

An obvious case of ground subsidence related to groundwater extraction was reported at Subang Hi-tech Park in 1998 (SSPG 1998). Some 20 units of 1-1/2 storey linked shop factories were affected. Ground subsided significantly within a period of two months during the illegal pumping of groundwater at an adjacent vacant land. When the pumping was stopped, the rate of building settlement reduced significantly. A borehole sunk during the investigation of the incident triggered a small sinkhole.

Sinkholes are occasionally triggered by soil investigation boreholes in ex-mining lands where the soil covers over limestone are thin.

## 5. Conclusion

Like limestone in other parts of the world, erratic karst topography commonly found in Kuala Lumpur Limestone is formed by a chemical dissolution process. The dissolution of limestone is a very slow process compared to human life span.

The karsts consist of deep dissections, potholes, steep depressions and solution channels, resulting in erratic limestone rock bedrock profile that poses great uncertainties and challenges in foundation construction.

Sinkholes are usually triggered by construction activities due to: loss of fines through groundwater seepage, lowering of groundwater table, imposing of additional loads, vibrations, direct punching of cavity cover by boreholes or piling. Limestone covered by thin soils is more susceptible to occurrences of sinkholes.

Abrupt drop in limestone profile of 60m to more than 100m have been observed within some building sites located near contact zones or fault zones.

## Acknowledgement

The author wishes to thank his colleagues particularly Assoc. Prof. B. K. Tan for their kind assistance.

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# SI & Geotechnical Engineering Design

*By: Ir. Neoh Cheng Aik*

In geotechnical engineering, SI (site investigation) is generally perceived to be a boring subject. Undeniably and invariably, SI is not only integral, but it is also a significant part of the geotechnical design process. SI is generally defined as a process to procure the **NECESSARY**, **ADEQUATE** and **RELIABLE** ground and soil data or properties to enable a safe and cost-effective geotechnical analysis and design to be carried out. Role of SI in geotechnical design process is illustrated in Figure 1.

What constitutes the **NECESSARY** parameters for a geotechnical design depend very much on the nature of the project, type of geological formation and the possible geotechnical problems anticipated. What can be considered **ADEQUATE** is quite subjective and it all depends on the judgment, experience and site knowledge of the designer. **RELIABLE** SI shall be planned, directed, monitored, supervised, analysed, interpreted and reported by a qualified geotechnical engineer. SI field and laboratory tests shall only be carried out by trained technicians and drillers using suitable equipment and test procedures complying with relevant test standards specified by the designer.

Only engineers well-versed in geotechnical design and SI are able to plan the scope of SI properly, in order to procure all the NECESSARY, ADEQUATE and RELIABLE parameters for the design. Those who know next to nothing or know very little about geotechnical design or SI and also are not aware that they so little about SI will not know what the necessary parameters to be known or required are for the necessary geotechnical design. Hence, to achieve the objective of SI, i.e. to procure the NECESSARY, ADEQUATE and RELIABLE SI parameters, geotechnical engineers or designers have to answer 3 questions:

What is known or quantifiable (through desk studies or walk-over survey)? What are the unknown factors and what ONLY needs to be known adequately and reliably? Figure 2 illustrates the fundamental concept of proper and effective planning of SI. In short, the most important thing in planning scope of SI is first to determine what are the parameters really needed to be known adequately and reliably to address the anticipated geotechnical problems for the project site. To achieve this, the engineer certainly has to know adequately about SI and geotechnical design required to address the geotechnical problems anticipated.

Without SI (or with inadequate SI or unreliable SI), geotechnical design is incomplete or hazardous and it has been often identified as one of the main factors accounting for geotechnical failures and construction delay, cost overrun, etc. In fact, the most frequent contractual claims and disputes in civil engineering construction projects are mainly on the basis of ground related to improper SI (inadequate or unreliable) or poor SI interpretation.

Proper planning of SI scope for various projects or structures in various different geological formations shall include the following aspects:-

- Potential geotechnical problems anticipated and relevant parameters required.
- How many boreholes or other relevant SI methods? Test frequency and locations?
- Criteria of terminating boreholes?
- Criteria of selection of types of field and lab tests? Frequency of tests?
- Criteria of selection of types of samplers? Frequency of sampling?
- Significance of groundwater conditions to the design and selection criteria of test method and test location.

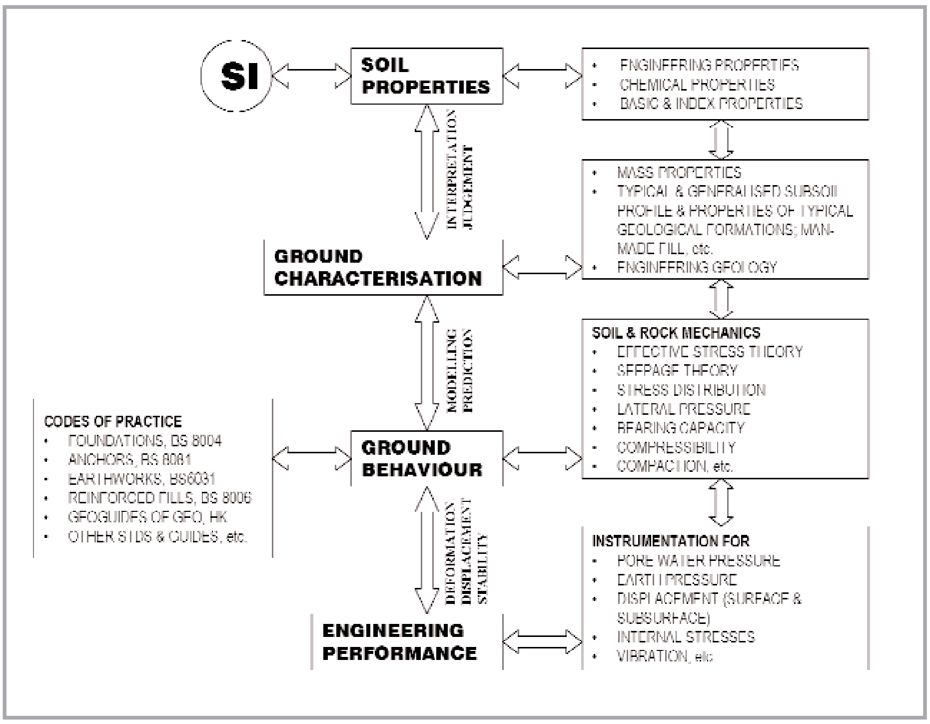



*Figure 1: Role of SI in geotechnical engineering design*

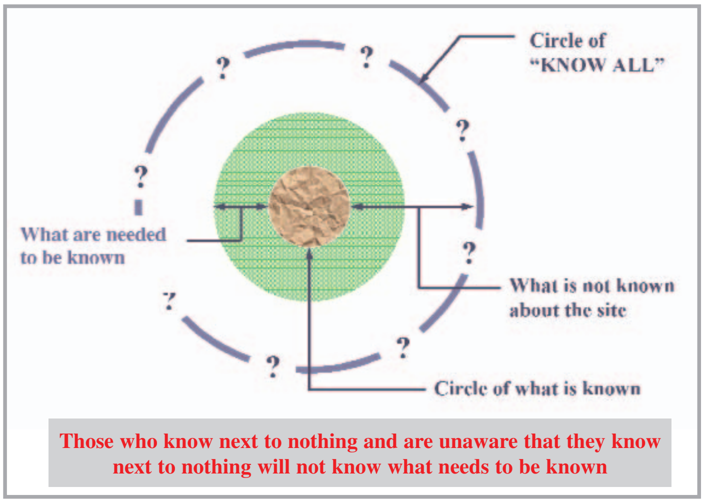



*Figure 2: SI & what needs to be known*

Reference and guidance related to the above aspects can be made to **REAM publication REAM-GL6/2004 "Guidelines for Planning Scope of SI Works for Road Projects"**, which provides useful guidance in good engineering practice related to planning scope of SI, soil properties and appropriate tests required to address the common geotechnical problems/issues usually encountered in design and construction of slopes, embankments, retaining walls, foundations of structures, pavement, etc., in various common geological formations. Applications and limitations of various SI methods, tests, sampling techniques, etc., are also elaborated in the REAM guidelines.

Understanding the significance, applications and limitations of various SI methods, field and lab test results or soil properties related to the geotechnical problems (stability, bearing, settlement, deformation, etc) identified for a specific structure on or in the specific site/ground is very important when planning scope of SI.

In brief, the scope of SI for a project depends mainly on what is known about the site and nature of the project i.e. the possible geotechnical problems and issues likely to be encountered during construction and in service. The scope of SI may also need to be varied in the light of new discoveries during the process of SI. To achieve the objective of SI in procuring the necessary, adequate and reliable SI results, only design engineers well versed in geotechnical design and SI shall be engaged to plan, to execute and to interprete SI works. ■

# A Glimpse of Engineering Geology and Rock Mechanics in Geotechnical Engineering in Malaysia

*By: Ir. Tan Boon Kong*

All civil engineering and construction works have to be founded in or on soils and rocks. Getting the site geology right is thus important especially for projects that are geologically orientated (e.g. rock slopes, dam, tunnel, etc). Detailed site investigation, including engineering geologic studies, not only provides for the proper "footing" for the commencement and implementation of the project, but also helps to identify and forewarn of any potential geology-related construction problems. In addition, past experiences in certain problematic materials (both soils and rocks) and certain geologic settings, can be relied on and usefully employed to avoid or avert future construction problems or failures. Hence, for example, the problematic residual soils of graphitic schist vis-à-vis cut-slope failures along major highways; and foundation problems and complexities in limestone karstic terrains are now well known to geotechnical engineers in Malaysia.

Project-specific requirements from engineering geology and rock mechanics in civil engineering or geotechnical engineering are plentiful, and can be illustrated by the following: (a) assessment of rock slope stability in cut-slopes for highways, housing schemes or hill-site developments, (b) damsite foundation permeability and grouting, (c) characterisation of rock mass quality, Q, for tunnel supports, etc.

The search for suitable construction materials, whether soils or rocks, for various civil engineering projects such as highways, dams, etc., is yet another important role of the engineering geologist. Availability and suitability of a particular soil or rock are, needless to say, dependent on the geology of the project area and vicinities.

Finally, geohazards such as landslides and slope failures, subsidence and sinkholes, rockfalls, debris flows, etc., are very real threats to civil or geotechnical works, whether the failures are natural or triggered by man's activities. Understanding these geo-logical phenomena and processes would, to say the least, help in preventing, averting or minimising the damage or fatality incurred when such failures do occur. To add to this list of geohazards, earth-quakes and tsunamis have now also "washed ashore" on Malaysian soils where once this was a land of relative peace and quiet as far as earthquakes and tsunamis are concerned. (Well, at least we don't have volcanoes!)

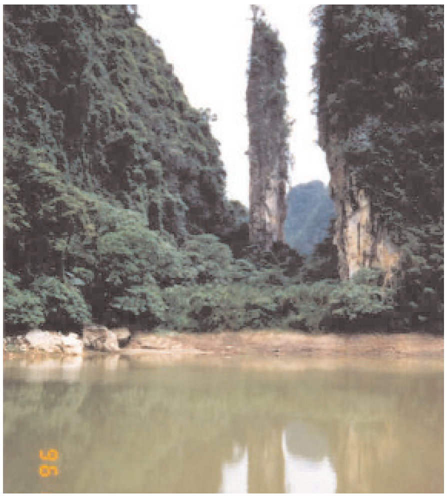
Now that you have had a glimpse of Engineering Geology and Rock Mechanics and would like to know more, you may refer to the following publications for a start (proceedings are available in IEM library):

a) Tan, B.K. (1999). "Engineering Geology – Some Case Histories in Malaysia." (Keynote Paper) Proc. GEOTROPIKA 99, UTM, Johor Baru, pp. 23-43.

b) Tan, B.K. (2004). "The practice of engineering geology in Malaysia." Proc. Malaysian Geotechnical Conf. 2004, 16-18 March 2004, IEM, Subang Jaya, Special Lecture, pp. 131-148. ■

*Plane failure in granite rock slope - SILK highway*

*Slope failure in ex-mining land due to rapid draw-down phenomenon : Cheras, K.L.*



*Limestone cliff stability - Tambun Tower*

*Limestone bedrock (highly pinnacled) vis-à-vis foundations - Kinta Valley*

*Tunnel in highly jointed granite - Sg. Selangor Dam diversion tunnel*

*Slope failure in graphitic schist - Lojing highway*

# Ground Improvement: Opportunities and Constraints

By: Ir. Kenny Yee

The need for ground improvement arises when the existing ground is unable to adequately sustain the load that is to be applied, as assessed by the design criteria. The existing ground is first evaluated in terms of bearing capacity, settlement and the rate of settlement; all are required to be within acceptable limits or otherwise, ground improvement may be considered. It is necessary first to identify whether the problem is one of stability or settlement or a combination. Man-made and natural deposits that usually require improvement are considered poor ground, as they are either soft clayey or loose granular materials as may be found in non-engineered filled ground with partially saturated fill in loose state, disturbed ground as in ex-mining lands where loose sand and soft slime materials are deposited by past mining activities, in filled valleys that contain soft alluvium, riverine deposits within a general watercourse, natural loose sands in the form of coastal deposits, organic soils which include soft marine clays that occurs often as coastal and estuarine deposits and peat. However, ground improvement is not necessarily applied to poor ground only. It may happen that a medium ground, which may not require improvement at a given load, may prove to be inadequate in relation to a higher imposed load.

During the past three decades, various ground improvement techniques have been used successfully in Malaysia for structures and infrastructure works. There are a number of well-established techniques that can be considered in any case. For the choice of techniques, the determining factors are likely to be the types of soil, influence of the construction process on adjacent structures, environmental factors, construction duration, tolerance on post construction settlement, rate of construction, availability of backfill materials, cost and maintenance. In practice, it may require the selection of one or a combination of techniques to satisfy performance requirements within a given budget and time constraints as each technique has its own advantages, limitations and economies. Today, ground improvement is no longer considered as a black box technical solution. It is a viable alternative to conventional structural support solutions (e.g. piled foundations.) In most instances, it proves to be the more economical solution. It is now routinely considered in most projects where poor grounds are encountered. However, ground improvement is seldom used as structural support for tall buildings and structures. The more "heavy" structures require heavier treatment while in general, infrastructure works require less stringent treatment.

Ground improvement techniques cover all in-situ controlled geotechnical construction processes aimed at improving the engineering performance through modifying and complementing their basic particulate constituents. Some of the common techniques used in Malaysia as shown in Figure 1 can be broadly categorised into ground improvement by (i) mechanical modification; (ii) hydraulic modification; and (iii) modification by inclusion (reinforcement). Mechanical process such as compaction by impacts using dynamic compaction or compaction by vibration using vibro compaction aims to improve coarse grained cohesionless soil (loose sand) where rapid densification is achieved by a reduction in air voids by means of short term external forces. Hydraulic process improves fine grained saturated cohesive soils (soft clay). Consolidation of soft clay resulting in a net decrease in the water content of the soil mass is done by means of a

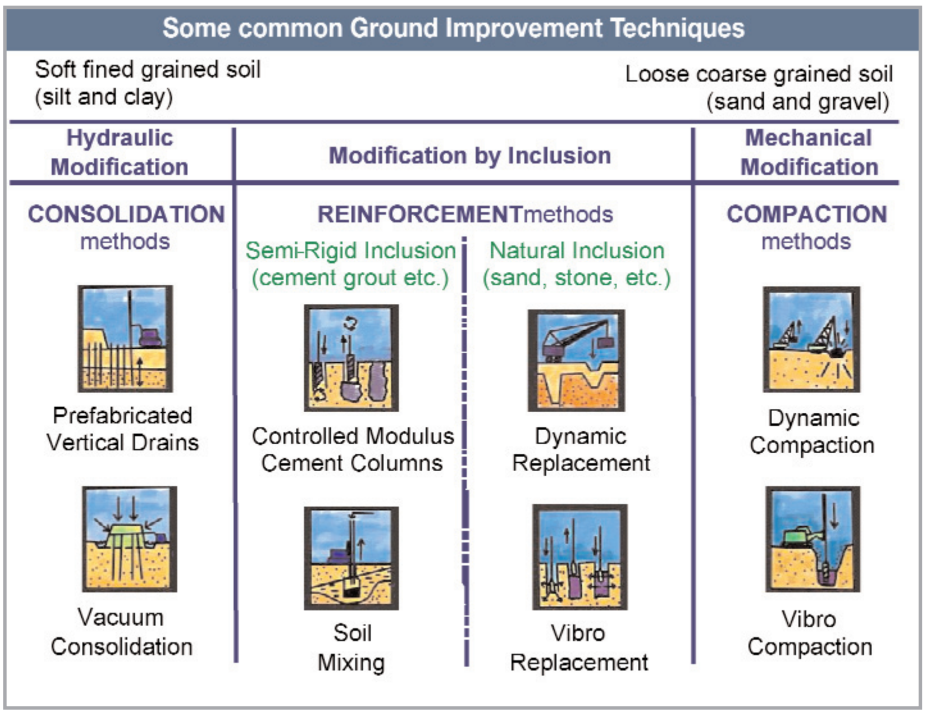



*Figure 1 : Some common ground improvement techniques*

# Routine Slope Maintenance Work

*By: Ir. Yee Yew Weng*

Most landslips occur some time after construction, triggered by water seepage into slope and after prolonged erosion by rain. Engineers are well versed with design of slope protection and drains to minimise such detrimental effects. However, in spite of the best design efforts, such provisions require periodic maintenance to ensure continual performance.

Design engineers seldom re-visit the hill slope they design after the project is completed, unless their scope of works specifically requires such service. Not all developers are aware of this issue. The owners of such properties are in majority lay persons who are oblivious to the fact that their slopes require regular attention. It is with this backdrop in mind that the Geotechnical Division of IEM has prepared a simple poster to inform the authorities, developers, engineers and the public living on hill-slopes of the importance to monitor and maintain their slopes The idea has been borrowed from what is now common practice in Hong Kong under the control of the Geotechnical Engineering Office, Government of Hong Kong. However, unlike in Hong Kong, there is no legislative control on slope maintenance in Malaysia. Until such laws are introduced, the onus is on engineers, developers and the public to self regulate the practice of slope inspection and maintenance.

It is hoped that this poster will contribute in some way to educate every relevant party, especially the public, that most landslides can be mitigated if they are identified early. The poster has been designed to communicate in lay terms tell-tale signs when slopes require attention. Most maintenance work requires only simple do-it-yourself effort, like clearing a clogged drain. Where more serious signs of imminent slope instability surface, the public should then seek professional help (a list of registered Professional Engineers is kept at IEM webpage, which is found at http://www. iem.org.my) Developers for structures on hills sites should provide for a long term slope maintenance program or clearly identify such a need to the potential buyer. It is the Geotechnical Division's vision that slope maintenance become as common place as do-it-yourself weekend gardening or a visit by the serviceman for the household air-conditioning unit. ■


Copies of the posters can be downloaded from the IEM website at http://www.iem.org.my/external/techdiv/GeoTechnical/Images/iem_slope.jpg

# Application of Geosynthetics in Malaysia

*By: Ir. Lee Eng Choy*

## 1. Introduction

Engineering geosynthetic products are widely used for civil engineering projects to solve various geotechnical problems. Among the family of geosynthetics and related products are woven and non-woven geotextiles, extruded, bonded and knitted geogrids, geocells, drainage composites, geosynthetic clay liners, geomembranes and composite biodegradable products. Geosynthetics are used in various fields, including environment, transportation, hydraulic works, agriculture, etc.

## 2. Functions of Geosynthetic Materials and Selection of Material Properties

Important functions of Geosynthetic products are filtration, separation, reinforcement, containment, barrier to fluids, etc. In the selection of the type of geosynthetic material for use in a particular application, its properties should be appropriate to suit the intended function(s) of the material. For example, for the filtration function, the geosynthetic material should possess the necessary properties to permit passage of fluids, but limiting passage of solids. These properties include permeability and effective pore size. In considering effective permeability, one has to take account of the permeability of the soil as well. It will not be economical to specify a high permeability for the geosynthetic material whereas the low permeability of the soil is the limiting value.

As for the separation function, the property to specify is the effective pore size of the geosyhthetic material. An important consideration to note is the effective size of the soil particles that need to be separated. Frequently, geosythetic material are used to separate cohesionless fill material from clayey soils. In this application, the limiting pore size should be related to the size of the clay particles.

For the reinforcement function, the tensile strength of the geosynthetic material is an important property to consider. The tensile strength, or long term design strength after taking into into consideration of various factors, required shall be adequate to take the anticipated working stress to be developed.

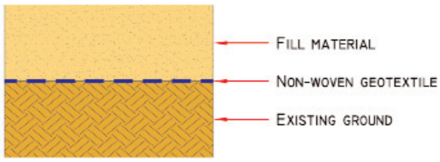



*Figure 1: Separater*

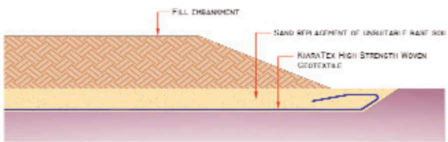


*Figure 2: Reinforcement of embankment*

## 3. Typical Applications of Geosynthetic Materials in Civil Engineering Works

### *3.1 Roads and Highways*

In the construction of roads and highways, the application of geosynthetic materials is widespread. This includes the stabilisation of poor subgrade to reduce differential settlement and rutting of the pavement. Types of geosynthetic material suitable for such applications include geogrid and geocells. These geosynthetic materials act to reinforce the subgrade and to improve the stiffness of subgrade or road base so as to reduce excessive localised shear deformation of the subgrade.

Roads nowadays frequently traverse over soft ground as well as through hilly areas. The construction of roads over soft ground requires treatment of the soft soils to improve the stability and to reduce settlement of the road. A typical ground treatment method utilises pre-fabricated vertical drains (PVD) to accelerate the consolidation settlement of the soft soil. This PVD consists of a non-woven filter fabric and a core which acts as a drainage medium. This is commonly applied together with a layer of non-woven geotextile as a separator between the soft clay and the sand drainage layer.

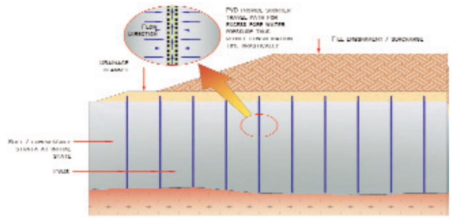


*Figure 3: Soft ground treatment (with PVD)*

Frequently, situations arise where the road embankment faces a stability problem as well. In this case, the embankment can be reinforced with either woven high-strength geotextile or geogrids. These two materials generally perform a similar function as reinforcement for the embankment.

As mentioned earlier, roads traverse over hilly terrains, requiring the construction of high embankments and steep slopes. Geosynthetic materials can be used to reinforce these embankments and slopes. These include the woven high strength geotextile and geogrids. Steep reinforced slopes and walls have often been constructed with the use of these geosynthetic materials.

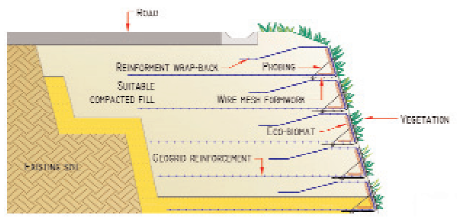


*Figure 4: Reinforced soil wall*

### *3.2 Reclamation*

Shortage of land areas for construction of built facilities has necessitated the need to reclaim land, both from the sea as well as from ponds and lakes. To facilitate placement of fill material over the soft soils at the base of such areas, woven high strength geotextile is laid over bottom of the sea or pond. The function of this layer of geotextile is to provide support for the fill materials as well as to spread the load over the soft soils. This layer of geotextile functions as basal reinforcement and prevents the occurrence of stability failures of the base as the fill materials are placed.

***3.3 Erosion Control***

Soil erosion on slopes has become an issue of concern. Mitigating actions such as by turfing have frequently failed to arrest the occurrence of soil erosion, especially in areas where vegetation growth is difficult or impossible. Such areas include steep slopes and slopes with acidic soils or hard and rocky soils. In this case, the application of geocells will help to enhance vegetation growth, thereby reducing the risk of erosion. Geocells can be infilled with fertilised soils and enhance vegetation growth.

Turf reinforcement mats have often been used to assist growth of vegetation on steep slopes. These mats serve to retain the seeds and prevent it from being washed downslope by rainfall and surface runoff.

## 4. Innovative Applications of Geosynthetic Materials

***4.1 Coastal Protection***

Amongst the various products within the Geosynthetic industry, geotubes and sand-filled mattresses are gaining popularity in coastal and marine works. These geotextile-tubes (Geotubes) can be used in a variety of coastal environments. It is particularly suitable for the protection of environmentally sensitive areas, such as mangroves and wetlands. It provides a barrier or dyke whereby sediment deposition behind these barriers can be formed, where mangrove growth can be initiated and maintained. This sediment deposition can be natural or it can be artificially filled with suitable soil. These geotextile tubes are fabricated from woven geotextile and non-woven geotextile. These tubes are commonly infilled with sand or clay slurry.

*Figure 5: Geotube in use for coastal protection works*

***4.2 Environmental Protection***

Environmental protection issues are becoming important especially in the reclamation projects. To prevent contamination of surrounding areas with sediments, silt curtains can be erected to line the boundary of the reclamation site. These silt curtains are fabricated either from woven geotextile or non-woven geotextile, depending in the hydrographic conditions at the location. These curtains are commonly suspended from floats. The function of these curtains is to retain suspended sediments within the reclamation site, hence preventing contamination of the areas outside the reclamation site.

*Figure 6: Silt curtain in use for environmental protection in coastal reclamation project*

## 5. Summary

Generally, geosynthetic materials has been effectively applied in various fields in civil engineering works. These applications have indicated the versatility of geosynthetic material to solve our engineering problems encountered in these projects. The performance of geotechnical works can be highly enhanced with the appropriate inclusion of geosynthetic products. ■

# The Role of Numerical Modelling in Geotechnical Engineering

*By: Ir. Liew Shaw Shong*

In many geotechnical engineering projects, numerical modelling software has been a common tool in design practice. Such design practice is primarily attributed to the advancement of computing power, which has made the practice very affordable in terms of cost and time, and also the young computer-literate professional. As geotechnical engineers, we work with notoriously complex materials; we have no control over their origin in terms of properties and spatial distribution, but we can investigate, understand their engineering behaviour and finally engineer the materials to suit a certain intended purpose. In the latter, it is very useful to translate the qualitative understanding of material behaviour and other related elements (collectively known as the physical system) into a simple mathematical system to quantify the engineering response, thereby identify risk and uncertainty. Numerical modelling is the modern approach to implementing the above two processes. The position of modelling in the concept of geotechnical engineering practice by Burland (1987) is well illustrated in the triangular relationship in Figure 1.

There are three main objectives of engaging numerical modelling for an engineering problem:

a. **Design** – Numerical modelling is used to explore more options in terms of feasible engineering solutions with appropriate evaluation of the constructability, performance (serviceability limit state) and risk of failure (ultimate limit state) which the options can offer. Then, a decision-making process would take place in selecting the appropriate options for project implementation.
b. **Prediction** – In certain engineering applications, prediction of the performance of a selected system is crucial for construction control and serves as an alerting threshold for implementing a contingency plan.
c. **Back calculation** – Back calculation is the method of measuring the performance of a geotechnical design in order to calibrate the model for improvement. More importantly, numerical analysis can assist in interpreting measured performance and rendering rational explanations.

Numerical modelling can be very precise, but accuracy against reality is normally doubtful as a result of the complex nature of the problem. It is extremely difficult to find a good agreement between the predicted trend and the measured performance. Even for a basement excavation, the wall deflection profiles within the same site very often do not coincide with each other, not to mention the accuracy of the prediction by numerical modelling. Despite the discouraging accuracy of prediction, the results are normally on the conservative side and reasonably acceptable for decision making if the model is prudently built and the outputs are carefully interpreted.

It is important to realise that numerical modelling is a process involving simulation of a physical system using a mathematical system rather than overemphasizing on its predictive capability. By going through the process and having a sound understanding of the physical system, numerical modelling will enhance the confidence level of the geotechnical engineer in making engineering judgements over a problem. This will also allow the geotechnical professional to establish substantiated experience, which can be easily referred to by others in the future.

The aforementioned process is illustrated in Figure 2 and is iterative and evolves as the model develops. It is as simple as possible when the model is initially built. As the model evolves, the complexity of the model can be gradually increased with a sound understanding of physical reality. An advanced model will not offer any increased benefit when dealing with a deficiency in input data. In some cases, it may do more harm than help in deriving a particular solution.

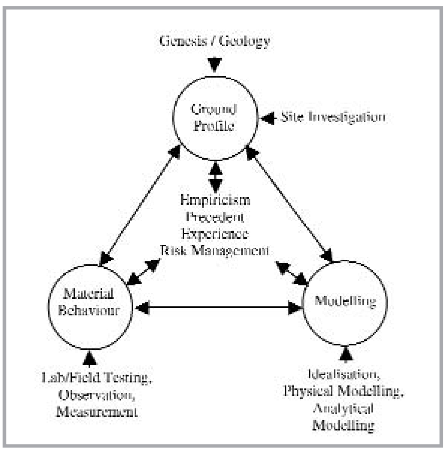



*Figure 1: Relationships between ground profile, material behaviour and modelling*

In numerical modelling, it is vitally important to identify the key input parameters, which have significant impact on the final results. In other words, these sensitive parameters shall be prudently established to minimise uncertainty and for a better predictive accuracy. Sensitivity analysis is a useful approach despite it being time-consuming. Its immediate benefit is the enhancement of confidence in adopting the design value over a range of possible values.

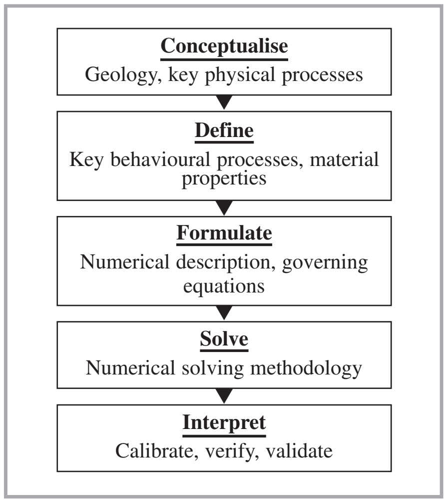



*Figure 2: Process of numerical modelling*

By no means numerical modelling can replace the good engineering judgement of an experienced professional. With this introduction to numerical modelling, it is hoped that the geotechnical engineer will use advanced modelling tools with the correct mind set and prevent the scenario of "garbage in garbage out". To promote proper usage of numerical modelling tools, the Geotechnical Engineering Technical Division of IEM has organised a 2-day course on computational geotechnics on 20-21 September 2004 and will continue to organise more courses on numerical modelling for novice users to advanced users in the future. ■

# Amalan Lestari Kejuruteraan Geoteknik

***Oleh: Prof. Madya Ir. Dr Zainab Mohamed, MBEM, FIEM, AGSM, Fakulti Kejuruteraan Awam, Universiti Teknologi MARA, Shah Alam, Selangor***

## Pengenalan

Di Malaysia amalan seseorang jurutera adalah di bawah kawalan AKTA 138, 1967 yang dimandatkan pada Lembaga Jurutera Malaysia. Definasi amalan ialah memberi nasihat profesional atau perkhidmatan kepada klien. Sumbangan jurutera awam sebagai sumber tenaga pelaksana visi dan misi negara jelas dilihat pada pembangunan fizikal, sosial, sumber tenaga mahir dan yang terkini memerlukan penglibatan dalam *R&D* bagi menjana pertumbuhan ekonomi negara. Pengiktirafan Ghazi Yawar seorang jurutera awam sebagai presiden Iraq (The Star, 2 Jun 2004) selepas era Saddam Hussain jelas sebagai pengukur kesinambungan pada sumbangan jurutera awam. Ini bermakna profesion jurutera merupakan jambatan yang merealisasikan visi kepada realiti. Dengan itu keputusan dalam perancangan dan perlaksanaan pembangunan negara tidak ditentukan oleh seorang jurutera secara terus.

## Senario Amalan Kejuruteraan Geoteknik di Malaysia

Pembangunan infrastruktur yang agresif sejak 20 tahun yang lepas dan kurang dari 20 tahun kehadapan telah banyak mencabar kredibiliti jurutera awam dalam usaha Malaysia mencapai status negara maju. Berita muka depan Utusan Malaysia (UM) bertarikh 4 Mac 2005 bertajuk "Selepas tinjau Taman Pertanian Bukit Cahaya Seri Alam dari udara... PM terkejut..." agak bercanggah dengan reaksi Menteri Besar Selangor yang dilaporkan dua hari sebelum itu (UM, 2 Mac 2005). Dua kenyataan tersebut memberikan perspektif yang berbeza mengenai amalan kerja kejuruteraan dalam pembangunan di sekeliling taman pertanian tersebut. Ia juga telah mencetuskan pendapat yang merumuskan sikap tidak perihatin badan penguatkuasa terhadap isu dan elemen alam sekitar.

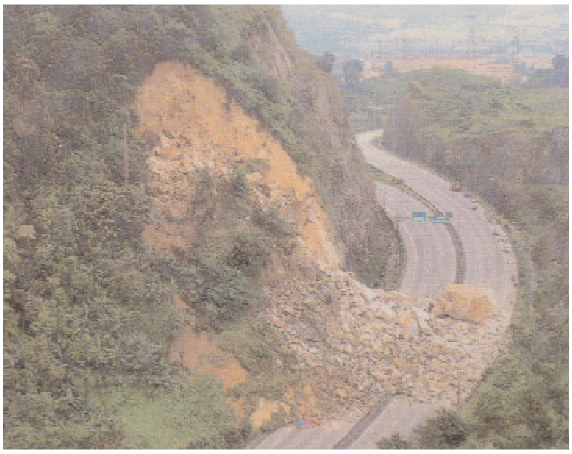
Penulis telah sekian lama terpanggil untuk melahirkan pendapat yang sejengkal hasil daripada bacaan ringan dari berita semasa berkaitan insiden geobencana. Bahan-bahan ini telah menjadi koleksi bahan pengajaran semasa bagi penulis. Antaranya seperti kegagalan cerun Gua Tempurung (Bulletin IJM, April 1996), gelinciran tanah di Km 303 Lebuhraya Utara-Selatan (UM, 14 Okt 2004), kegagalan cerun binaan di Km 52, Cameron Highlands (NST, 28 Feb 2004), kegagalan cerun Bukit Lanjan (UM, 27 Nov 2003) dan banyak lagi. Apa yang boleh dirumuskan bahawa setiap kali berlakunya geobencana, isu yang seringkali dike-tengahkan berkisar mengenai takrifan geobencana, punca tragedi, mengenalpasti sama ada sebab manusia atau semulajadi, salah siapa, faktor hujan dan laporan EIA. Disamping itu kerap dipapar-kan juga arahan semasa setiap kali terjadi geobencana seperti penubuhan badan khas (kenapa PLUS saja?) walaupun telah diakui perlunya penglibatan pakar geoteknik dalam projek-projek berisiko (NST, 29 April 2004). Kerapkali terdengar segelintir pengamal kejuruteraan yang tidak mahu menerima apa yang dilapor-kan oleh media dengan alasan fakta sebenar telah disalah lapor malah paling malang mereka merasakan tidak terlibat dalam projek tersebut. Rumusannya insiden menyayat hati Highland Tower pada 11 Disember 1993 dan isu pembangunan di persekitaran taman pertanian di Selangor masih tidak banyak mengubah senario lazim dimana pelbagai pihak memberikan ulasan dan saling menunding jari yang berakhir dengan persoalan pada tanggungan dan amalan keprofesionalan seorang jurutera. Penulis merasakan bahawa perspektif masyarakat dan kepercayaan mereka pada kredibiliti pengamal kejuruteraan adalah jauh lebih penting berbanding dengan sejauh mana penyelesaian secara teknikal telah diusahakan.

*Profil luluhawa tropika jasad batuan granit kelihatan pada cerun keratan di Bukit Tinggi, Pahang*

*Pandangan jasad batuan granit terluluhawa yang menarik di Ipoh, Perak*

Beberapa isu menarik yang mencermin sempadan ilmu dan amal pengamal kejuruteraan antaranya ialah penafian seorang jurutera bertauliah mengenai cadangan awal pembinaan cerun binaan di Cameron Highlands yang akhirnya runtuh. Percanggahan fakta dalam dua kertaskerja pengamal kejuruteraan (seorang geologi dan seorang lagi kejuruteraan geoteknik) yang telah membentangkan hasil kajian saintifik mengenai kegagalan cerun tersebut di satu simposium yang diadakan oleh sebuah institusi tempatan. Kesungguhan seorang jurutera bertauliah cuba mendefinasikan sempadan kerja jurutera geoteknik berbanding pengamal geologi (Buletin IJM, Mac 2005). Suasana yang serupa dapat dirasakan semasa penulis menghadiri persidangan *Malaysian Geotechnical Conference 2004* dan sebelum itu seminar *Geotechnical Aspect North-South Highway 1990*. Polimik ini menggambarkan kejanggalan jurutera geoteknik dan ahli geologi untuk duduk semeja. Secara tidak langsung ia menunjukkan batasan amalan ilmu pengamal kejuruteraan dalam bidang kepakaran masing-masing atau adakah masih terdapat rongga antara kejuruteraan geoteknik dengan kejuruteraan geologi bagi pengamal di Malaysia. Walaubagaimanapun coretan Presiden Institusi Jurutera Malaysia di muka depan Buletin IJM Mac 2005 boleh dianggap sebagai destinasi Institusi Jurutera Malaysia dalam usaha menyeru ke arah pembangunan lestari.

Pihak kerajaan dan badan profesional telah mula berusaha untuk menangani dan mengurangkan impak terhadap persekitaran terutama yang melibatkan aktiviti pembangunan fizkal, namun sejauh mana keberkesanannya masih samar. Dari sudut teknikal amalan dan pendekatan konvensional dalam pembangunan di kawasan sensitif serta kelulusan yang berkait rapat dengan undang-undang masih boleh dipertikaikan sama ada ia mencukupi atau belum dihayati sepenuhnya oleh semua pihak yang terlibat. Langkah Lembaga Jurutera Malaysia mewujudkan *Accredited Checkers* yang akan mempertanggungjawabkan hal kelulusan kepada pakar perunding yang dilantik (Buletin IJM, Jan 2005) diharap akan membuahkan hasil ke arah hasrat amalan lestari kejuruteraan geoteknik di Malaysia tercinta.



*Kegagalan cerun Bukit Lanjan menunjukkan campuran bahan tanah dan bahan batuan yang mencabar ilmu amalan kejuruteraan geoteknik*

*Salah satu kriteria pembangunan lestari ialah pemuliharaan bukit-bukau*

## Amalan Lestari Kejuruteraan Geoteknik

Keprofesionalan dan inovasi jurutera geoteknik tidak sepatutnya diperlekeh setiap kali berlakunya geobencana. Ini juga tidak bermakna pengamal seharusnya merasa selesa dengan pengetahuan dan pengalaman yang sedia ada. Insiden kegagalan cerun binaan yang berulang adalah salah satu petanda pada peri pentingnya seseorang pengamal memahami dan prihatin pada proses alam semulajadi yang bertindak balas dengan aktiviti buatan manusia. Kurangnya kesedaran pada proses alam yang menyebabkan perubahan dan kemerosotan sifat kekuatan jasad bumi menyebabkan langkah berjaga-jaga tidak diberi perhatian. Padahal ini dapat memberikan data yang sama berat bagi mengatasi masalah ketidakstabilan jangkamasa panjang sesebuah struktur geoteknik.

Amalan kejuruteraan geoteknik kerajaan Hong Kong adalah satu contoh yang terbaik pernah dirujuk oleh Malaysia dalam usaha menyediakan persekitaran penempatan penduduk di kawasan tanah tinggi yang selamat lagi lestari. Sistem selenggaraan cerun yang komprehensif telah dibina dan diamalkan oleh kerajaan Hong Kong bagi mengurangkan risiko bencana disebabkan kegagalan cerun. Beberapa persidangan pernah diadakan di Malaysia bagi mempelajari amalan kerajaan Hong Kong terutamanya selepas insiden Highland Tower, tetapi hasil dari persidangan tersebut masih menjadi tanda tanya.

Amalan lestari kejuruteraan geoteknik mendefinasikan ciri-ciri berikut:

- Menghayati perundangan, pengawalan dan polisi alam sekitar
- Amalan kejuruteraan geoteknik untuk faedah masyarakat
- Amalan keprofesionalan yang meminimum kesan negatif pada persekitaran
- Memberikan penilaian kuantitatif pada sifat dan proses geo-bahan yang tidak menentu
- Mempertingkatkan penilaian dalam kontak model jasad batuan dari bahan batuan
- Mempunyai kesedaran dan prihatin pada permasalahan geoteknik yang berkaitan dengan luluhawa
- Menggunakan kaedah pembinaan mesra alam
- Menghargai sumbangan khidmat pakar dari bidang lain dalam penilaian isu alam sekitar

Kriteria yang disenaraikan jelas menginteprestasi apa yang dimaksudkan dengan amalan lestari. Ini bermakna amalan lestari seseorang jurutera terletak pada sikap dan etika individu amnya dan kumpulan profesional khasnya yang terlibat secara terus dalam proses rekabentuk dan prosidur pembinaan walau apa dan di mana juga peranannya. Jika ini dapat dilakukan dengan berkesan, soal penguatkuasaan tidak akan timbul.

Jika disemak spesifikasi piawai bagi pembangunan fizikal sesebuah kawasan secara rambang, didapati prosidur bagi memulakan pembersihan tapak dan kerja-kerja tanah yang berkaitan dengannya menyatakan garispanduan am sahaja. Skop kerja pengorekan dan kerja-kerja tanah hanya menyenaraikan peraturan umum mengenai pembersihan tapak, sistem saliran kawasan yang hendak dibangunkan, kemusnahan struktur sedia ada, kerja pengorekan di bawah aras bumi dan pemeliharaan serta pemuliharaan pokok-pokok sedia ada. Arahan khusus bagi setiap skop kerja semuanya tertumpu pada maklumat terperinci yang sepatutnya diperincikan dalam pelan pembinaan. Ini bermakna apa dan bagaimana prosidur kerja hendak dilakukan mestilah dijelaskan dengan jelas dalam lukisan binaan, diselia dan dikuatkuasakan bagi memastikan kerosakan persekitaran disebabkan aktiviti pembangunan dapat diminimum. Pada masa yang sama keadaan cuaca Malaysia yang dirahmati hujan sepanjang tahun hendaklah diambilkira dalam perancangan kerja tanah bagi mengelak kesan banjir kilat di kawasan yang lebih rendah.

Sifat keterbukaan pengamal kejuruteraan adalah diharapkan supaya setiap geobencana yang terjadi dikongsi bersama agar kesilapan teknikal tidak berulang demi maruah profesion yang murni. Penghayatan pada laporan *EIA* boleh dilaksanakan melalui perancangan kerja yang lebih teratur dan mesra alam. Fokus utama pada kos pembinaan, tempoh projek yang pendek dan penguatkuasaan yang lemah menjadi penyebab kepada apa yang berlaku sehingga segelintir masyarakat merumuskan bahawa pem-bangunan fizikal telah menyebabkan kemusnahan alam sekitar. Aktivis-aktivis ini tidak pula menafikan bahawa kebaikan dan keselesaan hidup yang mereka dikecapi adalah hasil dari pembangunan negara. Oleh itu adalah penting kelemahan pada prosidur piawai pembangunan fizikal yang samar diteliti semula supaya perancangan kerja turut mengambilkira kesensitifan masyarakat dan kesan negatif pada alam sekitar.

Deklarasi Shanghai 2004 bertema *Engineers Shape The Sustainable Future* mengagong-kan peranan para jurutera (Buletin IJM, Mac 2005). Namun cabaran masa kini tentang keberulangkalian geobencana berkaitrapat amalan jurutera geoteknik dengan kemerosotan berterusan alam sekitar. Misi pembangunan komuniti jurutera sebagai sumber tenaga yang bertanggungjawab ke arah menyediakan suasana ke-hidupan masyarakat yang selamat dan harmoni mestilah dipertahankan. Jurutera diminta supaya lebih berdedikasi dalam membangunkan dunia yang lebih lestari melalui amalan ilmu yang menterjemahkan sumber kepada produk dan perkhidmatan. Kesedaran pada keseimbangan penggunaan sumber asli dan perlunya tinggalan untuk generasi akan datang tidak boleh diabaikan. Sudah sampai masanya jurutera Malaysia mempunyai keper-hatinan pada se-lenggaraan alam sekitar dan ekosistem bagi mempromosikan pembangunan lestari. Setiap cadangan pem-bangunan mestilah memfokus pada halatuju yang mempunyai indeks pengukur ke arah tema deklarasi .

## Penutup

Seperti biasa berita sensasi yang dimuatkan oleh media akan dilupakan. Namun sebagai rakyat Malaysia yang terlatih dalam kerjaya yang diberi kepercayaan dan mandat melaksanakan amanah dengan memegang pada etika kerja, adalah diharapkan setiap individu yang terlibat secara langsung atau sebaliknya hendaklah mula membuka mata. Pembangunan lestari adalah keperluan kritikal masa kini dan akan datang oleh itu pengamal kejuruteraan hendak-lah merenung kembali asas ilmu kejuruteraan untuk memper-tingkatkan kaedah amalan geoteknik yang sesuai dengan persekitaran iklim Malaysia. Disebalik perkembangan tekno-logi yang banyak membantu mempercepatkan proses analisis dan pembinaan , pengetahuan dan keperi-hatinan pada sifat semulajadi jasad bumi adalah kaedah rekabentuk yang terbaik bagi menjamin suasana kehidupan yang harmoni untuk generasi akan datang. Namun khidmat jurutera awam akan terbantut apabila peruntukan pem-bangunan fizikal tidak diimbangi dengan keperluan melabur pada amalan pem-bangunan lestari andainya semua pihak bersungguh-sungguh hendak mencapai hasrat negara maju pada tahun 2020. ■

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# Evolution of Precast Concrete Piles

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**Abstract**

*This article briefly traces the development of precast concrete piles in Malaysia. Vastly improved technologies for producing high-strength concrete coupled with developments in installation equipment and methods have significantly changed pile design and construction. The issues that will arise when the British codes of practice are withdrawn in a few years' time are addressed.*

## Introduction

Precast piles in the early years were mainly reinforced concrete with concrete of 20 N/mm$^2$ strength heavily reinforced with mild steel. Pile sizes were typically 300mm or larger, square section and had low working loads. Piles were often cast on site by main contractors, who also did their own piling works. The largest user of these piles was the Public Works Department or JKR. Piles for heavy structures such as bridges, wharves, ports etc. were made of steel.

In the last forty years or so, the development of precast concrete piles has been phenomenal. Today precast piles are reinforced concrete square, prestressed concrete square and hollow cylindrical prestressed spun with a wide range of sizes. With the rapid progress of the construction industry, factory manufacturing of concrete piles is now the norm. Piles are mass-produced in factory-controlled conditions making consistent quality control possible. Prestressed concrete spun piles have largely replaced steel piles in applications to support heavy and marine structures. For light structures, small sized prestressed concrete and reinforced concrete piles square sections, are now preferred over timber piles.

The advancement of precast concrete piles, in fact of the whole precast industry, is mainly due to the progress achieved in concrete technology, particularly improvements in making high strength concrete. Admixtures play a big part and none is more important than the super-plasticizer type. True to its name 'super', it imparts the ability to reduce the water content without loss of workability. Water cement (w/c) ratio of less than 0.30 is possible and hence higher concrete strengths can be obtained.

Pile drivers of present times are more efficient, mobile and environmental friendly than those of the past. The old workhorse of the piling industry, the diesel hammer (Figure 1), has been replaced by the hydraulic type. Hydraulic jack-in machines (Figure 2) are now being used to install piles especially in city centers where noise and vibration are important considerations.

*Figure 1: Diesel hammer, the old workhorse of the Piling Industry*

## Piling practice in the 1950's

In the 1950's most piles were reinforced concrete piles and were designed according to the British Code "Foundations" The Civil Engineering Code of Practice, No.4 (1954). Typical sizes and its corresponding carrying capacities are given in Table 1 (RAO). RAO mentioned that piles were made of grade 20 concrete and, where driving conditions were easy, grade 15 concrete was used. The minimum size of pile was 250 mm square with a working load of 25 tonnes.

Those piles were heavily reinforced with mild steel and included large volumes of lateral stirrups. The heavy reinforcement needed was probably because the concrete grades used were low. CP No. 4 recommended the minimum main longitudinal reinforcements to be 1¼% of the cross-sectional area of the piles for lengths up to 30 times their least

*Figure 2 : Injection machine, environmental friendly with less vibration and low noise (courtesy of Soilmech Engineering)*

width, 1½% for lengths 30 to 40 times and 2% for lengths over 40 times the least width.

## Piling Practice in the 1970's

Ting (1977) describes the piling practice in the 1970s. Piles were designed based on the British Standard CP2004 "Code of Practice for Foundations". According to Ting, the most common piles used were the 300mm and 375mm square section reinforced concrete piles. The concrete strength for the piles was only 25 N/mm2. (Table 2). The grades of concrete and cement contents for reinforced concrete piles as recommended by CP2004 are given in Table 3. (Grade 25 concrete was recommended for hard and very hard driving conditions and in marine works!) The working loads of the piles were low because of the concrete strength and concerns over in quality control. Prestressed concrete piles of square section were also used and some typical working loads are given in Table 2.

Neoh (1997) reported that the old JKR specifications for reinforced concrete piles were heavily reinforced such as 2.12% to 3.7% of main longitudinal reinforcement often using mild steel bars and lateral reinforcement of as much as 2.1% of the area of concrete. The high reinforcements were basically for piles which were cast on site. Figure 3 shows a reinforced concrete pile being used in the sea, which is not common these days.

*Figure 3 : Reinforced concrete pile used in the sea, not common these days*

## Current Practice

Precast concrete piles in current use are reinforced concrete square, prestressed concrete square and hollow cylindrical prestressed spun. Typical concrete strengths and reinforce-ments are given in Table 5.

Reinforced concrete piles are widely used in buildings. There are a variety of sizes ranging from the small (150mm square) to the large (450mm square). The concrete for reinforced concrete piles is typically 45 N/mm2 and hence the working loads are higher. (Figure 4)

*Figure 4: The present reinforced concrete piles of grade 45 $N/mm^2$*

Prestressed concrete piles are extensively used in marine ground conditions because of its durability advantage. (Figure 5) These piles have high load bearing capacities with high bending strengths and can be handled and driven in very long lengths, which make it very suitable as freestanding piles for wharves and bridges. Piles of single lengths of 40m have been successfully installed. In Malaysia most of the large prestressed concrete piles are cylindrical hollow spun piles and sizes ranging from 250mm diameter to 1000mm.

In recent years prestressed concrete spun piles are also used in buildings, especially in difficult soil conditions or when a strong pile is required to penetrate dense formation or debris. Prestressed concrete piles can be more competitive because of the high load bearing capacities.

*Figure 5 : Prestressed concrete spun piles driven in the sea*

## Relevant Code of Practice/ Standards

Pile design in Malaysia has always followed the British Standards, currently the BS 8004. However, all the British Standards will soon be replaced by Euro-codes; and similarly BS 8004 will be withdrawn and replaced by Euro-code 7 in 2008.

The Institution of Engineers, Malaysia (IEM) has come up with a position paper for concrete codes of practice for the local construction industry after 2008. IEM has recommended that the industry should follow Euro-code EC 2 - Euro Concrete Code of Practice. We may expect the foundation design to follow suit.

For the benefit of engineers who are wondering which code to follow after 2008, there is the recently published Malaysian Standard MS 1756:2004: Code of Practice of Foundations. It is basically a full adoption of BS 8004.

There are also the Malaysian Standards MS: 1314 Part 1 to Part 6 which were published in 2004 and are as follows:

Part 1: General requirements and specifications

Part 2: Method for determination of bending strength of precast concrete piles (bend test)

Part 3: Precast reinforced concrete square piles (RC piles) - Class M, Class J and Class S

Part 4: Precast pretensioned spun concrete piles (spun piles) - Class A, Class B and Class C

Part 5: Precast prestressed concrete square piles - Class X, Class Y, small piles Class PCS-1 and Class PCS-2

Part 6: Small reinforced concrete square piles - Small piles Class RCS-1 and Class RCS-2

Part 7: Guidelines to the installation and load testing of precast concrete piles (Under deliberation)

Although the fundamentals of pile design have not changed over the years, some of the following points may have to be reviewed.

***1. Criteria of static load test***

BS 8004 clause 7.5.6.5 states that "the ultimate bearing capacity of the pile may be taken as the force at which penetration is equal to 10% of the diameter of the base of the pile".

Although this criterion has been widely used by engineers to define the failure load of the static load test, it is time to analyse its limitation. This criterion was suggested by Terzaghi in 1942 when piles were large and had low working loads. For the modern high load-bearing capacity pile with small cross-sectional areas such as micro piles or steel piles, the "10% pile diameter" rule may not be applicable, especially for long piles. Sometimes the elastic shortening of long small piles is already larger than 10% of the pile diameter. Steel piles manufacturers have often challenged this criterion. (Constrado)

***2. Spacing of the piles***

The usual standard of 2 times diameter pile for end bearing piles and 3 times diameter for friction piles have to be applied with some common sense. The standard applies to large piles but not to small piles. For instance, when designing for 200mm sq. precast piles, 2 x diameter is only 400mm, which is unnecessarily close. In reality, the spacing of piles depends on the size of the pile, the working load, the length of the pile, and whether it is frictional or end bearing.

Figure 6 shows a four-pile group for 150mm square piles after installation. Note how close the piles are.

*Figure 6 : Spacing of the piles are too close*

***3. Lateral reinforcement.*** - BS 8004 (1986) recommends that the minimum diameter of stirrups is 6mm. This is also outdated as the modern day piles have much higher concrete strength and therefore can take higher driving stresses. Smaller diameters have been allowed by other codes. The Euro-code (EN 12794:2003-draft) on precast concrete products - Foundation piles, recommends that the minimum diameter of stirrups of 4mm for piles with transverse dimension smaller than 300mm, and for piles 300mm and larger, the diameter of the strings should be at least 5mm. In Hawaii and New Zealand, some piles had been successfully driven with only the pile head and toe reinforced. MS1314:2004 allows minimum diameter to be 4mm.

## The Future

***1. Self Compacting Concrete***

One of the most important recent developments, which may revolutionise precast concrete piles, is Self-Compacting Concrete (SCC). It was developed in Japan in the late 80s because of acute labour shortage. As the name suggests, SCC is simply a technology for producing flowing concrete which can be placed without the need for vibration. Self-Compacting Concrete is especially advantageous for difficult to place formwork or very congested steel network. SCC is made possible with the introduction of a new generation of super-plasticizers (known as poly-carboxylates) which give very high water reduction (up to 40%). Self-Compacting Concrete is currently used in precast concrete pile manufacturing in the United Kingdom where the concrete used is as high as 50 N/mm2.

In precast concrete works where cycle time is crucial these "super" super-plasticizers are used to achieve high early strengths without the need for steam curing. High early strength is also very important in prestressed concrete pile manufacturing for detensioning of tendons.

***2. Vibrating formwork***

Some pile manufacturers have used vibrating tables with great success to compact concrete. Concrete with low water-cement ratios (as low as 0.30) can be placed quickly It is sometime called no-slump concrete. (Figure 7) The cement content to achieve corresponding concrete strengths can be reduced hence providing cost savings.

*Figure 7 : No slump concrete used in vibrating formwork*

***3. Composite piles***

Plastic-steel composite piles have been used overseas in areas of highly corrosive soil (for example, high sulphate content) and for waterfront structures such as docks, wharf etc. It is made of steel or iron pipe core with recycled plastic cast over it. (Coduta)

Another new composite pile for corrosion resistance is the patented fiberglass-reinforced plastic concrete pile (FRP/ concrete pile). It consists of a hollow fiberglass reinforced plastic tube and a concrete core but these composite piles are expensive.

***4. Quality Assurance***

Piling contracts should require piling contractors to have quality systems similar to the ISO 9000 series. Quality assurance systems will give confidence that piles are installed to specifications and in accordance with good practice. Operation procedures should be documented for piling personnel to follow. The system also requires records to show evidence of work done. Training of personnel is an important part of a quality system and training of pile drivers is essential.

***5. Possible problems with future re-development works***

Old piles are beginning to be a problem in re-development works in urban areas of the industrialized countries. In London where land cost is at an extreme premium, old buildings are being replaced with new and more efficient structures. After many phases of development, the ground is practically filled with old foundations, leaving little room for new piles. Engineers are now looking at using existing piles.

In Malaysia, we may face problems with buildings which are built on ex-mining ground especially with extreme soft clay or slime. Re-development in the future will definitely call for basements and any excavation in slime areas is going to be a huge problem especially to adjacent structures built on these soft grounds.

We should keep good records of as-built piling works for future references.

## Overview

In the present slow economic climate of the construction industry, piling contracts are very competitive. Value engineering and alternative designs are becoming more common in the battle to win projects. However, competition can make designs more "innovative" and in some cases quite bold. There is the new pile design method which is sometime known as "Catalogue pile design". The design method is simply to match the column loads with the maximum working loads as recommended by the pile manufacturers, and using mainly single piles instead of groups.

Piling contractors are getting very specialized and when awarding jobs it may be worthwhile to investigate the contractor's reputation, experience and resources available to complete the job satisfactorily and on time.

Table 1. Common size of reinforced concrete piles in the early years (RAO, 1949)

| Pile Size | Concrete grade | Carrying Capacity |
|---|---|---|
| 25cm x 25cm | 20 | 25 tonnes |
| 30cm x 30cm | 20 | 35 tonnes |
| 35cm x 35cm | 20 | 45 tonnes |

Table 2. Typical pile and size used in the 1970s (Ting, 1977)

| Dimension | Type | Concrete | Nominal Mix Strength | Working Load (ton) |
|---|---|---|---|---|
| 300mm x 300mm | Precast reinforced concrete | 25 $N/mm^2$ | 1:1 ½:3 | 40 |
| 375mm x 375mm | Precast reinforced concrete | 25 $N/mm^2$ | 1:1 ½:3 | 65 |
| 350mm x 350mm | Prestressed concrete 21m pile depth | 41 $N/mm^2$ | 1:1:2 | 76 |
| 350mm x 350mm | Prestressed concrete 27m pile depth | 41 $N/mm^2$ | 1:1:2 | 110 |

Table 3. Cement content and cube strength of concrete for precast reinforced concrete piles (CP2004, 1972)

| Conditions | Grade designation | Minimum quantity of cement | Cube strength within 28 days after mixing: works test | |
|---|---|---|---|---|
| | | $kg/m^3$ | $N/mm^2$ | $kgf/cm^2$ |
| Hard and very hard driving Conditions for all piles and in marine works | 25 | 400 | 25 | 250 |
| Normal and easy driving conditions | 20 | 300 | 20 | 200 |

Table 4. Typical concrete strength and reinforcement of piles in current practice

| Type | Nominal Concrete Strength | Main reinforcement |
|---|---|---|
| Reinforced Concrete | 45 $N/mm^2$ | 1 - 1.2 % |
| Prestressed Concrete | 60 $N/mm^2$ | 3.5 $N/mm^2$ to 7 $N/mm^2$ (effective prestress) |
| Prestressed Spun | 60 $N/mm^2$ | 4 $N/mm^2$ to 7 $N/mm^2$ (effective prestress) |

Reinforced concrete piles are still the most common precast concrete piles. Perhaps it's because of its simpler and less capital intensive manufacturing process than prestressed concrete piles. Most of the old prestressed concrete piles manufacturers used heavy steel moulds to cast piles. The tendons were stressed against the moulds and de-tensioning was by cutting the strands. Piles are now manufactured in long line method where the tendons are stressed against the abutments. The forces are transferred into the concrete by releasing the strands gradually with hydraulics jacks. Sudden transfer by cutting is not allowed by most standards, including MS 1314:2004.

One of the most important parts of precast concrete piling is the splicing of piles. The most common method is the welded mild steel plates joint. (this joint is not too popular in UK where they use mainly mechanical joints. ).The basic principle is that the pile when joined should have the same strength as the body of the pile. MS 1314:2004 gives guidelines to a standard pile joint. However, there should not be just a standard joint for all forces conditions. The joints should be designed to its required strength, i.e. the joint which is subject to only purely compression should be different to one that's required to resist high bending forces. The Euro-code (EN 12794:2003 - draft) on precast concrete products - Foundation piles, gives four classifications of pile joints according to its required strength. The author is now conducting research and testing of pile joints at a local university.

With the recent earthquake scare in the country, there is a call for engineers to consider seismic loading in their design. Prestressed concrete piles are advantageous because of its high bending and flexural strength. In some earthquake-prone areas such as New Zealand and North America, prestressed concrete piles have almost replaced reinforced concrete piles. (Coduta)

## Conclusion

Precast concrete piles have transformed from piles of low concrete strengths and heavy reinforcements with low working loads to the modern high-strength piles with high capacities. With modern heavier and more efficient hammers, installation of piles with higher load capacities is possible.

Engineers should be more innovative and not merely follow the policy of "do things as we have always done". Most codes of practice derive a lot of its recommendations from experiences, often established through trial and error practice.

Quality control of both manufacturing and piling operations should be an integral part of pile design. A quality assurance system should be an important part of piling works.

We should adopt the Euro-codes for our foundation design after the British codes are withdrawn, as the Euro-codes would be based on a wider scope of experiences covering more diverse conditions in many European countries. ■

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# Ir. Ng Yit Kok's March From "Yap" To "Koi"

*By: Ir. Chin Mee Poon*

Once upon a time, an European sailor came to an island in the Pacific Ocean that he could not find in his map. He pointed to the land behind the native who had rowed out to meet him and asked for the name of the land. The native, thinking that that strange man wanted to know what he was holding in his hands, raised his oar and shouted: "Yap!"

Many years later, I landed on Yap Island with my good friend Ir. Goh Chye Koon (now Datuk). I had accompanied him there to submit a tender for a project funded by the World Bank. We had flown from KL to Manila, put up a night there, flown to Palau, again put up a night there, before flying to Yap.

Where the hell is Yap?

If you look at a world map, you will find Palau to the south-east of Manila, near the intersection between 135°E longitude and 7°N latitude, and Yap Island is on the straight line between Palau and Guam, about 500km from Palau. Yap Island and its surrounding islands are one of the 4 groups of islands that make up the Federated States of Micronesia.

I was quite surprised that I would ever end up on such a god-forsaken place as Yap. More surprised was I to meet fellow Malaysians there, not one, nor two, but four of them (with eight others not met in the island during our short stay there!) First there was a veterinary surgeon, then there were two consulting engineers, Ir. Ng Yit Kok and Mr. Lai Heng Wah, and finally there was Ir. Ng's wife. Ng and Lai were the engineers for the very project Chye Koon had come to tender for.

How those Malaysians came to live and work in Yap Island is another story. Ng and Lai worked there for two and a half years before they came back to Malaysia. They then worked for a housing developer and a number of construction companies, before they landed in Menta Construction Sdn. Bhd. about 10 years ago. Today they are both what they call "working directors" of the company.

I do not have any business dealings with them, but we do keep in touch with each other as friends should. It is in one of those casual conversations that I got to know that Ir. Ng Yit Kok has a very interesting hobby, that of keeping *koi*. He confided in me that he took up this hobby at almost the same time as he joined his present company. Before that he used to keep tropical fish. His progress from tropical fish to *koi* seemed to be very natural, as he enjoyed looking at other people's fish ponds and the sight of *koi* swimming leisurely in the water had a tranquilising effect on him. He found that to be a very effective way to "de-stress" from an engineer's hectic daily life.


*Last year's Koi show being officially openend by YB Datuk Tan Chai Ho, Deputy Minister of Home Affairs*

He has a so-called 40-tonne pond in his house, measuring about 7m long by 3m wide by 2m deep, which he constructed himself. He has about 20 beautiful *koi* in it, ranging in size from small to 77cm long.

Yit Kok puts his heart and soul into his hobby, and he has become very good at it. In fact, his knowledge in the field and his enthusiasm saw him holding the position of Vice President of ZNA Malaysia Koi Fish Club of Kuala Lumpur. This is his second year holding that position. This club was formed on 19 September 1996 and currently has about 200 members from all over the country. It is affiliated with Zen Nippon Airinkai (ZNA) of Japan, which is an association of *koi* lovers. Besides Malaysia, there are ZNA Koi clubs in North and South America, Europe, South Africa, Australia and all over Asia.

The world koi is an abbreviation of the word *nishikigoi*, which is a Japanese word that literally means carps with colourful scales. The science and art of breeding *koi* to produce the many different varieties seems to have originated in Japan, even though *koi* (i.e. carp) itself has not originated in Japan. It is then not surprising that all the terminologies related to the hobby of *koi* keeping are in Japanese.

The three most popular varieties of *koi* are: *kohaku* (red and white), *taisho sanshoku* or *sanke* (3 colours), and *showa sanshoku* or *showa* (also 3 colours). There are many varieties of *koi* differing in colours and patterns. Generally, these varieties can be classified into 10 classes from *kohaku* down to *kawarimono*.

A *koi* enthusiast derives a great deal of pleasure and satisfaction just observing his or her *koi* growing healthily and developing into great shape and size. Even greater pleasure and satisfaction is derived if the *koi* compare favourably with those of other enthusiasts and win prizes. In this sense keeping *koi* is similar to keeping pedigree dogs or cats.

To give its members an opportunity to show off their pride and compare notes with one another, the ZNA Malaysia Koi Fish Club organizes *koi* shows regularly. The latest one, the 5th Malaysian *Koi* Show & Championship

*YB Datuk Tan Chai Ho accompanied by Ir. Ng Yit Kok, inspecting the koi*

*Ir. Ng Yit Kok enjoying the beautiful koi in his 40-tonne pond*

2005, was held on 7 & 8 May 2005 in the Selangor Chinese Assembly Hall in Kuala Lumpur. About 700 *koi*, big and small, are expected to be displayed. Judging criteria include body structure and quality of colours.

The hobby of keeping *koi* can be relatively cheap. It can also be very expensive if the hobby is taken very, very seriously and only champion *koi* are kept. Some people are prepared to spend millions of ringgit indulging in the hobby.

It is learnt that our Prime Minister, as well as his predecessor, are both very enthusiastic *koi* hobbyists.

Yit Kok is quite crazy over the hobby. His wife, Loo Lai Leng, and their two children, a boy and a girl, also enjoy the hobby but are not that crazy.

The hobby is enjoyed by all races. More and more Malays and Indians are taking up the hobby with some of them winning grand prizes in *koi* shows. The hobby is also gaining popularity throughout the world.

One can take up the hobby without cutting a big hole in the pocket. Start small. You can buy selected locally-bred *koi* instead of imported ones. They are cheaper but not necessarily of poorer quality. Both imported and locally bred *koi* can produce good quality *koi*. It all depends on pairing through trial and error and serious culling, and the up-bringing of the *koi*. As good *koi* are difficult to come by, hobbyists usually turn to breeder farms with the reputation of consistently producing good *koi* through many years of experience and experiments.

But if you have to buy imported *koi*, Sakai Koi Farm and Momotaro Koi Farm, both in Hiroshima, are two of the top breeding farms in Japan. Other top names such as Dainichi, Matsunosuke, etc., are from Niigata, the original home ground for *koi* breeding in Japan.

Before one starts the hobby, however, seek advice and do it right from day one. It is of paramount importance that the filtering system of the pond must be correct, for the development of the *koi* depends on the quality of the water. With loving care and attention, your beautiful *koi* will give you many years of joy and fulfillment.

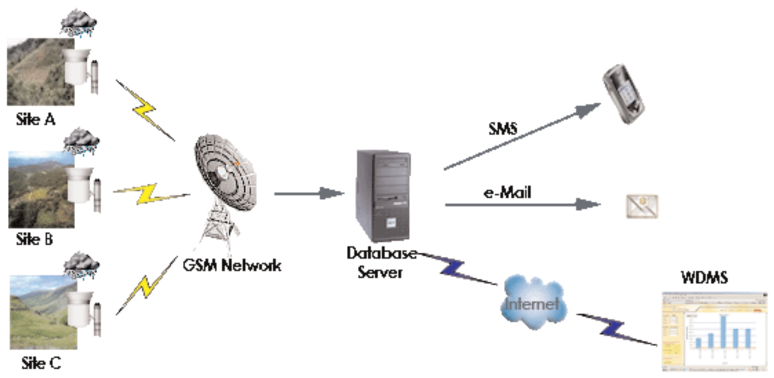
Like all healthy hobbies, *koi* keeping brings like-minded people together, thereby allowing new friendships to be developed and social circles to be increased. ■

# Telemetry Wireless Internet Web-Based Early Warning System for Critical Slopes in Malaysia – A Geotechnical Perspective

*By : Mr. Ang Koh An*

## INTRODUCTION

The rapid infrastructure development in the last two decades brought about an imbalance in natural formations, especially highway hill-slope cutting, in the name of accelerating our country into a developed nation in line with the goal of vision 2020. Being a prudent geotechnical engineer, one always strives to impart cost-effectiveness and economic value to the designing of cut slopes and hence, a certain degree of risk is factored into the design criteria in order to maximise the return of investment, especially on "privatised" highways. With more and more highways being built every year, and an increasing frequency of "critical slopes" being added to the watch-list by our regulatory body – Jabatan Kerja Raya (JKR), it is to surprise that the "Cawangan Cerun" or "Slope Branch" of JKR was formed last year to investigate the potential and impending problem of these so-called "critical slopes" along existing highways.




No matter how one defines the classes of these slopes, the most critical ones need to be instrument-monitored to ascertain the stability of the slope. In prior instances, if slope failure occurred without any degree of monitoring, it is easier for errant engineers to deduce and conclude that the slope failure occurred as an act of god. Now, with the advancement in technology and telemetry systems, continuous data monitoring of over short intervals of every second or minute allows geotechnical engineers to better model the critical slopes, to improve the predictability of slope failure and to gauge a more confident threshold level for early warning system.

## TYPICAL TYPES OF INSTRUMENT

In the field of geotechnical engineering, the typical minimum instrument involved in the monitoring of "critical slopes" consists of rain gauges, open standpipe piezometers and inclinometers.

The rain gauge by far is one of the most important instruments to be installed in a slope monitoring program as it allows for the measurement of rainfall over time. Unfortunately, over the past few years, rain gauges have not been utilise to their fullest extent due to fact that older generation rain gauges are unable to read shorter intervals and that an individual has to scale the top of the slope to collect rainfall readings.

Open standpipe piezometer is also a critical component as this instrument measures the pore pressure build-up during rainfall, as excessive infiltration of rain water into the ground will invariably increase the pore water pressure and hence, reduce the effective stress of the soil. Once the effective stress of soil reaches its critical stage, slope failure will occur. In the case of conventional water-level monitoring, the open standpipe piezometer measures the water table at a very large interval or during the descent of the dipmeter to take the reading of the water level and this actually provides an incomplete establishment of the relationship between "rain fall intensity" vs "open standpipe piezometer level". In fact, the measurement actually reads the soil permeability or water infiltration level of the soils.

An inclinometer hole is installed and socketed to the hard layer of the expected movement area to check the physical movement of the slope using a conventional mobile inclinometer probe of 0.5 meter gauge length, in order to obtain the profile of the hole. The subsequent hole profile readings are taken and compared against an earlier hole profile reading to determine if there have been any physical movement. Again, these readings are only taken once a day and continuous data monitoring seems to be impossible under these circumstances.

## NEW ERA OF TELEMETRY INSTRUMENT

With the advancement in technology and telemetry systems, continuous data monitoring of the above three instruments – rain gauge, water level and in-placed inclinometers, is now possible and hence, a new era of Telemetry Wireless Internet Web-Based Early Warning System is being heavily pursued by various researchers around the world.

It was unfortunate to note that although our country possesses such a large network of highways cutting through hill-slopes, only a handful of critical slopes are being modelled upon and field research data is scarce and incomplete due to unsustainable long-term data monitoring program.

Recently, one of our private highway toll concessionaires took the challenge of initiating their own "critical slope" monitoring program along a stretch of highway to show their corporate and social responsibility. The program started in 2004 and it comprises a) low-cost data-logging rain gauge for continuous rainfall recording, in order to obtain the rainfall intensity with data downloaded every two weeks compared to the previous manually-operated rain gauges, which can only offer, at best, daily rainfall measurement, b) open standpipe piezometer to measure the water table and a halcrow bucket to measure the maximum water table, although this is only done once every two weeks and c) inclinometer access hole with the standard manual inclinometer readings taken by lowering the inclinometer probe into the inclinometer access pipe and taking readings every 0.5 meter from the bottom of the access hole once every two weeks.

In 2005, the private highway toll concessionaire took a step further by implementing the first trial slope telemetry wireless internet web-based data monitoring program with threshold early warning system for the three parameters of rain fall intensity, piezometer pressure and movement in the in-placed inclinometers before fully implementing the system on all the critical slopes along the highway. The above system is made possible due to the locally developed technology for data-logging and telemetry systems and also the locally assembled components of the in-placed inclinometer with MEMS device to lower the cost of the instrument to a more acceptable level.

## THE IMPORTANCE OF CONTINUOUS MONITORING

Once again, the way to improve in the area of geotechnical instrumentation for critical slopes is to establish a long-term and short interval, continuous data monitoring system of the relevant critical parameters such as rain fall intensity, piezometer level and movement of the in-placed inclinometers. Once the long-term data trend of these parameters are sampled, one can then possibly analyse the data and produce statistical modelling to better predict the individual instrument's failure threshold. Of course, one should not forget the basic geological input of the slopes to derive the threshold levels for each and every instrument.

## FUTURE APPLICATIONS OF TELEMETRY IN OTHER AREAS

Currently, locally developed technology for data logging, telemetry systems and the locally assembled components of the in-placed inclinometer with MEMS device are only being tested for geotechnical aspects and we are very sure that the future is bright for the telemetry wireless internet web-based early warning system to be utilised in other aspects of Civil Material Testing. ■

# The Analysis And Design For Short Reinforced Concrete Column Using Computer Method

By: [1]Ir. John C. I. [2]Tiong, Mr. Ngu Soon Hui,
[1]B.Eng.(Civil), M.Sc.(Civil), M.I.E.M., P.Eng, [2]B.Eng. (Hons.) Electronics Engineering

## Introduction

Today engineers depend on computer more than their forefathers in carrying out their daily work. Computer aided analysis is now an indispensable part of a standard engineering curriculum and most engineers have at least some rudimentary acquaintance with the computer programs relating to their field.

This article serves to recount briefly the theory of Reinforced Concrete (RC) column analysis and demonstrate the use of computer method in the analysis and design for short RC column.

## Column analysis

Columns are vital structural elements for buildings. They are primarily used to carry compressive loads. They also carry bending moment due to the eccentricities in the applied load. Columns are generally divided into two categories, namely short columns and slender columns. Short columns are the columns which length is small compare to the dimensions of the cross section. For slender columns, the length is comparatively larger. For slender columns, there exist also secondary moments due to lateral displacements that could cause a significant reduction in axial load capacity. Only short column theory is discussed in this article.

In Malaysia, concrete is the conventional construction material. Reinforcement steel bars are added to the concrete in order to increase the load capacity and bending moments. A cross section view of a rectangular column with 4 reinforcement bars is shown in Figure 1.

A section under the action of applied loads and bending moments will have part of the region under compression and part of the region under tension. The line where the stresses change from compression to tension is called *neutral axis* (NA). For concrete, one assumes an equivalent rectangular stress block as shown in Figure 1. The maximum strain is taken as 0.0035.

For steel reinforcing bars, one assumes an elastic plastic relationship between stress and strain as shown in Figure 2. $fy$ is the yield strength for the steel and $\gamma_m$ is the partial safety factor for the steel.

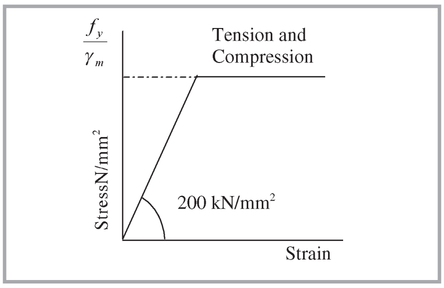



*Figure 2: Stress strain curve for reinforcement*

The equations relating axial load capacity and bending moment in a column is given by the following sets of equations:

$$P_n = P_{concrete} + \sum_{i=1}^{n} A_{bi} f_{si} - \sum_{i=1}^{n_{bc}} A_{bi} f_{ci}$$

$$M_{nX} = M_{xconcrete} + \sum_{i=1}^{n} A_{bi} f_{si} Y_{bi} - \sum_{i=1}^{n_{bc}} A_{bi} f_{ci} Y_{bi}$$

$$M_{nY} = M_{yconcrete} + \sum_{i=1}^{n} A_{bi} f_{si} X_{bi} - \sum_{i=1}^{n_{bc}} A_{bi} f_{ci} X_{bi}$$

$$M_{nX} = P_n e_y$$

$$M_{nY} = P_n e_x$$

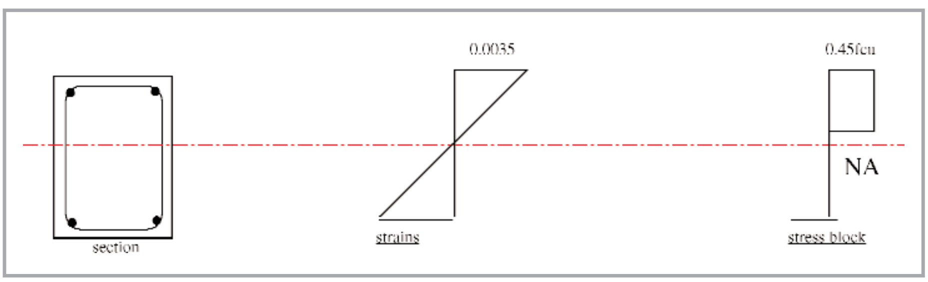



*Figure 1: A column with stress and strain relationship for concrete*

where $P_n$, $M_{nX}$, $M_{nY}$ are the total axial force strength and bending moment strengths about the global X- and Y-axis. $P_{concrete}$ is the force of the concrete; $M_{xconcrete}$ and $M_{yconcrete}$ are the bending moment in global X and Y axis due to the concrete respectively. $A_{bi}$ is the area of the steel bar $i$, $f_{si}$ the stress of the steel bar $i$, $f_{ci}$ the stress of the displaced concrete at steel bar $i$, $e_x$, and $e_y$ the are the eccentricities of the axial load, and $X_{bi}$ and $Y_{bi}$ are the x and y coordinate of the steel $i$ bar respectively. $n$ is the number of steel bar, $n_{bc}$ is the number of steel bar in the equivalent rectangular stress block region.

There are two kinds of column analysis. One is given the eccentricities of the loads and the diameter of the reinforcement bars; find the axial load capacity that can be sustained by the reinforced concrete section. Another involves finding the required bar diameters for given the axial load capacity and bending moment. To solve for either cases, one needs to know the location of the neutral axis. However the location of the neutral axis is usually unknown. Thus the solutions for the above equations are highly nonlinear in that one needs to determine the reinforcement bar area (or the axial load capacity) and the position of the neutral axis at once.

Such a problem is difficult to solve by hand, given the fact that the volume of arithmetic involved is laborious. Indeed, hand solutions have been restricted to a few highly symmetrical concrete shapes with highly symmetrical reinforcement bars layout for uniaxial bending, i.e. bending in one direction. For biaxial bending, one has to resort to approximate solution such as load contour method [6]. But this approach is approximation in nature and involves a few parameters that have to be determined by experiment for different concrete shapes and reinforcement bar layouts. Another popular approximate method is reciprocal load method [6]. However, this method is not applicable in a strong biaxial bending situation and thus its generality is limited.

## Computer solution:

With this, computer method seems to be the only way to analyze arbitrary shape RC columns under biaxial bending. One particularly popular method is Quasi-Newton method, a modification of Newton-Raphson method. As its name implies, this method can be traced back to Isaac Newton, who used its precursor to find roots of the nonlinear equation. Efforts have been labored to expand this technique to solve multiple coupled nonlinear equations. Because of its speed and ease for computer implementation, it has been widely used in virtually every discipline of engineering.

Quasi-Newton method is also well-adapted to the analysis of RC column under biaxial bending. There are a few variations of Quasi-Newton method such as [2] and [3]. We concentrate on the technique presented in [2]. As said, this method is fast to converge and general, but it may fail to converge on certain cases when the load is highly eccentric and the geometry of the concrete is highly irregular. A cure for this drawback is by introducing backtracking technique and coordinate transformation [1]. With this, Quasi-Newton method becomes applicable in commercial software.

## 2D interaction diagram

2D interaction diagrams are frequently employed to check for the adequacy of a reinforced concrete section. There are two kinds of interaction diagram, one is biaxial moment interaction curve plotted at a constant load, and another is axial load vs. moment plotted at a constant $M_{nx}/M_{ny}$ ratio. For the former, it can be used to determine the maximum allowable moment for a given axial load; for the latter, it is used to calculate the maximum allowable axial load and moment for a given $M_{nx}/M_{ny}$ ratio. Any load point that falls outside the curve is unacceptable because it exceeds the capacity of the section.

2D interaction diagram is just a special case of the more general 3D interaction diagram, which plots every possible set of value for $P_n$, $M_{nx}$ and $M_{ny}$ on 3D axis. The plot for 3D surface gives one a feel on the strength of bending moment for different $M_{nx}/M_{ny}$ ratio. It can somewhat serve as an accuracy check for the method or computer algorithm, for the surface should appear smooth. This 3D surface is also called failure surface.

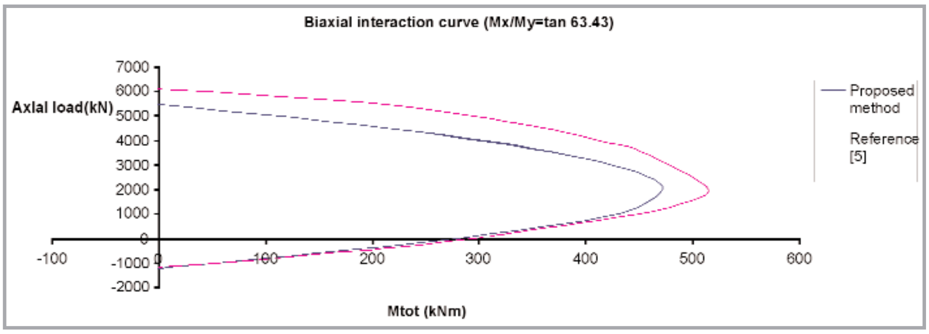



*Figure 3: Biaxial interaction curve at $M_{nx} = M_{ny}$*tan(63.43°), $M_{tot} = \sqrt{M_{nx}^2 + M_{ny}^2}$*

This name is derived from the fact that the surface is the capacity or the limits of the section. The section can take any load point that falls inside the surface; but any load combination that falls outside the 3D surface will cause the failure of the section.

## Example: Hollow-Circular Column under biaxial bending

Figure 4 shows a circular column of diameter 610mm with a circular opening of diameter 356mm. This column has 8 reinforcement bars of diameter 22.23mm.

Figure 3 shows the biaxial interaction curve at 63.43°. The results are compared to [5]. The material parameters are as given in reference [5] and will not be reproduced here. There are some slight discrepancies the two for axial load higher than 1000kN. The reasons for this could be due to:

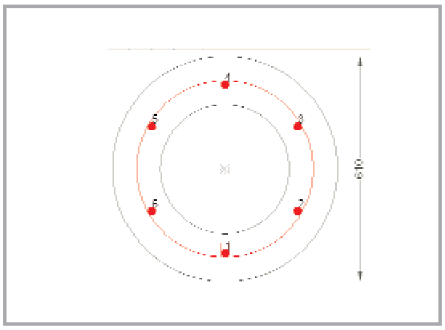



*Figure 4: A circular column with circular void*

1. The method used by this article uses equivalent rectangular stress block for concrete (Figure 1) whereas [5] uses a parabolic- linear curve.
2. A multi-linear elastoplastic stress-strain relationship for reinforcement is used in [5], whereas this article uses a linear-plastic stress-strain relationship as shown in Figure 2.

A 3D surface view for this column is presented in Figure 5.

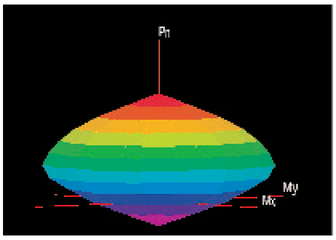



*Figure 5: A 3D failure surface for circular column*

## Example: T column with reinforcement bars

As a further demonstration of the ability of the proposed computer method, an example for biaxial interaction diagram for T column is shown in Figure 6.

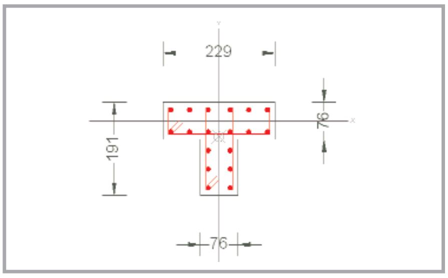



*Figure 6: A T shape column, material parameters are as given in [5]*

Figure 7 shows the comparison of this article result with reference [5] and reference [7] for $M_{nx} = M_{ny}$*tan(11°). The reasons for discrepancies between the proposed method and references are discussed before.

Figure 8 shows the 3D surface of the given section. Figure 9 is generated by cutting the 3D surface at the $P_n$ level of 345kN. It is evident that at this load level, the section can take higher moment about positive x axis than negative x axis.

## Conclusion

The theory for short RC column was briefly presented. The most popular computer technique for analyzing RC

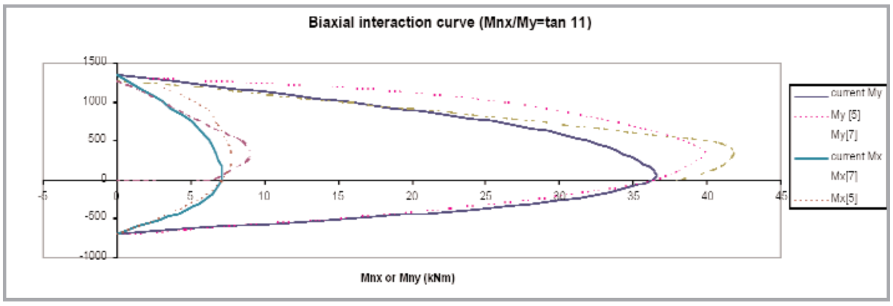



*Figure 7: $M_{nx}$ and $M_{ny}$ curve for the ratio $M_{nx}$ and $M_{ny}$*tan(11°)*

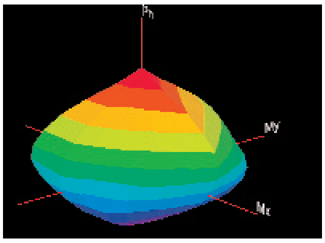



*Figure 8: 3D surface for T column*

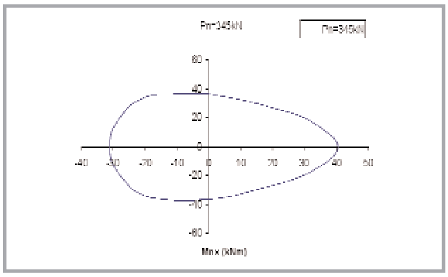



*Figure 9: $M_x - M_y$ curve at $P_n$ = 345kN*

column was introduced. Computer solution is faster, more economical, accurate and less prone to human errors. Two examples were presented to illustrate the concepts of biaxial interaction curve and 3D failure surface. The interaction curve can serve as a check on the adequacy of the section and thus is very useful in the analysis and design of RC column and thus is very useful in the analysis and design of RC column. ■

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# Reinforced Soil Structures With Geosynthetics

*By: Ir. Albert Lim Lum Kong, B.Sc. M.Sc., Polyfelt Asia Sdn Bhd*

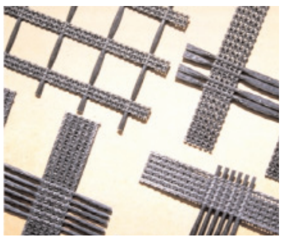
## Introduction

Throughout Malaysia, the availability of land for development is becoming increasingly scarce. Growing public resistance to the conversion of agricultural land and protected forest areas means town planners, engineers and architects are obliged to find ways to better utilise marginal and waste land that invariably comprises soft soils. In highland areas, the incidence of slope failures resulting from uncontrolled destruction of the natural vegetation is similarly becoming a common problem that requires an engineering solution.

Geosynthetics offer a practical and low-cost solution for a variety of problems associated with construction over soft or unstable soil and the repair of failed or unstable slopes. Geosynthetics are tough durable materials with defined engineering characteristics. They are easy to install and can, if designed correctly, reduce construction costs whilst significantly enhancing the strength and usefulness of unstable residual soil.

The complication with residual Malaysian soil is that it often comprises fine sandy clay or silt and is constantly saturated by heavy rain. Once it becomes too wet, it becomes unstable. Reinforcement of such soils is therefore a technical issue, requiring selection of reinforcement materials that are compatible with the soil and capable of performing a permanent reinforcing function without degrading or losing strength over time. Geosynthetic reinforcement, like all construction materials, therefore needs to have defined minimum quality standards and be designed into the soil. Correctly used, they are a versatile and cost-effective solution to a wide variety of common soil and engineering problems.

*Problems arising from construction over soft soils area commonly solved by installing geosynthetics directly over the soft subgrade*



*Polymer coated high tenacity polyester grids are suited to the reinforcement of gravels and sand*

*Non-woven geotextiles reinforced with high tenacity polyester yarns are used to strengthen and drain fine-grained clay soils*

*High tenacity knitted geotextiles are used to reinforce large soil structures over soft substrates*

## Reinforcement of unstable slopes

Slopes denuded of natural vegetation quickly erode and become unstable. Composite geotextile reinforcement designed to reinforce and drain fine-grained soils such as laterite are commonly used to strengthen and repair slopes such as the one shown in a local housing development project near Kuala Lumpur.

In such applications, the re-inforcement is placed in layers within the soil. The face of the slope is then hydro-seeded and a bio-degradable erosion protection mat is laid to protect the face from rainfall erosion until the grass is stabilised. The stability of the steep slopes is usually enhanced by incorporating a mesh facing system that includes grass. Slopes as high as 20m have been successfully treated using this method.

## Reinforced segmental block walls

Geosynthetic Reinforced Segmental Walls (SRW) incorporating modular concrete block facings is another fast growing application, particularly in township developments due to their cost-effectiveness and attractive and aesthetically pleasing appearance. These systems provide architects, property developers, engineers and house owners with a variety of finishes that can be adapted to any site configuration. Plants and vegetation can be added to enhance the final aesthetics.

The soil fill behind the block facings are reinforced with polymer coated, high tenacity fiber grids to increase stability and ensure the long-term integrity of the vertical structure. Structures as high as 10m are not uncommon.

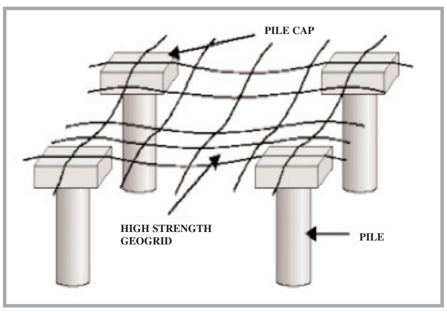

*Geosynthetic reinforced segmental block wall*

## Embankments over soft soil

Large expanses of saturated soft soil areas are common throughout lowland Malaysia. Any construction of roads, embankment approaches to bridges, factory sites, storage yards over such soil face a problem of settlement. In extreme cases, when the shear strength of the underlying soil is insufficient to carry the weight of the construction, failures such as that illustrated below occurs.

High tenacity reinforcement geotextiles laid over the soft soil substrate prior to construction provide a cost effective engineered solution to these problems. Not only is the structural integrity of the soil fill enhanced, more uniform settlement of the structure occurs.

In extreme cases, when the underlying soil is very soft and no settlement is allowed, it is necessary to install piles below the structure. Such applications are common under approaches to bridges, under rail track formations and high load storage yards, such as container depots. In such instances, conventional engineering practice requires a concrete slab to be cast over the piles. Geosynthetics can replace the slab contributing to large cost savings and faster construction time.




## Reinforcement of bridge abutments and vertical structures

The nature of residual sandy clay soil and heavy tropical rain prevalent in Malaysia necessitates that any geosynthetics used for reinforcement of residual soils be capable of undertaking both a drainage and reinforcement function and have a high soil-fabric interface friction.

In the below example, along the Ipoh to Rawang railway, a composite reinforcement of sandy clay laterite was used to construct a bridge approach abutment over the railway track. The system was quick and extremely low cost.


*Large expenses of soft clay and silt predominantly low clay areas*


*Typical fracture of a rural road due to instability of the underlying soil*


*Geosynthetic reinforced bridge abutment*


*Launching of geosynthetic reinforcement on seabed*

## Ports and Harbours

Construction of ports and harbours usually entails the placement of large volumes of earth and stone to create bund walls. To stabilise the bund and prevent loss wash out of sand and stone from wave action, such construction invariably requires the use of geosynthetics to reinforce the base of the bund wall and act as a filter behind the stone armour.

## Conclusion

Correctly designed and installed, geosynthetics have the capability to improve the strength of marginal soils. Use of geosynthetics significantly reduces construction costs and time whilst improving the overall quality and life span of soil structures. ■

*Note from the Editor: There were a few letters of comments received this month. One of these is published in this issue while the others will be published in the subsequent issue (July 2005). Any inconvenience caused is much regretted.*

# Comment on the Role of Engineers on Hill-Site Development

**By: [1]Ir. Hj. Look Keman bin Sahari, [2]Ir. Dr Mior Termizi bin Mohd. Yusof,**
**[1]BSc (Mining Engineering, Strathclyde), MSc (Explosives Ordnance Engineering, RMCS, Cranfield), FIEM, FIQ**
**[2]BSc (Mining Engineering, Camborne Sch. of Mines, UK), MSc, (Geotechnics/Rock Mechanics, Exeter), PhD (Geotechnical Engineering, USM), MIEM, FIQ**

We would like to refer to the article written by Ir. Tan Yean Chin on the above subject in the March 2005 issue of Jurutera Bulletin. Our comments are as follows:

As a mining engineer, the first writer has more than 25 years' experience in dealing with soil and rock slopes. As an engineer in the Geotechnical Engineering (Mining Technology) Division of the Mines Department, he had to make sure the slopes he designed remained stable long enough to ensure that mining can take place safely, and he also had to ensure that structures such as roads and railways near mining areas remain stable to enable the miners to mine valuable tin ore out of the ground and to ensure that said structures remained undisturbed. He also had many opportunities to carry out many technical investigations to deter-mine the reason why slope failures occurred in mines, some of which resulted in fatal accidents. Many such failures resulted in the death of many people, particularly those staying near mining areas. Slope failure cases such as that of the Capitol Mining incident in Puchong, 1981, where more than 20 people perished, could enable us to study these phenomena closely. Many field equipment such as vane shear, Mackintosh probe, SPT, Penetrometer and geophysical equipment such as seismic and electrical resistivity equipment were used to assist in the investigation. All typical laboratory tests to find the various soil parameters needed for safe slope design were carried out.

Early in the first writer's career, drawing and calculations were done manually to find a suitable safe slope and it was a tedious process, a stark contrast to the present, where computer programs are used. Malaysia was the number one producer and exporter of tin ore in the world at that time. Almost all tin ore was mined from alluvial ground, meaning soil, using opencast or gravel pump mining techniques. The mining engineers in Malaysia who dealt with mining slopes have to be well-versed in soil mechanics. In fact, Malaysian mining engineers are very familiar with soil slope stability at least in theory and practice through daily involvement and long experience. However, they may not use their knowledge to design civil structures.

The second writer used to work with the Mines Department overseeing mines and quarries in Kuala Lumpur, Kelantan and Sabah. In his work, he made sure that mine slopes in the mines were stable enough for mining and safe for the general public in the vicinity of the mines. He had made a study on the slope stability of what was one of the largest copper mines in Malaysia (500m depth, with a mine hole of 1.5km in diameter) and submitted a PhD thesis for it. He confirmed that geology plays a main role in determining the stability of the slope.

The factor of geology is very important in mining and also in the design of foundations for civil structures. Without a stable foundation, even the best design structures will not stand for very long. It is the duty of engineers to design such structures and it is also the duty of engineers to look into and design stable and safe foundations on the ground. The stability of foundations is not just dependent on where the foundation is and how it is designed but also on the geology of the area. In a hill slope area, we may be talking about areas which may be hundreds of metres away from the proposed structures and well beyond the areas given to the developers. In such cases, engineers need to be conversant with the local geology, like the geological structure, soil and rock types, dip and strikes, water conditions, etc. Unfor-tunately, not all civil engineers are competent enough to evaluate geological conditions, hence the need for geologists with engineering training or engineers with advanced geological training. Here we are talking about engineering geologists, civil engineers with geotechnical engineering training or a new breed of engineers called geological engineers or mining engineers with similar training. Civil engineers tend to specialise in soil mechanics and foundation engineering and mining engineers in rock mechanics with application in underground tunneling, tailing dams, explosives and rock blasting, and excavation engineering while others are somewhere in between. When dealing with development, regardless of whether it is for the development of a residential area, for highways, or for other structures on hill slopes, the knowledge of geology, soil and rock mechanics is very important and this requires the expertise of engineers and geologists. Such expertise is actually available in Jabatan Mineral and Geosains. Jabatan Mineral and Geosains actually has engineering geologists, mining engineers, mineral engineers, etc., with above-mentioned training though they may not be at the right division and at the right place.

Jabatan Mineral and Geoscience was formed as a result of the merger of the Geological Department and the Mines Department. It is therefore not correct for a developer or a private consultant engineer to restrict the department to comment only on geological conditions. Quite often the consultant engineer does not give sufficient site investigation reports to enable the officer in the department to give the desired comment. They are there to evaluate the consultants' report and not to write a report for the consultant to evaluate.

Development of hill slopes requires expertise of engineers and geologists and they have to work together to ensure the safety of proposed structures and also the people who are going to live there. While the design of structures is generally within the expertise of civil engineers, the ability to design safe slopes fall within the purview of not just civil engineers but other engineers with geological training or geologists with engineering training as well. No doubt the Registration of Engineers Act 1967 give professional engineers the right to submit plans but the engineers who submit such plans must show that they do have the expertise in the right field. They must understand and be able to explain what they submit and must be responsible for what they submit. Cutting and pasting or copying without understanding is not an option. Quite often, consultants just submit plans without the technical and geological report.

Being a Jack of all trades and the master of none will not do. This is one of the fields where engineers and geologists must work together for the benefit of everyone. After all, two heads are better than one. But of course, it is the engineer who will have to sign the plans.

The first writer is a retired engineer from the Mines Department and is now working as a consultant engineer. The second writer is also an ex-Mines Department engineer and is now a senior lecturer at Universiti Sains Malaysia, lecturing courses such as Geomechanics and Blasting Technology. ■

# IEM G&S Technical Delegation Tokyo Japan 2005, April 2nd-9th (8D6N)

*Reported by: Sdri. Jacqueline Tee Hsiao Lin*


After almost a one year period of planning and arranging, the committee members of the Japan Delegation have finally made it! The flight tickets and all the necessary arrangements were confirmed. All the delegation members were looking forward to meeting all the young Japanese engineers and learning from them. Two months before the trip, site visits were organised locally to see all the projects that are similar to those that we were going to visit in Japan. Then, comparisons can be made on the different aspect of practice and technology in these two countries. The delegates for the trip, comprised of a balance mix of young and senior engineers coming from various background.

## 3rd April 2005 (Sunday)

All the 12 member delegates departed to Narita Airport, Tokyo on the night of 2nd April 2005 and we arrived the airport in the morning the next day. Surprisingly, the airport did not look as high-tech as our very own KLIA, probably because the airport was quite old. Once we got out of the boarding area, we were greeted by large IEM sign and a group of young engineers. We are then introduced to Nishimura-san and Yukiko-san from the Japan Society of Civil Engineer (JSCE), our guides for the entire trip. Some of the young engineers also came a long distance just to meet up with us.

The weather was quite cold, we were informed that the cherry blossoms (sakura) have yet to blossom as the weather was still cold. Everyone was excitedly anticipating to witness the sakura, which will blossom and eventually wilt in seven days. All the delegates were packed into a bus and we were then brought around the city to visit some of the popular sights. We were like regular tourists; clicking our cameras and camcorders at every opportunity we found. First, we went to the Sensoji Temple and Asakusajinja Shrine where we were greeted by the sight of a large lantern. The place was crowded with tourists and locals alike, as it is the beginning of spring. Then, we were bundled off again to visit Ginza shopping area (akin to Starhill), the Imperial Palace and later in the evening, Odaiba, a shopping mall in the city. In between, we still found time to check into the hotel and had a nice lunch in town.

## 4th April 2005 (Monday)

The day started at 8am, when Nishimura-san picked us from the hotel and took us to the subway station. We were to go to our destinations by train as the traffic in Japan was very bad. The walk to the subway station was so thrilling, as there were like thousands of people commuting to work in the same manner. Most of us felt like part of the working-class in Japan, with an umbrella walking along the underground walkway to catch our train. We reached our first destination, JSCE just in time for our first meeting with the JSCE members. We were also taken around to see the facilities available at the institution.

After our tour in JSCE, we set off again to another institution, the Foundation of Rivers & Basin Integrated Communication (FRICS) and the Sabo Technical Center. We were briefed on the roles of these private organisations, which was in the compilation of data and the development of new technologies and methods.

In the evening, we went back to JSCE for our welcome dinner. We were greeted with a spread of food ranging from sushi, tempura, soba, and others that we were unable to name. It was a fabulous party hosted by JSCE. Most of us were busy getting to know the members of JSCE and exchanging contacts. We also presented some of our local delicacies such as dodol, keropok and other tit-bits for our counterpart. Most of them love the durian dodol and it seems like durian was hard to get in Japan.

## 5th April 2005 (Tuesday)

After the institutional exchange, it was time for site visits! We set off early in the morning again to the rural areas in the northern part of Tokyo. After the train ride, we were bundled again on a bus and set off to a gravel aeration and purification facility. As our hosts could not speak English, Yukiko-san from JSCE acted as our interpreter for the sessions.

After lunch, we went to the Metropolitan Area Outer Discharge Channel information centre where we were shown the model of the channel. Part of the channel is still undergoing construction but the remaining part of the channel is already in use. There are some similarities with our very own Gombak Diversion Channel and the Smart tunnel. Since, there was no flood; we even had the opportunity to go down to the surge tank.

We then proceeded to the Museum of Tone, Edo River and a site visit to part of the diversion channel undergoing construction. Taking the lift 70m down the shaft to the channel, we could see the last section of the channel. All of us were very impressed with the cleanliness of the job site. But time did not permit us to stay long and we were quickly bundled off to the city again for our next destination.

This time, we were to meet up with the members of Japan Water Agency (JWA) where yet again, we had a formal institutional exchange and presentation. To top off such a tiring day, we went for soba at this noodle shop with some of the young engineers. Some of the delegates even had the energy to go out for night supper.

## 6th April 2005 (Wednesday)

After such an eventful day, the delegates had some rest as the schedule of the next day was quite flexible. The focus was on transportation and roads. Our first destination was the Metropolitan Expressway Public Corporation traffic control centre likened to our own ITIS. As some of the delegates craved for sushi, we made our way to the Tsukiji Market where we feasted on sashimi, sushi and unagi. The market was the place where all the fresh fishes were sold through a bidding process in the wee hours of the morning.

After a satisfying lunch, we proceeded to the Yurikamome LRT control centre. After the presentation, we even had the chance to visit the site of the extension line of the privately-owned LRT. For the night, we were introduced to the night life of the local Japanese. The night started with a drinking session and dinner at the 'izakaya' recommended by the young engineers and proceeded with another drinking session at another location. The ever efficient Nishimura-san was so concerned that he reiterated a few times for all the delegates to wake up on time for the visit next morning. Everyone was reluctant to take their rest as tomorrow is yet another working day.

## 7th April 2005 (Thursday)

The last day of the visit was to the Port and Airport Research Institute (PARI) which was more than two hours away from the city. After the long train ride, we reached the coastal area of Japan where we were greeted by strong winds and smell of the sea. After the presentation and talk on tsunami, we were guided to the extensive laboratory in the institute. There were experimental lab for large structure, tsunami waves and other water related disaster.

As PARI is located in a small coastal town, all the delegates took some time to walk around town and appreciated some of the cherry blossoms that had just started to appear. It was time to say goodbye to Tokyo! The night was spent around the city centre, taking in all the sceneries and food along the street.

## 8h April 2005 (Friday)

Some of the delegates were so reluctant to leave that they extended their day while some flew back to KLIA. The delegates that stayed on were bundled onto the train again, this time by the Young Member Institution of Professional Engineer Japan (YMIPEJ) to the ryokan. Ryokan is a traditional house where all visitors sleep on tatami mat and bathe in the hot spring.

En-route to our destination, we were joined by 10 young engineers from the institution and enjoyed our lunch underneath the cherry blossom tree. We had a wonderful picnic and at the same time, we enjoyed the beautiful cherry blossoms around us. It was definitely worth the 1.5km walk up the hill.

At night, we had the traditional dinner and we were entertained by the Japanese with their songs and judo performances. The Malaysian delegates sang the 'Rasa Sayang' song in return. After dinner, everyone had an enjoyable bath in the outdoor hot spring and a nice sleep on the 'futon'.

## 9h April 2005 (Saturday)

It was a very solemn journey back to the city filled with exchanges of name cards and more photo taking. The young engineers sent us off at the train station and it's back to KLIA again!

The trip was filled with wonderful memories of beautiful sceneries, joyous and wonderful new friends. The Japanese were very courteous and took such initiative to communicate with us. Some even try to learn up Bahasa Malaysia few weeks before our arrival. We have learnt and seen so much, not only in terms of technology and engineering aspects, but culturally as well. Hopefully, more young engineers can come along together in our next delegation and experience this cultural exchange. ■

# Tips on Designing a Drainage System Using Free Software and Resources from the Internet to Meet the Requirements of the *"Manual Saliran Mesra Alam Malaysia"* (MSMA)

WATER RESOURCES TECHNICAL DIVISION

***Reported by: Ir. Dr Quek Keng Hong***

On 14 August 2004, the Water Resources Technical Division of IEM organised a half-day seminar entitled: ***"Tips on How To Design A Drainage System Using Free Software and Resources From the Internet To Satisfy the Requirements of the New Urban Stormwater Management Manual by the Department of Irrigation and Drainage."***

The Seminar which was held from 9.00 a.m. to 1.00 p.m. at Conference Hall A, Bangunan Ingenieur in Petaling Jaya, attracted a total of 83 participants.

The fee charged for the Seminar was RM50 for members, and RM80 for non-members.

The Seminar was conducted by Ir. Dr Quek Keng Hong, Chairman of the Water Resources Technical Division and a consulting engineer by practice.

Ir. Dr Quek has conducted many training workshops on the *Urban Stormwater Management Manual for Malaysia (Manual Saliran Mesra Alam Malaysia, or **MSMAM**)* published by the Department of Irrigation and Drainage (D.I.D.) in 2000.

He began his presentation by introducing the topic of his presentation that day.

He said as the title of the seminar implied, the purpose of the Seminar was to show participants how to design a drainage system using free software and resources available on the Internet – with the aim of fulfilling the requirements of ***MSMAM*** – the new urban drainage design guideline which was gazetted by the Malaysian Government in 2001.

Ir. Dr Quek said most engineers find it difficult to apply ***MSMAM*** because:

i) They do not understand the new theories and concepts presented in ***MSMAM***, and the changes from the old ***Planning and Design Procedure No.1 (PDP1)***,
ii) They do not know how to apply the new theories into practice, and
iii) They do not know what tools and resources they need to apply ***MSMAM***.

He said the Seminar would help participants overcome some of the problems faced by engineers.

The main topics of his presentation are divided into five parts as follows:

- Part A – What is ***MSMAM***?
- Part B – What are the major changes in ***MSMAM***?
- Part C – How to learn ***MSMAM***?
- Part D – How to solve problems in ***MSMAM***?
- Part E – Where to download free software and resources in ***MSMAM*** from the Internet?

Ir. Dr Quek said no printed notes would be given to the participants at the Seminar. But participants can download the notes in digital format from the website by subscribing to the free 7-day eCourse at: **http://www.msmam.com**.

He said those who missed out on the Seminar may obtain a free set of notes by subscribing to the eCourse at the website.

Ir. Dr Quek presented an interesting seminar to a packed conference hall. His presentation lasted three hours, followed by a Q&A session. The Seminar ended at about 2:00 pm – about an hour longer than originally scheduled.

The content of his presentation is summarised below.

*Ir. Dr Quek presenting his paper at the Seminar*

*Particpants listening to Ir. Dr Quek's presentation*

## Part A – What is *MSMAM*?

***MSMAM*** is the new urban drainage design guidelines published by D.I.D. in 2000 and gazetted by the Government in 2001.

Beginning 1st of January 2001, all drainage design by engineers in Malaysia must comply with the requirements of ***MSMAM***.

## Part B – What are the major changes in *MSMAM*?

***MSMAM*** includes major changes in design approach and procedures.

There is greater emphasis now on water quality management, in addition to water quantity management in ***MSMAM***.

Also, there is more comprehensive coverage of subject matters compared to ***PDP1***, with more emphasis on the use of computational methods.

Another difference is the units used: ***MSMAM*** is in SI units while ***PDP1*** is in imperial units.

View of the participants attending the Seminar

## Part C – How to learn *MSMAM*?

Ir. Dr Quek said the best way to learn ***MSMAM*** is to read only sections of the manual related to the topic of interest. For example, if you are designing a detention basin, read sections on computation of design storm, computation of peak discharge and reservoir routing.

He said it is important to build up a library of software, tools and resources recommended in ***MSMAM***.

According to him, there are some free software and resources recommended in ***MSMAM***. It is good to download these tools, install them, print out the manual and read them.

## Part D – How to solve problems in *MSMAM*?

According to Ir. Dr Quek, there are many new computational procedures in ***MSMAM*** and the best way to solve them is using spreadsheets or software.

He said there are many advantages of solving problems using a spreadsheet. For example, a spreadsheet can be programmed easily and modified later for different jobs.

Ir. Dr Quek showed the participants how to solve the following problems in ***MSMAM*** using a spreadsheet:

1. Computation of design storm
2. Computation of peak discharge
3. Reservoir routing
4. Design of detention basin
5. Design of sediment basin
6. Culvert design procedure
7. Hydrologic modelling
8. Hydraulic modelling

## Part E – Where to download free software and resources on *MSMAM* from the Internet?

Ir. Dr Quek said the Hydrologic Engineering Centre of the U. S. Army Corps of engineers has two free software recommended in ***MSMAM***. These are:

1. Hydrologic Model- ***HEC-HMS***
2. Hydraulic Model- ***HEC-RAS***

Also, the spreadsheets described in Part D can be downloaded for free at: http://www.msmam.com

He advised participants to visit the above websites and download the free software or spreadsheets. ■

**References:**

Drainage and Irrigation Department (2000). "*Urban Stormwater Management Manual for Malaysia.*" Ministry of Agriculture, Malaysia.

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**Shaiky's View**