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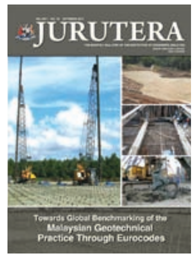

Photo courtesy of Geotechnical Engineering Technical Division

PROPOSED FUTURE THEMES

November 2011
Sustainable Energy *(Submission by September 1, 2011)*

December 2011
Agricultural and Food Engineering *(Submission by October 1, 2011)*

January 2012
Outreach of IEM and Branches *(Submission by November 1, 2011)*

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Milestone Changes of Design Philosophy in Geotechnical Engineering

by ***Ir. Liew Shaw Shong,***
Chairman, Geotechnical Engineering Technical Division

THE timely arrival of the new limit state geotechnical design code with the final draft of the Malaysia National Annex (MS EN 1997-1:2011 which is pending approval by SIRIM prior to publication by the Department of Standards Malaysia) is expected to end years of debate over the design philosophy of dealing with loading actions and resistances. After three decades, this final state of code harmonisation has been reached by the European Committee for Standardisation (CEN). Malaysia, being one of the Commonwealth countries which has traditionally referred to the British Standards and Codes of Practice in engineering design and construction, has also followed the same code migration as the British.

In the past, a simple global safety factor addressed both the uncertainties and material variations simultaneously when considering the necessary static equilibrium of the geotechnical structure, to ensure good performance during serviceability. Over the years, well documented experience from traditional working stress design practices have been established due to their simplicity and ease of comprehension by most geotechnical engineers.

By switching to limit state design utilising separate partial factors to account for uncertainty in actions/loadings and variability of material properties, geotechnical engineers now need to address these design aspects separately and, at the same time, maintain an economic design, if not improve it. For different geotechnical problems, three appropriate design approaches are allowed in EN 1997 Eurocode 7 – Geotechnical Design (EC7).

A transition period will be needed before the new design code can be used with confidence. During this period, geotechnical engineers will probably have no choice but to perform both the conventional working stress design and new limit state design to readjust their “feel” of the design outcomes and also to establish benchmarks for local ground conditions.

For students learning geotechnical design, more effort will be required to understand the basis of the different design approaches allowed in the new design code, and to address the uncertainty in the geotechnical actions/loadings, and ground variation with respect to the fixed partial factors adopted in the proposed Malaysia National Annex.

It is hoped that the cover story and relevant feature articles in this issue will offer a glimpse or insight into the new geotechnical design approach. To continue the momentum in familiarisation of the new geotechnical code by the engineering profession, the Geotechnical Engineering Technical Division will organise more road shows and courses to smoothen the transition in the implementation of the new code. ■

Development and Principles of Malaysia National Annex to Eurocode 7

by Ms. Suvarna Ooi

THE two British Standards traditionally used for the design of foundations (BS8004) and retaining structures (BS8002) have been withdrawn. Taking their place are the Eurocodes, the primary basis for designing buildings and civil engineering structures in Europe.

As such, Malaysian engineers, if they are to remain competitive globally, must move forward and begin to make the switch to the Eurocodes. To learn more, JURUTERA met up with Prof. Brian Simpson, Ir. Dr Ting Wen Hui and Ir. Yee Yew Weng for a glimpse into their experience with the Eurocodes, particularly Eurocode 7 (EC7) which is related to geotechnical engineering.

Prof. Simpson has been involved in the development of the Eurocodes since the early 1980s. The latter was finally published in 2004 and adopted for use in the United Kingdom ever since. He pointed out that, during the time of its development, there were numerous debates about the Eurocodes; some engineers were in favour of its introduction, while others were very much against it.

However, in the past few years since it has come into use, he has heard very little complaints about it. He said, "In fact, the response has been quite good since the Eurocodes was fully implemented, particularly for major projects by the larger engineering firms. Overall, the engineers are quite enthusiastic and have provided positive feedback about it."

According to Prof. Simpson, one of the very first projects that adopted the Eurocodes, particularly the EC7, was the Oresund Link project, a bridge-tunnel link between Denmark and Sweden. Since then, it has been adopted by many other major international projects including Crossrail, the underground railway system in the UK, which is currently in the design stage.

He said, "I have actually spoken to the Crossrail design team on the implications of the use of the EC7. One of the major issues that they had to deal with was designing for the water pressure beneath the underground station boxes. Not surprisingly, they found the EC7 quite helpful in tackling such a tricky situation."

Prof. Brian Simpson
Chairman of the BSI committee on geotechnical codes, B/526, which is responsible for the National Annex of Eurocode 7

Ir. Dr Ting Wen Hui
Chairman of the IEM Drafting Committee of Malaysia National Annex to Eurocode 7

Ir. Yee Yew Weng
Chairman of the IEM Working Group on Geotechnical Design

THE MALAYSIA NATIONAL ANNEX TO EC7

Prof. Simpson was also pleased to note that there are many similarities between the Malaysia National Annex and the UK National Annex, particularly in the way the piles are designed. At the same time, he also noted the immediate differences between the two, namely, the increase in the factor of safety for pile design and slope stability for Malaysia.

On the Malaysia National Annex, Ir. Dr Ting Wen Hui, explained that it enables the

(Continued on page 9)

WORKSHOP ON CASE HISTORIES OF DESIGN & CONSTRUCTION OF BORED PILES E053

Date & Time: 10 December 2011 (Saturday) 9.00a.m – 5.30p.m
Venue: Hotel Armada, Petaling Jaya, Arista Room, Level 3
Participants: Civil Engineers, Geotechnical Engineers, Structural Engineers, Building & Piling Contractors, Consultants, Project Managers, RE, Lecturers, Academics
Fee: A) Normal Price - RM 550/person B) Promotion Price - RM 450/person * for 2 or more people
Speaker: Ir. Neoh Cheng Aik KMN

SESSION 1
- Overview of pile foundation design.
- Practical bored pile foundation design with particular reference to boring, reinforcement cage and concreting. Scope of design verifications/analysis/calculations to meet EC 7 requirements.
- Scope of SI & ground characterization will be elaborated.
- Scope of inspection & recording for bored pile installation. Significance of these as part of QC?

SESSION 2
- Scope & methods of design validation to verify bored piles capacity & structural integrity.
- Works specification for bored pile installation. Standard Spec & typical addendum specifications.

SESSION 3
- Typical case histories to meet EC 7 requirements.
- Case Study 1
  Project briefs related to site conditions/site terrains, loadings and Client's requirements for a mixed commercial housing project consisting of three blocks of high-rise RC buildings including deep basement car park near a high slope.

SESSION 4
- Case Study 2
  As Case Study 1 but in limestone formation.
- Case Study 3
  Three maintained load test/PDA results for bored piles to evaluate.

WORKSHOP ON CASE HISTORIES OF BUILDING FOUNDATION FAILURES E054

Date & Time: 17 December 2011 (Saturday) 9.00a.m – 5.30p.m
Venue: Hotel Armada, Petaling Jaya, Arista Room, Level 3
Participants: Civil Engineers, Geotechnical Engineers, Structural Engineers, Building & Piling Contractors, Consultants, Project Managers, RE, Lecturers, Academics
Fee: A) Normal Price - RM 550/person B) Promotion Price - RM 450/person * for 2 or more people
Speaker: Ir. Neoh Cheng Aik KMN

SESSION 1
- Classification of types of building foundation failures.
- Building foundation failure investigation: scope, techniques & checklist.

SESSION 2
- Common design shortfalls & construction defects for building foundations.
- Common methods of remediation & technical basis/calculations.
- How ground vibration and ground movement can be generated to cause building foundation distress and failures? Mechanism? Assessments? Mitigations? Case histories?

SESSION 3
- Case Study 1
  Building foundation failure in filled ground.

SESSION 4
- Case Study 2
  Building foundation failure is about how some settling columns of buildings are remedied.
- Case History 3
  Presentation, illustration and discussion of 5 case histories of building foundation failures on soft ground.

DATE	CPD HOURS/POINTS	LIST OF COMING SEMINARS	SPEAKERS	PRICE
10 December 2011 (Saturday)	7	Workshop on Case Histories of Design & Construction of Bored Piles (E053)	Ir. Neoh Cheng Aik KMN BE (Hons), FIEM, FIHT, MICE MASCE, ASEAN Eng, P. Eng, C. Eng	Normal Price RM550/pax 2 or more RM450/pax
17 December 2011 (Saturday)	7	Workshop on Case Histories of Building Foundation Failures (E054)	Ir. Neoh Cheng Aik KMN BE (Hons), FIEM, FIHT, MICE MASCE, ASEAN Eng, P. Eng, C. Eng	Normal Price RM550/pax 2 or more RM450/pax

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Ir. Dr Ting Wen Hui: *Practicality of engineering skill and expertise are required both for the present method and in applying the Eurocode7*

country to set Nationally Determined Parameters, which have been left open in the main code (Eurocode 1997 Part 1 or EC7-1) for determination by national bodies. The parameters include certain design rules such as design approach, partial factors and model factors. It also allows each country to include non-conflicting complementary information (NCCI) as references to assist users in applying the code.

He said, "For example, to establish the values of partial factors and model factors in the Malaysia National Annex, calibration exercises were carried out by the drafting committee and reviewed. The values of these factors are set in such a way that a design applying EC7 essentially matches the values obtained in the present design procedure using the working stress method."

Ir. Dr Ting also pointed out that the Malaysia National Annex is continually open for public feedback. He said, "Improvements are always to be expected for any code or standard, thus IEM will be setting up the necessary mechanism to monitor the progress of the application of the Eurocodes and make appropriate amendments from time to time."

According to Ir. Yee, during the preparation of the Malaysia National Annex, it was found that hoards of data were available from different consultants and contractors. Unfortunately, most of these data had not been collated with sufficient substantiated records, hence could not be directly cited in the Malaysia National Annex.

He also pointed out that Malaysia has unique geotechnical concerns with slopes, peat, ex-mining land, etc. As such, he stated that research grants should be made available by the Government and directed to the right channels to further enhance understanding in these important areas.

He added that the current Malaysia National Annex, which only covers Part 1 of BS EN 1997, will be published in early 2012 with the completion of the final draft by the Technical Committee on Geotechnical Works, TC 17 (SIRIM) under the Chairmanship of Ir. Dr Mohd. Nor Omar. In addition, the publication of Part 2 of BS EN 1997 will only be determined next year.

Ir. Yee also pointed out that IEM is currently involved in drafting amendments to the Uniform Building By-Laws (UBBL), which include the usage of the Malaysia National Annex. Although the grace period for its adoption would depend on the lawmakers, from a practical point of view, the period should not be less than two years.

POTENTIAL CHALLENGES IN APPLYING THE EC7

Prof. Simpson pointed out that, in the UK, the majority of the engineers discovered that applying the EC7 in their work was not as challenging as some had made it out to be. He noted that young engineers in particular, adapted to the use of the code more easily compared to those who have been much longer associated with the practice of the code.

Ir. Dr Ting added, "Even in a design situation using the present working stress method, engineers need to evaluate and understand the design problem, and deal with the issues that arise, such as the relevant ground conditions, performance of the super and sub structure, and the foundation, risks assessment and mitigation of risks. As such, appropriate levels of engineering skill and expertise are required both for the present method and in applying the EC7."

At this point, Ir. Yee related his personal experience on the use of the code. He said, "I first used the EC7 when I was working in the UK more than 10 years ago. It took me some time to get used to the nomenclature. However, after the initial struggle, I found that the document actually guides the engineer to carry out their design in a clear and systematic way."

He added, "For example, graduate engineers tend to dive straight into running computer software and deriving solutions to problems from there. The EC7, on the other hand, reminds the practitioner to dedicate time to gather sufficient data from the site, study historical records, understand functionality requirements, derive the engineering parameters, etc. The document is practical in its application and is relevant to the industry."

To date, IEM has conducted several workshops for local engineers on the Malaysia National Annex to EC7 in major cities throughout the country. Prof. Simpson observed that, although the engineers were keen to learn, many of those who attended were not geotechnical engineers and hence, were not very advanced in their knowledge of soil mechanics and geotechnics.

He said, "We do not, strictly speaking, require the local engineers to have very advanced knowledge in these areas. However, it would certainly help in their understanding of the Eurocodes. It is important for them to realise that those who are going to design the ground needs to understand the ground."

TEACHING OF THE EUROCODES

According to Ir. Dr Ting, the Eurocodes have not only become globally accepted, a number of countries outside Europe are also currently adopting the Eurocodes (with appropriate adaptations) as their national standards. As such, if Malaysia wants to penetrate the global market, its engineers need to be knowledgeable and competent in using the Eurocodes.

Prof. Simpson stated that there is currently an ongoing debate on the teaching of the codes of practice as some universities believe that they should focus solely on teaching soil mechanics and ensure a proper understanding of the ground, instead of providing training on the design procedures of the codes of practice.

He said, "Although I sympathise with both views, I feel that the most important thing is for engineers to understand the basic mechanics, particularly soil mechanics and the behaviour of soil materials. The latter is clearly much more important than knowing the details of a particular code of practice."

Ir. Dr Ting Wen Hui: *Competency in using Eurocodes, enables our engineer to embrace global market*

Ir. Yee, on the other hand, felt that it is essential for local universities to teach design using the EC7. He said, "The educationists should become an expert with its usage. The EC7 encompasses more than just the systematic and proper design approaches. It was also written to help enhance trade between different nations in Europe, and to allow them to speak the same technical language."

Either way, Prof. Simpson advised local engineers to attend trainings on the Eurocodes and to read up on the subject to smoothen the adoption process of the codes of practice in their work. During the workshops that were mentioned earlier, he also recommended several publications, including two new publications, namely, "Concise Eurocodes: Geotechnical Design" and "Decoding Eurocode 7".

He said, "The most important thing, however, is for Malaysian engineers to move forward and start applying the codes of practice in their work. Although they may take a bit of time to get used to it, they should not become easily discouraged. In fact, I have noticed that once people understand it properly and use it regularly, they generally become quite enthusiastic about it."

Personally, he was very pleased to note that Malaysian engineers have put in a lot of work in the Malaysia National Annex to EC7. He said, "Overall, I believe Malaysian engineers will find the EC7 very helpful, particularly in allowing them to design the structures in a coordinated and consistent manner."

Finally, he would like to welcome comments and criticisms from Malaysian engineers who have used the Eurocodes. He said, "The Eurocodes will be a developing document, as such, we will take note of the comments we receive from around the world." ■

Note: IEM wishes to thank Prof. Brian Simpson, Ir. Dr Ting Wen Hui and Ir. Yee Yew Weng for sharing their views and highlighting the issues involved in the switch to Eurocode 7.

Issues Raised by the Application of Eurocode 7 to the Design of Reinforced Soil Structures

by Mr. Micheal Dobie

MALAYSIA is adopting Eurocode 7 (EN 1997-1:2004) as its national standard for geotechnical design, referred to here as EC7. Currently, EC7 does not cover the detailed design of reinforced fill structures and the values of the partial factors given in EN 1997-1 have not been calibrated for reinforced fill structures. EN 14475:2006 provides guidance on the execution of reinforced fill structures; a future European Standard will cover their design. However, there are various aspects of reinforced soil design which may be addressed by the current issue of EC7. Analysis of the external stability of reinforced soil structures is examined by modelling the reinforced fill block as a gravity retaining wall (e.g. sliding, bearing capacity and overturning). In addition, stability analysis is used to check overall stability. Furthermore, a number of National Annexes have been published which do provide requirements for reinforced soil design. One such example is Germany.

The purpose of this paper is to examine a number of issues which will arise when the current EC7 recommendations are applied to gravity retaining wall design and stability analysis, in particular, in circumstances which are likely to arise in reinforced soil design. The points raised here were previously made in a presentation during the 2011 AGM of the Geotechnical Engineering Technical Division of IEM on 11 June 2011, and have also been provided in greater detail as comments on the Draft Malaysian National Annex to MS EN 1997-1:2011. The important observation in relation to these comments is that the National Annex should be used to clarify or provide guidance to designers using the EC7 in Malaysia, especially where ambiguity or lack of experience in applying EC7 requirements exists.

CONSIDERATION OF PARTIAL LOAD FACTORS IN GRAVITY RETAINING WALL DESIGN

EC7 defines load factors as follows for permanent actions and transient actions (live loads):

ACTION		SYMBOL	SET	
			A1	A2
Permanent	Unfavourable Favourable	γ_G $\gamma_{G,\,fav}$	1.35 1.0	1.0 1.0
Transient	Unfavourable Favourable	γ_Q $\gamma_{Q,\,fav}$	1.5 0	1.3 0

For Set A1, unfavourable actions are increased, whereas favourable actions are factored by 1.0 for permanent actions and 0 for transient actions (live loads). In reality, the factors and their values appear to have slightly different functions, certainly so when applied to either gravity retaining wall analysis or stability analysis:

- For permanent actions, both the weight density and dimensions are likely to be reasonably well known, so presumably the aim of applying 1.35 to unfavourable permanent actions is to ensure a certain margin of safety, likewise favourable actions are taken at face value for the same reason.
- For transient actions (live loads), the higher partial factor for unfavourable loads would appear to reflect a greater uncertainty, which is the nature of live loads, while at the same time, providing some margin of safety. However, the value of 0 for favourable live loads is being used to model the fact that when they are favourable, the safest assumption is that they are absent.

However, it is possible that, for an unfavourable situation, although live load is present, a component of the live load is actually favourable. This gives rise to a situation where applying $\gamma_{Q,fav} = 0$ might not be logical. One obvious case is the sliding stability of a gravity retaining wall as shown in Figure 1. In terms of BS 8006-1:2010 nomenclature, this situation is examined using Load Case B where downward actions are taken as favourable, but lateral actions are unfavourable. Considering only the live loads, it is clear that the live load (LL2) must be present behind the wall to generate unfavourable lateral thrust on the wall. Therefore, $\gamma_Q = 1.5$ is applied to the horizontal component of the earth pressure action, P_{aqh}. However, there is also a vertical component (P_{aqv}) and for the worst case senario, $\gamma_{Q,fav} = 1.0$ should be used. It is not logical to apply $\gamma_{Q,fav} = 0$.

However, for the live load on top of the retaining wall (LL1), clearly the critical case is that the live load is absent, so $\gamma_{Q,fav} = 0$ is applied. Therefore, the use of $\gamma_{Q,fav} = 0$ is not so much due to uncertainty, but to establish an absolute case that the live load is not present. Therefore, there needs to be a second definition of $\gamma_{Q,fav} = 1.0$ for situations where the live load must be present, but its action is favourable.

It should be noted in the example given here that the application of the single-source principle would result in P_{aqv} being factored by $\gamma_Q = 1.5$, so that the issue would not arise. However, this approach results in increasing an action which is favourable (i.e. helping to prevent sliding), which does not seem to be logical.

Load factors applied to transient actions - Load case B

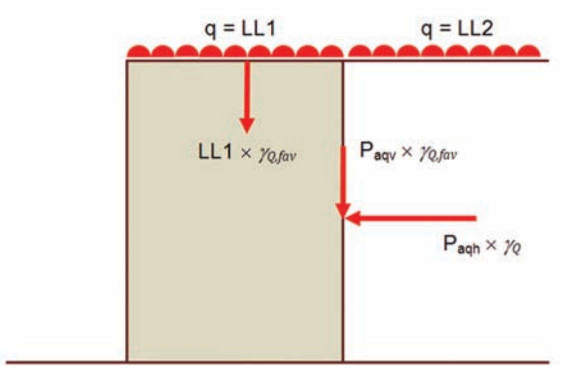

Figure 1: Forces used to analyse sliding

INVESTIGATION OF COEFFICIENT OF ACTIVE EARTH PRESSURE

EC7 provides a method of calculating earth pressure in Annex C (Informative). Section C2 includes a numerical method based on slipline fields, and according to Item (1), it includes certain approximations on the safe side, and may be used in all cases. The conventional method of calculating K_a for complex geometry is to use the Coulomb equation, in this case, giving the horizontal component K_{ah}:

$$K_{ah} = \frac{\cos^2(\phi' + \alpha)}{\cos^2\alpha\left[1 + \sqrt{\dfrac{\sin(\phi' + \delta)\sin(\phi' - \beta)}{\cos(\alpha - \delta)\cos(\alpha + \beta)}}\right]^2}$$

where

ϕ' = angle of shearing resistance of fill
δ = wall friction angle
α = angle of wall back measured against vertical (positive leaning towards the fill)
β = upper slope angle measured against horizontal (positive sloping upwards)

It should be noted that this only applies to the effect of the soil mass retained by the wall. For superimposed uniform surcharge, K_{ah} as given above should be multiplied by the following expression. It can be seen that this expression will be 1.0 unless both α and β are > 0 at the same time (i.e. there is both a sloping surface behind the wall, and the back of the wall is inclined):

$$\frac{\cos\alpha \times \cos\beta}{\cos(\alpha + \beta)}$$

The Coulomb equation is the analytical solution derived by finding the maximum lateral thrust from the backfill based on a simple wedge analysis (i.e. simple linear failure surface). The same value of K_a is found by examining a large number of wedges graphically until the wedge giving the maximum lateral thrust is found (sometimes known as the Culmann method or Coulomb sweeping wedge method).

In the case of reinforced soil design, it is common for the back of the wall to be inclined backwards, and also for the retained backfill to have an upward inclined surface as shown in Figure 2. Normally, the active earth pressure coefficient in this case would be calculated using the Coulomb approach. In order to examine the suggested EC7 slipline method versus Coulomb, a series of calculations have been carried out to compare the values of K_a given by the two methods.

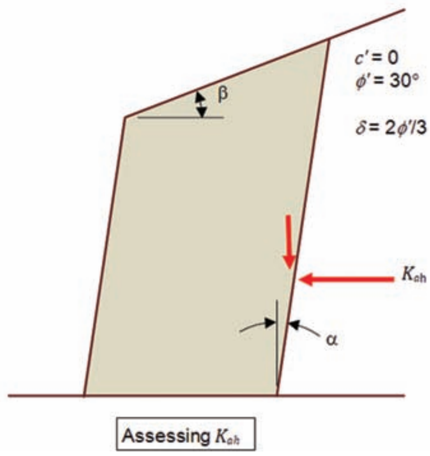

Figure 2: Definition of angles for gravity retaining wall

The results of the comparison are shown on two graphs in Figure 3, one for the lateral thrust due to the soil mass, and the other for the surcharge (UDL). The y-axis value in each graph is the ratio of K_{ah} (calculated according to Coulomb) to K_{ah} (calculated according to the EC7), and the x-axis is the wall inclination (positive is leaning backwards towards the fill as shown in Figure 2). The calculations have been carried out for three different backfill angles, and are based on ϕ' = 30° and δ = 2ϕ'/3. These values are fairly typical for the design of gravity retaining walls. Some observations based on this analysis:

- For Rankine conditions ($\delta = \alpha = \beta = 0$), all methods (both for soil mass and UDL) give the same result. (not shown in Figure 3)
- For a vertical wall, provided that $\delta = \beta$, all methods (both for soil mass and UDL) give the same result.
- Beyond these simple cases, the graphs in Figure 3 give some idea of the sensitivity of the calculation. In general, if the K_a ratio > 1.0 on the graph, then Coulomb gives a higher K_a, thus is more critical.
- Based on the examination of the graph for the K_a ratio for soil mass, once the wall leans backwards towards the fill, then Coulomb is more critical, except for cases with level back and steep wall angle.

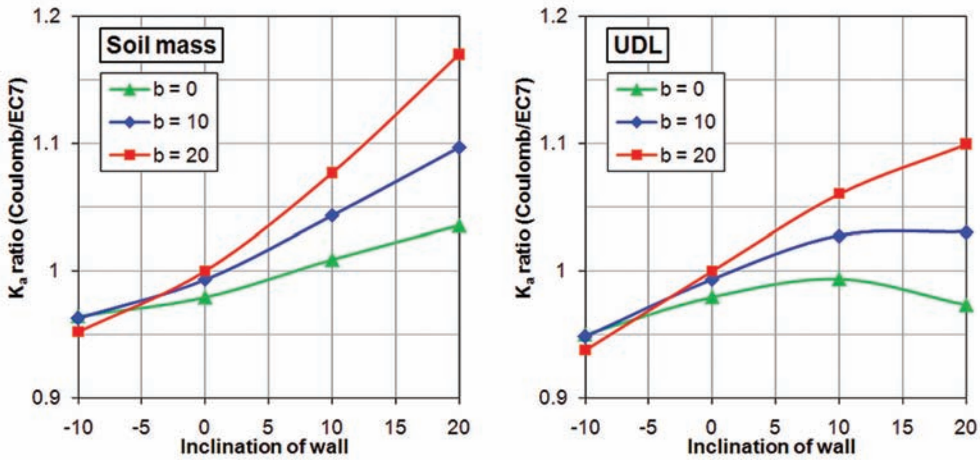

Figure 3: Comparing K_a using the method given in the EC7 with Coulomb

- In the case of UDL, for level backfill, the EC7 method is always more critical. However, for walls that lean backwards and have even gentle upward inclination of the backfill surface, then Coulomb is more critical.
- In most gravity retaining wall analyses, lateral force due to the soil mass is generally considerably higher than lateral force due to surcharge.
- The contents of items (13) and (14) of the EC7, Annex C should be noted as follows:

(13) Both for passive and active pressures, the procedure assumes the angle of convexity to be positive ($v \geq 0$).

(14) If this condition is not (even approximately) fulfilled, e.g. for a smooth wall and a sufficiently sloping soil surface when β and ϕ' have opposite signs, it may be necessary to consider using other methods. This may also be the case when irregular surface loads are considered.

INVESTIGATION OF BEARING RESISTANCE CALCULATION FOR GRAVITY RETAINING WALLS

EC7 provides a method of calculating bearing resistance in Annex D (Informative). The method is similar to the traditional Terzaghi solution, taking into account the eccentricity and inclination of the load applied to the foundation. For the case of frictional soil with c' = 0 and zero burial depth, the bearing resistance (P_v) is given by:

$$P_v = 0.5\gamma N_\gamma X_\gamma L^2_{eff}$$

where,
γ = weight density of foundation soil
N_γ = bearing capacity factor
X_γ = inclination factor
L_{eff} = effective foundation width

The effective width is defined using the Meyerhof approach. Both effective width and the inclination factor are calculated by taking into account the actions applied to the foundation. These actions consist of:

- vertical actions due to the mass of the wall and any superimposed surcharges PLUS the vertical components of earth pressure actions applied to the back of the wall,
- horizontal actions due to the retained backfill soil and any surcharges applied above the backfill.

It should be noted that the value of P_v is particularly sensitive to the value of L_{eff}, because this parameter is raised to the power of 2. In carrying out this calculation, the designer is faced with a number of choices:

- should the actions used to calculate eccentricity and inclination factor be characteristic (unfactored) or design (factored) values,
- in the case of the vertical components of the earth pressure actions on the back of the wall, should these be based on single-source principles or worst-case principles,
- using the terminology in BS 8006-1:2010, gravity retaining wall design is normally considered under two load cases for ULS: Load Case A in which all actions are considered unfavourable (i.e. both vertical and horizontal actions) which is normally the critical case for bearing resistance; and Load Case B in which downward vertical actions are considered as favourable which is normally the critical case for checking sliding on the base.

The reason for the third choice is that, in cases where horizontal actions are relatively large, Load Case B may be critical for bearing. It is, therefore, normal to carry out such bearing resistance calculations for both load cases, and take the worst case as critical.

To examine the effects of these choices on the bearing resistance calculation for a typical gravity retaining wall, two cases have been examined as shown in Figure 4 (being a common geometry for a gravity retaining wall). The main difference is the surface of the backfill: in one case, it is horizontal with a 12kPa surcharge, and in the other, it is

(Continued on page 16)

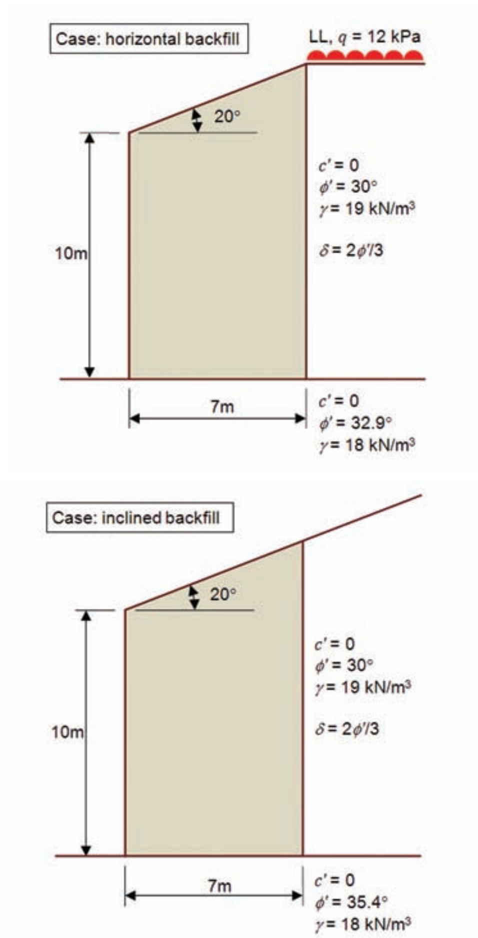

Figure 4: Design cases used to examine bearing resistance calculation according to the EC7

Load case for horizontal backfill with 12 kPa surcharge		Load Case A		Load Case B	
Actions for calculating eccentricity and inclination factor		Unfactored	Factored	Unfactored	Factored
EC7 for Germany (unfactored, worst case)		0.943		0.691	
DA1 Combination 1	SS WC	0.673 0.673	0.687 0.687	0.516 0.494	0.940 1.160
DA1 Combination 2	SS WC	1.218 1.218	2.208 2.208	1.218 1.203	2.208 2.332
DA2	SS WC	0.943 0.943	0.962 0.962	0.723 0.691	1.316 1.624
DA3	SS WC	1.218 1.218	2.208 2.208	1.218 1.203	2.208 2.332

Load case for inclined backfill without surcharge		Load Case A		Load Case B	
Actions for calculating eccentricity and inclination factor		Unfactored	Factored	Unfactored	Factored
EC7 for Germany (unfactored, worst case)		0.939		0.695	
DA1 Combination 1	SS WC	0.670 0.670	0.670 0.670	0.518 0.497	1.077 1.374
DA1 Combination 2 (*)	SS WC	1.287 1.287	3.351 3.351	1.287 1.287	3.351 3.351
DA2	SS WC	0.939 0.939	0.939 0.939	0.725 0.695	1.508 1.923
DA3 (*)	SS WC	1.287 1.287	3.351 3.351	1.287 1.287	3.351 3.351

inclined. All other parameters and dimensions are the same in both cases, except that the ϕ' value of the foundation soil has been adjusted to give FS = 2.0 on bearing according to a conventional "lumped safety factor" design method (giving 32.9° and 35.4° respectively for the two cases).

For both cases, the bearing resistance following the EC7 approach has been assessed and is reported in the following tables in terms of the "degree of utilisation" denoted by Λ_{GEO} and defined as:

$$\Lambda_{GEO} = \frac{E_d}{R_d}$$

where E_d = design actions or effects of actions
R_d = design resistance
$\Lambda_{GEO} \leq$ 1.0 for a satisfactory design

Λ_{GEO} is given in the tables below for DA1 (Combinations 1 and 2), DA2 and DA3. In addition, the EC7 requirements for Germany are included. These are well established, and the National Annex and related standards have defined the use of "worst-case" earth pressure and unfactored loads to calculate eccentricity and inclination factors.

From the examination of these values, it should be noted that:

- SS denotes single-source and WC denotes worst-case principles regarding actions from earth pressure applied to the back of the wall.
- For Load Case A, SS and WC give the same results, because all actions are regarded as unfavourable.
- For Load Case B, WC gives higher Λ_{GEO} for the factored cases, but lower for the unfactored cases. However, the effect is not major, and would result in only a small change in dimensions to give the same result.
- For DA1 Combination 2 and DA3, Load Case A and Load Case B give the same results because all load factors are set to 1.0, except when a live load is present.
- For the DA1 approach, where the more critical result is used for the final design, it is clear that this is provided by Combination 2 for all cases, and by a considerable amount. Combination 2 uses material factors only (plus load factor on live load), and this can be considered as a relatively new approach for gravity retaining wall design compared to load factor or lumped safety factor approaches.

(Continued on page 18)

- In comparing DA1 Combination 1 with DA2 (the two "load factor" design approaches), the difference between any two equivalent cases is a factor of 1.4, because DA2 applies γ_{Rv} = 1.4 to bearing resistance, whereas DA1 Combination 1 applies γ_{Rv} = 1.0.
- By far the most important decision is whether or not to use factored or unfactored actions in calculating eccentricity and inclination factors. If factored actions are used, then Load Case B is likely to be critical.
- In order to achieve $\Lambda_{GEO} \leq 1.0$ for the unfactored cases in DA1 Combination 2 and DA3 (*), it is necessary to increase the foundation width to 7.58m (from 7m), an increase of only 8%.
- However, in order to achieve $\Lambda_{GEO} \leq 1.0$ for the factored cases in DA1 Combination 2 and DA3 (*), it is necessary to increase the foundation width to 9.65m (from 7m), an increase of 38%.

EXAMINATION OF STABILITY ANALYSIS ACCORDING TO EC7 USING BISHOP'S ROUTINE METHOD

The purpose of this section is to outline the adjustments which must be made when using stability analysis following the requirements of EC7. This is done by using Bishop's routine (aka simplified) method of slices based on a circular failure surface. In particular, part of the aim of this section is to explain some of the statements made in Section 7.3.3 of BS 6031:2009. These commentaries are extremely helpful, and give an authoritative outline of the important aspects of carrying out stability analysis to EC7 requirements. Relevant sections from Section 7.3.3 of BS 6031:2009 are repeated in italics.

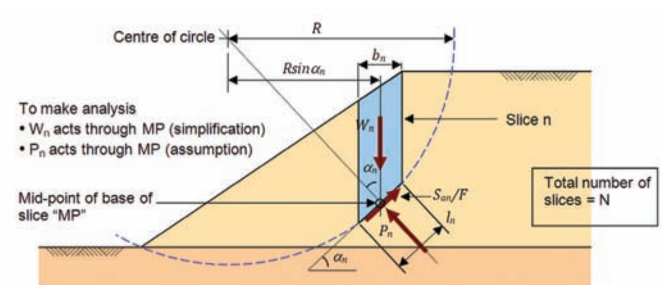

Figure 5: The method of slices based on a circular arc

The formulation of Bishop's routine method of slices is well known, and will not be repeated here. The method is based on taking moments as shown in Figure 5. However, the factor of safety is introduced by applying "F" to soil strength. This is an important point and immediately gives a point of difference in relation to EC7.

The normal situation and required assumptions/simplifications for the method of slices based on a circular arc are as shown in Figure 5. The well known equation derived by the Bishop's routine method is as follows:

$$F = \frac{R\sum \left[c'b_n + (W_n + Q_n - ub_n)\tan\phi'\right]\left[\dfrac{\sec\alpha_n}{1 + \dfrac{\tan\phi'\tan\alpha_n}{F}}\right]}{R\sum (W_n + Q_n)\sin\alpha_n}$$

Because the formulation of this equation is based on moments, the "R" term has been retained. It should be noted that:

- "F" appears on both sides of the equation, so that iteration is required to find a solution. This is an inevitable result of applying "F" to soil strength in the formulation of the equation.
- The denominator on the RHS is effectively the disturbing moment due to the weight of the slices, but it should be noted that part of this moment is actually stabilising (the slices to the left of the lowest point of the failure circle as shown).
- However, due to the way Bishop's routine method is formulated, this does not matter, and the equation will appear as shown even if the stabilising moment is initially added to the moment of the shear resistance.
- The Q_n term has been included to represent live load applied to the mid-point of the top surface of each slice.
- Pore-water pressure is included as the actual pressure (u) instead of using the pore-pressure ratio.

According to EC7, the basic equation defining the GEO limit state is:

$$\Lambda_{GEO} = \frac{E_d}{R_d} = \frac{\text{design (factored) effect of actions}}{\text{design (factored) resistance}} = \frac{1}{F} \leq 1.0$$

Bishop's routine method may be formulated following this approach, and the resulting equation will appear as follows (retaining the same structure of the equation, with disturbing moments in the denominator, so that the results is given in terms of $1/\Lambda_{GEO}$:

$$F = \frac{1}{\Lambda_{GEO}} = \frac{R\dfrac{1}{\gamma_{Re}}\sum\left[\dfrac{c'}{\gamma_{c'}}b_n + (\gamma_{G,fav}W_n + \gamma_{Q,fav}Q_n - ub_n)\dfrac{\tan\phi'}{\gamma_{\phi'}}\right]\dfrac{\sec\alpha_n}{\left[1 + \dfrac{\tan\phi'\tan\alpha_n}{\gamma_{\phi'}}\right]} - R\sum(\gamma_{G,fav}W_n + \gamma_{Q,fav}Q_n)\sin\alpha_n}{R\sum(\gamma_G W_n + \gamma_Q Q_n)\sin\alpha_n}$$

It should be noted that:

- "F" no longer appears on the RHS of the equation, because the factor on soil strength is fixed as $\gamma_{\phi'}$.
- The moments from slices which resist failure are included in the numerator, and the reason for the sign being negative is that the α value for these slices is also negative.
- All partial factors are included with favourable and unfavourable load factors being applied as appropriate for the worst-case.

The difficulty in using the equation in this form is that existing software packages would need significant rewriting. Also see comment from BS 6031:2009:

In addition the treatment of actions due to gravity loads and water is difficult since these loads might be unfavourable in *part of the sliding mass but favourable in another part. In a traditional analysis of a circular failure surface, part of the slope mass is producing a positive driving moment (i.e. it is unfavourable) and part of the slope mass is producing a negative driving moment (i.e. it is favourable) and the moments produced by the two parts depend on the position of the point about which moment equilibrium is checked. The application of different partial factors to each part of the slope introduces scope for confusion and requires a degree of complexity of analysis that is not readily available and not justified given the nature of the problem.*

In order to avoid these issues, the favourable (resisting) moment due to soil mass is considered as "negative disturbing moment", so it is added to the denominator, and to minimise complication, a single load factor definition is applied, i.e. unfavourable. This results in the equation appearing as follows, which is pretty much the same as the original equation:

$$F = \frac{1}{\Lambda_{GEO}} = \frac{R\frac{1}{\gamma_{Re}}\sum\left[\frac{c'}{\gamma_{c'}}b_n + (\gamma_{G,fav}W_n + \gamma_{Q,fav}Q_n - ub_n)\frac{\tan\phi'}{\gamma_{\phi'}}\right]\frac{\sec\alpha_n}{[1+\tan\phi'\tan\alpha_n]}}{\gamma_{Re}R\sum(\gamma_G W_n + \gamma_Q Q_n)\sin\alpha_n}$$

ADJUSTMENTS REQUIRED FOR "LOAD FACTOR" METHODS (DA1-1 AND DA2)

For these methods, all material partial factors are set to 1.0. If in addition both $\gamma_{G,fav}$ and $\gamma_{Q,fav}$ are taken as 1.0 ($\gamma_{Q,fav}$ should be taken as 1.0 if it is present but favourable - see the first section of this paper), then after some adjustment the equation reduces to:

$$F = \frac{1}{\Lambda_{GEO}} = \frac{R\sum[c'b_n + (W_n + Q_n - ub_n)\tan\phi']\frac{\sec\alpha_n}{[1+\tan\phi'\tan\alpha_n]}}{\gamma_{Re}\gamma_G R\sum(W_n + \frac{\gamma_Q}{\gamma_G}Q_n)\sin\alpha_n}$$

This method is the "approximate" method given by Frank et al, see comments from BS 6031:2009:

If the single-source principle is not applied, then a special procedure has to be followed, if using commercially available software, in order to apply different factors to stabilising and destabilising actions. Frank et al [5] describe one such procedure, but by ignoring the single-source principle, Combination 1 becomes more critical than Combination 2 in most design situations using an effective stress analysis and results in an equivalent global factor of safety of about 1.35.

In order to use this method, the procedure would be:

- Adjust the live loads by a factor γ_Q/γ_G although this will also affect the numerator, so there is a slight error.
- Carry out a "normal" stability analysis using Bishop's routine method, and find "F".
- Then $\Lambda_{GEO} = \gamma_{Re}\gamma_G / F$

The alternative is to use the single-source principle and apply unfavourable load factors to all forces. In this case, the equation becomes:

$$F = \frac{1}{\Lambda_{GEO}} = \frac{R\sum[c'b_n + (\gamma_G W_n + \gamma_G Q_n - ub_n)\tan\phi']\frac{\sec\alpha_n}{[1+\tan\phi'\tan\alpha_n]}}{\gamma_{Re}R\sum(\gamma_G W_n + \frac{\gamma_Q}{\gamma_G}Q_n)\sin\alpha_n}$$

With reference to the commentary in BS 6031:2009, the above equation follows this comment:

For this reason, a note to 2.4.2 of BS EN 1997-1:2004 states "Unfavourable (or destabilising) and favourable (or stabilising) permanent actions may in some situations be considered as coming from a single source. If they are considered so, a single partial factor may be applied to the sum of these actions or the sum of their effects." This note, commonly referred to as the "single-source principle", allows the same partial factor to be applied to the stabilising and destabilising actions. When using Combination 1, it is recommended that the partial factor for the unfavourable action of the soil is applied to the weight density of the soil.

The problem with this approach is that the margin against failure relies almost entirely on the resistance factor γ_{Re}. To see this clearly, the equation can be set for the simple case of a dry slope with c' = 0:

$$F = \frac{1}{\Lambda_{GEO}} = \frac{R\gamma_G\sum[W_n\tan\phi']\frac{\sec\alpha_n}{[1+\tan\phi'\tan\alpha_n]}}{\gamma_{Re}\gamma_G R\sum W_n\sin\alpha_n}$$

In this case, the γ_G values cancel out, so that only γ_{Re} remains. For DA1 Combination 1, γ_{Re} = 1.0, thus there is no margin against failure. For this reason, the commentary in BS 6031:2009 states:

In an effective stress analysis, the effect of the partial factor is to increase the destabilising action and to increase simultaneously the shearing resistance of the soil, which cancels the effect of the partial factor.

and

In both cases, Combination 1 tends to be less critical than Combination 2 in almost all design situations. (Exceptions might occur when extremely large variable actions apply or the soil strength is extremely low).

ADJUSTMENTS REQUIRED FOR "MATERIAL FACTOR" METHODS (DA1-2 AND DA3)

For these methods, all partial load factors and resistance factors are set to 1.0. The stability equation then becomes:

$$F = \frac{1}{\Lambda_{GEO}} = \frac{R\sum\left[\frac{c'}{\gamma_{c'}}b_n + (W_n + \gamma_Q Q_n - ub_n)\frac{\tan\phi'}{\gamma_{\phi'}}\right]\frac{\sec\alpha_n}{\left[1+\frac{\tan\phi'\tan\alpha_n}{\gamma_{\phi'}}\right]}}{R\sum(W_n + \gamma_Q Q_n)\sin\alpha_n}$$

This has the benefit of being completely unambiguous, and because actions and water pressure are all unfactored, effective stress is preserved correctly in determining soil shear resistance.

In order to use this method, the procedure would be:

- Adjust the material properties by the material factors $\gamma_{\phi'}$ and $\gamma_{c'}$.
- Carry out a "normal" stability analysis using Bishop's routine method, and find F.
- Then $\Lambda_{GEO} = \gamma_{Re}\ \gamma_G / F = 1/F$

SUMMARY OF COMMENTS

In using DA1, the requirement is that both Combination 1 and Combination 2 are checked and the most critical result is used to determine the design. Based on the comments above and the extract from BS 6031:2009, there are two main options for Combination 1:

- Use the Frank et al approximation, so that Combination 1 is likely to be critical with an equivalent traditional lumped F≈1.35.
- Use the single-source principle for Combination 1, so that Combination 2 is likely to be critical with an equivalent traditional lumped F≈1.25.

There is one final comment to make, namely, that most of the approximations and adjustments as described to permit the easy use of the Bishop's routine method of slices as formulated in existing software are acceptable as long as the target "F" = 1.0 when the analysis is performed. This is the case for DA1 Combination 2. However, for DA1 Combination 1 and DA2, if the Frank et al approach is used, then the target will be >1.0, so this also leads to some uncertainly in using the load factor methods.

The comments given in the first section of this paper concerning $\gamma_{Q,fav}$ apply equally well in stability analysis. In general, live loads are only applied to the tops of slices when $\alpha > \phi'$ for dry slopes.

CONCLUSION

The publication of the Malaysian National Annex to EC7 gives the authorities an opportunity to provide clarification and reduce ambiguity. Without such a clarification, there could be major differences in the methods used by engineers to carry out geotechnical design with subsequent differences in the resulting structures, in particular:

- Consideration should be given to establishing an additional definition of $\gamma_{Q,fav}$ = 1.0 for situations where the live load must be present, but its action is favourable
- The method of calculating active earth pressure given in Annex C.2 underestimates earth pressure in cases where a retaining wall leans backwards and the surface of the retained fill slopes upwards. This geometry is common for reinforced soil structures, and it is recommended that this point should be made and advice given in the National Annex.
- Bearing resistance for gravity retaining walls has a special problem inasmuch as the applied lateral load is of a significant proportion compared to the applied downward vertical load. The main issue that arises is: should the calculation of the foundation effective width and the inclination factor be based on factored or unfactored loads? There are supplementary issues related to the use of single-source or worst-case principles, as well as the use of Load Case A and Load Case B. In particular, there may be major issues using DA1 Combination 2 with factored loads. There is wide support for using factored loads, however, some countries in the EU are adopting a special DA2* (or presumably DA1 C1*) where unfactored loads are used. It is strongly recommended that the National Annex should give advice on this, and that extensive sensitivity calculations be carried out beforehand. If factored loads are recommended, then this is likely to result in the base width of gravity retaining walls becoming considerably wider than that provided by "conventional" design. It is strongly urged by the author that unfactored loads be used. The main logic is that resistance is resistance, so if factored loads are used to calculate a component of resistance, and load factors are used again in the final verification, then the load factors have effectively been applied twice.
- It is recommended that stability analysis requires a special section giving general advice and clarification on how to apply the EC7. The draft National Annex includes reference to BS 6031:2009. The 2009 version includes extensive reference to applying EC7 principles to stability analysis, and in particular, Section 7.3.3 is helpful. It is important that the National Annex states whether Combination 1 should follow the single-source principle (making it irrelevant in most cases) or the Frank *et. al.* approach (possibly making it critical). ■

Note:
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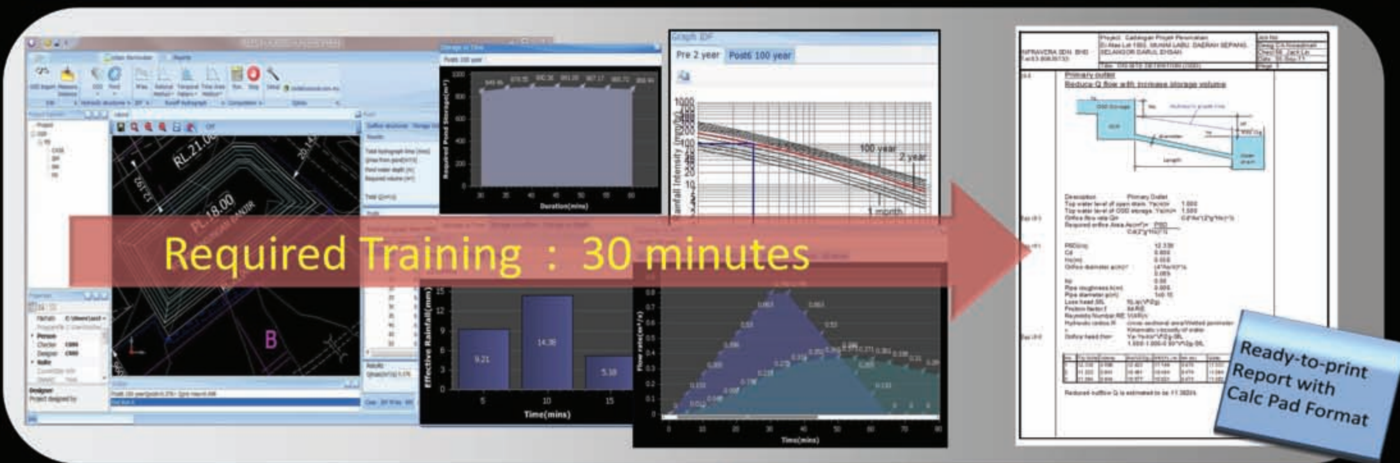

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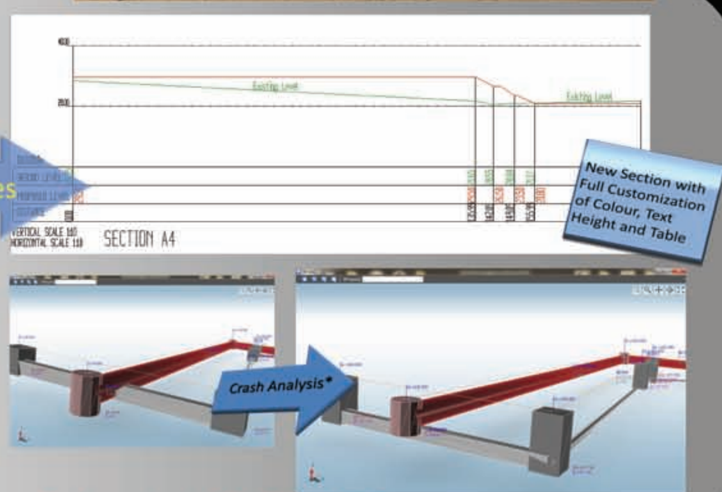

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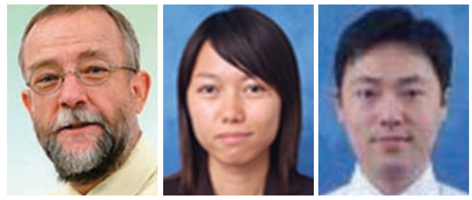
An Approach for Seismic Design in Malaysia following the Principles of Eurocode 8



by Dr J. W. Pappin, Ms. P. H. I. Yim and Mr. C. H. R. Koo

1. INTRODUCTION

Eurocode 8 is a useful document providing systematic guidance for the seismic design of buildings and other structures. It is difficult to apply to countries outside of Europe however as it appears to have a very limited definition of the seismic hazard that is basically expressed in terms of the peak ground acceleration having a 10% probability of being exceeded in the next 50 years (equivalent to a return period of 475 years). It does incorporate spectral shapes that are anchored to this peak ground acceleration, however, and this enables earthquake ground motion response spectra thresholds, that define when seismic ground motion needs to be considered and whether ductile detailing of superstructures is necessary, to be estimated. Response spectra are very helpful as they give a direct indication of the distortion that a structure is ilkely to experience during the design seismic ground motion provided that the fundamental period of the structure is known.

The study reported in this paper includes a preliminary probabilistic seismic hazard assessment for Malaysia including Peninsular Malaysia, Sarawak and Sabah. This assessment is based on the USGS database for earthquakes in the past 40 years, combined with recently developed attenuation relationships by the Nanyang Technological University (NTU). Design response spectra having a 10% probability of being exceeded in the next 50 years applicable to bedrock sites were developed for several locations in Malaysia. It is shown that these vary considerably both in terms of magnitude and in terms of spectral shape. These spectra are compared with the Eurocode 8 design thresholds and recommendations for seismic design in Malaysia are made.

2. EUROCODE 8 DESIGN CRITERIA

Eurocode 8 states that earthquakes can be ignored if the bedrock peak ground acceleration having a 10% probability of being exceeded in the next 50 years is less than 4%g ($0.39m/s^2$). For higher seismic ground motions, it also states that simplified design rules that avoid the use of ductile detailing can be used if the bedrock peak ground acceleration having a 10% probability of being exceeded in the next 50 years is less than 8%g ($0.78m/s^2$). For larger seismic ground motions, the full provisions of Eurocode 8 including ductile detailing requirements are recommended.

Unfortunately, peak ground acceleration is not sufficient to define seismic ground motion as it does not take into account the frequency content of the motion. It is well established that the building's response is dependent on the frequency content and it is conventional practice to define seismic ground motion in terms of response spectra which define the peak elastic response of structures as a function of their modal periods (Housner, 1959). For buildings up to about 10 storeys, their fundamental period, which is equal to about the number of storeys divided by 10, is sufficient to define their seismic response. For higher buildings, full elastic dynamic analyses are required as their higher mode responses often become significant.

Eurocode 8 does include standard response spectral shapes and these can be used together with the threshold peak ground accelerations as discussed previously to define threshold seismic design criteria in terms of bedrock response spectra. Figure 1 shows these criteria when seismic design needs to be considered and ductile detailing is recommended. It should be noted that very similar bedrock outcrop response spectral criteria can be determined from the United States Building Code (ASCE 7, 2010) for deep soil sites having SPT N values between about 15 and 50 blows per 300mm.

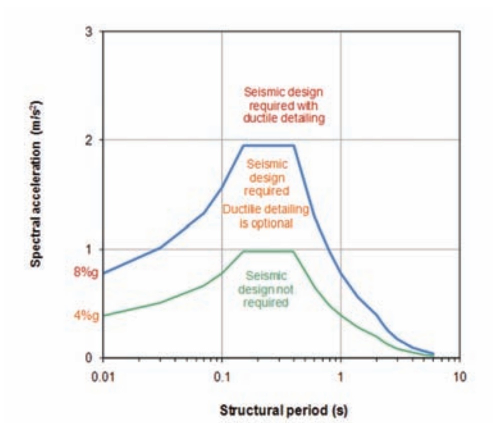


Figure 1: Eurocode 8 seismic design criteria expressed as bedrock spectra

3. SEISMIC HAZARD ASSESSMENT

3.1 Seismic hazard assessment methodology

The probabilistic seismic hazard assessment methodology, e.g. Cornell (1968), McGuire (1993), has been applied using Oasys SISMIC, an in-house program of Arup. The probabilistic seismic hazard assessment methodology comprises the following steps:

i) Potential seismic sources are defined on the basis of regional geotectonics and seismicity.

ii) Seismicity parameters defining the rate of earthquake activity are derived for each of the potential seismic sources.
iii) Ground motion attenuation relationships, considered to be appropriate for the region, are identified.
iv) The annual frequencies of various levels of specified ground motion levels being exceeded are derived by first determining the likelihood that each ground motion will be exceeded if an earthquake of a certain magnitude at a certain distance occurs. By multiplying this likelihood with the annual frequency of such an event occurring in any of the source zones, the annual frequency of the ground motion occurring is derived. By summing the results from all relevant earthquake distances and magnitudes, the overall annual frequency is established.

3.2 Earthquake catalogue

Instruments for recording earthquake motion have been deployed round the world since the turn of the 20th Century. Seismic networks became more widespread, and by the mid 1960's, the increased number of instruments enabled the reliable detection of smaller magnitude events. The seismological data used in this study has been obtained from the USGS catalogue (http://earthquake.usgs.gov/earthquakes/eqarchives/epic) which provides data on events greater than magnitude 4.5 since 1972. The data covers an area between latitude 14 °S to 22 °N and longitude 90 °E to 132 °E.

All catalogues contain some aftershock sequences. Aftershocks are earthquake events that are usually connected with a parent event, which is often large, whilst foreshocks precede such events. Immediately after a large earthquake, numerous aftershocks occur on a short time scale, however, later in aftershock sequences the time interval between earthquakes becomes longer. The removal of fore and aftershocks can be a subjective procedure which relies on the skills of the seismologist to identify such events. Gardner and Knopoff (1974) have proposed a windowing procedure to remove aftershocks which is based on the Southern California earthquakes. The procedure relates the maximum possible distance and time of an aftershock to the main shock magnitude. This method has been adopted for this project. Figure 2 shows all the events within the study area after the fore and aftershocks have been removed.

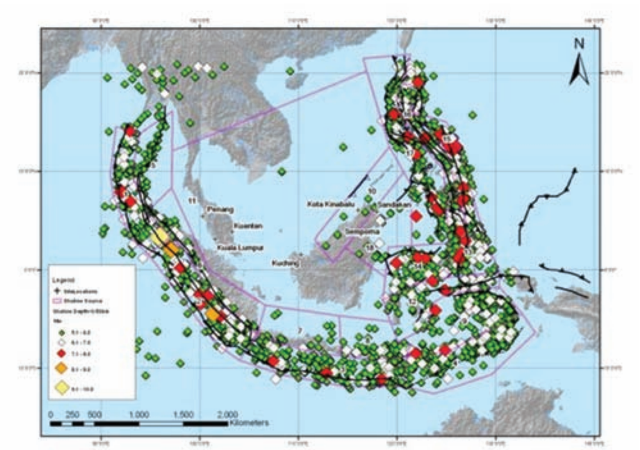


Figure 2a: Earthquake catalogue since 1972 to a depth of 50km with after-shocks removed

Figure 2b: Earthquake catalogue since 1972 at depths of 50 to 150km with aftershocks removed

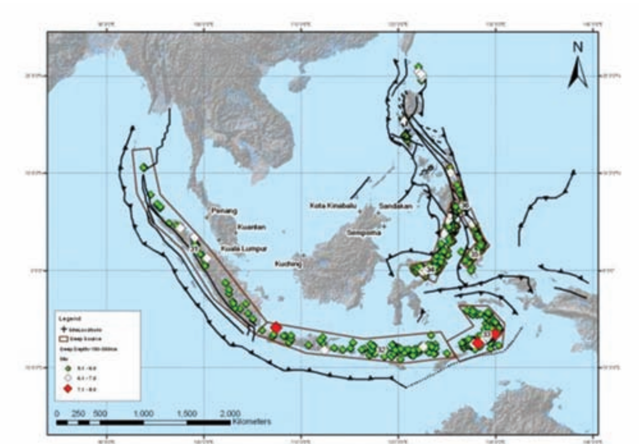


Figure 2c: Earthquake catalogue since 1972 at depths of 150 to 300km with aftershocks removed

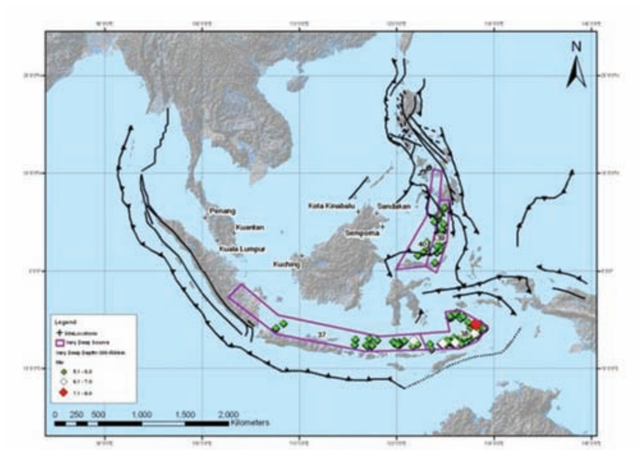


Figure 2d: Earthquake catalogue since 1972 at depths of 300 to 500 km with aftershocks removed

Figure 2: Earthquake catalogue since 1972 at depths with aftershocks removed

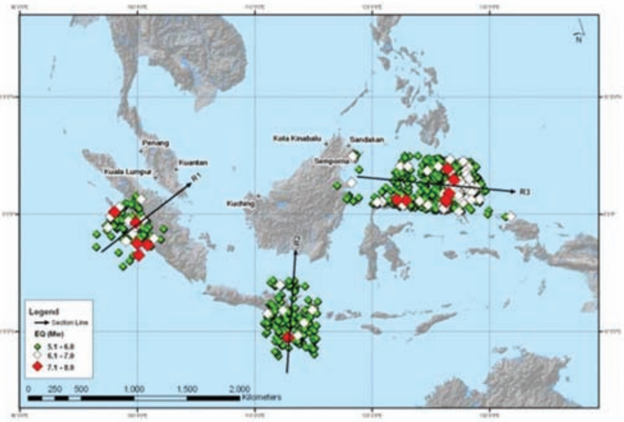


Figure 3a: Plan showing the location of the three sections through the crust

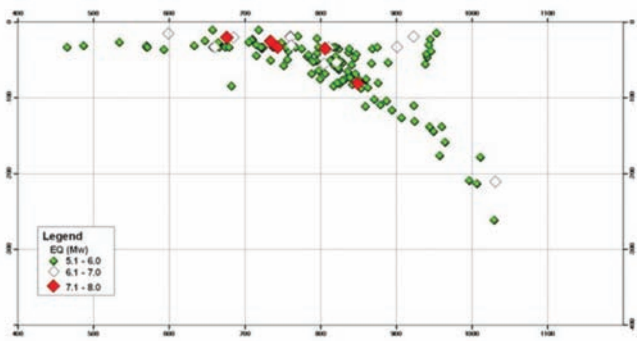


Figure 3b: Section R1 through Sumatra

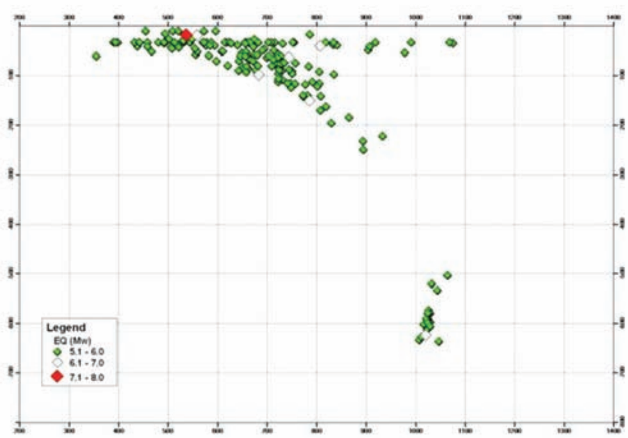


Figure 3c: Section R2 through Java

It is clear that Malaysia is surrounded to the west, south and east by areas of very high seismicity that are associated with major tectonic structures formed at the boundaries between the Asia tectonic plate and the India-Australia tectonic plate to the southwest and the Pacific tectonic plate to the east. These boundaries generally represent subduction zones which dip under the Asian tectonic plate. In addition, there are surface fault zones close to the surface above the deeper subduction zones. Figure 3 shows a plan and three sections through the crust to illustrate this effect.

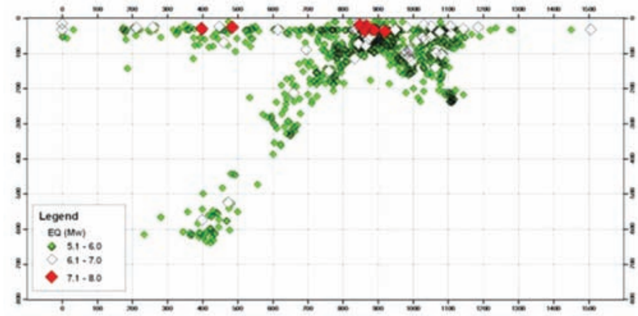


Figure 3d: Section R3 through the Celebes Sea

3.3 Catalogue completeness and earthquake magnitude recurrence

The statistical completeness of the catalogue has been assessed. Figure 4 shows the magnitude recurrence relationship for earthquakes in the whole study area in the conventional form proposed by Gutenberg and Richter (1956) as follows:

$$\mathrm{Log}_{10}\, N = a - bM$$

where N is the annual number of earthquakes greater than magnitude M and a and b are constants.

In this form, the annual number of earthquakes greater than magnitude M is plotted as a function of that magnitude. If a data set is complete, the annual number of earthquakes greater than each magnitude will be similar for a range of time periods (assuming there are no temporal trends in the level of seismicity). Figure 4 shows the annual number of earthquakes from various time periods since 1970 which are complete above magnitude 5. A complete set of data includes records for all the events that occurred above a certain magnitude over a considered time period.

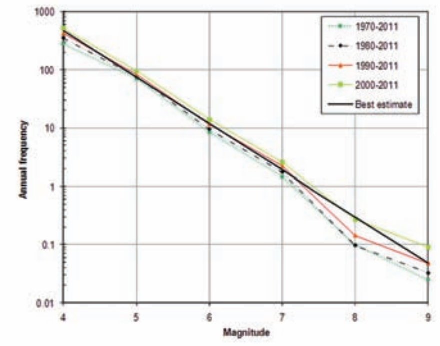
3.4 Seismic source zoning

Figure 2 shows the various area source zones that have been assumed for the probabilistic seismic hazard estimation. The seismic activity within each area has been represented by a Gutenberg Richter relationship that matches the observed seismicity within each area and the sum of these relationships for each of the four depth ranges are shown by the best estimate lines in Figure 4.

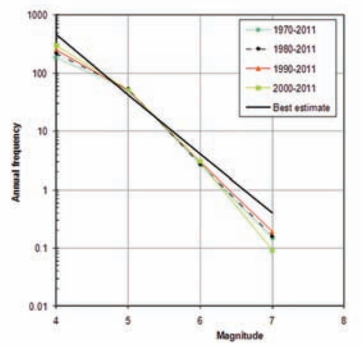
3.5 Minimum and maximum magnitude

A minimum earthquake magnitude of Mw equals to 5 is adopted for this study for the reason that, below this magnitude, an earthquake is unlikely to cause any significant structural damage.

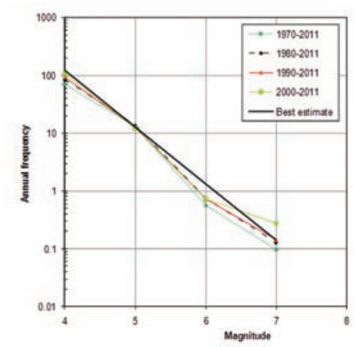
For earthquakes down to 50km, generally a maximum magnitude of 8.5 has been assigned except for Areas 1 to 3 which have been assigned a maximum magnitude of 9.5, Area 10 with a magnitude of 7.5, Area 11 with a magnitude of 7 and Area 18 with a maximum magnitude of 8. For earth-quakes between 50km and 150km, a maximum magnitude of 8 has generally been assigned except for Areas 26, 29 and



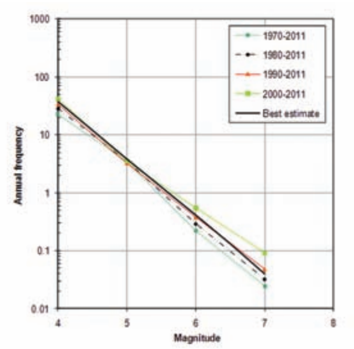
a) Earthquakes to 50km depth



b) Earthquakes from 50 to 150km depth



c) Earthquakes from 150 to 300km depth



d) Earthquakes from 300 to 500km depth

Figure 4: Magnitude recurrence plots for earthquakes at various depth ranges

Table 1: Focal depths and weightings

Zone Numbers	Seismogenic Depth	Focal Depth (weighting %)			
1 to 18	50km	10km (20%)	20km (25%)	30km (25%)	40km (30%)
19 to 30	150km	65km (30%)	90km (25%)	110km (25%)	135km (20%)
19 to 30	300km	170km (35%)	200km (23%)	250km (28%)	300km (14%)
19 to 30	500km	350km (32%)	400km (27%)	450km (23%)	500km (18%)

30 which have been assigned a maximum magnitude of 7.5. For earthquakes between 150 and 300km, a maximum magnitude of 8 has been assigned in the areas within Indonesia and a maximum magnitude of 7.5 has been assigned to the areas in the Philippines. For earthquakes between 300 and 500km, a maximum magnitude of 8 has been assigned in the areas within Indonesia and a maximum magnitude of 7 has been assigned to the areas in the Philippines.

3.6 Focal depth

The focal depths of the earthquakes reported in the USGS catalogue have been analysed. It should be noted that a depth of 33km is the default value for the data for unknown focal depth. Consequently, depth values of 33km have been excluded from the depth distribution analysis. The focal depth distribution is found to be wide with focal depths extending to greater than 500km. The deeper earthquake events are associated with the regional tectonic features in the region. Table 1 summarises the focal depths and weightings adopted in this preliminary assessment.

3.7 Attenuation relationships

No attenuation relationship for response spectral values has been specifically developed for Malaysia or the surrounding region. In this study, the attenuation relationships for the distant plate boundary earthquakes in the subduction zones and major fault zones in Indonesia and the Philippines, the attenuation relationships recently developed by Pan et al. (2007) from NTU have been adopted. These relationships are based on the seismological stochastic simulations on a fault rupture source model and have been verified by the recorded distant earthquakes from the Sumatra Subduction Zone and the Sumatra Fault.

While the attenuation relationships described above are appropriate for distant large events that may affect Malaysia, they are not suitable for the few events that may occur in the immediate vicinity within the stable continental region. It is considered that the most appropriate relationship for this area is one similar to that developed for eastern North America. This area has a rigid crustal structure and is likely to be similar to that of Malaysia. The most recent relationship derived for eastern North America by Atkinson and Boore (2006) has been used for these local areas (Zones 10, 11, 18 and 30 on Figure 2).

4. RESULTS OF THE SEISMIC HAZARD ASSESSMENT

Design response spectra for horizontal bedrock motions have been determined for various locations in Malaysia for seismic ground motion having a probability of 10% of being exceeded in the next 50 years for structural periods up to 5 seconds. The spectra are suitable for a structural damping of 5% and are shown in Figure 5. It is to be noted that these design spectra have the same probability of occurring at all structural periods and do not necessarily match the seismic ground motion that may arise from a particular individual future earthquake.

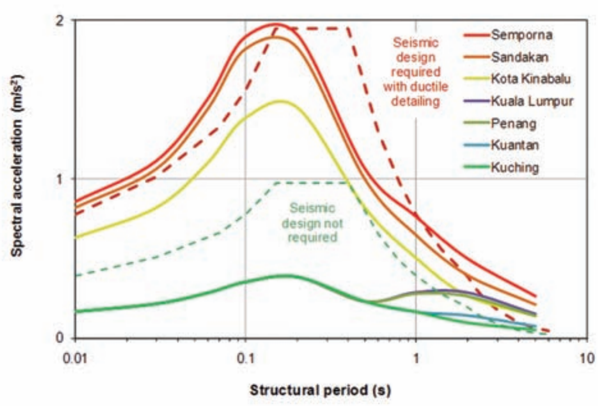


Figure 5: Design response spectra for horizontal bedrock motion

It should be noted that the peak ground acceleration values are plotted at a structural period of 0.01 seconds and shows that the three locations in Peninsular Malaysia, namely, Kuala Lumpur, Pulau Pinang and Kuantan, all have very low peak ground acceleration values of about 0.2m/s^2, or about 2% of gravity. Kuching in Sarawak has a similar value, however, the three locations in Sabah, namely, Kota Kinabalu, Sandakan and Semporna, have significantly higher peak ground accelerations of between 0.7m/s^2 and 0.9m/s^2, or about 7% to 9% of gravity.

5. IMPLICATIONS TO THE DESIGN OF STRUCTURES IN MALAYSIA

5.1 Where is seismic design required?

The earthquake design criteria implied by Eurocode 8 and shown previously in Figure 1 are also shown on Figure 5. On the basis of peak ground acceleration, only the locations in Sabah should consider seismic loading in the design of new buildings. While western Sabah (i.e. Kota Kinabalu) could use simplified design rules that avoid the use of ductile detailing, eastern Sabah (i.e. Sandakan and Semporna) is marginally over the 8% of gravity criterion, as such, ductile detailing should be used. If the whole response spectrum for each location is considered, similar conclusions can be drawn for these locations in Sabah. For Sandakan and Semporna, the spectra imply that ductile detailing should certainly be considered for longer period structures having fundamental periods above about 1 second. For lower rise shorter period buildings, ductile detailing could be ignored but at the expense of using a lower behaviour factor, q, which will result in higher seismic design forces.

For locations on the western side of Peninsular Malaysia, however, it can be seen that the spectra for Kuala Lumpur and Pulau Pinang increase and is above the Eurocode seismic design threshold criterion at periods above about 1.5 seconds. This increase in seismic hazard is due to the significant seismic activity under Sumatra and implies that, for long period structures having fundamental periods above 1 second, seismic loading should be considered as part of their design. This leads to the important conclusion that buildings above about 10 storeys, especially those founded on deep or soft soil deposits on the western side of Peninsular Malaysia, should consider seismic loading as part of their design. While the level of seismic loading is sufficiently small that ductile detailing could be avoided, the designer may still wish to use ductile detailing to take advantage of the lower seismic design forces that result as a consequence of using a higher behaviour factor, q, appropriate to buildings incorporating ductile detailing.

5.2 Site response effects

The spectra shown in Figure 5 are for horizontal seismic ground motion for a rock outcrop site. It is well known that local soil conditions can have a significant effect on the ground surface seismic ground motion and this effect needs to be considered in design. Eurocode 8 achieves this by specifying different spectral shapes for site soil profiles that are assigned to a specific soil class on the basis of the geometric average of the soil shear velocity in the upper 30m of the soil deposit. Table 2 summarises the soil profile classification system. Eurocode 8 should be referred to for full details of the averaging methodology. Eurocode 8 has special rules for liquefiable sites and very deep soft day sites that require site specific dynamic site response analyses as discussed later.

Eurocode 8 cannot be used directly to determine the effect of the soil profile site response effects as it gives different spectral shapes rather than amplification factors. This is potentially directly applicable to sites in Sabah as the spectral shape for a bedrock outcrop site is similar to that in Eurocode 8 as shown in Figure 5. It is not helpful for the western side of Peninsular Malaysia, however, as the underlying spectral shape is so different for a bedrock site. To overcome this problem, site response amplification factors implied by the Eurocode curves have been derived for the various site classes as a function of the fundamental structural period. They are shown in Figure 6.

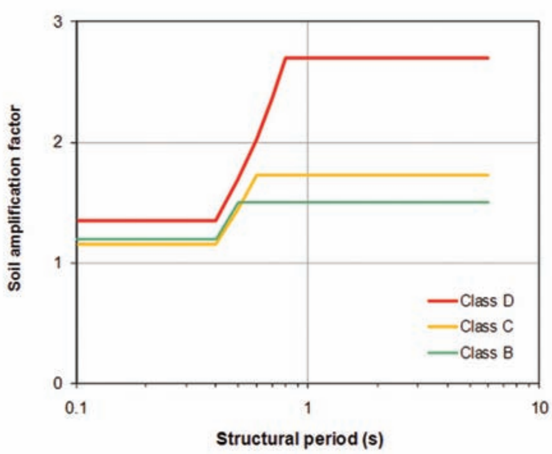


Figure 6: Site response amplification factors implied by Eurocode 8 as a function of structural period

Table 2: Summary of Eurocode 8 soil profile classification

Site Class	Soil Profile Name	Average Properties in the upper 30m		
		Shear-Wave Velocity, V_s, (m/s)	SPT, N (blows/300mm)	Undrained Shear Strength, S_u, (kPa)
A	Rock or thin (<5m) soil	$800 < V_s$	Not applicable	Not applicable
B	Very dense or stiff soil	$360 < V_s \leq 800$	$N > 50$	$S_u > 250$
C	Dense or stiff soil	$180 < V_s \leq 360$	$15 < N \leq 50$	$70 < S_u \leq 250$
D	Loose or soft to firm soil	$100 < V_s \leq 180$	$5 < N \leq 15$	$20 < S_u \leq 70$

The period dependent factors shown in Figure 6 could be directly applied to the bedrock spectra shown in Figure 5 for any of the locations in Malaysia. Alternately, if the shear wave velocity profile can be determined for the site being investigated, conventional dynamic site response analyses could be used to determine the ground surface spectrum. Many computer programs are available to do this (see Visone et al. 2010 for various examples). These programs all require the input of earthquake time histories that are compatible with the appropriate bedrock outcrop response spectrum, but the selection and scaling of these is beyond the scope of this paper. ■

Note: IEM wishes to thank Dr J.W. Pappin, Ms. P.H.I. Yim and Mr. C.H.R. Koo, from Arup Hong Kong for contributing this article.

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UNIMAS and EPC Synergy to Provide Rural Folks with Clean Water and Sanitation

Universiti Malaysia Sarawak (UNIMAS) will partner EPC Synergy Sdn Bhd to develop clean, safe drinking water and good sanitation in the rural areas. A memorandum of understanding has been signed which will enable members from both parties to explore potential research and consultancy projects in areas where potable water and electricity supply are not available or lacking. The team from Unimas will comprise experts in hydrology, water resources engineering, wastewater treatment and micro-hydro.

Unimas vice-chancellor Prof Datuk Dr Khairuddin Ab Hamid was confident that the alliance would help meet the aspirations of the Rural and Regional Development Ministry to increase water supply coverage throughout Malaysia.

He added that the collaboration was also an initiative to supplement and support the establishment of Green Energy Island, an ongoing agenda of the Energy, Green Technology and Water Ministry.

(Sourced from The Star)

Ssangyong Awarded RM431.1 million Contract by GuocoLand Malaysia

GuocoLand (M) Bhd has awarded Ssangyong Engineering & Construction Co., Ltd a RM431.1 million construction contract for Parcel 1 of the integrated Damansara City project. The contract involved the construction and completion of two luxury condominium blocks, a six-level elevated carpark and 5-6 levels of basement for the proposed mixed development project in Damansara Heights. The contract is the first of two parcels for GuocoLand Malaysia's flagship project.

Apart from the condominium blocks, the mixed development project also includes two office towers, a five-star hotel and a lifestyle mall. The new landmark will have a gross built-up area of about 2.2 million square feet on a freehold 8.5-acre site. Damansara City is one of the key entry point projects under the Economic Transformation Programme.

(Sourced from The Star)

11 Consulting Companies to Oversee KLIFD Project

The RM26 billion Kuala Lumpur International Financial District (KLIFD) will be overseen by 11 local and foreign consultants appointed by 1Malaysia Development Bhd. Among the selected local companies are traffic management consultant Perunding Trafik Klasik Sdn Bhd, quantity surveyor Perunding NFL Sdn Bhd, landscape architect Akitek Jururancang Malaysian Sdn Bhd and land surveyors Jurukur Perpaduan Sdn Bhd and Jurukur ESA Sdn Bhd. The infrastructure engineering consultants are EDP Consulting Group Sdn Bhd and Buro Happold Consulting Engineers, a UK and US consultant which also acts as KLIFD's sustainability consultant.

Others include security and risk engineers ARUP Jururunding Sdn Bhd and ARUP Group International. KEO International Consultants from Qatar was selected as programme management adviser. The appointments are in addition to the two master planners named recently, Akitek Jururancang Malaysia Sdn Bhd and Machado Silvetti & Associates. As one of the entry-point projects under the Economic Transformation Programme, the KLIFD is slated to be completed in two decades, with its first phase operational by 2016.

(Sourced from The Star)

Technip Bids for RM1 Billion Deepwater Project

Technip Malaysia has submitted a bid for a deepwater job worth RM1 billion. If the bid is successful, it will be the company's third project. Edgar Pushparatnam, Technip Malaysia's Managing Director, said the company's first deepwater project, the Kikeh Spar is located at a depth of 1,330 metres in offshore Sabah. Kikeh Spar is the first deepwater development in Malaysia and also the first spar installed outside of the Gulf of Mexico. In 2006, Technip was awarded its second deepwater contract by Malaysia Marine and Heavy Engineering Sdn Bhd for Shell's Gumusut-Kakap project.

Pushparatnam said the deepwater market is a major growth area for the Asia Pacific. Technip's global order book as of 30 June 2011 was 9,413 million euros and the Asia Pacific represents 13% of that amount. He also said that the company's plant in Johor, which manufactures flexible pipe and umbilical, has received orders from clients in Malaysia, China, Vietnam and Indonesia.

(Sourced from BERNAMA)

Johor Continues to Venture into Water Resources

The Johor state government will continue to seek out new sources of water for the long-term needs of its residents and industries. Menteri Besar Datuk Abdul Ghani Othman stated that, at the moment, the state government was exploring the potentials of the Sungai Sedili Besar in Kota Tinggi as a source of water supply. The government may also seek to increase the capacity of the Sungai Tebrau treatment plant if the effort to improve the quality of water at the river is successful. A similar plan for the Sungai Johor water treatment plant is also being considered.

The menteri besar said that although water supply at Gunung Pulai was quite limited, it was capable of increasing the water supply to the area. He added that the state government was also prepared to expand the channelling of raw water from one river to another to accommodate the capacity of water treatment plants. At the moment, the plan was being implemented by building a pipeline from Sungai Bekok to the Parit Raja Water Treatment Plant in Batu Pahat.

(Sourced from BERNAMA)

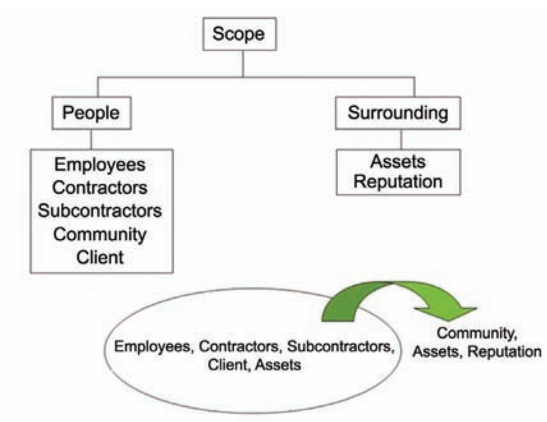
SAFE TEA TIME

Safety Management System (SMS)

by Ir. Shum Keng Yan

THE acronym SMS does not represent what you would normally think it would be. SMS, in this case, stands for Safety Management System, or perhaps you are more familiar with the term OHSMS (Occupational Health and Safety Management System). Since we now have a general statement of the safety policy being displayed at the reception, we need to make sure that we live up to our commitments.

Let us start with the scope. The business needs to understand the scope of the operations. We need to understand what we need to cover, and this is where the scope comes in. The scope can be summarised below:

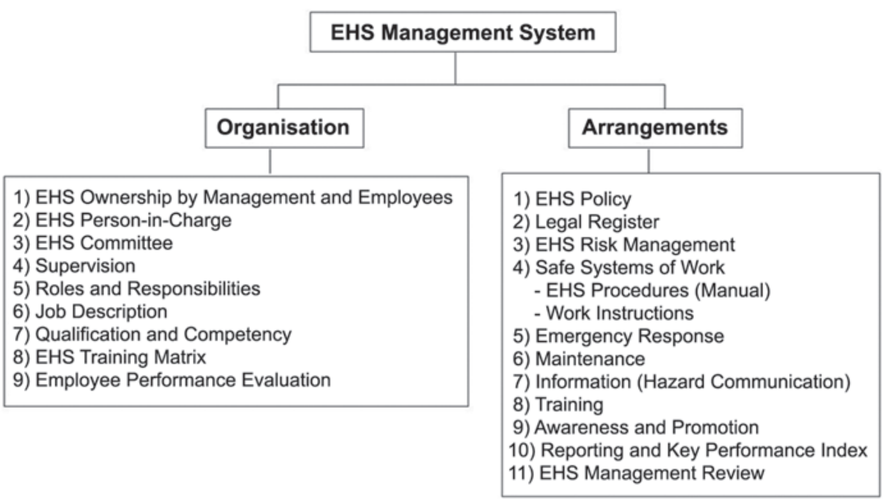


The organisation then needs to establish the SMS framework to fulfill the commitments based on the identified scope. The Occupational Safety and Health Act 1994 mentioned the organisation and its arrangements. Basically, the organisation and its arrangements is the framework for the SMS and is depicted in the diagram below. I have used the term Environmental, Health and Safety (EHS) for the sake of convenience.

I have included the tools to support the organisation under the "Organisation" bucket. These tools include proper Roles and Responsibilities, Job Description incorporating EHS, proper EHS Performance Evaluation, etc.

In the coming issues, we will discuss key items in "Organisation" and "Arrangement". We have already covered the Person-in-Charge, EHS Policy and the basics of Risk Management in past articles. Meanwhile, if you would like to share your thoughts on this, please send an email (not SMS) to *pub@iem.org.my*. ■

Good Safety comes from Good Management. Good Management comes from Good Leadership. Thus, Good Safety is an indication of Good Leadership! Good leaders produce all-rounded results in profitability, quality and safety! Wishing you a Happy Deepavali!



Road Show on Malaysia National Annex to Eurocode 7

by Ir. Chua Chai Guan

GEOTECHNICAL ENGINEERING TECHNICAL DIVISION

THE road show on the Malaysia National Annex to Eurocode 7 (EC7) was conducted as a series of one-day workshops in Kuala Lumpur, Pulau Pinang, Kuching and Johor Bahru from 11 July 2011 to 18 July 2011. The workshop was conducted by two distinguished speakers, i.e. Prof. Brian Simpson, who is the Chairman of the UK National Annex to EC7 and has been working with the EC7 for more than 30 years, and Ir. Tan Yang Kheng, who serves as the Chief Drafter of the Malaysia National Annex to EC7 and has been working on the Malaysia National Annex since 2007. The workshop drew about 150 participants nationwide.

The main purpose of this road show is to increase the awareness among engineers about the adoption of the Malaysian Euro Norms (MS EN) in Malaysia, as well as the training on the practice of the EC7. This is part of the programs organised by the IEM EC7 Drafting Committee before turning the National Annex into an official SIRIM document. It is expected that the revised Uniform Building By-Law (UBBL) would incorporate the use of the Eurocodes in the near future as the current British Standards have been progressively withdrawn since 2010 (e.g. BS8002 and BS8004). Thus, there is an urgency for our engineers to familiarise themselves with this new code of practice.

The birth of the Eurocodes is meant to provide a common basis, design criteria and understanding among the member states of the European Union (EU), enhance free trade within the EU and improve the competitiveness of the European industry. Besides the European continent, they will also be adopted or widely referenced by Hong Kong, Russia, Singapore, South Africa, Malaysia and other Commonwealth countries.

Prof. Simpson advised the workshop participants that the Eurocodes may seem difficult from a distance but is actually quite straightforward when a person starts to use it. Hence, the key to mastering the new code of practice is to "just do it" right away.

The main skeleton of the workshop covers the introduction to the EC7, the Malaysia National Annex and a selection of design parameters and design of piled foundations based on the EC7 methodology. At the end of the workshop, participants were given a simple exercise on pile design using the Eurocodes approach.

Prof. Simpson highlighted that, using the Eurocodes approach, a geotechnical project would be governed by the following standards:

a) MS EN1997-1 and MS EN1997-2 (General rules, ground investigation and testing for geotechnical design)
b) Execution standards drafted by CEN/TC288
c) Ground properties standards drafted by CEN/TC341 (ISO/CEN Standards)

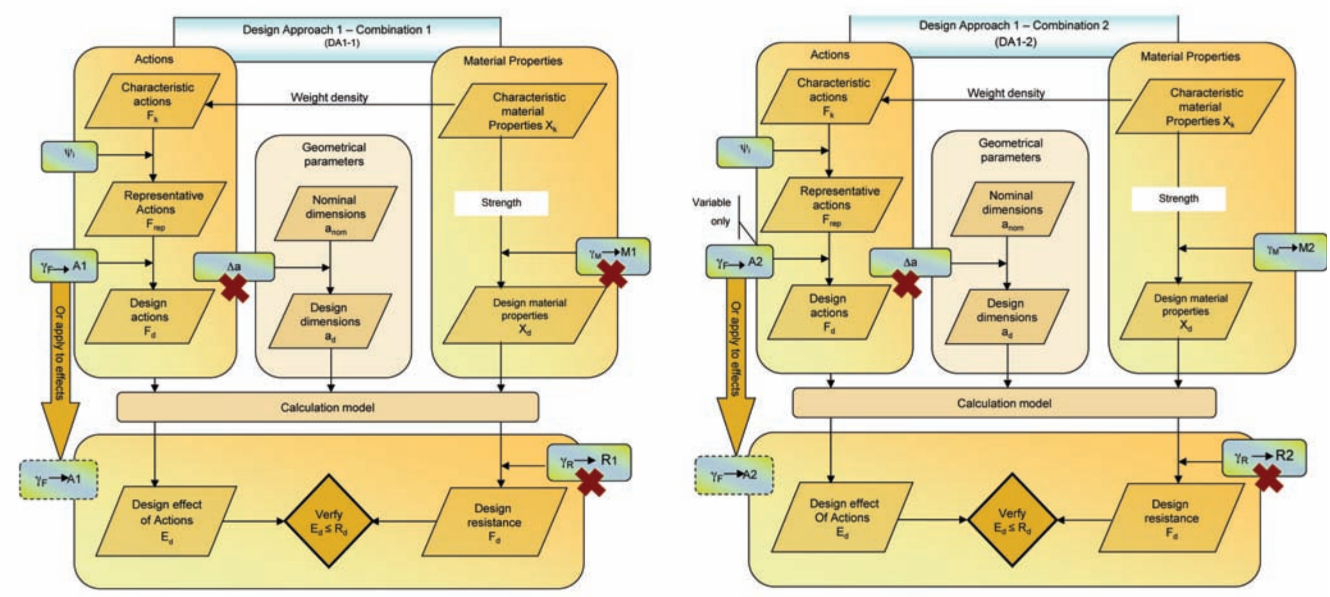


Figure 1: Design flow as described in design approach and combination (DA1-1 and DA1-2) (after Bond & Harris 2008)

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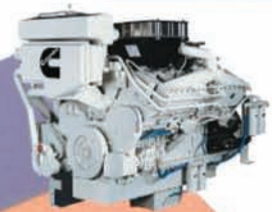
POWER DIVISION, HQ

Cummins Power Generator (CPG)

Silent Type Generator



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d) Non-Conflicting Complementary Information (NCCI)
e) Other structural Eurocodes

The EC7 applies the limit state concept used in conjunction with the partial factor method, as well as the principles and requirements for the safety, serviceability and durability of structures as described by the EN 1990 (Basis of Design). The fundamental approach is to define the design values of actions, effects of actions, material properties, geometrical data and resistances by applying a set of "nationally determined partial safety of factors" on the respective characteristic values such that the design effects of actions are always smaller than design resistances. Alternative particular sets of partial factors are assigned to three different design approaches, namely, DA1, DA2 and DA3, the choice of which is determined by each individual nation and the corresponding set of partial factors is provided in the National Annex. In the Malaysian context, DA1 (see Figure 1) is selected with factors chosen to suit local practices. Besides the above, EC7 also requires an understanding of the ultimate limit state, serviceability limit state, documented geotechnical site investigation, design report, execution, supervision and monitoring program during the entire course of construction.

Ir. Tan presented that the basis of the Malaysia National Annex is to adopt the UK National Annex to EC7, and adapting it to the Malaysian practice wherever deemed fit. The method used to establish the values of the partial factors, model factors and correlation factors is the deterministic method (one of the methods described in Eurocode EN 1990).

The aim of the code calibration exercise is to ensure that the design to EC7 is essentially similar to that attained by conventional working stress design methods using the global factor of safety.

The main differences in the Malaysia National Annex compared to the UK National Annex are as follows:

a) Partial factors for soil parameters (γ_M) in Table A.NA.4
b) For pile foundations, partial resistance factors in Tables A.NA.6 to 8 and correlation factors in Tables A.NA.9 to 11
c) Jack-in piles (Not in the UK NA, but included in the Malaysia NA)
d) Ground anchors
e) Three country-specific data to geotechnical designs in Malaysia are mentioned, namely,
   i) Foundations in limestone areas
   ii) Geotechnical works in peat
   iii) Partially saturated fill

On pile foundation design, Ir. Tan highlighted that the partial resistance factor values were revised higher by 10% to meet the criterion that pile design to EC7 is essentially similar to the design produced from the current working stress design using the global safety factor (see Figure 2).

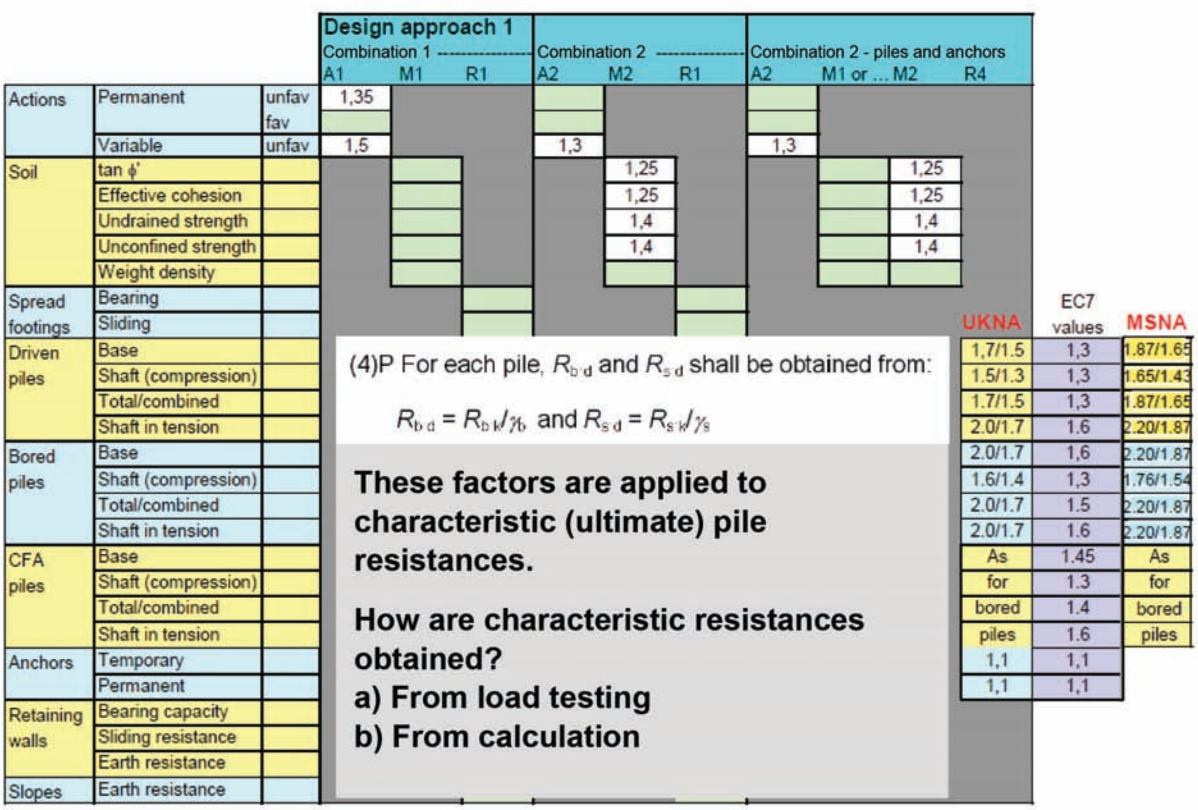

Figure 2: Selection of partial factors is a national choice (after Simpson 2011)

Nevertheless, he stressed that these values are subject to review and revision after a certain period of usage. A maintenance group to the new code in SIRIM should be set up for this purpose.

In general, the workshop was well received by the engineers at the different venues. The organiser thanked the two speakers and presented them with a token of appreciation.

Readers are encouraged to download the handout material from the IEM web portal, http://www.myiem.org.my/events/eventregistration.aspx?id=360 and try the design exercise used in the workshop, see Appendix A: Example 2.3: Pile foundation in stiff clay, taken from the European Technical Committee 10 (ETC10), http://www.eurocode7.com/etc10.

APPENDIX A: EXAMPLE 2.3 PILE FOUNDATION IN STIFF CLAY (DESIGN EXERCISE USED IN THE EC7 WORKSHOP)

A building is to be supported on 450mm diameter bored piles founded entirely in stiff clay and spaced at 2m centres (see Figure 3). The piles are bored dry, without casing, and concreted on the same day as boring. Each pile carries a characteristic vertical permanent load of 300kN and a characteristic vertical variable load of 150kN. This is a small project for which there will be no load testing. Settlement in service is to be limited to 20mm. The pile's design working life is 50 years. The clay is over-consolidated marine clay of Miocene age, containing fissures and occasional claystones. Bedding is essentially horizontal.

The undrained shear strength of the clay at different depths can be determined from the results of four different types of tests that were carried out at the site: triaxial tests on samples from six percussion bored boreholes SG11, SG12, SG14, SG15, SG16 and SG17, SPTs in the six percussion bored boreholes, one CPT test and two self-boring pressuremeter (SBP) tests carried out at the locations shown in Figure 4, the results of the CPT tests, the logs of boreholes SG14 and RC13, and the results of the two SBP tests are available for reference in the IEM web portal, http://www.myiem.org.my. The design may select any or all of these data. Appropriate correlations are to be used to determine the characteristic values for design. Figure 5b shows a depth of 20m, the undrained shear strength is assumed to increase no further.

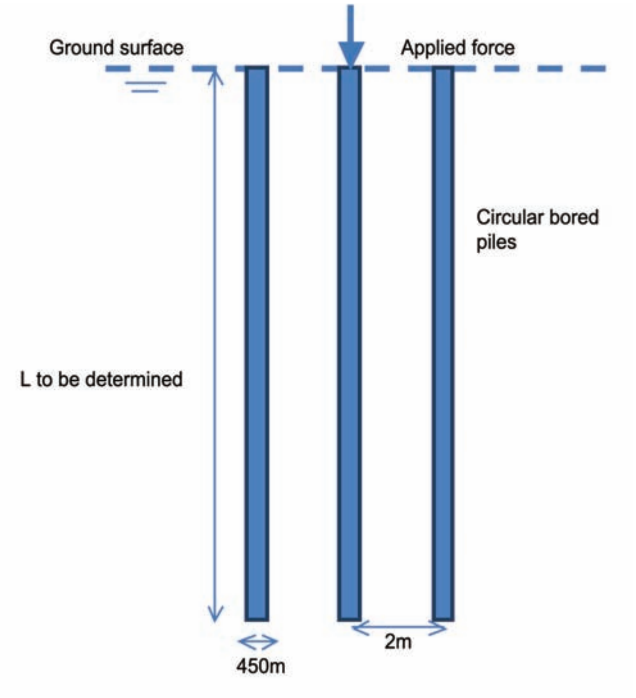

Figure 3: Pile foundation in stiff clay (after Simpson 2011)

Figure 4: Site plan (after Simpson 2011)

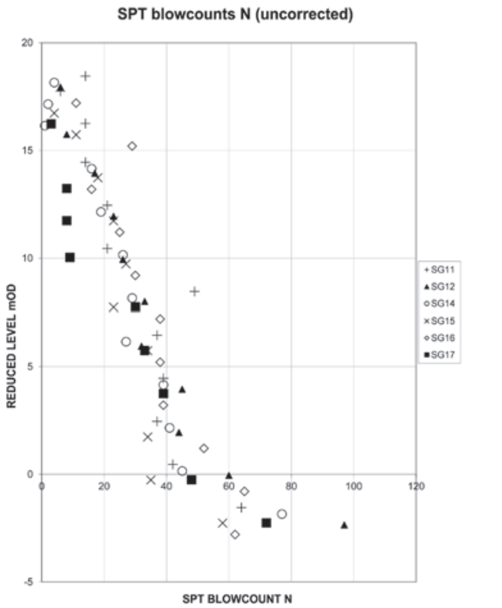

Figure 5a: Combined SPT blowcounts (after Simpson, 2011)

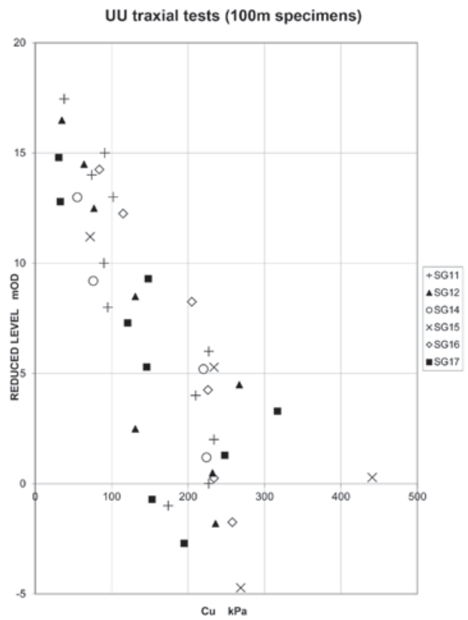

Figure 5b: Results of undrained triaxial test (after Simpson 2011)

The water table is at the surface of the clay, and water pressure may be taken to be hydrostatic. The weight density of the clay may be taken as 20kN/m^3. At this location, the ground surface should be taken to be +17m OD (OD = Ordnance Datum, i.e. reference level), which is also the level of the surface of the stiff clay. Using EC7, determine the design length of the pile at the location shown in Figures 5(a-b). The solution to this design example will be provided by Ir. Tan Yang Kheng, Ir. Dr Chan Sin Fatt and Ir. Dr Ting Wen Hui in the next issue of JURUTERA. ■

REFERENCES:

[1] Bond. A and Harris A, 2008, Decoding Eurocode 7, London: Taylor and Francis, 616pp.

[2] Simpson. B, 2011, The Institution of Engineers, Malaysia (IEM), Malaysia National Annex to EC7 Workshop

One-Day Seminar on Engineering Fill

GEOTECHNICAL ENGINEERING TECHNICAL DIVISION

by Ir. Dr Chan Swee Huat

THE one-day seminar on Engineering Fill was held at the Tan Sri Prof. Chin Fung Kee Auditorium, Wisma IEM with a total attendance of 47 participants.

The seminar consisted of four lectures. The first lecture, entitled "Large Scale Compaction Works on Heterogeneous Fill", was delivered by Ir. Kenny Yee. The ground improvement was related to the construction of the King Abdullah University of Science & Technology (KAUST) campus in Saudi Arabia.

The presentation dealt with the design and construction of the ground improvement works which, upon completion, should facilitate the use of shallow foundations in the treated ground for supporting low-rise buildings and infrastructure. Dynamic compaction (DC) and dynamic replacement (DR) methods were adopted to densify the sabkha soil and loose silty sand found at the site. The sabkha soil consists of 28% to 56% fines and typically has very low SPT-N values, i.e. not greater than 2.

The typical work procedure adopted in this project consisted of:

1) Identifying the general thickness of the sabkha soil using cone penetration tests (CPT);
2) Visually inspecting on-site the penetration of pounders to determine whether the DC or DR treatment method is to be used;
3) Carrying out pressuremeter tests (PMT) in the treated ground to assess the factor of safety (FOS) against bearing capacity failure (minimum requirement: FOS ≥ 3.0);
4) Carrying out stress analysis to verify that the future imposed stress in the subsoil does not exceed the yield stress (PY) of the subsoil;
5) Revising compaction spacing, grid pattern or compaction energy, if the requirement in Step (4) cannot be achieved;
6) Carrying out PMT to check for settlement compliance; and
7) Monitoring settlement during surcharging period.

The lessons learnt and recommendations include the need to:

1) Formulate a simple design concept that could be understand by the client, engineers and contractors;
2) Formulate a simple work procedure so that the right works are carried out during construction; and
3) Prepare simple checklists for acceptance criteria and QA/QC.

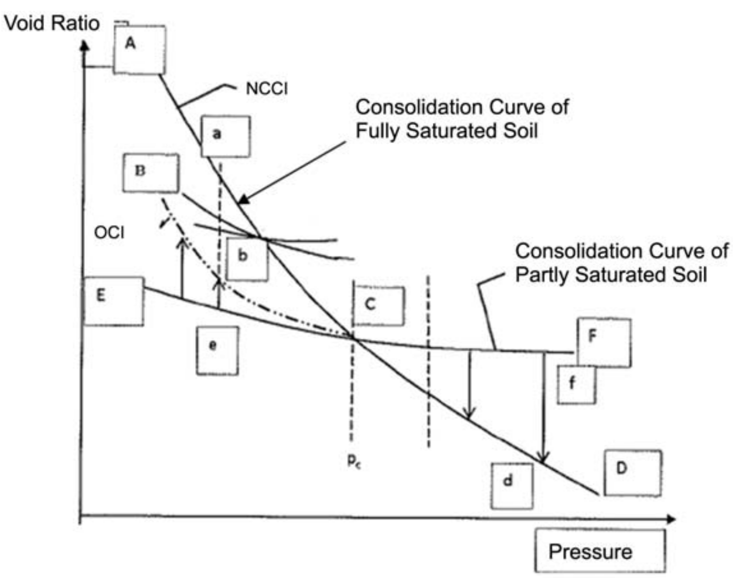

Figure 1: Consolidation curves of partly- and fully saturated soils (Ting, 1999)

The second lecture, entitled "Settlement of Prepared Ground", was delivered by Ir. Dr Ting Wen Hui. In this context, "prepared ground" refers to ground that has been compacted to provide a specified settlement performance. The presentation highlighted that in past case histories, misconception on the engineering of fill had occurred for prepared ground. It was thought that a well-compacted fill may 'support' a building load, and it was not considered that the "collapse settlement" of a partly saturated fill could take place under self-weight, when the fill was subsequently saturated by the infiltration of surface and subsurface water.

Two case histories on problematic collapse settlements of prepared ground were described. Studies by Ir. Dr Ting and others showed that the partly saturated soil becomes unstable on saturation and follows a path to reach the relevant stable state on full saturation. If the path followed falls on the right hand side ('wet' side) of the intersection point C (see Figure 1), the partly saturated soil on saturation collapses and results in collapse settlements (Point C denotes the intersection point between consolidation curve of partly saturated soil and consolidation curve of fully saturated soil).

The third lecture, entitled "Engineered and Unengineered Fill Slopes, and Case Studies", was delivered by Ir. Neoh Cheng Aik. The lecture discussed the design aspects of fill slopes, e.g. design criteria, stability, settlement, slope stabilisation, ground treatment, compaction, slope protection, drainage, etc. The lecture also illustrated common engineering problems encountered in various cases of fill slopes and suggested possible mitigation measures.

Several case histories of fill slopes that encountered failures or distress were used to demonstrate how the investigations and rectification works were carried out. It was highlighted that failures of unengineered fill slopes are neither accidents nor acts of God; they are mainly due to technical shortfalls as a result of oversight, ignorance or unawareness of the necessary mitigations against what could go wrong at site.

The last lecture, entitled "Reclamation and Rehabilitation of Land for Housing and Infrastructure Development", was delivered by Ir. Dr Ooi Teik Aun. The speaker recommended engineers to explore the innovation of using non-conventional methods when poor soil conditions may impair the integrity and serviceability of the structures. In such situations, the natural condition of poor soil needs to be altered to meet the project requirements where settlement limits are more stringent and poor ground strength needs to be significantly improved.

Commonly used ground improvement schemes, such as removal and recompaction, preloading, vacuum consolidation, stone columns, dynamic compaction, dynamic replacement, vertical drains, and use of geosynthetics, were described and various case histories were presented in this lecture. Due to increasing awareness of the impact of construction on the environment, sustainable construction techniques using green technology, such as ground improvement, were recommended. A carbon footprint auditing system was introduced for some of the commonly used ground improvement methods. Carbon dioxide (CO_2) emission audit analyses showed that ground improvement is a sustainable construction method that reduces CO_2 emission compared to conventional earthmoving and piling works.

Lastly, a token of appreciation was presented to each of the speakers. The seminar ended with great applause from the floor. ■

REFERENCE:

[1] Ting, W.H. (1999) "A Survey of Embankment Construction Practice and Future Developments", Year 2000 Geotechnics, AIT, Bangkok.

CONDOLENCES

With deep regret, we wish to inform IEM members that Allahyarham Engr. Ibrahim Jaffar bin O.I. Humayun Khabeer (G 39146) and Allahyarham Dato' Ir. Mohammad Aidid bin Haji Zakaria had passed away on 24 May 2011 and 26 August 2011 respectively. On behalf of the IEM Council and management, we wish to convey our condolences to their families.

IEM Editorial Board

Ground Freezing Technique for Shield Tunnel Launch and Arrival: Case Studies in Taipei

by Engr. Chow Chee Meng

GEOTECHNICAL ENGINEERING TECHNICAL DIVISION

THE technical talk presented by Mr. Wu Chien Min from Resources Engineering Services, Inc., of Taipei, Taiwan, highlighted the application of ground freezing for shield tunnel launch and arrival based on case studies in Taipei which demonstrated the application of ground freezing technology in difficult site conditions.

Some of the difficulties that needed to be overcome include seepage problems due to its close proximity to the Danshui River and the presence of the highly permeable, water bearing Chingmei gravel layer (Figure 1).

Figure 1: Conditions at tunnel launch and arrival, and its location near the Danshui River

The process of ground freezing involves removing heat from the ground to cause a drop of the subsurface temperature below the freezing point of moisture in the pore space. The frozen moisture then acts as a cementing agent, binding the soil particle together and providing structural support via the soil mass.

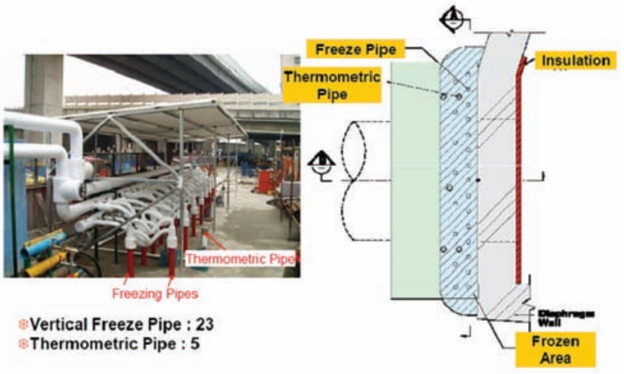

Figure 2: Vertical freezing for launching

Figure 3: Freezing station

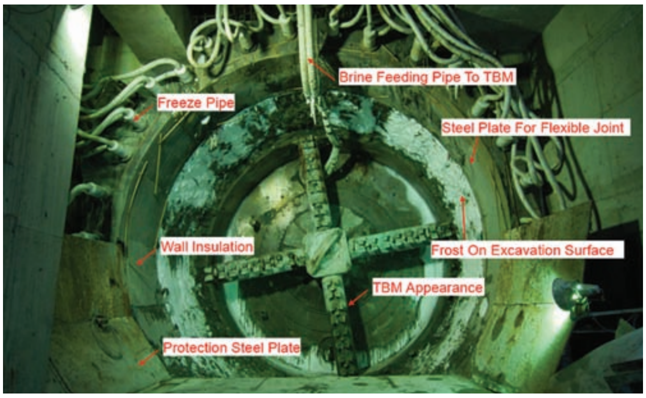

Figure 4: Successful face breaking

Some typical equipment at site is shown in Figures 2 and 3. The freezing system adopted in the case history is the closed-brine (a strong saline solution, e.g. calcium chloride) system. The other available method is the open liquefied gas system. The cost per unit for heat extracted using the liquefied gas system is generally much higher compared with the closed-brine system and is only competitive for small, short-term projects.

The application of artificial ground freezing has enabled the tunnel construction to be successfully carried out (Figure 4). It is interesting to note that the ground freezing operation was carried out during the summer season in Taipei when the weather is similar to Malaysia. Readers who are interested in the technology of artificial ground freezing may refer to publications from the International Symposium on Ground Freezing (ISGF). ■

The 20th Annual Prof. Chin Fung Kee Memorial Lecture

GEOTECHNICAL ENGINEERING TECHNICAL DIVISION

by Ir. Tan Ek Khai and Ir. Yee Yew Weng

THE 20th Annual Prof. Chin Fung Kee Memorial Lecture was held at the Auditorium Tan Sri Prof. Chin Fung Kee, Wisma IEM. The annual event features distinguished lecturers from local and international engineering fraternities and is jointly organised by The Institution of Engineers Malaysia and the Engineering Alumni Association of the University of Malaya.

The lecture featured a lecture by Prof. Pedro Simão Sêco e Pinto entitled "Dam Engineering: State of the Art and Practice, Observed Behaviour and Future Challenges". Prof. Pinto was invited by the Management Committee due to his experience in research and engineering practice globally on geotechnical engineering, especially in dams and earthquake engineering, which was the subject of his lecture.

Over his 30-year career, he has authored and co-authored over 350 technical and scientific reports and more than 150 papers for international conferences and journals. He has also contributed to four books on various subjects. Prof. Pinto is the Immediate Past President of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE) and has also served as the ISSMGE Vice President for Europe. He is currently the Professor of Geotechnical Engineering at the University of Coimbra, Portugal, and the Principal Research Engineer for the Portuguese National Laboratory of Civil Engineering (LNEC).

The lecture was chaired by Ir. Dr Chan Sin Fatt, and a total of 163 participants attended the event. Prof. Pinto presented many well-documented case histories from many parts of the world related to embankment dams behaviour under static and seismic actions. In his lecture, Prof. Pinto touched on the following issues: the background of embankment dam engineering history; a summary of factors affecting embankment dam behaviours with emphasis on the requirements for materials characterised in embankment dam engineering; the design and analysis of dam stability under static and seismic conditions; reservoir-triggered earthquakes and its causative factors; dam monitoring and inspections; and an analysis of the ageing effects of dams and its rehabilitation.

Risks associated with dam projects were discussed using experience from past failures and incidents. He explained that 65% of dam failures were due to the ageing or deterioration of the structure, whilst only 10% were due to slope failure. Lessons learnt from failures suggest that major dams need an independent review board and a design team should follow its construction closely. He concluded that the major concerns surrounding reservoirs involves social factors (i.e. resettlement) and the environment.

In his lecture, Prof. Pinto drew wisdom not only from engineers, but also included thoughts from philosophers ranging from Plato to Hippocrates. He said that the "7 pillars of engineering wisdom" are: Precedents, Practice, Principles, Prudence, Perspicacity, Professionalism and Prediction.

He is also familiar with Tan Sri Prof. Chin Fung Kee's academic and learned society work, and made references to these works in his lecture.

At the end of the lecture, Prof. Pinto kindly answered some questions from the floor. Ir. Dr Chan closed the proceedings by presenting Prof. Pinto with a memento, accompanied by loud applause from the audience. ■

Photo 1: Some Advisory Committee Members of the Prof. Chin Fung Kee Memorial Lecture with Prof. Pinto (From left: Ir. Y. K. Tan, Ir. Dr. T. A. Ooi, Ir. S. L. Ng, Ir. Dr. S. F. Chan, Prof. Pinto, Academician Datuk Ir. Prof. H. T. Chuah, Ir. C. Y. Choo, Ir. Y. W. Yee)

Note: The 21st Prof. Chin Fung Kee Memorial Lecture entitled "Engineering and Entrepreneurship: Is it an Oxymoror?" is to be delivered by Tan Sri Dr Francis Yeoh Sock Ping at JW Marriott Hotel on 5 November 2011. Kindly refer to the IEM web portal at www.myiem.org.my for further details.

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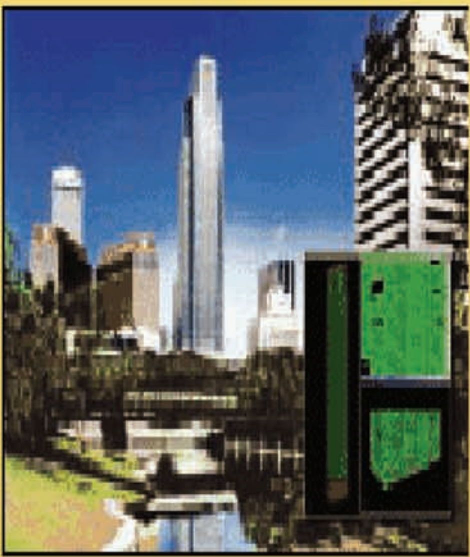

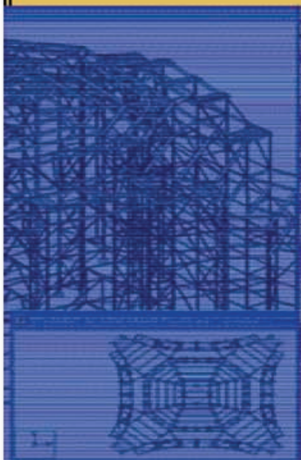

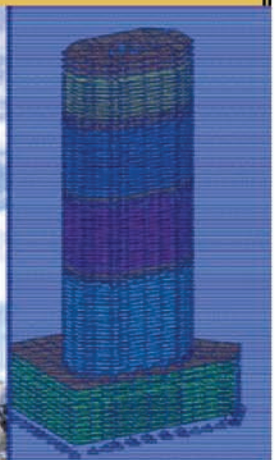

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Gathering of Views and Opinions on Seismic Investigations in Peninsular Malaysia – Report on the IEM Workshop on Earthquake (Part 1)


by Ir. Assoc. Prof. Dr Chiang Choong Luin, Jeffrey in collaboration with Ir. Mun Kwai Peng

IEM TECHNICAL COMMITTEE ON EARTHQUAKE

Note: This is Part 1 of a two-part article. Part 2 will be published in the November 2011 issue.

AFTER the two-day course on earthquake ground motions and responses of reinforced concrete buildings on 22-23 June 2010, delivered by Prof. Nelson Lam from Melbourne University, Australia, and Dr Tsang Hing Ho from Hong Kong University (which was reported in the February 2011 issue of JURUTERA), a two-day workshop was held at Bangunan Ingenieur. The topic of discussion revolved around earthquake engineering development in Malaysia, with a specific focus on the determination of suitable peak ground accelerations for Peninsular Malaysia.

The panel of experts invited to provide their inputs and opinions included Prof. Lam, Dr Tsang and Dr Kusno Megawati from Nanyang Technological University (NTU), Singapore. The participants were specially invited by the Civil and Structural Engineering Technical Division, IEM (CSETD) and Geotechnical Engineering, as well as the IEM Technical Committee on Earthquake. The workshop was chaired by Ir. MC Hee, who is a member of CSETD and the WG1 Chairman of the Technical Committee on Earthquake.

DAY 1 PROCEEDINGS

The following is based on written notes by Ir. Mun Kwai Peng, a member of the Technical Committee on Earthquake.

Seismic attenuation models and peak ground accelerations

Prof. Lam started by delivering a short presentation on his research work on seismic engineering in Australia, and the formulation of the Component Attenuation Modelling (CAM) method, which has been widely used by many researchers in the Asia-Pacific region, including India and China, where earthquakes of both near and far fields are common occurrences. He then presented some of the provisions and recommendations of Eurocode 8 or EN 1998-1, which is a standard document currently being evaluated by the IEM Technical Committee on Earthquake for adoption as the Malaysian Standard.

When questioned by a participant, Prof. Lam explained that the formulated CAM model is a deterministic approach to working out the peak ground accelerations and other related parameters. The method focused on attenuation modelling on the transmission of seismic waves from the epicentres at certain distances from the measured site, hence there is no emphasis on probabilistic considerations.

Local researchers have tended to apply probabilistic approach in determining attenuation models based on established methods formulated in the United States. From the findings of PGA values published in noted papers, these are in the range of 0.08g to 0.10g for the western side of Peninsular Malaysia.

These predicted PGA values are considered quite high considering that the Malaysian Meteorological Department (MMD) has produced recorded measurements of very low local PGA values (from 0.0015g to 0.003g) at the height of the 2004 Boxing Day earthquake in Banda Aceh, and also from the far field seismic wave transmitted during the 26 March 2005 Nias earthquake.

Far field seismic effect from Sumatra

Prof. Lam gave an interesting insight into the earthquake effect in Peninsular Malaysia. For long distance or far field earthquake effect, he suggested that the code drafters should not refer to recommendations from any standards or codes of practice. For example, for the Sumatra subduction zone earthquake (on the western side facing the Indian Ocean), the Eurocode 8 models cannot be used in this country.

By that, he meant that the seismic response spectra or peak ground acceleration methodology may not be applicable. However, the seismic design detailing for structures, such as for reinforced concrete buildings, may be applicable if the right ductility class is used. For example, in Peninsular Malaysia, the classification DCL (ductility class low) or even DCM (ductility class medium) may be considered for design consideration.

The subduction zone offshore on the west coast of Sumatra is more seismically active compared to the land faults along the inland of Sumatra.

Local earthquakes or near field seismic considerations

The next panel expert to present his view was Dr Kusno. He introduced his research background and the latest

development in his research findings on carrying out data collection and acquisition in the study of ground soil profile through the use of the geophone and global positioning system (GPS). He has done such fieldwork surveys in Indonesia, Singapore and Hong Kong. The intention of the site work investigation is to learn and correlate the soil profiles to past earthquake events occurring at the surveyed sites.

From the data collected and analysed, a true picture can then be formed on how the seismic waves can be attenuated (reduced in its dynamic effect) or be magnified, especially in soft clayey soils, as experienced in the "bowl of jelly" effect during the earthquake of Mexico City in 1985. Dr Kusno was quite concerned with the possibility of a local earthquake occurring in Bukit Tinggi, and he recommended intensive investigation by local researchers in this area.

Dr Tsang concurred with Dr Kusno, and based on his previous experience while carrying out a joint geophone seismic survey with Dr Kusno and his team from NTU, he said it would be worthwhile for Malaysia to undertake a similar geophone seismic survey in Kuala Lumpur and its surrounding area, of which he would be glad to assist. He even suggested for Malaysia to send representatives to participate in a geophone survey exercise in Hong Kong that has been planned for next year. From the technological transfer and knowledge gained, local researchers could then take the lead to initiate similar geophone survey exercises in Peninsular Malaysia, starting from the Klang Valley region.

On a side note, Dr Kusno mentioned that he has employed both probabilistic and deterministic approaches in ascertaining seismic parameters such as PGA values, and from his experience, the results of both methods are not that far off.

Bukit Tinggi fault line and its long-term implications

There were various views from the floor on how the local earthquake from the far field Sumatra seismic wave may not be as dangerous as the potential local or near field earthquakes. Earthquakes in East Malaysia are not something new. For example, in places such as Lahad Datu, Sabah, the ground motion felt were always a cause for concern, in view of some of the damages found in building structures and injury to the local inhabitants. However, in the peninsula itself, there is a local fault which has been identified at Bukit Tinggi, near Bentong, Pahang.

With an estimated total length of 80km, the vicinity of the Bukit Tinggi fault means that earthquakes with a magnitude of 3.5 have been experienced before. The latter has been confirmed by the records of the MMD, Seismic Division. The workshop participants all agreed (with recommendations from the international panel of experts) to the suggestion to monitor the Bukit Tinggi fault for three years. Once sufficient data has been gathered, these shall then be sent to the panel experts for further study and verification.

The workshop participants agreed with this direction, but questions were raised on the long-term research effort required and the necessary substantial funding that would be needed. Although this effort should be opened to all stakeholders, it has to be led by research institutions and seismic experts, including geologists. Not only did a representative from the Ministry of Science, Technology & Innovation (MOSTI) voiced the ministry's interest in supporting such work, the effort would also be a good platform for all stakeholders to come together and support IEM in collaboration with local universities and overseas seismic experts.

Further fieldwork or desk study work has to be done, such as searching for the archive of past records and investigation reports previously submitted. It was brought to the attention of the workshop participants

(Continued on page 49)


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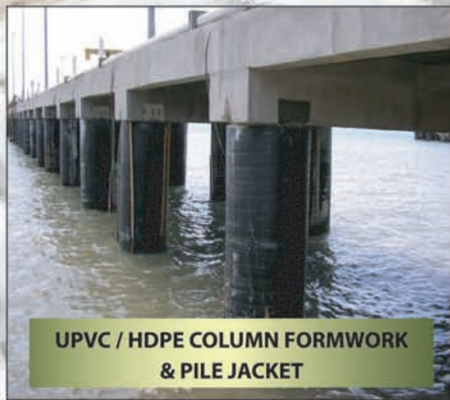
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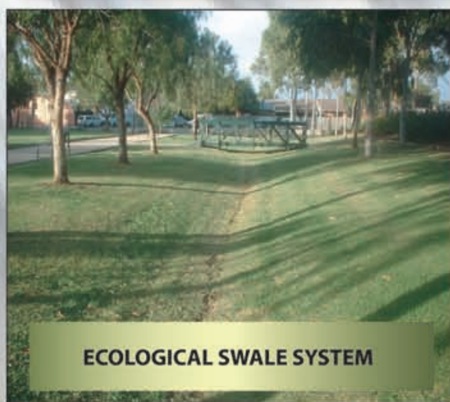
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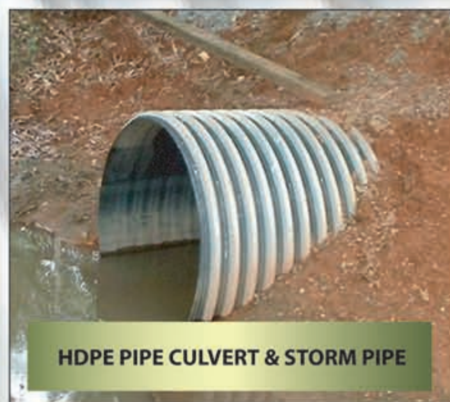
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Tel: **03-3348 8033** (Hunting Line) Fax: **03-3348 7283**, **3342 5613**

Email: **imb@imb.com.my / imbuhan@imb.com.my** that the Department of Minerals and Geoscience (JMG) has carried out a geological survey of the Bukit Tinggi fault, however, the completed report has been classified and will not be circulated before declassification. It was suggested that the relevant authorities, including MMD, should be contacted for the release of the said document for study by the panel experts. A representative from JMG was invited to attend the second day of the workshop.

Financial support from governmental agencies for local seismic studies

Financial support was also required from various governmental agencies which have a stake in the health and development of the local construction industry, namely, Jabatan Kerja Raya (JKR) or the Public Works Department, the Construction Industry Development Board (CIDB), MOSTI through its Department of Standards Malaysia (DSM) and, last but not least, the Ministry of Housing and Local Government (MOHLG). The specific study areas that need the immediate attention of local researchers should include the following:

- attenuation model;
- design return periods for earthquake;
- attenuation properties of local soil;
- peak ground acceleration;
- peak ground velocity;
- peak ground displacement; and
- soft soil amplification

A likely outcome of the study is the production of a seismic hazard map for Malaysia (starting first with Peninsular Malaysia), and perhaps a seismic response spectra for far field earthquakes from Sumatra. A suggestion was made by Prof. Lam to merge the local and far field seismic response spectra, and to study the need to produce a response spectrum for both types of earthquakes, instead of having two separate entities.

Foreseeable local earthquake intensity scenarios

At this point, Prof. Lam provided one of the most interesting pieces of information. With regards to the 80km long Bukit Tinggi fault, which is located only about 20km away from the Kuala Lumpur city centre and only a stone's throw away from Genting Highlands, Prof. Lam suggested that the highest possible magnitude of earthquake that can be generated from the fault could be in the range of M7.2. From his years of research experience, the following estimated peak ground accelerations and velocities were suggested in Table 1.

The three international panel experts were of the opinion that, based on the research findings from their work on far field seismic effect (due to Sumatra's subduction zone) and with reference to work by others (including Prof. Balendra at NUS), a PGA value of 0.015g for Peninsular Malaysia is not far fetched. This coincides with the BS8110's provision for 1.5% notional lateral loads (based on dead loads on the particular floor in question).

SHASSIC

Safety and Health Assessment System In Construction

(CIS 10 : 2008 SHASSIC)

20 CCD POINTS

Enhancing The Level Safety and Health in Construction Industry Through SHASSIC

WHAT IS SHASSIC

Safety and Health Assessment System in Construction or SHASSIC is an independent method to assess and evaluate the safety and health performance of a contractor in construction works/ projects. SHASSIC was developed by a Technical Committee comprises industry stakeholders. It was published as Construction Industry Standard or CIS 10 : 2008 in November 2008.

Start

↓

Application → Application Form received by CIDB

↓

Confirmation of Project Status → Project to be assessed must has physical work progress between 25% to 75%. The assessment cover three components as follows:

a. Document Check (40%)
b. Workplace Inspection (40%)
c. Employees Interview (20%)

↓

Notification on assessment date and implementation → Assessment by accredited CIDB SHASSIC Assessor

↓

Preparation of reports and score → The assessor will assess and prepare SHASSIC report and score.

↓

Notification of SHASSIC Score → SHASSIC score will be notified to the applicant

↓

End

SHASSIC assessment is free of charge (FOC)

For futher information and application form on SHASSIC, kindly visit our website : http://www.cidb.gov.my

For enquires, please contact :

Standard And Quality Division
Construction Industry Development Board Malaysia
Level 10, Grand Seasons Avenue, No. 72, Jalan Pahang, 53000 Kuala Lumpur.

Ir. M. Ramuseren +(6)03 – 2617 0360 ramu@cidb.gov.my
Nor Hamiza Binti Zahar +(6)03 – 2617 0396 hamiza@cidb.gov.my
Hari Sundar Hari Dass +(6)03 – 2617 0358 hari@cidb.gov.my
Nik Arif Nik Shukri +(6)03 - 2617 0372 arif@cidb.gov.my

CIDB MALAYSIA

Lembaga Pembangunan Industri Pembinaan Malaysia
CONSTRUCTION INDUSTRY DEVELOPMENT BOARD MALAYSIA

Ibu Pejabat CIDB, Tingkat 7, Grand Seasons Avenue, No.72, Jalan Pahang, 53000 Kuala Lumpur.
P.O.Box 12278, 50772 Kuala Lumpur. Tel : 603 - 2617 0200 Fax : 603 - 4045 1808
http://www.cidb.gov.my

Table 1: Suggested PGA and PGV values for a range of earthquake magnitude 20km away

Types of structures affected	Measured earthquake magnitude at source 20km away	Peak ground acceleration (PGA)	Peak ground velocity (PGV)
Exceptionally sensitive	M6.5	180 gals (or 0.18g)	180m/s
Hospitals	M6.0	150 gals (or 0.15g)	110m/s
Others	M5.5	80 gals (or 0.08g)	60m/s

And to add to their estimation, a soil magnification of 4 would be acceptable, not a magnification of 10 as proposed by a local researcher.

Conclusion to Day 1 proceedings

It has been said that intraplate earthquakes can take anywhere from 500 to 1200 years to occur again (which is synonymous with the concept of return periods). Earthquakes are extremely difficult to predict, and it is even more difficult to believe that it will not happen again at the same location. The Bukit Tinggi fault is moving and is continuing to move – perhaps at a rate of several millimetres over hundreds or thousands of years. And the fact that it had previously experienced a M3.5 earthquake makes it a likely candidate for more earthquakes in the foreseeable future.

In comparison, Prof. Lam noted that, the intraplate faults in Australia have no prior records of earthquake incidents, and in areas previously defined as seismic free zones, the sudden and unexpected occurrence of M5.5 earthquakes (e.g. in Newcastle, NSW in 1989 and in Kargoolie, Western Australia in 2009) had literally sent shockwaves around the continent. It has brought about substantial changes in the seismic design provisions in the Australian Standards for engineering structures. ■

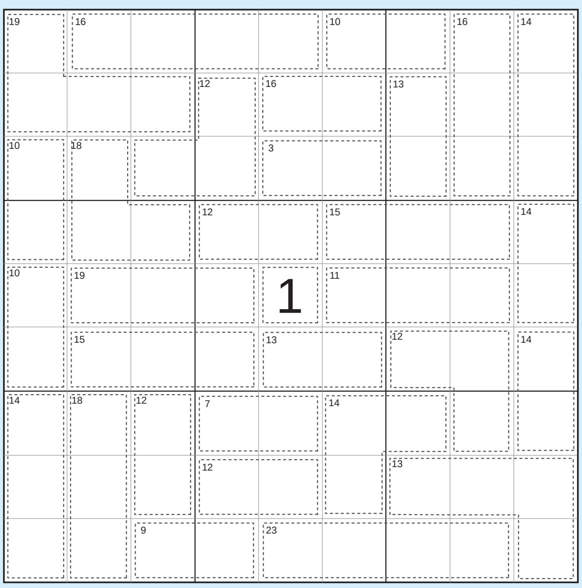
NEWS FROM IEM LIBRARY

1) IEM is pleased to announce that Library information is now available on the IEM Portal (www.myiem.org.my). Members can now perform various activities such as searching for book titles, lodging of book requests (recommendations) and making book reservations through the Internet.

   Members are required to produce their membership cards for scanning purposes when borrowing books from the Library. (The Library is open every Monday to Friday from 9.00 a.m. to 6.00 p.m. and every Saturday from 9.00 a.m. to 1.00 p.m.)

2) IEM has subscribed to the ICE Ground Engineering eBooks and Journal Collection from 2000 onwards. Members are able to view and download full text articles (in PDF format) in the Library.

The Library Sub-Committee wishes to thank the Geotechnical Engineering Technical Division for bearing the cost of subscribing to the journal.



1SUDOKU Centerpiece "1"

by Mr. Lim Teck Guan

Fill in the remaining 80 squares with single digits 1-9 such that there is no repeat of the digit in every Row, Column and Block. The number at the top left hand corner of the dotted cage indicates the total for the digits that the cage encompasses.

For tips on solving, visit www.1sudoku.com.my

(*Solution is on page 57 of this issue.*)

Technical Visit to Hong Kong

IEM PENANG BRANCH

by Ir. Sim Siew Ping, Catherine

Note: This is a summarised version of the report. The full report may be viewed on the IEM web portal at www.myiem.org.my.

IEM (Penang Branch) organised a technical trip to Hong Kong from 22-26 September 2010 led by its Immediate Past Chairman, Ir. Lim Kok Khong. In conjunction with the visit, HKIE organised a series of technical presentations, forums, talks, technical walking tours, and get-together sessions which provided opportunities for sharing of experiences and identification of potential collaboration areas, with the ultimate goal of enhancing local engineering knowledge and skills.

Figure 1 (Clockwise) – Group photo at entrance of CEDD Building; Souvenir Exchange between HKIE Geotechnical Engineering Office represented by Mr. Mak Shu-hei and IEM Penang Branch Immediate Past Chairman, Ir. Lim Kok Khong, Group photos at CEDD Conference Room; Presentation by HKIE, Forum/discussion participants

PRESENTATION ON LANDSLIDE PREVENTION BY MR. MAK SHU HEI OF HONG KONG CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT (CEDD)

by Engr. Law Chun Teik

The Deputy Head of the Geotechnical Engineering Office, GEO (Island) gave a presentation to the team on the Landslide Prevention Action System in Hong Kong. Delegates were briefed on pertinent regulations and the general functions of GEO, including auditing the design of geotechnical works and ensuring required safety standards were met in every new development project. With the introduction of the Landslide Preventive Measures (LPM) Programme, delegates were briefed on the control and monitoring system from planning stage to project launching stage, management of financial resources, monitoring of expenditure and progress, undertaking maintenance works, and other functions. GEO has also introduced the Landslip Prevention and Mitigation Programme (LPMitP), where the objective is to supplement the LPM by handling landslide risks associated with inherited man-made slopes and the natural hillside catchment.

BRIEFING ON GEOTECHNICAL CONTROL IN HONG KONG BY MR. C.K. WONG

by Ir. Quak Boon Kwong

Hong Kong has a hilly terrain with a substantial portion of urban development located near hillsides. Altogether, about 60% of Hong Kong is hilly land. As Hong Kong's population grew, more and more hillsides have been used for urban development. As a result, more relatively steep man-made slopes and retaining structures were built close to buildings, as well as infrastructure such as public roads. Thus, the risk of landslides has increased over the years. In order to minimise the landslide hazard, GEO of CEDD was established in Hong Kong, and has developed an overall landslide risk reduction strategy. To minimise the risk arising from new development, GEO audits all new private slopes and implements strict planning of land use.

GEO exercises geotechnical control over private development through the statutory authority of the Buildings Department (BD). The BD reviews and approves the following plans from a developer or its consultant before the commencement of physical works.

- Building Plan
- Demolition plan
- Ground Investigation Plan
- Site Formation Plan
- Foundation Plan
- Excavation or Lateral Support Plan

GEO provides BD with geotechnical advice during the submission and approval process. During construction, it is a statutory requirement that the construction work must be inspected and monitored by a qualified site

(Continued on page 54)

supervisor who is also the registered structural engineer or registered geotechnical engineer's site representative. Site auditing by the authority is also conducted from time to time to detect any potential non-compliance with the approved plans. For planning and land use, GEO provides the Planning Department with geotechnical input at the early stages of land development, identifying geotechnical constraints and advising on the suitability of land for specific use.

GEOTECHNICAL CONTROLS OVER EXISTING DEVELOPMENT

The Hong Kong Government has implemented an on-going program that involves systematically selecting and examining all government slopes, followed by maintenance and upgrading of any site that is proven to be substandard. For privately-owned slopes, the government actively encourages the owners to maintain the slopes regularly and to upgrade them, if found necessary. The authorities will serve the statutory 'dangerous hillside order' to the relevant party if there is any slope which is deemed dangerous. By taking necessary preventive measures, the risks associated with new projects are kept small, and this has helped substantially to slow down the overall trend of increase in landslide risk in Hong Kong. ■

DONATION LIST TO THE WISMA IEM BUILDING FUND

40th Announcement

The Institution would like to thank all contributors for donating generously towards the Wisma IEM Building Fund. Members and readers who wish to donate can do so by downloading the form from the IEM website (http://www.myiem.org my) or by contacting the IEM Secretariat at +603-7968 4001/5518 for more information. The list of recent contributors, as at 31 August 2011, is shown below.

NO.	MEMBERSHIP NO.	DETAILS
1	02908	ABU HASHIM BIN ABD. GHANI
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3	12730	KAMALUDIN BIN ABDUL SAMAD
4	24537	LAU CHOON HUI, ALAN
5	13340	MOHD. SHAHIRUDIN BIN HAJI TAHA
6	42430	MUHAMMAD MAHADI BIN MOHAMAD
7	00948	NG TUAN HONG
8	08126	SUFFIAN B. WAHID
9	40010	TERRENCE SELVIN A/L ABRAHAM PATTU
10	10340	WONG SHU VUI, ANTHONY
11	11101	ZUHAIRI BIN YUSOFF

MEMBERSHIP WITH THE INSTITUTE OF MATERIALS, MALAYSIA

The Institute of Materials, Malaysia (IMM), registered under the Societies Act with the Registrar of Societies in Malaysia in 1987, will be celebrating its 25th Anniversary in 2012. In conjunction with this occasion, the Council of the IMM has approved an offer of free "ordinary grade" membership to members of other recognised professional bodies globally.

IMM is making this offer to encourage greater participation in the field of material technology. To join IMM, a one-time nominal handling fee of RM40.00 will be imposed.

Kindly contact the IMM Secretariat at 603-5882 3574 or visit the IMM website at www.iomm.org.my for more information on registration requirements.

The Editorial Board, IEM

CALL FOR SUBMISSION OF MANUSCRIPTS FOR IEM JOURNAL

The IEM Journal is an engineering peer-reviewed publication issued quarterly by The Institution of Engineers, Malaysia (IEM). IEM Journal is dedicated to increasing the scope and depth of research across all areas of engineering.

IEM Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence in any of the engineering fields, and will publish:

- Original articles on findings from basic and applied research;
- Case studies;
- Critical reviews, surveys, options, commentaries and essays.

We invite you to submit your manuscripts in Times New Roman (12 point, double spaced) format to:

IEM Journal Editorial Board
Standing Committee on Information and Publications
Lots 60/62, Jalan 52/4, P.O. Box 223 (Jalan Sultan)
46720 Petaling Jaya, Selangor Darul Ehsan
E-mail: pub@iem.org.my/sec@iem.org.my

The Copper Canyon Railway of Mexico

by Ir. Chin Mee Poon

MY wife and I reached the railway station in Los Mochis before 5.00 a.m. Although it was still dark, there were already quite a number of tourists there, who came for the same reason: they were all waiting to board the train for Chihuahua. However, their main purpose was not get to Chihuahua as soon as possible, it was the journey itself that they were looking forward to.

The railroad starts at close to sea level from Los Mochis on the coast of the Gulf of Mexico (formerly the Sea of Cortez) and cuts across the coastal plain in a north-east direction. It then encounters the Sierra Tarahumara, and has to wind its way over the lofty mountain range with the help of 86 tunnels and 39 bridges before descending gradually to the northern city of Chihuahua at 800m above sea level, covering a total distance of 653km and reaching a maximum altitude of 2500m. The construction of the railroad began in 1898 but was not completed until 1961. It took the Mexican government eight years of hard work to overcome the major obstacles imposed by the mountains.

Our train left the railway station at 6.02 a.m., two minutes behind schedule. It was a Primera (First Class) Express train scheduled to make 11 stops along the way and arrive at Chihuahua at 8.56 a.m. The train had only four coaches: two for passengers, one for the bar and one for dining. The fare from Los Mochis to Chihuahua costs 2179 New Mexican pesos (about RM564), which was very expensive indeed.

Another train, known as the Clase Economica Turistica, was scheduled to depart one hour later at 7.00 a.m., make 13 stops along the way and arrive at Chihuahua at 8.42 p.m. It might be less comfortable, but the fare was only half of that for the first train. Nevertheless, we opted for the first train because we did not want to reach Chihuahua late at night as we did not have any hotel reservation there.

The journey was quite mundane initially. About 3 hours and 45 minutes into the journey, however, the train chugged over the 500m long Aguacaliente Bridge, the longest bridge in the entire journey, and soon entered mountainous terrain. Spectacles began to unfold. After going through its first tunnel on the journey, the 1838m long tunnel #86, the train went through one tunnel after another every few minutes.

At 11.30 a.m., our train made a 180° turn over a curved bridge from one side of a canyon to the other. It continued to wind its way up the mountain and, at one stage, we could see the beautiful curved bridge below us. Oh, it was such an unforgettable sight!

We were going through the most dramatic section of the whole journey and it is Tarahumara territory. When our train stopped at San Rafael for 40 minutes, many Tarahumara women were trying to sell their hand-woven leaf baskets to the passengers. At the Divisadero station, many Tarahumara hawkers were selling food and souvenirs. Behind the hawker stalls was a viewing platform on top of a cliff overlooking the 2km deep and equally wide Copper Canyon.

After Creel at 2330m above sea level, we passed through a long tunnel and began to descend. Travelling on a high plain after the dramatic mountainous section, I was very fortunate indeed to witness a spectacular sunset unfolding behind the train. For a solid 15 minutes, I was happily snapping away at the mesmerising display of light and colours. This happened about two and a half hours before our train pulled into the Chihuahua railway station 10 minutes behind schedule.

It is no wonder that this railroad, known officially as the Chihuahua al Pacifico ("Chepe") Railroad, offers one of the most extraordinary rail journeys in the world.

And yes, to clear the doubt that has been on your mind all this while, Chihuahua is indeed the place of origin for the adorable dog breed by the same name. However, you will be disappointed if you try to look for the breed in the City of Chihuahua today as they are surprisingly absent. ■

To All Members,

Date: 12 September 2011

CANDIDATES APPROVED TO SIT FOR YEAR 2011 PROFESSIONAL INTERVIEW

The following candidates have been approved to sit for the Professional Interview for 2011.

In accordance with Bylaws 3.9, the undermentioned names are published as having applied for membership of the Institution, subject to passing the year 2011 Professional Interview.

If any Corporate Member of the Institution has any reason as to why any of the candidates is not a fit and proper person for election, he should communicate in writing to the Honorary Secretary. Such communication should be lodged ***within a month*** from the date of this publication.

Thank you.

Ir. Prof. Dr Lee Teang Shui
Honorary Secretary,
The Institution of Engineers, Malaysia

NEW APPLICANTS

Name	Qualifications
CIVIL ENGINEERING	
AMIRRUDIN BIN JOHARI	BSc (CALIFORNIA STATE) (CIVIL, 1989)
AZUA BT SAPIEE @ ABD RAZAK	BE HONS (UNIMAS) (CIVIL, 1998)
ABDUL HADI BIN ABDUL AZIZ	BSc HONS (GLASGOW) (CIVIL, 1984)
HALIM SHAH BIN MD SHURANI	BE HONS (UTM) (CIVIL, 2006)
TANG CHEE HOW	BE HONS (USM) (CIVIL, 2001)
THEN SIN EAU	BE HONS (USM) (CIVIL, 2001)
ELECTRICAL ENGINEERING	
CHEONG HAR	BE HONS (UM) (ELECTRICAL, 1970)
ISMAIL BIN MOHD KASSIM	BE HONS (UiTM) (ELECTRICAL, 1989)
MOHD FAIZ BIN ABU BAKKAR	BE HONS (UTM) (ELECTRICAL, 2007)
MOHD HAFEZ BIN AMIRRUDIN	BE HONS (UTM) (ELECTRICAL, 2007)
MECHANICAL ENGINEERING	
AHMAD FUAD BIN BABA	BE HONS (UIA) (MECHANICAL-AUTOMOTIVE, 2006)
CHU HON FEI	BE HONS (SHEFFIELD) (MECHANICAL, 1999)
EDWIN SABINUS	BE HONS (LIVERPOOL JOHN MOORES) (MECHANICAL, 1997)

TRANSFER APPLICANTS

Mem No.	Name	Qualifications
CHEMICAL ENGINEERING		
36273	POK BOON LEK	BE HONS (UTM) (CHEMICAL, 1997)
CIVIL ENGINEERING		
26968	GAN SIM KEAT	BE HONS (UTM) (CIVIL, 2003)
24268	KOK KEITH LIN	BE HONS (CANTERBURY) (CIVIL, 2000)
28027	LEE K JIN	BE HONS (UTM) (CIVIL, 2000)
28049	MAK CHIN ONN	BE HONS (UM) (CIVIL, 2004)
33798	MARLENE CLARISSA THOMAS LIKUP	BE HONS (UNIMAS) (CIVIL, 2006)
29149	MOHD AFANDI BIN KONTING	BE HONS (UTHM) (CIVIL, 2003)
43854	SANDEEP SHARMA A/L NEKERAM	BE HONS (UTM) (CIVIL, 2006)
26518	TAN CHIN HAN	BE HONS (UTM) (CIVIL, 2003)
21682	THANG CHEE KEONG	BE HONS (UTM) (CIVIL, 2004)
35650	VIGNESHWARAN KARUNANIDEE	BE HONS (UMS) (CIVIL, 2006)
26622	WONG AIK PEOY	BE HONS (UTM) (CIVIL, 2006)
23665	WONG TZEH CHUAN	BE HONS (NOTTINGHAM) (CIVIL, 2001)
43162	YEE KEAT LEONG	BE HONS (UTM) (CIVIL-ENVIRONMENTAL, 2006)
47109	ZAHLAN BIN SULAIMAN	BE HONS (UPM) (CIVIL, 2000)

TRANSFER APPLICANTS

Mem No.	Name	Qualifications
ELECTRICAL ENGINEERING		
42433	AHMAD FADZLI BIN MAT RAHIM	BE HONS (MALAYA) (ELECTRICAL, 2003)
15753	HASSAN BIN KAMAL	BE HONS (UTM) (ELECTRICAL, 1992)
HIGHWAY AND TRANSPORT ENGINEERING		
42433	SHANMUGA SEKAR THENAPPAN	BE (ANNAMALAI) (CIVIL, 1987) MSc (UPM) (HIGHWAY & TRANSPORT) (2004)
INSTRUMENTATION AND CONTROL ENGINEERING		
38007	TEE KIEN HING	BE HONS (UKM) (ELECTRICAL, 2006)
MECHANICAL ENGINEERING		
25804	CHING CHEE KENG	BE HONS (UTM) (MECHANICAL, 2004)
33896	EZRAL BIN ABDULLAH	BE HONS (UiTM) (MECHANICAL, 2003)
25662	LIAU KOK LENG	BE HONS (LIVERPOOL JOHN MOORES) (MECHANICAL, 2001)
34849	LIM YEN SIANG	BE HONS (ADELAIDE) (MECHANICAL, 2007)
23779	TIAN FUNG WANG	BE HONS (UM) (MECHANICAL, 2004)

IEM DIARY OF EVENTS

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

Engineering Education Technical Division

17 November 2011
TALK ON HEAT PIPES AND EXCHANGERS
Time: 5.30 p.m. to 7.30 p.m.
Venue: TUS Lecture Room, 2nd Floor, Wisma IEM, Petaling Jaya
Speaker: Ir. K.S. Ong

Electrical Engineering Technical Division

3 December 2011
TALK ON THEORY AND CALCULATION OF FAULT CURRENT USING A COMMERCIAL SOFTWARE
Time: 9.00 a.m. to 11.00 a.m.
Venue: TUS Lecture Room, 2nd Floor, Wisma IEM, Petaling Jaya
Speaker: Ir. Lee Chong Kiow

IEM MAJOR EVENTS

12-13 JUNE 2012
11TH CONCET INTERNATIONAL CONFERENCE ON CONCRETE ENGINEEING AND TECHNOLOGY
Venue: Kuala Lumpur
Email: sec@iem.org.my

14-16 JUNE 2012
WOMEN IN ENGINEERING AND TECHNOLOGY CONFERENCE [WIETC2012]:
'Stepping Out of the Shadow'
Organised by: Sub-Committee on Women Engineers
Email: jac@iem.org.my
(Call for papers)

OTHER EVENTS

For more information, kindly contact the organiser accordingly.

27-30 November 2011
29TH CONFERENCE OF ASEAN FEDERATION OF ENGINEERING ORGANISATIONS ON SUSTAINABLE URBANISATION: ENGINEERING CHALLENGES AND OPPORTUNITIES (CAFEO 29)
Venue: The Rizqun International Hotel, Bandar Seri Begawan, Brunei
Tel: +673 238 4021 Fax: +673 238 4021 Email: cafeo29.brunei@gmail.com
Website: www.puja-brunei.org
(Invitation to register)

COUNCIL ELECTION FOR SESSION 2012/2013

3rd Announcement

Nomination papers for the Election of Council Members for Session 2012/2013 will be posted on the IEM website (http//www.myiem.org.my) and made available at the IEM Secretariat office by 23 November 2011. The closing date for nominations is on 21 December 2011.

Thank you.

Dato' Pang Leong Hoon
Election Officer, IEM

Answer for 1Sudoku published on page 51 of this issue.

3	1	5	6	4	8	2	9	7
8	2	6	3	9	7	5	1	4
9	7	4	5	2	1	8	6	3
1	9	2	4	8	3	7	5	6
6	3	7	9	1	5	4	2	8
4	5	8	2	7	6	1	3	9
7	4	9	1	6	2	3	8	5
2	8	3	7	5	9	6	4	1
5	6	1	8	3	4	9	7	2

Note: *This is a continuation of the list approved by 378th Council Meeting on 18 July 2011 which was first published on page 58 of the September 2011 issue.*

TRANSFER TO THE GRADE OF FELLOW MEMBER

Mem No.	Name	Qualifications
CIVIL ENGINEERING		
15253	LIU CHONG YEW	BE HONS (MONASH) (CIVIL, 1984) ME (MONASH) (CIVIL, 1987)
MECHANICAL ENGINEERING		
05327	THE PIAW NGI	BE HONS (PORTSMOUTH POLY) (MECHANICAL, 1980)

TRANSFER TO THE GRADE OF MEMBER

Mem No.	Name	Qualifications
CHEMICAL ENGINEERING		
25761	LAU BEN FANG, RAYMOND	BE HONS (UTM) (CHEMICAL, 2001)
25488	VONG CHWEE CHIN	BE HONS (UPM) (CHEMICAL, 2000)
30562	ZAKI YAMANI BIN ZAKARIA	BE HONS (BRADFORD) (CHEMICAL, 1999) ME (UTM) (CHEMICAL, 2004)
39160	ZURAIDA WONG BINTI ZULKIFLI	BE HONS (ADELAIDE) (CHEMICAL, 2000)
CIVIL ENGINEERING		
24187	BEH WEI SIM	BE HONS (UM) (CIVIL, 2000)
16592	CHANG AIK HOOI	BE HONS (SHEFFIELD) (CIVIL & STRUCTURAL, 1994)
19769	CHIA WEN HWA	BE HONS (UTM) (CIVIL-CONSTRUCTION MANAGEMENT, 2003)
25413	CHOO HOW WEE	BE HONS (UNITEN) (CIVIL, 2004)
25560	DORIS BT PRIMUS	BE HONS (UNIMAS) (CIVIL, 2001)
25602	FARAH HAZNEE BINTI AHMAD	BE HONS (UNITEN) (CIVIL, 2003)
33987	HAFIFI HAFIDZ BIN MOHD	BE HONS (UTM) (CIVIL, 2005)
21184	HAN CHEE KEONG	BE HONS (UM) (CIVIL, 2002)
24472	IMELDA ANAK JELANI	BE HONS (USM) (CIVIL, 2001)
9810	ISMAYATIM BIN HAMDAN	BSc (HARTFORD) (CIVIL, 1987) MSc (UPM) (INFORMATION TECHNOLOGY, 2001)
24408	KALAIKUMAR A/L VELLAYUTHAM	BE HONS (UTM) (CIVIL, 2002) MSc (MANCHESTER) (STRUCTURAL, 2007)
18395	KRISHNAKUMAR A/L PARAMANANDAN	BE HONS (UM) (CIVIL, 2002)
26422	LAU SHENG RONG, JEFFREY	BE HONS (QUEENSLAND) (CIVIL, 2004)
26863	LIM CHI AUN	BE HONS (NTU, SINGAPORE) (CIVIL, 2004)
21957	LIM KHEAN MIN	BE HONS (NOTTINGHAM, UK) (CIVIL, 2000)
22313	LOKE YAN WAI	BE HONS (UPM) (CIVIL, 2000)
19414	MOHAMED MUBARAK BIN ABDUL WAHAB	BE HONS (UTM) (CIVIL, 2000) ME (MELBOURNE) (STRUCTURES, 2006)
35534	MOHD AZHARI BIN MOHD SAPIE	BE HONS (UTM) (CIVIL, 2007)
37227	MOHD AZREEN BIN SAIDIN	BE HONS (UTM) (CIVIL, 2004)
37878	MOHD FADZLY BIN AHMAD ZAWAWI	BE HONS (USM) (CIVIL, 2001)
41103	MOHD NAJIB BIN ABDULLAH	BE HONS (UTM) (CIVIL, 2004)
45364	MOHD NAZREE BIN YUSOF	BE HONS (UTM) (CIVIL-CONSTRUCTION MANAGEMENT, 2002)
28047	MOHD ZAMRY BIN ZAKARIA	BE HONS (UTM) (CIVIL, 2005)
21474	MONA VOO LU TIN	BE HONS (BIRMINGHAM) (CIVIL, 2000)
15569	MORIS BIN SAMY	BE (UM) (CIVIL, 1991)
12346	MUSLIM BIN ABDULLAH	BE (MIDDLESEX POLY, CNAA) (CIVIL, 1987)
24859	NG BOON CHONG	BE HONS (UTM) (CIVIL, 2003)
15131	NG BOON SAI	BE HONS (UPM) (CIVIL, 1994)
24519	OOI CHOY HOONG	BE HONS (UTM) (CIVIL, 2003)
29051	PASCHAL DAGANG ANAK KEVIN AKEU	BE HONS (UiTM) (CIVIL, 2003)
26488	RAHAIMI BIN ABDUL KAHAR	BE HONS (UM) (CIVIL, 2003) ME (UM) (SCIENCE, 2007)
17772	RASIDI BIN SENIN	BE HONS (UiTM) (CIVIL, 1999)
NEW	TAN CHIA PYNG	BE HONS (UTM) (CIVIL, 2002)
25268	TAN HUN KIN	BE HONS (USM) (CIVIL, 2002)
21378	THAM LIAN YU	BE HONS (UTM) (CIVIL, 2002) ME (UTM) (CONSTRUCTION MANAGEMENT, 2003)
24452	THONG CHIN MUN	BE HONS (UTM) (CIVIL, 2001)
36302	THONG FOO HOW	BE HONS (UTM) (CIVIL, 2003)
11773	VIJAYAKUMAR A/L M. BALACHAND	BE HONS (UM) (CIVIL, 1988)
37251	WANG CHAN YONG	BE HONS (UTM) (CIVIL, 2003)
37054	WANG LIANG CHUAN	BE HONS (UTHM) (CIVIL, 2005)
29104	WONG MUN FAI	BE HONS (UKM) (CIVIL & STRUCTURAL, 2005)
38624	YEO TIONG HUI	BE HONS (USM) (CIVIL, 2004)
22215	YII TOH LEONG	BE HONS (MANCHESTER) (CIVIL, 2000)
29816	ZAIDI BIN IBRAHIM	BE HONS (UTM) (CIVIL, 2005)
26935	ZALINA BINTI MOKHTAR	BE HONS (UM) (CIVIL, 2004) MSc (UiTM) (CIVIL, 2008)
ELECTRICAL ENGINEERING		
18039	ABDUL AZIZ BIN ABDULLAH	BE HONS (LIVERPOOL JOHN MOORES) (ELECTRICAL & ELECTTRONIC, 1996)
26868	CHAN CHIAW YIN	BE HONS (UKM) (ELECTRICAL & ELECTRONIC, 2004)
25746	CHANG YEE LING	BE HONS (UTM) (ELECTRICAL, 2003)
29628	LAI KOK FU	BE HONS (UTM) (ELECTRICAL, 2003)
20090	LEE YEE SENG	BE HONS (UTM) (ELECTRICAL, 1999)
25178	LIN KEE MING	BE HONS (UNITEN) (ELECTRICAL POWER, 2004)
17157	LUI MAN LEONG	BE HONS (UTM) (ELECTRICAL, 2006)
38848	MAK KAH WEE	BE HONS (UTM) (ELECTRICAL, 2005)
28978	MOHD FAIRUZ BIN ABDUL HAMID	BE HONS (UTM) (ELECTRICAL, 2002) ME (UTM) (ELECTRICAL-POWER, 2008)
30596	MUHAMMAD HAFIZUDDIN BIN MOHAMAD	BE HONS (UM) (ELECTRICAL, 2006)

TRANSFER TO THE GRADE OF MEMBER

Mem No.	Name	Qualifications
19721	RADZILAN BIN ABDUL RAHMAN	BE HONS (UTM) (ELECTRICAL, 1999)
33766	SIOW JAT SHERN	BE HONS (MMU) (ELECTRICAL, 2007)
20335	TOH LEONG SOON	BE HONS (UTM) (ELECTRICAL, 2003) ME (UTM) (ELECTRICAL, 2006)
ELECTRONIC ENGINEERING		
29661	FRANCIS ABLIGADO ANAK BUJET	BE HONS (UNIMAS) (ELECTRONIC & TELECOMMUNICATION, 2000)
23044	LIEW CHIA PAO	PART 1 & 2 (ECUK) (ELECTRONICS, 2001)
INSTRUMENTATION & CONTROL ENGINEERING		
38664	ABDUL MALEK BIN CHE SOH	BE HONS (USM) (ELECTRICAL & ELECTRONIC, 2002)
24931	KIRUBAGARAN A/L ARUMUGAM @ ARMUGAM	BSc (WICHITA STATE) (ELECTRICAL, 1999)
MECHANICAL ENGINEERING		
44184	ABD LATIFF BIN YAAKOB	BE (MINNESOTA) (MECHANICAL, 1989)
30564	ARMAN BIN ARIFFIN	BE HONS (UTM) (MECHANICAL, 2005)
24484	HASRIL BIN HASINI	BE HONS (SHEFFIELD) (MECHANICAL, 2000)
23766	KWONG QI JIE	BE HONS (UTHM) (MECHANICAL, 2006) MSc (UPM) (ENERGY ENGINEERING, 2010)
33733	MUHAMMAD AMIN BIN ROMELI	BE HONS (UTM) (MECHANICAL, 2002)
38878	MUHAMMAD ILLIA'AZAR BIN ILIAS	BE HONS (UTM) (MECHANICAL, 2004)
22520	PHEH GUAN CHOON	BE HONS (UPM) (MECHANICAL, 2004)
22053	PREM RAKESH A/L SUBRAMANIAM	BE HONS (UNITEN) (MECHANICAL, 2005)
21815	TANG TUNG PIN	BE HONS (UM) (MECHANICAL, 2004)
21169	VASAN A/L MARIAPPAN	BE HONS (UTM) (MECHANICAL, 2002) BE HONS (UPM) (AGRICULTURAL, 1998)

PASS PAE

Mem No.	Name	Qualifications
ELECTRONIC ENGINEERING		
16879	RIZALUDIN BIN KASPIN	BE HONS (VICTORIA UNI OF MANCHESTER) (ELECT & E'TRONIC, 1992) MSc (UPM) (COMMUNICATION & NETWORK, 2003)
INSTRUMENTATION & CONTROL ENGINEERING		
26899	MOHD REDZUAN BIN MOHD RAFIEE	BE HONS (UTM) (ELECTRICAL, 2003)

ELECTION TO THE GRADE OF MEMBER

Name	Qualifications
AGRICULTURAL ENGINEERING	
WAN WAI THONG	BE HONS (UPM) (AGRICULTURAL, 1993)
CHEMICAL ENGINEERING	
WONG LOONG CHING	ME (EXETER) (CHEMICAL & PROCESS, 1999)
ZULKERNAIN BIN MAT ADAM	BE HONS (UM) (CHEMICAL, 1994)
CIVIL ENGINEERING	
ABANG AFFENDY BIN ABANG SEPUAN	BE HONS (UM) (CIVIL, 2000)
BAHARUDDIN BIN ABDULLAH	BE HONS (UTM) (CIVIL, 1986)
ERNI MAWAR BINTI BURHANUDDIN	BE HONS (UTM) (CIVIL, 1999)
FAZLEE BIN DAUD	BE HONS (UKM) (CIVIL & STRUCTURAL, 1998)
GORCARAN SINGH @ GURCHARAN SINGH A/L GURDIT SINGH	BSC (IDAHO STATE UNI) (CIVIL, 1992)
HIDZRAMI BIN SHAMSUL ANWAR	BSC (CALIFORNIA STATE UNI) (CIVIL, 1986)
HII KING YUNG	BE HONS (CANTERBURY) (CIVIL, 1989)
LAW SEK HUI	BE HONS (UKM) (CIVIL & STRUCTURAL, 2002)
LEAN KOK WOEI	BE HONS (USM) (CIVIL, 1999)
LEE MEI FOONG	BE HONS (UM) (CIVIL, 2002)
LING NENG YIN, STEVEN	BE (AUCKLAND) (CIVIL, 2003) ME (NEW SOUTH WALES) (TRANSPORT, 2004)
MOHAMAD ADHAR BIN YAHAYA	BE HONS (UiTM) (CIVIL, 2003)
MOHD ADIB BIN PAHORUDIN	BE HONS (UTM) (CIVIL, 2003)
MOHD YAZID BIN AHMAD	BE (SOUTH BANK) (CIVIL, 1994)
NUR SHARINAWATI BINTI ZAINUDIN	BE HONS (USM) (CIVIL, 2002)
WONG MING CHANG	BE HONS (UTM) (CIVIL, 1999)
WONG WEE LIM	BE HONS (UTM) (CIVIL, 2002)
YAP LEAN KENT	BE HONS (USM) (CIVIL, 2002)
ZARABIZAN BIN ZAKARIA	BE HONS (UTM) (CIVIL, 2002) ME (UPM) (HIGHWAY & TRANSPORTATION, 2009)
ELECTRICAL ENGINEERING	
CHONG SIEW LEUNG	BE (MONASH) (ELECTRICAL, 1989)
GOBI KANNAN A/L SUPRAMANIAM	BSC (WESTERN MICHIGAN) (ELECTRICAL, 1999) ME (UNITEN) (ELECTRICAL, 2009)
HARRIEZAN BIN AHMAD	BSC (NORTHWESTERN UNI, USA) (ELECTRICAL, 2000)
LIM KEW TEE	BSC (TENNESSEE) (ELECTRICAL, 1993)
SARAVANA KUMARAN A/L ARUNACHALAM	BE HONS (UTM) (ELECTRICAL, 2004)
TAN LET KEONG	BE HONS (UM) (ELECTRICAL, 1988)
TUNG PANG KHIEN	BE HONS (UNITEN) (ELECTRICAL POWER, 2004)
INSTRUMENTATION & CONTROL	
NG CHIN GUAN, JASON	BE HONS (UTP) (ELECTRICAL & ELECTRONIC, 2005)

ELECTION TO THE GRADE OF MEMBER

Name	Qualifications
MECHANICAL ENGINEERING	
CHIA SWEE PENG	BE HONS (UM) (MECHANICAL, 1997)
GAN CHEE HAU	BE HONS (SHEFFIELD) (MECHANICAL, 2002)
KHAIRUL NIZAM BIN MD TOHIT	BE HONS (UTM) (MECHANICAL, 2002) MSC (UPM) (INDUSTRY & SYSTEM, 2006)
MALEK FAIZAL BIN IDRUS	BSC (MARQUETTE, USA) (MECHANICAL, 1990)
SAIFULBAHARI BIN ABDUL HAMID	BE HONS (UM) (MECHANICAL, 2000)
SHAHUL HAMID BIN MOHD ISMAIL	BE HONS (ADELAIDE) (MECHANICAL, 1975) ME (ADELAIDE) (SCIENCE, 1982)
THAN SHEAU WEI	BE HONS (UTM) (MECHANICAL, 2001)

PASS PAE

Name	Qualifications
CIVIL ENGINEERING	
BAZLI BIN MAT AKHIR	BE HONS (USM) (CIVIL, 1997)
SHARIFUDDIN BIN SULAIMAN	BSC (MISSOURI) (CIVIL, 1988)
ELECTRICAL ENGINEERING	
AZIZUDDIN BIN ZAKARIA	BE HONS (GLAMORGAN) (ELECTRICAL & ELECTRONIC, 1997)
MECHANICAL ENGINEERING	
SUKHAIRUL NIZAM BIN ABDUL RAZAK	BE HONS (UTM) (AERONAUTICS, 1995)

TRANSFER TO THE GRADE OF GRADUATE

Mem No.	Name	Qualifications
CHEMICAL ENGINEERING		
42768	ALIF AZWAN BIN ABDUL WAHAB	B.E.HONS.(UiTM) (CHEMICAL, 2010)
23710	BEE SOO TUEEN	B.E.HONS.(UTM) (CHEMICAL, 2006) M.E.(UTM)
31869	NG CHAI LENG	B.E.HONS.(UTM) (CHEMICAL, 2010)
25716	SHOBA SEKARAN	B.E.HONS.(UTM)(CHEMICAL-GAS,06)
CIVIL ENGINEERING		
33310	AHMAD RUSDI BIN SULONG	B.E.HONS.(UiTM)(CIVIL,09)
23342	AMELIA BINTI ABDUL MALEK	B.E.HONS.(UiTM)(CIVIL,06)
33315	AWANG NASRIZAL BIN AWANG ALI	B.E.HONS.(UiTM)(CIVIL,09)
27103	CHIN CHING WEI	B.E.HONS.(USM)(CIVIL,07)
43425	DARUL NAFIS BIN ABAS	B.E.HONS.(UTM)(CIVIL,11)
33512	DORIS ASMANI BINTI MAT YUSOF	B.E.HONS.(UiTM)(CIVIL,10)
43878	ERRWAN BIN ABDUL RASHID	B.E.HONS.(UTM) (CIVIL, 2011)
43424	HARLINA BINTI MD NOR	B.E.HONS.(UTM)(CIVIL,11)
29533	HONG BOON KHANG	B.E.HONS.(UPM)(CIVIL,10)
28269	KOK YING CHYN	B.E.HONS.(USM)(CIVIL,09)
26631	KUEK YI HAO	B.E.HONS.(MALAYA)(CIVIL,07)
36910	LEE JIEN YEIH	B.E.(RMIT) (CIVIL, 2010)
38981	LEONG PEIR WEN	B.E.HONS.(UTAR)(CIVIL,10)
38989	LIM CHUN HAN, JUNIOR	B.E.HONS.(UTAR)(CIVIL,10)
37312	LIM SHEA LI, ANNIE	B.E.HONS.(UTAR)(CIVIL,10)
43879	MD ALI NIZAN BIN RAMLI	B.E.HONS.(UTM) (CIVIL, 2011)
31099	MOHAMMAD FAHMI BIN MOHAMMAD SOBRI	B.E.HONS.(UMP)(CIVIL,07)
42640	MOHD AFFANDI BIN MOHD	B.E.HONS.(UTM)(CIVIL,11)
31219	MOHD AZHAR BIN ZAINUL ABIDIN	B.E.HONS.(UiTM)(CIVIL,09)
31080	MOHD FAIZUL BIN YUSOF	B.E.HONS.(UMP) (CIVIL, 2007)
19597	MOHD SALLEHUDIN BIN MUHAMAT YAAKOP	B.E.HONS.(UiTM) (CIVIL,2001)
32021	MUHD JOHAN ARIFF BIN MUHAMMAD FANI	B.E.HONS.(USM) (CIVIL. 2008)
28394	NG JIA LIN	B.E.HONS.(UTAR)(CIVIL,10)
33498	NUR SYAFAWATIE BINTI MOHAMED SARI	B.E.HONS.(UiTM)(CIVIL,10)
31537	PANG CHANG HUI	B.E.HONS.(UTM)(CIVIL,10)
35916	SEAH WEI CHENG	B.E.HONS.(UTM)(CIVIL,10)
33327	SYAZANA SYAHIRAH BINTI JAMALUDDIN	B.E.HONS.(UiTM)(CIVIL,10)
28105	TAN KAI LOON	B.E.HONS.(USM) (CIVIL, 2009)
29484	TEO LENG HOOI	B.E.HONS.(UPM)(CIVIL,10)
33008	TEOH CHUANG YEEN	B.E.HONS.(UTM)(CIVIL,10)
35930	THONG CHU JIUN	B.E.HONS.(MALAYA)(CIVIL,10)
21175	TOH CHIN KOK	B.E.HONS.(UTM) (CIVIL-CONSRTUCTION MGMT,01)
42175	TOU YOK SAN	B.E.HONS.(USM) (CIVIL, 2010)
42378	WONG LEONG URN, TIMOTHY	B.E.HONS.(UNIMAS)(CIVIL,10)
28301	YAP AI CHOO	B.E.HONS.(USM)(CIVIL,07)
28197	ZAINAL ABIDIN BIN HASAN	B.E.HONS.(MALAYA) (CIVIL, 2007)
ELECTRICAL ENGINEERING		
29336	GANAESAN A/L TEVADASIN	B.E.HONS.(UMP) (ELECTRICAL-POWER SYSTEMS,10)
34910	JAMALUDDIN BIN ABU BAKAR	B.E.HONS.(UTM)(ELECTRICAL,10)
41472	LIM YEE KUAN	B.E.HONS.(UNITEN) (E'TRICAL & E'TRONIC,2010)
MECHANICAL ENGINEERING		
32425	MOHD KHAIRUL EFFENDI BIN MUHAMMAD	B.E.HONS.(UiTM)(MECHANICAL,09)

TRANSFER TO THE GRADE OF GRADUATE

ELECTRONIC ENGINEERING

Mem No.	Name	Qualifications
23572	AHMAD 'ATHIF BIN MOHD FAUDZI	B.E.HONS.(UTM)(COMPUTER,04) MSc(UTM)(E'TRICAL,06) PhD(OKAYAMA)(SYSTEM INTERGATION,10)
36572	MOHD AIZAT FAIZ BIN MOHD YAZID	B.E.HONS.(UMP) (ELECTRONIC,09)
37859	SAIFUL AKMAL BIN MD RAFI	B.E.HONS.(UNITEN) (E'TRICAL & E'TRONIC,2010)

ENVIRONMENTAL ENGINEERING

Mem No.	Name	Qualifications
28603	KHAIROOL ANWAR BIN ALIAS	B.E.HONS.(MALAYA)(ENVIRONMENT,07)

MECHANICAL ENGINEERING

Mem No.	Name	Qualifications
28661	ABUL ASWAD BIN ABDUL LATIFF	B.E.HONS.(UKM) (MECHANICAL, 2009)
31300	AHMAD JOHARI BIN ROSLI	B.E.HONS.(UiTM) (MECHANICAL, 2009)
34444	EM POH PING	B.E.HONS.(UTeM) (MECHANICAL, 2009)
26145	MAHFODZAH BINTI MD. PADZI	B.E.HONS.(UTM) (MECHANICAL, 2007)
28619	MICHAEL A/L ISSAK	B.E.HONS.(UTeM)(DESIGN & INNOVATION,09)
25140	MOHD HAZRAD UMAR BIN ABD RAHMAN	B.E.HONS.(UiTM) (MECHANICAL, 2008)
30245	MOHD SHAHAR BIN SULAIMAN	B.E.HONS.(UiTM) (MECHANICAL, 2010)
25931	MUHAMMAD FALIQ ANWAR BIN MUHAMMAD FAUZI	B.E.HONS.(UTM)(MECHANICAL,06)
32910	NORFAIZIRA BINTI SHARIFUDDIN	B.E.HONS.(UTM)(MECHANICAL,09)
28624	POH PAY ING	B.E.HONS.(MMU)(MECHANICAL,07)
27431	SAIFUL DIN BIN SABDIN	B.E.HONS.(UTHM) (M'FACTURING & PRODUCTION,07)
27215	SORAYA SRI CAHAYA BINTI ABDUL HAMID	B.E.HONS.(UNITEN) (MECHANICAL, 2009)

MECHATRONIC ENGINEERING

Mem No.	Name	Qualifications
21901	YANG CHUAN CHOONG	B.E.HONS.(IIUM)(MECHARONICS,04)

ADMISSION TO THE GRADE OF GRADUATE

AEROSPACE ENGINEERING

Mem No.	Name	Qualifications
48880	ABDUL GHANI BIN AHMAD	B.E.HONS.(UPM)(AEROSPACE,00)
48923	MD AMZARI BIN MD ZHAHIR	B.E.HONS.(GLASGOW)(AEROSPACE,04) PhD(LONDON)(RESEARCH,10)
48879	TANG SING PENG	B.E.HONS.(USM)(AEROSPACE,09)

AGRICULTURAL ENGINEERING

Mem No.	Name	Qualifications
48105	HUANG YUK FENG	B.E.HONS.(UPM) (AGRICULTURAL, 1999) M.SC (UPM) (CIVIL,01) PhD (UPM) (WATER RESOURSES,05)
48061	KHAIRUNNISA BINTI HAMDAN	B.E.HONS.(UPM) (AGRICULTURAL, 2009)
48103	SAZALI BIN WAHAB	B.E.HONS.(UPM) (AGRICULTURAL, 2000)

BIOCHEMICAL ENGINEERING

Mem No.	Name	Qualifications
48854	AZRIL BIN MOHAMAD AZIZ	B.E.HONS.(UIAM) (BIOCHEMICAL-BIOTECHNOLOGY,08)
48867	MOHD HANAFI BIN MAT SOM	B.E.HONS.(MALAYA)(BIOMEDICAL,06) MSc(WALES)(BIOMEDICAL,08)
48434	NUR FARAHIYAH BINTI MOHAMMAD	B.E.HONS.(MALAYA) (BIO-MEDICAL,06) MSc(MELBOURNE,07)

CHEMICAL ENGINEERING

Mem No.	Name	Qualifications
48509	EMY SYAFINAS BINTI HAMID @ OSMAN	B.E.HONS.(UMP)(CHEMICAL,07) MSc(WALES)(PETROLEUM,10)
48040	HAIRUL NAZIRAH BINTI ABDUL HALIM	B.E.HONS.(USM) (CHEMICAL, 2004) M.SC. (USM) (CHEMICAL,08)
48091	HIAP HOCK BOON	B.E.HONS.(UPM) (CHEMICAL, 2006)
48451	LIM UEI BANN	B.E.HONS.(UTM)(CHEMICAL-GAS,01)
48856	MOHD ABU YAZID BIN ABU BAKAR	B.E.HONS.(MALAYA)(CHEMICAL,09)
48431	MOHD AZMIER BIN AHMAD	B.E.HONS.(USM)(CHEMICAL,00) MSc(USM)(CHEMICAL,03) PhD(UM)(CHEMICAL,07)
48912	MOHD NIZAM BIN TEH KAMARUDDIN	B.E.HONS.(UTM)(CHEMICAL,07)
48518	NAZREEN ABDUL RAHIM	M.E.HONS.(LOUGHBOROUGH) (CHEMICAL,07)
48862	NUR SYAFIKAH BINTI MOHAMAD SHAHAPUZI	B.EHONS (UTM) (CHEMICAL, 10)
48111	PARANI KUMAR A/L P. SUBRAMANIAM	B.E.HONS.(UTM) (CHEMICAL, 1999) M.E. (UTM) (GAS,99)
48888	SHAHRIL BIN MOHAMAD	B.E.HONS.(UMP)(CHEMICAL,07) MSc(UTP)(SCIENCE,11)
48475	TEOH HUI CHIEH	B.E.HONS.(UKM)(CHEMICAL,01) MSc(UKM)(CHEMICAL,04)

CIVIL ENGINEERING

Mem No.	Name	Qualifications
48038	ABD MUHAIMIN SYAHMAN BIN MOHD NGAH	B.E.HONS.(UTP) (CIVIL, 2006)
48852	ABDUL MANAF BIN AHMAD FAWZAN	B.E.HONS.(KLIUC)(CIVIL,10)
48863	ADLAN RAFHAN BIN BURAHAN	B.E.HONS.(UTM)(CIVIL,00)
48058	ADRIAN ANAK JON	B.E.HONS.(UiTM) CIVIL, 2004)
48905	AHMAD ALINAFIA BIN ALIAS	B.E.HONS.(UNIMAS)(CIVIL,07)
48067	AHMAD HAFIZ BIN ROSLAN	B.E.HONS.(UNITEN) (CIVIL, 2007)
48847	AHMAD SYAWAL BIN YAHYA	B.E.HONS.(UTM)(CIVIL,09)
48921	AMIDAH BINTI MOHD UJANG	B.SC.(ABERDEEN)(CIVIL,87)
48079	AZHAR B. HASSAN	B.E.HONS.(UTM) (CIVIL, 2009)
48110	AZIZAH BINTI BAHAROM	B.E.HONS.(UiTM) (CIVIL, 2002)
48883	AZIZUL BIN MASURI	B.E.HONS.(UTM)(CIVL,09)

ADMISSION TO THE GRADE OF GRADUATE

Mem No.	Name	Qualifications
48858	CHAN CHEAH FEI	B.E.HONS.(UTM)(CIVIL,08)
48093	CHEONG JIT SENG	B.E.HONS.(USM) (CIVIL, 2005)
48895	CHEW CHIN YEANG	B.E.HONS.(UTM)(CIVIL,06)
48454	CHIA HUI CHING	B.E.HONS.(UNIMAS)(CIVIL,09)
48477	CHIN LIAN FON	B.E.HONS.(UTHM)(CIVIL,09)
48432	CHIN TEN YEE	B.E.HONS.(UMS)(CIVIL,05)
48928	CHUA KIAT SIONG, KENNY	M.E.HONS.(SWANSEA)(CIVIL,10)
48893	CHUNG HENG KONG	B.E.HONS.(UKM)(CIVIL & STRUCTURAL,06)
48101	DICKSON ANAK ANTHONY	B.E.HONS.(UiTM) (CIVIL, 2007)
48495	FOO TUN YUNG, ROBIN	B.E.(SOUTH AUSTRALIA)(CIVIL,05)
48480	GAN KHAI SIAN	B.E.HONS.(USM)(CIVIL,10)
48851	GU KOK KIN	B.E.HONS.(UTM)(AWAM,10)
48453	HII KING WOU	B.E.HONS.(KUiTTHO)(CIVIL,06)
48907	HO KING FOO	B.E.HONS.(UMS)(CIVIL,09)
48925	HONG YING TOONG	B.E.HONS.(LEEDS) (CIVIL & STRUCTURAL,03)
48071	JILL FLUER C BENSING	B.E.HONS.(UTM) (CIVIL, 2006)
48102	JIRAM ANAK JACK	B.E.HONS.(UiTM) (CIVIL, 2008)
48489	JOE PRIMUS KAYAU	B.E.HONS.(WARWICK)(CIVIL,98)
48456	JOVILIS BIN MAJAMI	B.E.HONS.(UMS)(CIVIL,10)
48501	KANG YEE PING	B.E.HONS.(UTM)(CIVIL,10)
48506	KEE CHING GUAN	B.E.(NANYANG)(CIVIL,02) MSc(NANYANG)(GEOTECHNICAL,06)
48115	KENNY BIN PAPING	B.E.HONS.(UiTM) (CIVIL, 2005)
48924	KHOO CHEN KIAT	B.E.HONS.(NOTTINGHAM)(CIVIL,06)
48481	KHOO LAI PENG	B.E.HONS.(UMP)(CIVIL,10)
48500	KHOO TIAN HUI	B.E.HONS.(UTHM)(CIVIL,09)
48476	LAM YOKE WOH	B.E.HONS.(MALAYA)(CIVIL,10)
48927	LAU TECK LEONG	B.E.HONS.(BIRMINGHAM)(CIVIL,00) MSc(BIRMINGHAM)(CIVIL,05)
48918	LEE VOON HEE	B.E.HONS.(NSW)(CIVIL,09) MSc((NSW)(GEOTECHNICAL,09)
48068	LEE WOEI CHANG	B.E.HONS.(UTeM) (CIVIL, 2006)
48520	LEOW YOONG KHA	B.E.(QUEENSLAND)(CIVIL,09)
48850	LIAW YONG MING	B.E.HONS.(UNITEN)(CIVIL,10)
48096	LIM CHING YAW	B.E.HONS.(WESTERN AUSTRALIA) (CIVIL, 2007)
48868	LIM GEE ZHIONG	B.E.HONS.(UNIMAS)(CIVIL,09)
48896	LOH WEI LUN	B.E.HONS.(UMS)(CIVIL,10)
48911	MOHD AJIB BIN MAT DAUD	B.E.HONS.(UiTM)(CIVIL,07)
48471	MOHD AZIM BIN MOHD ARIF	B.E.HONS.(MALAYA)(CIVIL,06)
48045	MOHD FAIZAL BIN JALIL	B.E.HONS.(UTM) (CIVIL, 2008)
48069	MOHD KALMIZAN B. YUSOFF	B.E.HONS.(USM) (CIVIL, 2005)
48458	MOHD MAIZIZ BIN FISHOL HAMDI	B.E.HONS.(UTM)(CIVIL,06) MSc(UTM)(CIVIL-STRUCTURE,08)
48452	MOHD NASER BIN SULAIMAN	B.E.HONS.(UMP)(CIVIL,10)
48511	MOHD SAIFUL BIN ZAKARIA	B.E.HONS.(UiTM)(CIVIL,07)
48034	MUHAMAD ADZHA BIN IBRAHIM	B.E.HONS.(USM) (CIVIL, 2004)
48872	MUHAMAD AZHAR BIN RAMLEE	B.E.HONS.(UiTM)(CIVIL,06)
48933	MUHAMMAD FURQAN BIN KHIDIL	B.E.HONS.(UTM)(CIVIL,09)
48457	MUHAMMAD KHUSAIRI BIN ABDUL MURAD	B.E.HONS.(UiTM)(CIVIL,02)
48505	NASRUL HADI BIN AMIR	B.E.HONS.(UTM)(CIVIL,00)
48890	NOREENA BINTI ABD SATTAR	B.E.HONS.(UTHM)(CIVIL,07)
48055	NORZAMZILA BINTI MUSTAFA	B.E.HONS.(UTM) (CIVIL, 2004) M.SC. (UTM) (BULDING MGMNT'05)
48849	NUR MIZHUARI BIN HJ ABDUL SAMAT	B.E.HONS.(UTM)(CIVIL,09)
48902	NURAINI BINTI MUAR	B.E.HONS.(UiTM)(CIVIL,07)
48885	NURUL HUDA BINTI ISHAK	B.E.HONS.(UTHM)(CIVIL,10)
48092	PUSPANATHAN A/L SUBRAMANIAM	B.E. HONS (UMP) (CIVIL, 2009)
48075	R. THINAGARAN A/L V. RAMASAMY	B.E.HONS.(UTM) (CIVIL, 2005)
48054	RAHIMAH BINTI SHAHAR	B.E.HONS.(UTM) (CIVIL, 1990)
48059	RAJA KHAIRUL AMIR B. RAJA KAMAL BASHAH	B.E.HONS.(UiTM) (CIVIL, 2010)
48900	RAMESH KUMAR A/L PUSPASAGARAM	B.E.HONS.(UNISEL)(CIVIL,08)
48942	RASHIDAH BINTI ADON @ MOHD DON	B.E.HONS.(UTHM) (CIVIL-CONSTRUCTION,07)
48478	RUZAINI HAFIZUDDIN BIN MOHAMMAD	B.E.HONS.(KUiTTHO)(CIVIL,06)
48899	SAHARA BINTI SAI'EN @ ABDULLAH	B.E.HONS.(UMS)(CIVIL,07)
48874	SASITHARAN A/L NAGAPAN	B.E.HONS.(UTHM)(CIVIL,03)
48098	SEET KHING LIONG	B.E.HONS.(USM) (CIVIL, 2010)
48484	SEOW WUI GIAP	B.E.HONS.(UTM)(CIVIL,06)
48455	SHARIL AZHAR BIN NOORDIN	B.E.HONS.(UiTM)(CIVIL,03)
48051	SIVANANDAN A/L BALAKRISHNAN	B.E.HONS.(UTM) (CIVIL, 2002)
48944	SULAIMAN BIN ABDUL GHANI	B.SC.(LEHIGH)(CIVIL,90)
48884	SUTHAGARAN A/L SUBRAMANIAM	B.E.HONS.(UTM)(CIVIL,04), MSc(UTM) (CIVIL-TRANSPORTATION & HIGHWAY,07)
48517	TAN KHAI YIH	B.E.HONS.(UTM)(CIVIL,01)
48503	TEH WAI SAN	B.E.HONS.(UTAR)(CIVIL,10)
48085	TENGKU ISKANDAR B TENGKU ISMAIL	B.E.HONS.(UTHM) (CIVIL, 2005)
48080	THIAN BOON CHUNG	B.E.HONS.(UPM) (CIVIL, 2003)
48502	TONG HAN SENG	B.E.HONS.(MALAYA)(CIVIL,10)
48076	V N BALAKUMAR A/L V NALLATHAMBI	B.E.HONS.(UTM) (CIVIL, 2006)
48894	YAP KAH JUN	B.E.HONS.(UTHM)(CIVIL,09)
48483	ZICKRY AZIZAN BIN YUSUF	B.E.HONS.(UNIMAS)(CIVIL,09)

COMPUTER ENGINEERING

Mem No.	Name	Qualifications
48873	AZZA ISKANDA BIN ZAINAL	B.E.HONS.(UTM)(COMPUTER,05)
48073	SHAMSUL FAKHAR BIN ABD GANI	B.E.HONS.(UNiMAP)(COMPUTER,06)

ELECTRICAL ENGINEERING

Mem No.	Name	Qualifications
48516	ABDUL AZIZ BIN JAMALUDIN	B.E.HONS.(UiTM)(ELECTRICAL,07)
48035	ABDUL RAHIM ABDUL RAZAK	B.E.HONS.(USM) (ELECTRICAL, 2000) M.SC (USM) (E'TRICAL & E'TRONIC,06)
48897	AHMAD FIRDAUS BIN AHMAD FUAD	B.E.HONS.(UTM)(ELECTRICAL,03)

ADMISSION TO THE GRADE OF GRADUATE

Mem No.	Name	Qualifications
48095	AHMAD SUHAIMI BIN MOHAMED	B.E.HONS.(MALAYA)(E'TRICAL,04)
48932	AINOL ADNAN BIN OSMAN	B.E.HONS.(UiTM)(ELECTRICAL,01)
48855	AZREENA BINTI SAADIN	B.E.HONS.(UiTM)(E'TRICAL, 02)
48072	CHONG NYEN LOONG	B.E.HONS.(HERTFORDSHIRE) (E'TRICAL & E'TRONIC,00)
48939	CHOW KOK SUN	B.E.(TASMANIA)(ECTRICAL POWER,10)
48940	EUGENE LEE	B.E.HONS.(UTeM) (ELECTRICAL-INDUSTRIAL POWER,05)
48097	FAREEZAN SALHA BINTI MOHAMED AZAHAR	B.E.HONS.(UTeM) (INDUSTRIAL POWER,06)
48100	FAZLIN BINTI HASSAN NAZIRI	B.E.HONS.(IMPERIAL) (E'TRICAL & E'TRONIC,04)
48482	GARRY PATRICK FERNANDO	B.E.HONS.(UNITEN) (ELECTRICAL, POWER,06)
48462	HAFIZI BISRULHAFI BIN MOHAMAD ZIN	B.E.HONS.(UTM)(ELECTRICAL,07)
48078	HISHAM BIN HUSSIN	B.E.HONS.(SHEFFIELD)(E'TRICAL,96)
48914	ISHAN BHARAT KUMAR PATEL	B.E.HONS.(UNITEN)(ELECTRICAL & ELECTRONICS,09)
48070	KOW CHIEN KHUANG	B.E.HONS.(UNITEN) (E'TRICAL & E'TRONIC,05)
48910	KRISHNAN A/L PANERSELVAM	B.E.HONS.(AIMST) (ELECTRICAL ELECTRONIC,08)
48043	LEONARD AROKIASAMY LOURDES	B.E.HONS.(UNITEN) (ELECTRICAL POWER,05)
48494	LIEW WEN HAUR	B.E.(QUEENSLAND)(ELECTRICAL & COMPUTER,06) MSc(QUEENSLAND)(MANAGEMENT,09)
48042	LIM CHUN SHEN	B.E.HONS.(UNITEN)(ELECTRICAL POWER,09)
48919	LIM KWAN SIN	B.E.HONS.(CURTIN)(ELECTRICAL,09)
48891	LOH CHANG FOO	B.E.HONS.(MALAYA)(MECHANICAL,04)
48915	LOKE KIT WAH	B.SC.(KENTUCKY)(ELECTRICAL,97)
48460	MD. NAJIB BIN MAN	B.E.HONS.(UTM)(ELECTRICAL,03)
48860	MOHD FAUZEE BIN MOHD AFANDI	B.E.HONS.(UPM)(E'TRICAL & E'TRONIC,09)
48114	MOHD HAMZAN BIN KAMAL BAHRI	B.E.HONS.(UNITEN)(E'TRICAL & E'TRONIC,10)
48056	MOHD IBRAHIM BIN ABDUL WAHID	B.E.HONS.(UTeM)(INDUSTRIAL POWER,07)
48037	MOHD SAIFUL BIN AHMAD TAJUDIN	B.E.HONS.(UTM)(E'TRICAL ,05)
48461	MOHD SYAIRIS B. CHE DIN	B.E.HONS.(UiTM)(ELECTRICAL,00)
48106	MOHD. AZIZI SAFUAN BIN CHE ROS	B.E.HONS.(UiTM)(E'TRICAL,09)
48869	MUHAMMAD BENJAMIN BIN HASNI SUHAIMI	B.E.HONS.(MMU) (ELECTRICAL,08)
48464	MUHAMMAD MUIZZ BIN MOHD NAWAWI	B.E.HONS.(UTeM)(ELECTRICAL-CONTROL, INSTRUMENTATION & AUTOMATION,07)
48472	MUHAMMAD SHAZWAN BIN MUSTAFA	B.E.HONS.(UNITEN) (ELECTRICAL POWER,10)
48866	MUHD TAHIR HUSAINI BIN SAMSUDIN	B.E.HONS.(UiTM)(ELECTRICAL,03)
48877	NANTHA KUMAR A/L RAMAN	B.E.HONS.(UTM)(ELECTRICAL,01)
48033	NG HENG GUAN, IVAN	B.E.HONS.(UTP) (E'TRICAL & E'TRONIC,09)
48081	NUR AFANDE BIN ALI HUSSAIN	B.E.HONS.(UTM)(E'TRICAL,03)
48886	NUR ALIFF BIN MD SAHIBUDIN	B.E.HONS.(UKM)(E'TRICAL & E'TRONIC,10)
48090	PEE YE WAI	B.E.HONS.(MMU)(E'TRICAL,09)
48119	RAZIMAH BINTI ABDUL RAHIM	B.E.HONS.(UiTM)(E'TRICAL,98) M.E.(UTM)(E'TRONIC & E'TRICAL,07)
48117	ROSAIFUL LIZAM BIN OTHMAN	B.E.HONS.(UTM)(E'TRONIC,06)
48514	RUSDEE AZEEM BIN MOHAMAD RUSLI	B.E.HONS.(UTP)(E'RICAL & E'TRONIC,09)
48116	SIOW LIP KHAI	B.E.HONS.(UPM)(E'TRICAL & E'TRONIC,10)
48878	SITI ADIBAH BINTI SHEIKH HUSSIEN	B.E.HONS.(UTHM)(ELECTRICAL,09)
48846	SYED MOHD SYATHIR BIN SYED ALI ZAINOL ABIDIN	B.E.HONS.(UMP)(CHEMICAL,07)
48903	TAY SIO HOON	B.E.HONS.(UTHM)(ELECTRICAL,03)
48473	VINOTHKUMAR A/L KUNCHUKANAN	B.E.HONS.(UNITEN) (E'TRICAL & E'TRONIC,08)
48435	WEI CHNG KAI	B.E.HONS.(UNiMAP)(ELECTRICAL,10)
48459	WOO CHIN JYE	B.E.HONS.(USM)(ELECTRICAL,08)
48931	ZUL HAZRAN BIN HUSNI	B.E.HONS.(UNITEN) (ELECTRICAL & ELECTRONICS,07)
48522	ZULFADLY ANUAR BIN TAIP	B.E.HONS.(UKM)(E'TRICAL & E'TRONIC,04)

ELECTRONIC ENGINEERING

Mem No.	Name	Qualifications
48875	AHMAD ROHAIZAD BIN YUSOFF	B.E.HONS.(UTP)(E'TRICAL & E'TRONIC,05)
48510	ANIS NURASHIKIN BINTI NORDIN	B.E.HONS.(UIAM)(COMPUTER & INFORMATION,99), MSc(GEORGE WASHINGTON)(COMPUTER,02) PhD(GEORGE WASHINGTON) (COMPUTER,08)
48519	ARIZA BINTI MOHD YUSOF	B.E.HONS.(USM)(E'TRICAL & E'TRONIC,97)
48497	ASMAWI BIN MOHD KHAILANI	B.E.HONS.(UKM)(E'TRICAL & E'TRONIC & SYSTEM,00) MSc(UPM)(MANUFACTURING,10)
48089	AZLINA BINTI MOHD. IBRAHIM	B.E.HONS.(UNIMAS) (E'TRONIC & T'COMMUNICATION,99)
48467	AZRIN HAFIZAL BIN ABD HAMID	B.E.HONS.(UTHM)(ELECTRICAL,07)
48039	FAWNIZU AZMADI HUSSIN	B.E.(MINNESOTA)(E'TRICAL,1999) M.E.Sc(NSW)(SYSTEMS & CONTROL, 01hD(NARA,08)
48937	FITRI DEWI BINTI JASWAR	B.E.HONS.(UTM)(E'TRICAL & E'TRONIC,02) MSc(UTM)(ELECTRICAL,07)
48108	HASRUL' NISHAM BIN ROSLY	B.E.HONS.(UTeM)(ELECTRONIC,06)
48083	HOO MOW HENG	B.SC.HONS.(UTM)(E'TRICAL,97)
48468	ISMAIL BIN SAAD	B.E.HONS.(UPM)(E'TRONIC & COMPUTER,99), MSc(SOUTHAMPTON) (MICROELECTRONICS SYSTEMS DESIGN,02), PhD(UTM)(ELECTRICAL,09)

ADMISSION TO THE GRADE OF GRADUATE

Mem No.	Name	Qualifications
48488	KAMARUL 'ASYIKIN BINTI MUSTAFA	B.E.(TOKYO UNI)(E'TRICAL & E'TRONIC,04) MSc(UKM)(COMMUNICATION & COMPUTER,10)
48876	KANNAN A/L RAMAN	B.E.HONS.(UPM)(E'TRONIC/COMPUTER,97)
48094	KARTHIGESU A/L NAGARAJOO	B.E.HONS.(UTHM) (ELECTRICAL, 2003)
48487	KHAIRUL MUZZAMMIL BIN SAIPULLAH	B.SC.(INHA)(ELECTRICAL & COMPUTER,07) MSc(INHA)(E'TRONIC,11)
48901	KOH CHEE HONG	B.E.HONS.(UTM)(E'TRICAL & E'TRONIC,03)
48047	LEE HON FEI	B.E.HONS.(UCSI)(E'RICAL & E'TRONIC, 10)
48036	MASTURA SHAFINAZ BINTI ZAINAL ABIDIN	B.E.HONS.(UTM) (E'TRICAL & E'TRONIC,08)
48430	MOHAMAD ALIF SHAH BIN ALKHARIB SHAH	B.E.HONS.(UKM) (COMMUNICATION & COMPUTER,08)
48936	MOHD JOHARI @ ESA BIN IBRAHIM	B.E.HONS.(UTeM) (ELECTRICAL-INDUSTRI,06)
48508	MOHD KHAIR HASSAN	B.E.HONS.(PORTSMOUTH)(ELECTRICAL,98) MSc(UTM)(ELECTRICAL,01)
48466	MOHD NIZAM BIN OTHMAN	B.E.HONS.(USM) (ELECTRICAL & ELECTRONIC,99)
48041	MOHD SAAD BIN HAMID	B.E.HONS.(MMU) (ELECTRONICS MAJORING IN COM,03)
48118	MOHD SHAHRIEEL BIN MOHD ARAS	B.E.HONS.(UiTM)(E'TRICAL,04) M.E(UTM,06)
48913	MOHD ZAIDI BIN MOHD TUMARI	B.E.HONS.(UTM)(E'TRICAL -MECHATRONIC,08) MSc(UTM)(MECHATRONIC & AUTOMATIC CONTROL,10)
48082	MOHD. NORHAZREE BIN EASA	B.E.HONS.(UTHM)(E'TRICAL,07)
48052	MUNIRAH BINTI MD. NUJID	B.E.HONS.(UTHM)(E'TRICAL,03)
48909	NASRUL FADHRULLAH BIN ISA	B.E.HONS.(UNITEN)(ELECTRICAL & E'TRONIC,02) MSc(BUSINESS MANAGEMENT,10)
48908	NG SOOK HAN, LEONA	B.E.HONS.(UMS)(ELECTRICAL & ELECTRONIC,01)
48465	NURUL WAHIDAH BINTI ARSHAD	B.E.HONS.(KUiTTHO)(ELECTRICAL,06)
48463	NUURDIANTY BINTI ISMAIL	B.E.HONS.(UMP)(ELECTRONIC,07)
48084	ONG SENG KEONG	B.SC.E.HONS.(UTM)(E'TRICAL,98)
48048	SARAVANAN A/L SOCKANATHAN	B.E.HONS.(UCSI)(E'RICAL & E'TRONIC, 10)
48121	SHUKUR BIN SALEH	B.E.HONS.(UiTM) (ELECTRICAL, 2005)
48049	SUGENDRAN A/L S. PALANISAMY	B.E.HONS.(UCSI)(E'RICAL & E'TRONIC, 09)
48515	THANESH KHANA A/L SANMUGAM	B.E.HONS.(MMU) (ELECTRONIC- NANOTECH,10)
48490	TIONG TECK CHAI	PT.II.(EC)(ELECTRICAL & ELECTRONIC,01)
48861	TOH KAL VIN, KENNY	B.E.HONS.(USM)(ELECTRONIC,09)
48064	YOHANNES YEREMIA	B.E.HONS.(UCSI)(E'TRICAL & E'TRONIC,10)
48499	ZAMANI BIN MD SANI	B.E.HONS.(USM) (ELECTRICAL & ELECTRONIC,00) MSc(USM)(ELECTRICAL & ELECTRONIC,09)

FOOD & PROCESS ENGINEERING

Mem No.	Name	Qualifications
48865	INTAN SYAFINAZ BINTI MOHAMED AMIN TAWAKKAL	B.E.HONS.(UPM)(PROCESS & FOOD,08)
48864	MOHD ZUHAIR BIN MOHD NOR	B.E.HONS.(UPM)(PROCESS & FOOD,07)

MANUFACTURING ENGINEERING

Mem No.	Name	Qualifications
48513	LIM CHEE MENG	B.E.HONS.(UKM)(MANUFACTURING,01)
48436	NYEOH CHENG YING	B.E.HONS.(USM)(M'FACTURING ENGINEERING WITH MANAGEMENT,08)

MATERIALS ENGINEERING

Mem No.	Name	Qualifications
48889	LISA LEONG	B.E.HONS.(USM)(MATERIAL,97)

MECHANICAL ENGINEERING

Mem No.	Name	Qualifications
48442	ABDUL MALIK BIN ZAINAL ABIDIN	B.E.HONS.(USM)(MECHANICAL,05)
48491	AHMAD JAIS BIN ALIMIN	B.E.HONS.(IMPERIAL)(MECHANICAL,98) MSc(UTM)(MECHANICAL,03) PhD(COVENTRY)(MECHANICAL,07)
48113	AHMAD TAJUDDIN BIN HAMZAH	B.E.HONS.(UTeM) (MECHANICAL, 2006)
48032	ALIA RUZANNA BINTI AZIZ	B.E.HONS.(UTeM) (MECHANICAL, 2009)
48853	ALVINDER SINGH A/L JARNAIL SINGH	B.E.HONS.(UNITEN) (MECHANICAL,09)

ADMISSION TO THE GRADE OF GRADUATE

Mem No.	Name	Qualifications
48470	ANAND A/L GHNAVELLO	B.E.HONS.(UTM)(MECHANICAL,01)
48871	AZENI BINTI AHMAD	B.E.HONS.(UTHM)(MECHANICAL,08)
48057	AZUAN BIN ABU TALIB	B.E.HONS.(UNIMAS) (MECHANICAL, 2002)
48922	B.T. HANG TUAH BIN BAHARUDIN	B.E.HONS.(UMIST)(MECHANICAL,00) PhD(LIVERPOOL)(MECHANICAL,08)
48120	CHAN PAUL WANG, TERENCE	B.E.HONS.(UNIMAS) (MECHANICAL, 2008)
48916	CHIENG LEE HUI	B.E.HONS.(CURTIN)(MECHANICAL,10)
48930	CHONG EWE JIN	B.E.HONS.(MALAYA)(MECHANICAL,07)
48088	CHOOI JIA HOONG	B.E.HONS.(MALAYA) (MECHANICAL, 2009)
48898	CHUA YI SHENG	B.E.HONS.(UTAR)(MECHANICAL,10)
48479	DEE BOON HUEI	B.E.HONS.(UTP)(MECHANICAL,09)
48086	DIVANNATH A/L MANIVASAGAM	B.E.HONS.(MMU) (MECHANICAL, 2009)
48906	ELTON BIN HENRY MUT	B.E.HONS.(UTHM)(MECHANICAL,08)
48870	FADZLY BIN YAHAYA	B.E.HONS.(UNISEL)(MECHANICAL,07)
48439	FAHMEER BIN NGALIMAN	B.E.HONS.(UTM)(MECHANICAL,08)
48920	FAIEZA BINTI ABDUL AZIZ	B.E.HONS.(BRADFORD)(MECHANICAL,97) MSc(UPM)(MECHANICAL,02) PhD(WALES,06)
48062	GAJENDRAN S/O THIVASALAM	B.E.HONS.(UNISEL) (MECHANICAL 2008)
48469	HOO WAI CHUAN	B.E.HONS.(UNITEN)(MECHANICAL,10)
48926	INTAN ZAURAH BINTI MAT DARUS	B.E.HONS.(WALES)(MECHANICAL,98) PhD(SHEFFIELD)(MECHANICAL,04)
48446	ISVARAN A/L VYAPURI @ C.VIAYAPURI	B.E.HONS.(USM)(MECHANICAL,04)
48521	JESMIN ZAFFRI BIN AKAN	B.E.HONS.(UiTM)(MECHANICAL,07)
48077	JEYACHANDRAN A/L THAVAMTOO	B.E.HONS.(MALAYA) (MECHANICAL, 2002)
48845	KAPIL PUNJ	B.E.HONS.(UNITEN)(MECHANICAL,10)
48063	KOH YIT YAN	B.E.HONS.(LEEDS) (MECHANICAL, 2002) PhD (LEEDS) (PHILOSOPHY,06)
48512	KU JOO HAR	B.E.HONS.(UTHM)(MECHANICAL,09)
48107	KUANG VOON FEI	B.E.HONS.(MMU) (MECHANICAL, 2007)
48904	KWAN CHEN HUI	B.E.HONS.(UNITEN)(MECHNICAL,10)
48857	LAI KUAN LEE, SAMUEL	B.E.HONS.(UNITEN)(MECHNICAL,10)
48445	LAU TZE WAY, SAIJOD	B.E.HONS.(MMU)(MECHANICAL,09)
48493	LAW KOK WEI	B.E.(WESTERN AUSTRALIA)(MECHANICAL,08)
48450	LEE KOK YIK	B.E.HONS.(UTAR)(MECHANICAL,10)
48892	LEE YONG SEN, JOEL	B.E.HONS.(UNITEN)(ELECTRICAL,04)
48943	LEM YAL MING	B.E.HONS.(UTM)(MECHANICAL,05)
48449	LEW CHEE YEE	B.E.HONS.(MMU)(MECHANICAL,09)
48044	LIM CHIN LEONG	M.E.HONS(NOTTINGHAM)(MECHANICAL,10)
48437	LIM CHONG LYE	B.E.HONS.(UKM)(MECHANICAL,06)
48941	MARIA ALFAH BINTI MOHD ABDULLAH KOI	B.E.(TSUKUBA)(MECHANICAL,81)
48046	MOEY LIP KEAN	B.SC.(KENTUCKY) (MECHANICAL, 1999) M.SC. (KENTUCKY)(MECHANICAL,01)
48444	MOHAMAD SABRI BIN MOHAMAD SIDIK	B.E.HONS.(USM)(MECHANICAL,05)
48485	MOHAMED HAMDAN BIN MOHAMAD IBRAHIM	B.SC.(UTM)(MECHANICAL,99) MSc(UKM)(MANUFACTURING SYSTEM,10)
48066	MOHD ADZRIE BIN HJ. RADZALI	B.E.HONS.(MMU) (MECHANICAL, 2005)
48448	MOHD ADZUAN BIN CHE AZMI	B.E.HONS.(UTM)(MECHANICAL,08)
48917	MOHD AMAL ASROL BIN OMAR	B.E.(MELBOURNE)(MECHANICAL,09)
48443	MOHD FAIRUZ BIN MOHD	B.E.HONS.(UNITEN)(MECHANICAL,06)
48881	MOHD IZHAR BIN HARUN	B.E.HONS.(UTM)(MECH-AERONAUTIK,03)
48441	MOHD NASROL BIN ABU HASAN	B.E.HONS.(UTM)(MECHANICAL,08)
48109	MOHD ZAKRIMAN BIN MOHD ZAMIN	DIP.ING.(FACHHOCHSCHULE) (MECHANICAL,09)
48498	MOHD ZULFAQAR BIN MOHD ALI	B.E.HONS.(NORTHUMBRIA) (MECHANICAL,97)
48929	MORTEZA TALEBI MAZRAE SHAHI	B.E.(MALEK ASHTAR)(MECHANICAL,08) MSc(UKM)(MECHANICAL,10) PhD(UKM)(MECHANICAL,11)
48050	MUHAMAD KAMARUL AZMAN BIN MOTAHAR	B.E.HONS.(UiTM) (MECHANICAL, 2006)
48887	MUHAMAD ZUHAIRI BIN SULAIMAN	B.E.HONS.(UNIMAS)(MECHANICAL,07)
48112	MUHAMMAD FARHAN BIN ROMELI	B.E.HONS.(UTM) (MECHANICAL, 2009)
48060	NG KENG YONG	B.E.HONS.(UTM) (MECHANICAL, 2010)
48848	NG POH KIAT	B.E.HONS.(UKM)(MECHANICAL,07)
48882	NG ZHAN YAN	B.E.HONS.(USM)(MECHANICAL,08)
48104	NOR HAZRIL BIN MOHD NOOR	B.E.HONS.(UTM) (MECHANICAL, 2010)

ADMISSION TO THE GRADE OF GRADUATE

Mem No.	Name	Qualifications
48099	NORHAYATI BINTI MAT ISA	B.E.HONS.(UTM) (MECHANICAL, 2010)
48433	RAPHAEL STEPHEN	B.E.HONS.(UTeM)(MECHANICAL-DESIGN & INNOVATION,08)
48486	ROSMAHADI BIN ALI	B.SC.(GEORGE WASHINGTON)
48440	SALMI BIN SAMSUDIN	B.E.HONS.(UKM)(MECHANICAL,06)
48935	SHAHRIZWAN EFFENDI BIN HASHMI	B.E.HONS.(UTM)(MECHANICAL - MARINE TECHNOLOLOGY,06)
48504	SHAHRUL IKHWAN BIN ABDUL KHALID	B.E.HONS.(UTM) (MECHANICAL-AERONAUTICS,09)
48438	SULAIMAN BIN MOHD MUSLIM	B.E.HONS.(UTM)(MECHANICAL,03)
48859	TEOH YEW HENG	B.E.HONS.(USM)(MECHANICAL,07)
48053	THAM SOOK CHAN	B.E.HONS.(UTM) (MECHANICAL, 2008)
48087	VIJEY A/L SUBHRAMANIYUN	B.E.HONS.(MALAYA) (MECHANICAL, 2009)
48496	WAN MOHD HUSNI BIN MOHD NASIHUDDIN	(MECHANICAL SYSTEM,03)
48447	WONG KUEN CAN	B.E.HONS.(UNITEN)(MECHANICAL,04)
48065	YANG KOK WEI	B.E.HONS.(UTeM) (MECHANICAL, 2008)
48938	YAP WENG SUON	B.E.HONS.(UTAR)(MECHANICAL,09)

MECHATRONICS ENGINEERING

Mem No.	Name	Qualifications
48934	ANG CHEE TONG	B.E.HONS.(MONASH)(MECHATRONIC,08)
48074	HANIF BIN MD ASNYAT	B.E.HONS.(UIAM) (MECHATRONIC, 2005)
48492	SIK RUOH HORNG	B.E.HONS.(SWINBURNE) (ROBOTICS & MECHATRONICS,08)
48507	TAQIUDDIN AHMAD KENDONG	B.E.(QUEENSLAND)(MECHATRONIC,08)

POLYMER ENGINEERING

Mem No.	Name	Qualifications
48474	SIVACHANDRAN A/L KUNCHUKANAN	B.E.HONS.(UTM) (CHEMICAL-POLYMER,06)

ADMISSION TO THE GRADE OF INCORPORATED MEMBER

CIVIL ENGINEERING

Mem No.	Name	Qualifications
48122	ZAFARULLAH S/O DR. ALLAH BUX NIZAMANI	B.E.(MEHRAN UNI OF ENG & TECH, PAKISTAN) (CIVIL, 1992) M.E.(NED, PAKISTAN) (CIVIL) (2002)

ELECTRICAL ENGINEERING

Mem No.	Name	Qualifications
48523	KOK CHIN CHAI	B.E.(WARNBOROUGH)(ELECTRICAL,01)
48125	MURULEEDRAN A/L JENTERAN	B.E.HONS.(NORTHUMBRIA) (ELECTRICAL & ELECTRONIC, 2002)
48124	YAP SIEW LING	B.E.(LINCOLN) (ELECTRICAL & ELECTRONIC, 2003)

MECHANICAL ENGINEERING

Mem No.	Name	Qualifications
48123	TAN HONG CHUAN	B.E.HONS.(SUNDERLAND) (MECHANICAL ENG. WITH DESIGN, 2006)

TRANSFER TO THE GRADE OF INCORPORATED MEMBER 2011

ELECTRICAL ENGINEERING

Mem No.	Name	Qualifications
20019	JAYAKUMARAN SHANMUGAM	B.SC.(SOUTHERN PACIFIC) (ELECTROMECHANICAL,06)
20020	PARTHIBAN A/L KATHAMMUTHU	B.SC.(SOUTHERN PACIFIC) (ELECT & E'TRONIC, 2007) DIP (FIT) (ELECTROMECHANICAL, 1997)

***Note:** For the list of approved admissions to the grade of Student member, please refer to the IEM web portal at http://www.myiem.org.my.*

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RM1,761,153.70 from IEM Members and Committees
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(ANOTHER RM9,817,344.30 IS NEEDED)

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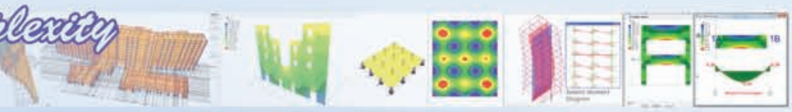

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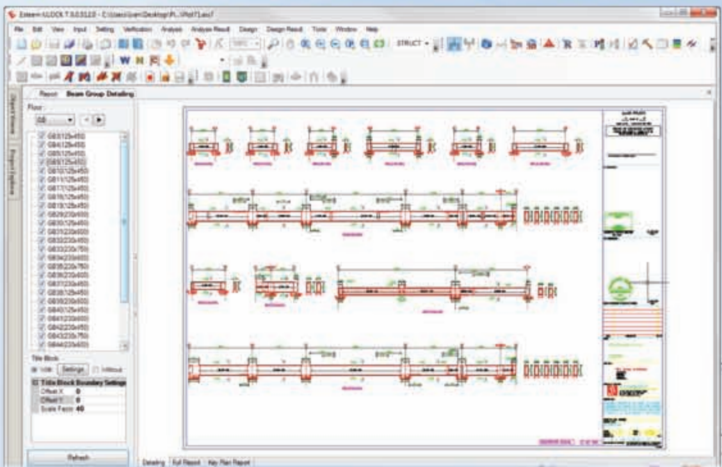

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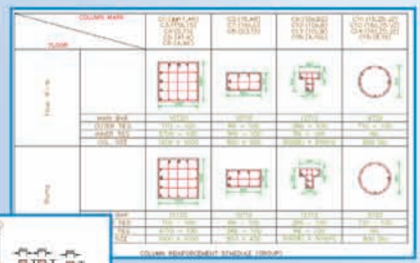

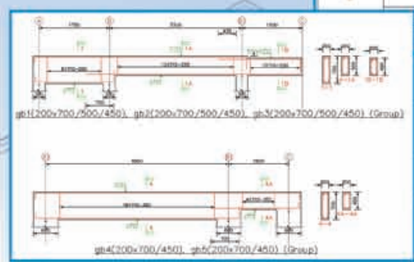

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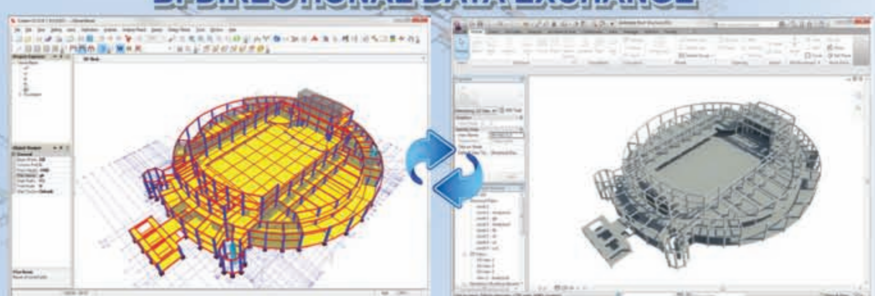

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