Current Status & Future Development of Geotechnical Engineering Practice in Malaysia

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ABSTRACT The professional practice of geotechnical engineers in Malaysia is regulated by the Board of Engineers, Malaysia under the rules and regulations of the Registration of Engineers Malaysia (Amendment) Act 2002. The Act has no specific section on the registration and practice of geotechnical engineers except for the indirect mention of geotechnical engineers in the registration of Accredited Checkers. The newly proposed Accredited Checker in the disciplines of geotechnical and structural engineering is primarily for the registration of professional engineers with specialist knowledge and practical experience in the above discipline of specialisation. Many local authorities presently require developers to engage Accredited Checkers for slopes with high risk to ensure safety.

The role of geotechnical engineers has become more prominent as sites with good soil condition that only requires simple geotechnical input is scarce. New developments have now moved towards areas of soft ground, ex-mining land and hilly lands. This paper describes the current status of geotechnical engineering practice and its likely future development. It also highlights the major differences between Malaysia and some countries particularly on the aspects of contractual, design and construction.

1 BACKGROUND

The professional practice of engineers is regulated by The Board of Engineers, Malaysia (BEM) which was established in 1974 under the Registration of Engineers Act 1967 (Act 138) Malaysia. The Act has been amended in year 2002 and renumbered as Act A1158.

The establishment of BEM and Registration of Engineers Act of Malaysia was mooted by The Institution of Engineers, Malaysia (IEM). IEM is the learned institution for all engineers and was formed in 1959 and later admitted as a member of the Commonwealth Engineers Council in 1962. The Institution represents all disciplines of the engineering profession and is one of the qualifying bodies for Professional Engineers (P.Eng) in Malaysia. The other qualifying and licensing body is BEM.

Another professional engineering organisation in Malaysia is The Association of Consulting Engineers Malaysia (ACEM) which was established in 1963. It is an association of consulting engineers and consulting engineering firms. Membership of ACEM is restricted to those licensed with the Board of Engineers Malaysia either as an individual or as a firm.

2 LEGAL REQUIREMENTS

In Malaysia, ACT A1158; Registration of Engineers (Amendment) Act 2002 stipulates that all engineers including graduate engineers shall register with BEM if wish to take up employment as a Graduate Engineer. However, only graduate engineers from university with a recognised engineering programme can register with the Board. The word 'Engineer' is protected under the law just like medical doctor to ensure public safety.

The Act also stipulates that only registered Professional Engineers shall be entitled to use the abbreviation "Ir." before their name or the abbreviation "P.Eng." after their name. Similarly, the law also stipulates all consulting firms in corporate bodies shall only be allowed to practise as consulting engineers upon BEM's approval. The Board of Directors of an engineering consulting firm shall consist entirely of registered Professional Engineers. The amendment 2002 allows the establishment of multi-disciplinary practice. The board of directors for the practice to comprise of Professional Engineer, Professional Architects and/or registered Quantity Surveyors. The equity holding of the multi-disciplinary practice shall be controlled by the professionals with a minimum combined share holding of 70% and of which the professional enginers and/or bodies corporate providing professional engineering services shall hold a minimum 10% of the overall equity.

The recent amendment 2002 has included a section to register Accredited Checkers (AC). Registration of Accredited Checkers is intended to ensure safety for buildings on the hillsite. Which are considered to be high risk areas.

3 ACCREDITATION OF DEGREE ENGINEERING PROGRAMME

Accreditation of an engineering degree programme for public universities was initially conducted by Institution of Engineers Malaysia. When the Board of Engineers Malaysia was established, the accreditation was later jointly carried out. Section 10 (1) (a) of the Act A1158 accepts any person who holds the recognised qualification for Graduate Membership of The Institution of Engineers, Malaysia which are recognised by the Board shall be entitled on application be registered as a Graduate Engineer.

The recent liberalization of the Education Act in Malaysia which allows establishment of private institution has necessitated the formation of Malaysia Accreditation Board for private institutions of higher learning. The scope of the accreditation covers all courses including engineering programmes. To ensure consistency in accreditation, a joint body called "Engineering Accreditation Council" was formed under the coordination of Board of Engineers Malaysia to accredit engineering degree programmes.

The accreditation examines among others, the following:-

a) academic programmes which include the curriculum programmes and syllabi, laboratory works, industrial trainings and project work
b) the academic staff and students
c) learning facilities which include libraries, computers, laboratories and etc.
d) Quality Management System

On the academic programme, the minimum credit hours are 120 for students with A-level or equivalent. One credit hour is defined as one hour of lecture per week for a minimum of 14 weeks in a semester excluding examination and mid-term break. Two-thirds of the credit hours should be on engineering core subjects and one-third on other related topics such as communication, management, law, economics, public safety and etc., Laboratory work or workshop, final year project and industrial training are also included but with lesser weightage and limited to a certain maximum credit hours.

The academic full-time staff to students ratio should be better than 1:15. The academic staff should generally have a post graduate degree of Master level or higher. A dynamic quality management system is also important.

4 THE ROUTE TO A PROFESSIONAL ENGINEER

The requirements for registration as a professional engineer and be licensed to practice independently are:-

a. be registered as a Graduate Engineer with BEM and
b. have satisfied the training requirements of BEM; and
c. have passed the Professional Assessment Examination of BEM or registered as Corporate Member of IEM; and
d. have been residing in Malaysia for a period of not less than six months immediately prior to the date of application

The training requirements for a registered Graduate Engineer include a minimum of three years of satisfactory practical experience, shall include:-

a. planning, design, execution or management of such works as comprised within the profession of engineering
b. in engineering research; or
c. in teaching a course leading to a degree qualification approved by the Board and

At least one year of such practical experience for adaptation shall be obtained in Malaysia under the supervision of a Malaysian registered Professional Engineer of the same discipline or an approved allied discipline and shall be in the fields of engineering practice other than in research and teaching. Generally, most engineers take four to six years to acquire the required experiences before applying to sit for the assessment examinations.

Two reports are required for professional assessment. The report on training and experience should be of length 1500 – 2000 words and the other report on a design or feasibility study or research. The candidate documents on experience shall be assessed by two registered Professional Engineers and followed by an interview and essay examinations. The objectives are to ensure that an applicant has acquired the necessary practical experience under proper supervision and ability to communicate effectively for independent practice and public safety.

The essay examinations include two parts: one part covers the experience and the other on the code of ethics and engineers in society.

All registered Professional Engineers are required to renew their registration every year.

5 CONTINUING PROFESSIONAL DEVELOPMENT

All graduates who register after January 1998 are required to have attended the Continuing Professional Development (CPD) programme. It includes 60 contact hours on courses related to code of ethics, health and safety at work including relevant by-laws and regulations, engineering management practice and topics related to engineering. In addition, the mandatory training also includes 24 days of extended training. CPD for previously registered engineers are encouraged to have an average of 150 hours of CPD for three years. It is likely that this voluntary CPD would be mandatory in a few years time.

6 FOREIGN ENGINEERS

The Board (BEM) also registers foreign engineers under temporary registration. Generally, approval for registration is given to foreign engineers in a joint-venture or government project. Applicant should be licensed in his or her own country for individual practice and has more than ten years of experience in the relevant field. The foreign engineer has to be sponsored by a local counterpart who is a registered Professional Engineer in need of the service. The temporary registration is given for a period of not exceeding one year for a specific project(s) and may renew if deem fit by the Board.

7 GEOTECHNICAL ENGINEERS

The present Act of Parliament and Regulations do not have a specific requirement for the registration of geotechnical engineers. However there are legislations that are relevant to the professional practice of Geotechnical Engineers:-

1) ACT 133, Street, Drainage and Building Act 1974 and its Uniform Building By-Laws 1984 (UBBL)
2) ACT 514 Occupational Safety and Health Act 1994

In general, this Act 133 prohibits commencement of work either building or earthworks without approval from the local authority. However, local authorities and their officers shall not be liable for design and construction supervision. The responsibility on these rests on professionals particularly engineers for engineering work as stipulated in Section 71 of Act 133 and By-law 258.

In Malaysia, the scope of work for civil and structural consultancy service generally involves carrying out geotechnical analysis, design and supervision of geotechnical works are. The term of Geotechnical engineer is loose by used. Since the law protects the word “Engineer” (as discussed in 2. Legal Requirements), engineering geologists cannot claim themselves as geotechnical engineers unless they become professional engineer following the route highlighted in Section 4.

8 GEOTECHNICAL CONSULTANTS

In Malaysia, there are only a few independent geotechnical engineering consulting firms and normally they are only engaged as specialist consultant to assist the main consultant of a project. Many geotechnical engineers either practice as sole proprietor or work in a multidiscipline consultants (e.g. Civil and Structural Consultants). In view of this, not all projects will engage geotechnical consultant unless the project involves difficult ground conditions (e.g. soft ground, hill-site, Limestone formation, etc), complicated foundation or retaining structures (e.g. deep basement, raft or combine foundation, etc.) or ground treatment selection and design. However, with more awareness in the construction industry on the importance of geotechnical engineering input to ensure success of the project in terms of safety, value engineering and construction duration, the role of geotechnical engineers will be more significant.

Since geotechnical consultants are only engaged as supporting role and specialist input, therefore the main consultant (C&S consultant) is the submitting engineer to local authorities for approval.

9 SPECIFICATION AND CODES OF PRACTICE

Specifications of work are left to the registered Professional Engineers according to general practice. The codes of practice used in Malaysia generally follow Malaysian Standards. If the Malaysian Standard is not available for a specific work, then British Standards or other the accepted Standards could be used. Most of the Malaysia Standards for geotechnical works are largely adopted from the British Standards. For hill-site development, reference is commonly made to Geotechnical Manual for Slopes published by Geotechnical Engineering Office (formerly known as Geotechnical Control Office) of Hong Kong.

10 SUPERVISION OF WORK

The UBBL spells out the necessary by-laws which include among others, the need and responsibility of registered (submitting) engineer to supervise the construction work. The registered engineer for the work shall certify various stages of completion including setting out, completion of foundations and certificate of fitness for occupation. In all these certifications, the registered engineer has to certify that the work has been carried out according to the design, requirements of the by-laws; construction drawings as well as supervision and take full responsibility of the work.

The responsibility of submitting person (professional engineer) on supervision of work includes supervision for subsurface investigation. This is in line with Part IV, Code of Professional Conduct of the Registration of Engineers Regulation 1990 that requires Professional Engineers to discharge their professional duty with due care and diligence. Failure to do so contravenes the Act and calls for disciplinary action under the Registration of Engineers Act.

The level of supervision is left to the submitting person to decide. It is generally expected that the submitting person would delegate significant part of the supervision to his team that he or she has a direct control with a system to ensure a construction complies to the drawings and specifications.

Since the submitting engineers are usually the Civil and Structural (C&S) consultants, they will be responsible for the full-time supervision of the project. geotechnical consultants who are engaged to provide specialist input on either foundation, retaining structures, ground treatment of the project, will assist the C&S in critical elements of the works that are related to geotechnical engineering. However, for geotechnical remedial works such as remedial and strengthening of slopes failure, underpinning of foundation, etc., geotechnical consultants shall provide full-time supervision for the works to ensure compliance to drawings, specifications, good engineering practice and safety.

11 SCALES OF FEES

One of the functions of the Board (BEM) is to fix the scale of fees to be charged by registered Professional Engineers for a professional service. Malaysia is one of the very few countries in the world to have official scale of fees. One of the objectives of the scales is to prevent undercutting among engineering consultants. This would maintain the necessary professional input to ensure public safety. However, it is difficult for BEM to enforce this provision in the Act due to difficulties in getting evidence. General, in private practice, it is a free market with negotiation guided by the scale of fees.

12 ENGINEERS' RESPONSIBILITY & LIABILITY

The responsibility and liability of an engineer are spelt out in the UBBL where it places the liability on the submitting engineer (registered Professional Engineer) for failure. In Malaysia, the existing legislations place engineers under the potential threat of liability for an indefinite period and no provision in sight yet to limit that liability.

13 CURRENT AND FUTURE TRENDS

13.1 Prospect of Geotechnical Engineers

As the population of a country such as Malaysia continues to grow coupled with scarcity of suitable development land, future development would undoubtedly have to be built on very difficult ground conditions such as hilly terrain, soft ground, former mining land, limestone formation, congested urban landscape, etc. These together with a backdrop of increasing specialisation of the engineering profession, the awareness and the demand for geotechnical engineers will be more prominent.

13.2 Subsurface Investigation and Laboratory Tests

In Malaysia, Subsurface investigations (S.I.) and laboratory tests are planned and supervised by geotechnical engineers. However, the works are carried out by independent specialist contractors.

The proper planning of subsurface investigation (S.I.), specifying correct types of field and laboratory tests and full-time supervision of works are necessary to ensure reliability of the parameters (soils, rocks, groundwater levels, etc) for geotechnical engineering designs.

The practice of subsurface investigation in Malaysia are summarised by Gue (2000), Gue & Tan (2000b), Tan & Gue (2001). The most common probing techniques are boreholes using rotary wash boring, piezocones, in-situ penetration vane shear tests and mackintosh probes. Sometimes pressuremeter tests are carried out to obtain stiffness of the soil for retaining wall design especially deep excavation for basements. When advancing the boreholes, percussion method is not recommended unless it is used to determine bedrock profiles.

In boreholes, undisturbed soil samples are collected using either piston, thin wall or mazier sampler depends on the stiffness of the soil. Standard Penetration Tests (SPT) carried out in the boreholes are very popular in Malaysia to obtain design parameters for design of piles or indirect correlation to strength and stiffness.

Laboratory tests commonly carried out for soil samples are soil classification tests, Unconfined Compression Test (UCT), Triaxial Tests (UU, CID, CIU with pore water pressure measurements), Oedometer tests, shear box tests, etc. For CIU or CID tests, it is important not to use sidedrains and do not specify multi-stage testing. Side drains should not be used as this has shown to produce inconsistency in the sample (Tschebotarioff, 1950 and GCO, 1991). Multistage tests should not be used as the second test will be significantly affected by the failure surface formed in the first test (GCO, 1991). For rock samples, UCT and point load tests are common.

The electronic transfer of geotechnical and geoenvironmental data through unified format such as the Association of Geotechnical Specialists (AGS) format has started in Malaysia. This is to unify the file and data format which allows data to flow between the project team members and archive of data for the country in the future. The typical use of the unified geotechnical data is shown in Figure 3.

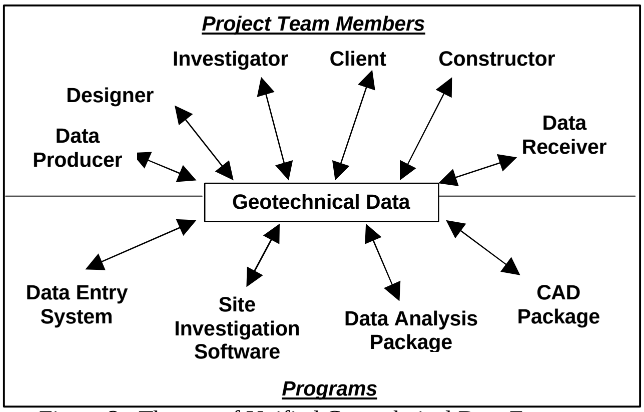

Figure 3 : The use of Unified Geotechnical Data Format

13.3 *Hill-Site Development*

With scarcity of flat land and the change in Malaysian life-style towards country style living, hill-site development within Malaysia is increasing with time especially near a city like Kuala Lumpur. With the recent awareness of the difficulty and risks involve in building on hill-sites, a more systematic control of hill-site development is taking shape through public and private sectors. One of them is the position paper titled “Mitigating the Risk of Landslide on Hill-Site Development” (IEM, 2000) prepared by The Institution of Engineers, Malaysia.

In the IEM position paper, the slopes for hill-site development are proposed to be classified into three classes and the necessary requirements are as follows :

(a) Class 1 Development (Low Risk): Existing Legislation Procedures can still be applied.

(b) Class 2 Development (Medium Risk): Submission of geotechnical report prepared by professional engineer to the authority is mandatory. The taskforce viewed the professional engineer for hill-site development as those that have the relevant expertise and experience in analysis, design and supervision of construction of the slopes, retaining structures and foundations on hill-site.

(c) Class 3 Development (Higher Risk): Other than submission of geotechnical report the developer shall also engage an “Accredited Checker” (AC) in the consulting team. In the original proposal by the taskforce, the AC shall have at least 10 years relevant experience on hill-site and have published at least five (5) technical papers on geotechnical works in local or international conferences, seminars or journals.

The classification is based on the geometry of the slopes such as height and angle for simplicity of implementation by less technical personnel in our local authorities. Although in actual condition there are many other factors affecting the stability of the slopes like geological features, engineering properties of the soil/rock, groundwater regime, etc, but in order to make the implementation of the classification easier, simple geometry has been selected as the basis for risk classification. Table 1 summarises the details of the classification and as shown in Figure 1. (Gue & Tan, 2002).

From the review of several case histories of landslides in Malaysia, IEM (2000) summarises the causes of the failures as follows :-

(a) Design - inadequate subsurface investigation and lack of understanding of analysis and design.

(b) Construction - lack of quality assurance and quality control by contractors.

(c) Site supervision and maintenance - lack of proper site supervision by consulting engineers during construction and lack of maintenance after construction.

(d) Communication – lack of communication amongst various parties during construction.

Class	Description
1 (Low Risk)	For slopes either natural or man made, in the site or adjacent to the site not belonging to Class 2 or Class 3.
2 (Medium Risk)	For slopes either natural or man made, in the site or adjacent to the site where : o $6m \le H_T \le 15m$ and $\alpha_G \ge 27^o$ or o $6m \le H_T \le 15m$ and $\alpha_L \ge 30^o$ with $H_L \ge 3m$ or o $H_T \le 6m$ and $\alpha_L \ge 34^o$ with $H_L \ge 3m$ or o $H_T \ge 15m$ and $19^o \le \alpha_G \le 27^o$ or $27^o \le \alpha_L \le 30^o$ with $H_L \ge 3m$
3 (Higher Risk)	Excluding bungalow (detached unit) not higher than 2-storey. For slopes either natural or man made, in the site or adjacent to the site where : o $H_T \ge 15m$ and $\alpha_G \ge 27^o$ or o $H_T \ge 15m$ and $\alpha_L \ge 30^o$ o with $H_L \ge 3m$

H_T = Total height of slopes
= Total height of natural slopes & man made slopes at site and immediately adjacent to the site which has potential influence to the site. It is the difference between the Lowest Level and the Highest Level at the site including adjacent site.
H_L = Height of Localised Slope which Angle of Slope, α_L is measured.
α_G = Global Angle of Slopes (Slopes contributing to H_T).
α_L = Localise Angle of Slopes either single and multiple height intervals.

Table 1 : Classification of Risk of Landslide on Hill-Site Development. (after IEM, 2000)

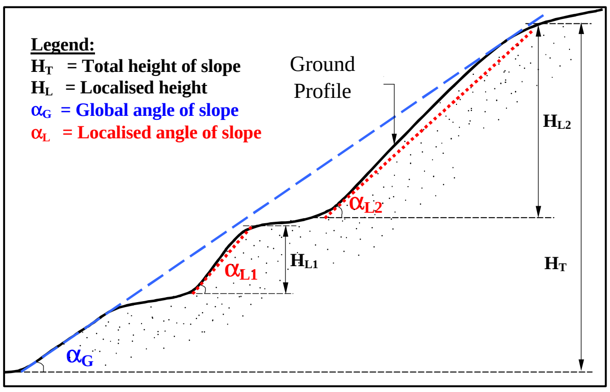

Figure 1 : Geometries of Slope (after IEM, 2000)

IEM (2000) recommends the following :-

(a) To appoint qualified and experienced checking consultants to audit submitting engineers’ designs for major development in higher risk areas.

(b) To appoint a full time resident professional engineer to supervise construction.

(c) Developers, contractors and supervisors be made further accountable to the authorities for construction safety. There should be deterrent imposition of penalties on the defaulting parties in the approval, design, supervision and the construction processes.

The IEM position paper also proposes that a new federal department called "Hill-Site Engineering Agency" be formed under the Ministry of Housing and Local Governments to assist Local Governments in respect to hill-site development. The Agency is to assist local authorities to regulate and approve all hill-site developments. The Agency could engage or out source, whenever necessary, a panel of consultants to assist and expedite implementation. For existing hill-site development, the Agency should advise the local government to issue "Dangerous Hill-Side Order" to owners of doubtful and unstable slopes so that proper remedial and maintenance works can be carried out to stabilize unstable slopes and prevent loss of lives and properties.

In general, Geotechnical Manual for Slopes published by Geotechnical Engineering Office (formerly known as Geotechical Control Office) of Hong Kong has been widely used with some modifications to suit local conditions by geotechnical engineers in Malaysia (Gue & Tan, 2002). Presently it is not advisable to include soil suction (negative pore pressure) in the design of the long term slopes in view of many factors that can cause the loss of the suction during prolong and high intensity rainfall, especially during the monsoons that occur at least twice a year.

13.4 Registration of Accredited Checker (Geotechnical) for Hill-Site Development

The Board of Engineers, Malaysia (BEM) is in the process of formulating the registration of Accredited Checkers with the disciplines of Geotechnical and Structural Engineering. An accredited checker shall be a registered professional engineer with the Board. Among other requirements, an Accredited Checker shall have a minimum of 10 years experience in the relevant discipline.

The registration of Accredited Checker (Geotechnical) is aimed for hill-site development, although some agency such as Public Works Department of Malaysia has already implemented the requirements of Independent Geotechnical Engineers as Checkers for some of the road projects.

13.5 Development on Soft Ground Area

The development of national road networks, residential and commercial developments have encroached into areas underlain with very soft soils (e.g. alluvial soils, marine clays, etc.). In this formation, usually the competent layer (stiff or dense soils) and bedrock are very deep (sometimes more than 60m deep) and resulting in higher cost of foundation.

One of the major problems faced by piled structures in this area is the negative skin friction acting on the deep foundation due to the settling subsoil (consolidation and secondary compression) under loading of the fill which is usually inevitable in order to control flooding and drainage requirements. In view of this, geotechnical engineers of Malaysia have started using settlement reduction piles coupled with strip-raft foundation for housing development (2-storey to 6-storey residential and commercial buildings) at soft ground areas. When designing the foundation system, short piles (length of pile is 1/4 to 1/2 of the depth to hard layer with SPT>50, depending on the load of the structures) are located strategically to control differential settlements rather than to reduce the overall average settlement and to reduce the net contact pressure between the strip-raft and the soil beneath the raft. This system is the hybrid of piled rafts design combining 'creep piling' and differential settlement control piling defined by Randolph (1994).

Piled rafts with different pile lengths have also been used as more cost effective foundation replacing conventional piled to set system as support for 2500Ton oil storage tanks on very soft alluvial clayey soil of about 40m thick as shown in Figure 2. The storage tanks sit on a 20m diameter and 500mm thick reinforced concrete (RC) circular raft. The pile points have been strategically located at the RC raft. Varying pile penetration lengths have been designed to minimize the angular distortion of the thin RC raft and the out-of-plane deflection at the tank edge. (Liew, et al. 2002)

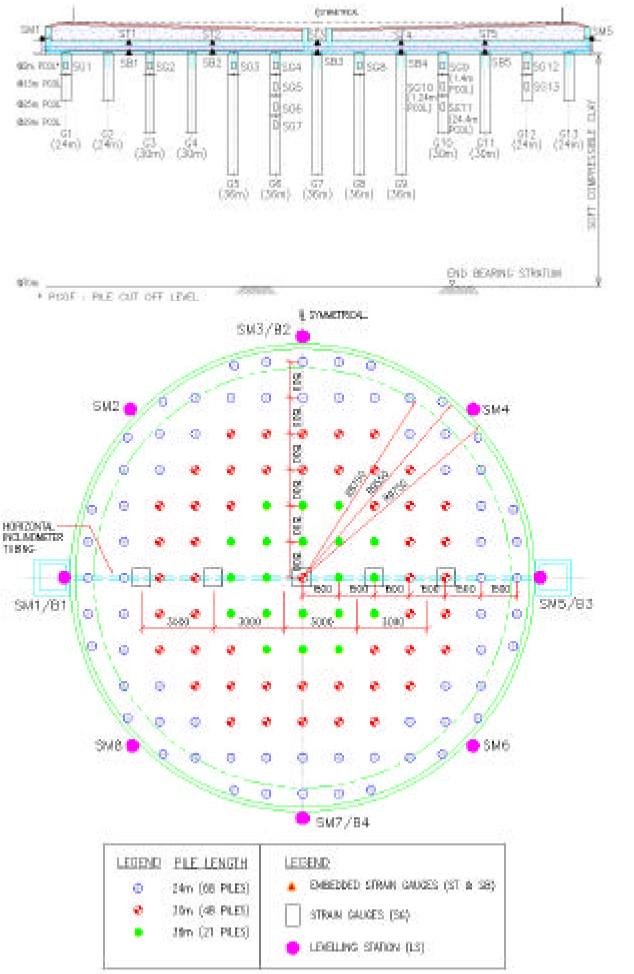

Figure 2 : Details of Piled Raft with varying Pile Lengths (from Liew, et al., 2002)

The current trend in the design of expressway or rail embankment over soft ground has placed emphasize on value engineering and long term serviceability of the ground treatment options. The conventional ground treatment methods such as surcharging, partial soft soil replacement, prefabricated vertical drains with surcharge, stone columns, dynamic replacement, piled embankment with reinforced concrete slab, or combination of the techniques are still widely used in Malaysia. Emphasis is also put on controlling differential settlement between piled structures (viaducts and bridges) and approach embankment (usually unpiled). The techniques commonly used in Malaysia are transition piled embankment, expanded polystyrene (EPS), oversized culvert, etc. (Gue, et al. 2002).

13.6 Developments in Congested Urban Areas

In the expensive and congested urban area like Kuala Lumpur, Penang and Johor Bahru, basements have been constructed to effectively utilise the underground for car parks and other usage. Other than basements, construction of tunnel in the city has been extensively carried out for light rail transit.

Many deep basements have been constructed in Kuala Lumpur. One of the deepest excavation depth used for basement is 28.5m for Berjaya Times Square, Jalan Imbi (Tan, et al., 2001). The commonly used retaining wall systems are diaphragm wall, contiguous bored piles, secant piles, sheet piles and soldier piles. The support system commonly used includes pre-stressed ground anchors, internal strutting, top-down or semi top-down, etc. Finite element method is widely used in the design of deep excavation in view of its versatility in modelling soil-structure interaction and capacity to predict more representative ground deformations of the retained soil which is very important to ensure safety of adjacent properties in the congested urban area.

Tunnelling especially with tunnel boring machines (TBM) in urban area of Kuala Lumpur has been a challenge especially tunnelling through different geological formations with different complexity. Three major geological formations are found in Kuala Lumpur namely; metasedimentary, granite and cavernous limestone or marble. Many surprises were encountered even with comprehensive ground investigation due to the geological features such as pinnacles, sinkholes, cavities and slump zones and etc. Additional feature such as the very strong rock; Skarn, which has an unconfined compressive strength of about 300mPa posed additional difficulties to the tunnelling (Gue & Muhinder, 2000). Working in limestone formation and its surrounding area, requires frequent change of equipment and as well as increase in the time of construction when some of the features mentioned above are encountered. In view of the difficulty of the tunnelling projects, input from experience geotechnical engineers and engineering geologists are very important. Since the tremendous development of the Finite Element Method in three-dimensional (3-D) analysis, it is the trend in Malaysia to take advantage of this technique instead of the conventional two-dimensional plane strain method.

Development on ex-mining land are also common in Malaysia. The mining process leaves behind ponds, loose sandy soils, and slime deposits in the pond or on land. The slime is a waste material from mining and is a very soft silty clay usually containing some fine sand (Ting, 1992). In these areas, proper geotechnical engineering input is very important to prevent failures during construction and long term serviceability problems such as continuing settlement of the fill with time, etc.

13.7 Foundation Design for Highrise

In Malaysia, geotechnical analyses and designs of foundations still generally rely on conventional design method. However, the trend is moving towards limit state design with emphasis on serviceability limit state which requires proper prediction of deformation (e.g. settlement vs load).

Piles are used to support highrise structures. The selection of the types of pile will depends on the factors such as loading, ground conditions, geological formation, noise etc. The piling systems used in Malaysia include bored piles, driven pre-cast piles, micropiles, jack-in piles, barrette piles, etc. The design of bored piles in residual soils generally follow simple empirical correlations to SPT'N' values as presented by Toh et al. (1989) and Tan et al. (1998). When designing bored piles, the base resistance shall be ignored unless it is dry hole and the base can be properly cleaned and inspected. This is due to the impracticality to properly clean the base of bored pile drilled through unstable bored hole. The prediction of pile movement under different loads is also gaining popularity in Malaysia. (Gue, et al. 2003).

In the areas where driven piles are prohibited by the local authority due to noise, jack-in piles using square piles (size 150mm to 300mm onwards) and spun piles (diameter of 300mm to 600mm) have gain popularity in view of its lower construction cost compared to bored piles.

13.8 Site Supervision

As site supervision has been repeatedly identified as one of the major causes of poor quality work and failures. Hence, enhancement of regulations related to site supervision will likely be implemented. Among others, it is likely that permission to commence construction work could only be carried out after the names and qualifications of the site supervision team are submitted to the local authority.

13.9 Supporting Professional

The supporting professionals for geotechnical work such as engineering geologists, geophysicists and etc. are engaged directly by engineers. Presently, there is no act of parliament to regulate the practice, as these professionals do not deal directly with lay public. Nevertheless, steps have been taken by geologists to push for enactment of an act to regulate geologists for mining and engineering services.

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