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Brooklyn Bridge in New York City, opened in 1883. It took 14 years to build and it was the first suspension bridge to use steel for its cable wire. It was also the first bridge to use explosives in a dangerous underwater device called a caisson. At the time it was built, the 3,460-foot bridge was also crowned the longest suspension bridge in the world.

Cover photograph courtesy of Dimension Publishing Sdn. Bhd.

The Young Renaissance: Time To Let Go?

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

The Institution of Civil Engineers (ICE), U.K. recently announced the appointment of the youngest president, Colin Clinton, to take over the 187 year old institution which has some 70 000 members worldwide, including a good number in Malaysia. His predecessor on a tour of this region last year brought along a representative of the young engineers in addition to his Director of Knowledge. During the last WFEO General Assembly and World Engineering Convention in Shanghai in November, a protem committee for a Young Engineers Group was formed and in the recent CAFEO22 in Myanmar in December, the Young Engineers literally stole the show, coming in full force and providing much enthusiasm and support to the gathering of some 1000 engineers in Yangon.

It appears the days of the young engineers have finally arrived. Down in Malaysia, graduate engineers constitute 75% of the total registered engineers with the Board of Engineers, Malaysia. And in IEM, the Graduate & Student Section (G&S) is definitely on the upswing, being one of the most active sections in the IEM and undertaking a number of new and interesting initiatives and projects. Our IEM G&S is represented in the WFEO Young Engineers protem committee and were actively involved in CAFEO22.

All these developments can only bring a good omen to the engineering profession which is currently suffering from loss of respect especially amongst school leaving children compared with many other professions. The much needed injection of young blood has finally come, to ensure the profession as well as the institution are again imbued with the dynamism and creativity that is so important to a modern organisation. It is easy to be complacent, enjoying our comfort zone and becoming oblivious of the fact that the world is moving on. Too many organisations had suffered from the old-men's club syndrome where creativity and innovations are sent to the back burners. Under a good leadership, the young engineers can have a better chance of returning engineering to its former glory.

A good leader is one who knows the time to let go gracefully and without leaving a bomb in his chair. I sincerely believe it is time to support and slowly make way for the emergence of the younger generation while we remain ever ready to offer any advice or assistance that they may need in their endeavour. ■

CALL FOR CONTRIBUTIONS

To all Members and Readers,
The Editorial Board is planning for future issues of the Bulletin. Those interested in contributing can either write to the Editorial Board or e-mail pub@iem.org.my. Guidelines for contributions can be found on the IEM website.

Readers are also invited to contribute articles or opinion pieces not related to the themes listed. We welcome ideas and suggestions from our readers.

Please submit contributions early to meet our material deadline.

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Apr 2005	Geotechnical Engineering
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Jul 2005	Computer Engineering
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Sep 2005	Disaster Management

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Specialists and Early Specialisation

By: Ir. Hj. Look Keman bin Sahari

I was a council member representing Chemical and Others from the 1997-2000 session. Being a member of a smaller discipline, I can see the problems facing members from these smaller specialised disciplines. We are not only well distributed throughout the country thus making it difficult to congregate together to attend a meeting, it is also difficult to get a quorum for an AGM or even normal meetings. We face the problems of being small and more or less specialised. A geological engineer for example can be considered as a subset of a civil engineer and has to compete with them, but cannot practice as a civil engineer.

An explosive engineer like me has to compete with mining engineers, civil engineers and even mechanical engineers to prepare explosives and blasting reports. One government department may accept a professional report and plan from an engineer of a related discipline only but another may accept a report from any engineer as long as the engineer has a P.E. and the experience. This sometimes make us wonder whether it is worthwhile to go for a specialised degree early and find that the demand for such engineers is very limited; or it may be better to go for a common engineering first degree and a specialised degree later. There are pros and cons on this subject and there is a never-ending debate on it.

The other subject of interest is: doctors who have postgraduate degrees and training call themselves specialists or "*doktor pakar*" after a certain number of years of training. I don't understand why engineers with several degrees and fellowships dare not call themselves specialists while many expatriates who come to Malaysia to work do call themselves as such. Are we so humble or we dare not take responsibility of being called "expert"? It is a high time that we should consider this particular route. It will help differentiate between the real expert and a jack-of-all-trade engineer who can do a little bit of everything but is a master of nothing. I know there are many engineers who are experts in many fields but if they don't declare themselves as such how would a potential client know who should he go for consultation. This could also be a reason why many local contractors go for foreign engineering consultants. I think we should be brave enough to tell others that we are an expert in our particular field. Then we can go and compete with others as experts locally and also overseas. Maybe we should set a rule on when we can call ourselves expert (*jurutera pakar*).

How about those who go for early specialisation such as geological engineers, aeronautic engineers, and petroleum mining and mineral engineers. Can we call them expert after a certain qualifying training and experience? After all, the job market for early specialisation is so limited.

I hope this will be food for thought to those engineers from specialised disciplines like mine and also others who are really specialists. ■

LRT Launchers Did The Trick For Bridge Superstructure Over Jalan Kuching!

By: Dr Yap Weng Fatt, PATI Sdn. Bhd. (A UEM Builders Berhad Company), BSc. (Jt Hons.), PhD, FIEM, MIES, P.Eng. (M), FICE, AIStructE, CEng.

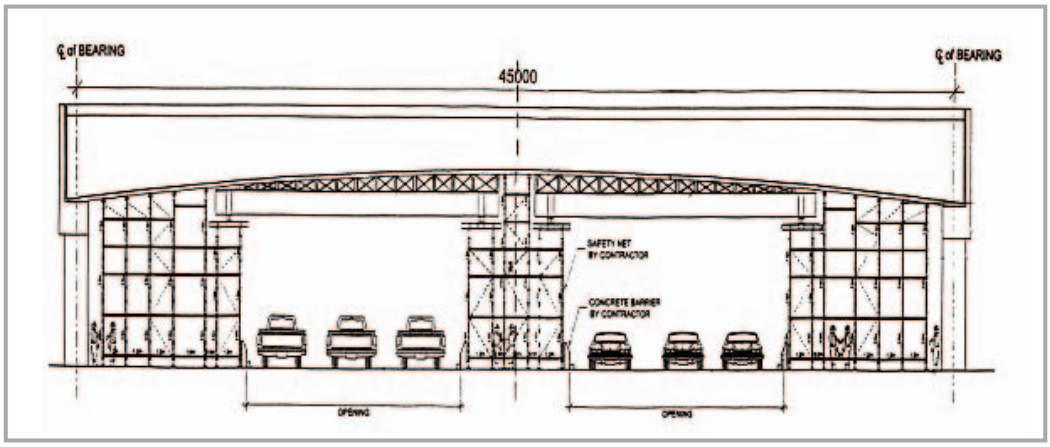

Figure 1 : Scaffolding option

Introduction

Though challenging, the construction of any bridge over a heavily trafficked road can be a nightmare, more so when the road is a principal artery leading to and in the vicinity of the city centre. That was exactly what the project team had to face when the company was awarded the job in April 2002 to build the 45m span separate deck, dual carriageway twin-celled box-girder bridge over Jalan Kuching, leading to the Antah Towers.

The original concept for constructing the bridge superstructure involved mid-deck support and narrowing of lanes along Jalan Kuching but this option was soon discarded owing to the anticipated massive inconvenience to the public caused by traffic upheaval.

Through creative thinking, the team came up with a viable alternative solution to the problem. It was decided that the cobwebs should be dusted away from the launching gantries previously used for constructing the PUTRA Light Rail Transit System Two (LRT2) concrete viaducts and have them adapted for use. If successful it would mean no hindrance to traffic flow, no central supports, safe operation and clean appearance throughout construction, with a little free advertisement added in as a bonus!

This turned out to be exactly the case and even though some additional strengthening to the boxes were required and the bridge deck had to be built in stages (it was not possible for the pair of steel gantry boxes to fully carry the 1000 odd tonnes self-weight of the cast insitu deck) the effort was worth it.

Proposed Vs Adopted Deck Construction Option

Originally, constructing the deck superstructure involved the positioning of a central support at the median and reducing the road width along Jalan Kuching (Figure 1).

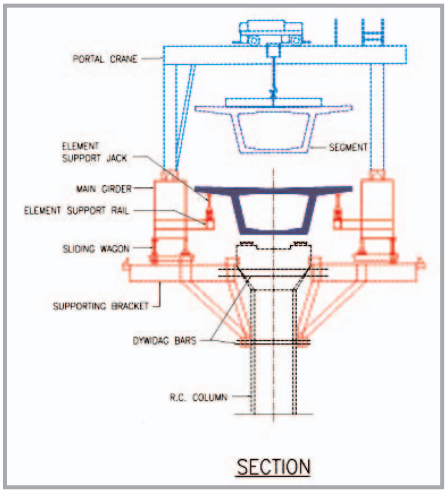

Figure 2 : LRT2 Launching Gantry

Assembly of heavy duty scaffoldings, placing of steel support beams by cranes, and traffic management are features of this erection method.

In the adopted solution, the past successful performance of the launching gantries (when they were used to construct the entire elevated portions of the 29.1km LRT2 System, crossing over live traffic at major roads and railways in the city e.g. at NKVE, LDP, Federal Highway, Jalan Bangsar) was once again relied upon, albeit now not with full regalia. Only certain components of the launcher, mainly the girder boxes with the element support rails and the accompanying launching noses, were utilised.

Details of Adopted Option

Figure 2 depicts overall the various components that make up the launching gantry when used for erecting LRT2 viaduct concrete segments. For current usage, only the items indicated in solid lines were selected. Basically, two rectangular boxes and two truss end noses when connected together form a single line of girder, and the self-launching capability of these steel box girders was made use of to span them over the busy highway, and the mode of use of these boxes was then modified to allow them to act as temporary supports for building the bridge.

Launching Sequence

Prior to launching, the boxes for each line of girder were supported on temporary concrete blocks and joined. The noses were then added and the whole assembly systematically and carefully checked, particularly at the bolted connections, to ensure that the girder was ready for launching. Due to space constraint, the northernmost girder had to be pushed and guided into position through a curve, which was more difficult, while the remaining

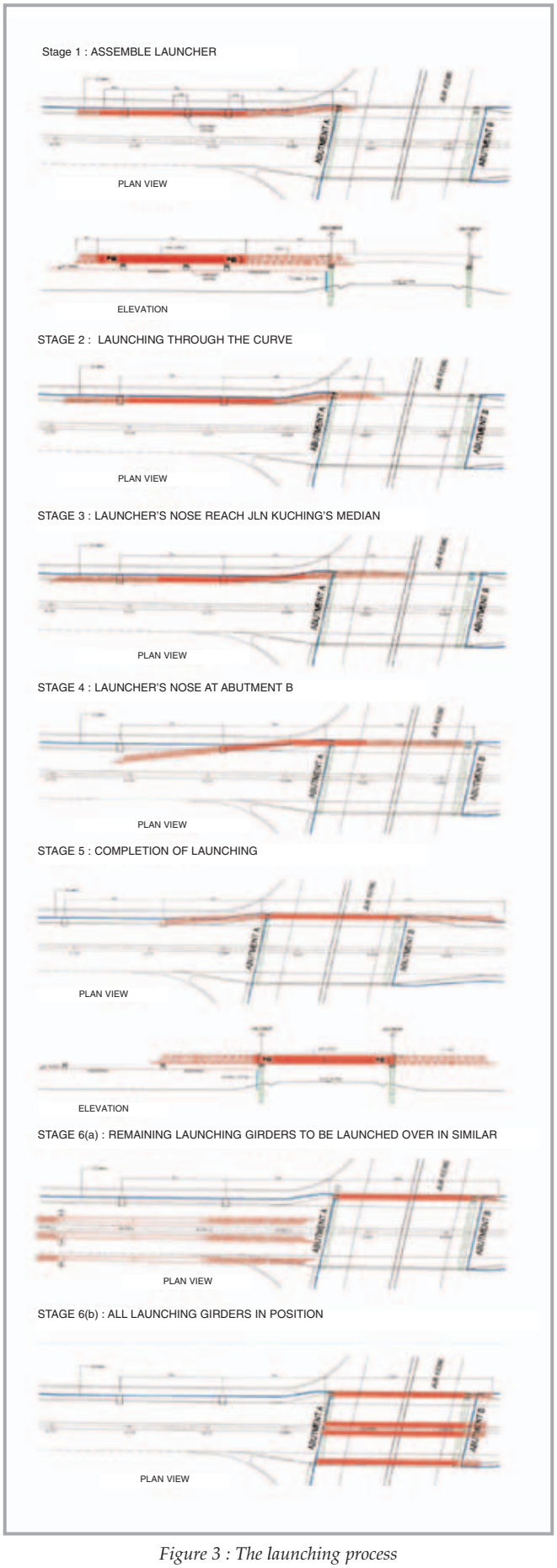

Figure 3 : The launching process

three girders were straight. The various stages of the launching process are shown in Figure 3.

Launching the girders over Jalan Kuching took about a day each time but because of the gradual process and the non-necessity for traffic diversion or the presence of big mobile cranes, the motorists were largely unaware of what was going on above them and only noticed when the box girders were in place and supported on the abutments (Figure 4).

Erection of Deck Support System

To support the falsework for the bridge deck, steel I-beams were placed by a crane sited at abutment A to span transversely on the element support rails of the two box girders (Figure 5). Because of the curved soffit of the deck and the minimum 5.0m height restriction requirement above

Figure 4 : LRT launcher in position

the road, the bridge deck had to be built above its final position. To do so, the transverse beams near to both ends of the bridge had to be erected below the element support rails. Safety nettings were placed on top of the transverse beams before plywood boards were installed to cover fully the whole area between girders and up to both abutments. Effectively a totally sealed and safe working platform had been created to allow subsequent works on the deck superstructure to proceed (Figure 6).

Construction of Concrete Box Deck

As stated earlier, the two girders were not strong enough to support fully the concrete deck superstructure. As such the webs had to be constructed as individual curved base I-beams, starting first with one of the edge webs being cast at the centre, stressed to carry its own self-weight, and then jacked sideways to its final position. This procedure was repeated with the other edge web, and finally the centre web was cast in position without any

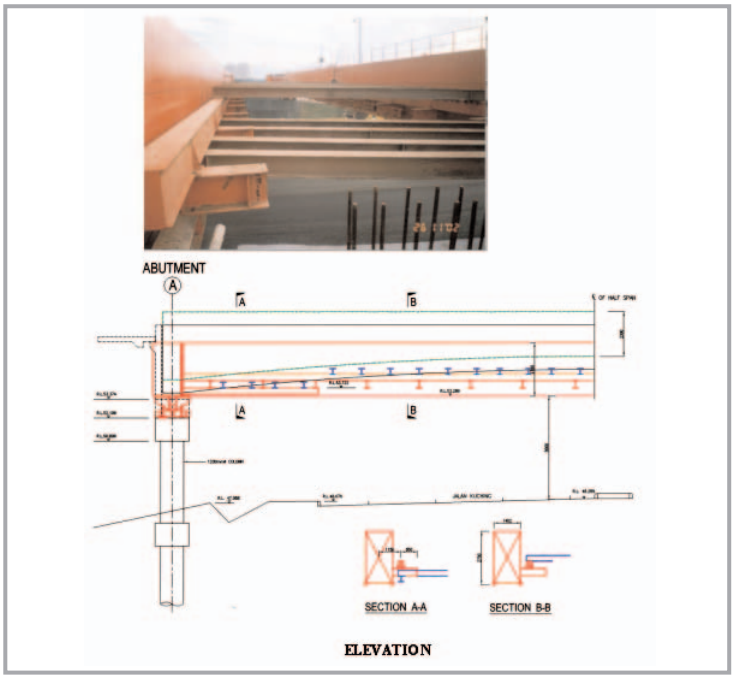

Figure 5 : Positioning of transverse beams

Figure 7 : Deck construction sequence

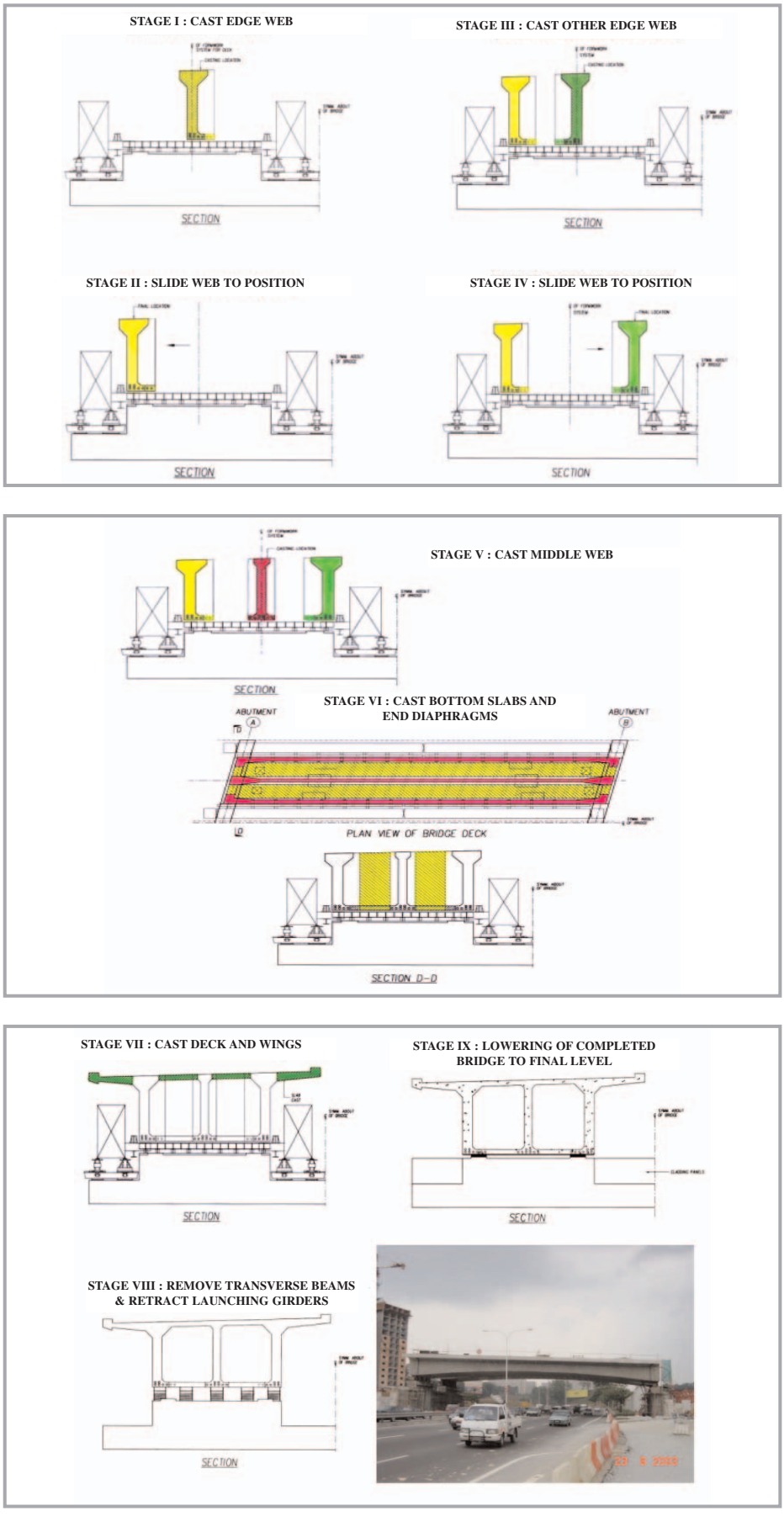

Figure 6 : Full working platform

need to shift. The bottom slabs and end diaphragms were cast next, and finally the top slabs and cantilever wings to form the twin-celled box deck superstructure. The whole sequence is detailed in stages 1 to 7 (Figure 7). Because two pairs of gantry girders were used, work on both decks could be carried out almost concurrently. Once completed, the timber forms and falsework were removed, followed next by the transverse I-beams using chain blocks. The box girders were retracted one by one over the highway (stage 8), and finally the completed bridge deck had to be lowered very slowly about 1 metre to its final position (stage 9).

Conclusion

Currently the bridge is fully completed and vehicles have started plying over it. Construction had been very challenging but, most important of all to the project team, the objectives that they had set out to achieve were fully met. At least by now, without the gantry boxes blocking the view, the curious public is aware of what we were doing as initially, when the steel boxes were first launched over Jalan Kuching, many people were under the impression that PATI was constructing another LRT System in KL! ■

Acknowledgement

The author wishes to acknowledge the strong effort put in by the project team to resolve the various unexpected problems and issues that had surfaced during the works and compliments them on a job well done. Thanks are also due to our client Ideal Appraisal Sdn Bhd for giving us the opportunity to work on this project and for placing their trust in our construction method.

Hot In-Place Recycling: An Introduction

By: Ir. Ahmad Kamil bin Arshad, BEng, MSc, MBA, LLB, P.Eng, MIEM

Introduction

Hot in-place recycling (HIPR) is an alternative method of pavement rehabilitation whereby the existing deteriorated wearing course is remedied by recycling the layer and rejuvenating its binder properties by adding a small amount of recycling agent. In addition, a certain amount of fresh asphaltic mix may be added to improve its aggregate gradation or to make-up the quantity deficiency due to rut depressions.

HIPR method has been previously used on the North-South Expressway in the 1990's but its use on other roads in Malaysia is almost unknown except for several trial demonstrations. In the year 2003, the method was introduced on Federal Route 181 (road leading towards Pulau Indah, Kelang) and it is expected that several other roads are to be rehabilitated with this method.

This article attempts to provide a brief introduction to the HIPR process, equipment for the process, selection criteria for the suitable pavement candidate, mix design, construction process, quality control and finally, the advantages and disadvantages of this process.

Hot In-Place Recycling Process

In general, the HIPR process involves (1) the softening of the existing surface by heating, (2) mechanical removal of the softened pavement surface by scarifying, (3) mixing it with rejuvenator /recycling agent and/or addition of virgin hot mix asphalt (HMA) and (4) placing the recycled material on the original pavement site before (5) compacting it with normal rollers (Figure 1).

There are three types of HIPR process according to the American Recycling and Reclaiming Association [1], namely:

- **Surface Recycling/Heater Scarification** – The process involves: (1) heating the existing pavement surface, (2) scarifying the softened surface, (3) adding a recycling agent, (4) mixing the loose recycled material, (5) spreading and placing the recycled mix with a free floating screed, and (6) compacting the mix with conventional rollers and procedures. Depths of 20mm to 25mm are common for this type of recycling method.
- **Remixing** – The remixing process consists of the following steps: (1) Heating the pavement to a depth of 37.5mm to 50mm; (2) scarification and collection of RAP in windrow; (3) addition of virgin aggregate, recycling agent, or fresh HMA mix; (4) mixing in a pugmill; and (5) spreading recycled mix and compacting.
- **Repaving** – surface recycling is combined with a simultaneous overlay of new HMA to form a thermal bond between recycled and new layers. The recycled depth generally ranges from 25 to 50mm.

Figure 1: HIPR Equipment Train: Preheater, Remixer, Tipper, Rollers (Source: http://www.propel.com)

In Malaysia, the most common method presently used is the remixing method with a recycled depth of 50mm, as described earlier.

Equipment

Historically, an equipment using the heater scarification process was originally developed in the 1930s in Utah, U.S.A. However, it is generally accepted that the first boom of HIR equipment and processes occurred in the 1950s and 1960s, with the advent of the repaving process invented by Cutler. The modern era of recycling was initiated in the mid-1970s, whereby more complex and technologically advanced machinery were manufactured such as the use of infrared type heaters and the use of stationary teeth or rotating milling heads for the removal of the softened pavement [2].

The development of HIPR equipment and process (particularly the remix process) have been rapid since late 1980s and early 1990s, enabling existing pavement to be recycled deeper and an acceptable high quality asphalt pavement laid down which is comparable to other similar rehabilitation methods. Presently, among the latest innovations include the use of a combined heating system whereby a combination of hot air under forced convection and an indirect low-level infrared heaters is used to reduce excessive heat (Figure 2). This is because excessive heat can damage the asphalt binder due to accelerated oxidation of the binder in the pavement [2].

A typical HIPR equipment train (remix process) consists of a preheater, remixer, tipper truck, tandem and tyre

roller. The preheater, which is equipped with clusters of infrared heaters fed with propane gas, softens the wearing course by heating the pavement to between 140°C to 170°C.

The remixer includes a receiving hopper for additional mix, infrared heaters and a rotating scrarifier (Figure 3). The scarifier unit scarifies the softened pavement and the rejuvenator is sprayed on the reclaimed material. It is then augered to the center of the machine where it enters a pugmill mixer and is mixed thoroughly with the virgin mix. After thorough mixing, the material is discharged from the mixer as a windrow in front of the auger and screed [3].

The blended mix is then placed on the original pavement site by a compacting screed. Normal compaction is carried out with a steel tandem roller and rubber tired roller.

Selection Criteria of Pavement Candidate

The HIPR process is used to treat surface distress such as surface cracking, minor rutting and raveling. It is not suitable for base or subgrade related distresses. It is basically a preventive maintenance treatment whereby the damaging effects of surface distresses is mitigated early to prevent further deterioration of the pavement structure. A good candidate pavement for rehabilitation with HIPR is any hot mix asphalt pavement with a stable base, adequate drainage, and does not have the following characteristics:

1) Failures that are base/subgrade related.
2) Rutting more than 50% of the depth to be recycled.
3) Mat thickness of less than 75mm.
4) Cracks deeper than the scarifying depth.
5) Low binder content – less than 4%.
6) Poor or soft aggregates.
7) Large aggregates – larger than 19mm diameter.
8) Evidence of stripping
9) Existence of geofabrics material such a petro-mat at the scarified depth.

To determine a candidate pavement for HIPR, the following must be carried out:

1) Structural evaluation and visual inspection of the candidate pavement.
2) Obtaining cores of the roadway surface to determine:
   a) Mat thickness.
   b) Aggregate size, hardness and gradation.
   c) Percent of asphalt.
   d) Existence of geo-fabric material such a petro-mat and its depth.
   e) Evidence of stripping.
3) Reviewing records from the "as-built" drawings of the roadway.
4) Interviewing field maintenance personnel.

After a candidate pavement has been selected, a qualified materials engineer should conduct further testing at his/her discretion.

Figure 2: HIPR machine using combination of hot air under forced convection and low level infra-red heating system [2]

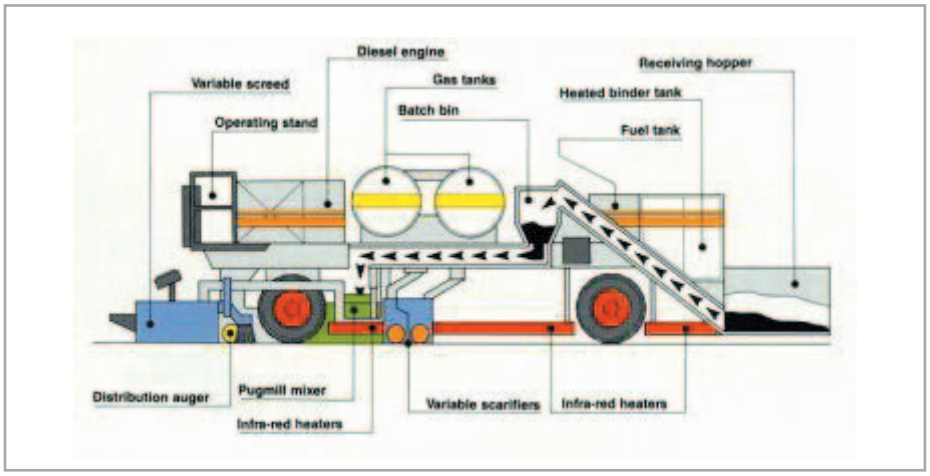

Figure 3: Various components of a typical remixer machine [3]

Mix Design

HIPR mix designs are generally performed to restore the characteristics of the existing aged asphalt pavement similar to those of virgin HMA. The two major steps in mix design procedure are material evaluation and mix design.

The objective of the material evaluation step is to determine the important properties of the component materials. The steps involved are sampling, determination of properties of in-situ asphalt pavement material or RAP and recycling agent.

The mix design step consists of using the Marshall Design Method to determine the type and percentage of recycling agent required. In summary, the overall mix design process involves the following steps:

- Evaluation of the existing aged asphalt pavement including asphalt binder, aggregate gradation and mix properties.
- Determining whether the existing asphalt binder needs rejuvenation.
- Selecting the type and amount of recycling agent.
- Determining the need for and amount of admixture including aggregate gradation, type and amount of asphalt binder.

Figure 4: The actual remixer machine (back view) [3]

- Preparing and testing both asphalt binder and mix specimens in the laboratory.
- Evaluating tests results and determining the optimum combination of admixture and recycling agent.

Construction

Prior to the HIPR process, areas with isolated base and/or subgrade failures is reconstructed first up to the binder layer. The pavement surface is then cleaned of any loose and deleterious material such as silt, dirt and other debris by brooming or other cleaning methods.

The pavement is heated with a pre-heater (Figure 5) to a temperature of about 130°C to 150°C but not more than 160°C to 170°C to prevent burning and charring of the pavement surface. The heated pavement is then immediately scarified using the remixer machine (Figure 6), before being added with the specified quantity of recycling agent and fresh ashphaltic mix. The recycled material and the fresh mix is blended in the remixer's pugmill before being laid on the existing pavement with the attached paving screed on the remixer machine.

The HIPR surface is then compacted using the normal compaction procedures used in the conventional laying method. The JKR Specifications specified that the minimum temperature before the start of rolling must be 110°C to prevent stiffening of the mix during compaction. According to the asphalt Institute, below 85°C, the mix has stiffened to such extent that compaction is no longer effective. CSIR of South Africa recommends that rolling shall take place between 90°C to 130°C for 80/100 penetration grade bitumen mix.

Joints poses a special problem for the HIPR process as certain procedures have to be followed to achieve the required finished HIPR surface. The JKR Specifications require that heating shall extend at least 100mm into adjacent mat to enable a hot-on-hot longitudinal joint to be constructed [5].

Sometimes this is not possible due to space constraints (e.g. in a dual-two road, requirements to open one lane to traffic may prevent the extension of heating). Proper compaction at the joints is vital to prevent joint cracks and also to achieve a neat surface finish.

Quality Control

In general, three types of specifications are used: (1) method, (2) end-result, and (3) a combination of method and end-result. JKR Malaysia currently adopts a specification which is a combination of method and end-result specification [5], This ensures that proper equipment and work procedures are followed by the contractor and at the same time the specified performance of the end product is achieved.

Some recommended guidelines for quality control (QC)/quality assurance (QA) of the recycled mix in HIPR process are as follows [4]:

- Depth of scarification is measured to ensure adequate thickness of the recycled layer.
- Application rate of recycling agent – the quantity used is calculated and the asphalt content before and after adding recycling agent is calculated to ensure that it is within the specified range (generally 5–7%).
- Fresh bituminous mix addition rate is calculated from the quantity used.
- Temperature of the recycled mix behind the screed is measured to ensure that a minimum temperature of 110°C is achieved before compaction commences.
- Coring of laid recycled wearing course to determine the compacted thickness, Marshall Density and binder penetration.

Advantages and Disadvantages of HIPR

Advantages of HIPR

The advantages of hot in-place recycling are the following: (1) conservation of energy and materials, (aggregates, asphalt and transport fuel) (2) no milling waste disposal (3) pavement geometrics are preserved or restored, (4) surface distresses such as cracks and minor rutting not caused by structural inadequacy can be corrected, and (5) existing surface mixes can be modified.

The other advantages of hot in-place recycling are: (6) surface frictional resistance can be improved, (7) the process is relatively cheap, (8) the method needs less traffic control compared to the other rehabilitation and techniques.

Disadvantages of HIPR

The disadvantages of HIPR include the following: (1) high acquisition cost of the HIPR equipment, (2) a dedicated and skilled team of operators/workers is required, (3) existing pavement properties must be relatively homogenous for the process, (4) where there are manholes and bridge joints, manual paving operations must be carried out, (5) four legged intersections may not be suitable as there is difficulty of obtaining the proper crossfall using the HIPR equipment, (6) excessive smoke particularly where there is dirt and paintwork, (7) length of the HIPR equipment may be unsuitable for places with limited access and sharp turning radius such as urban areas.

Conclusion

The HIPR process is an alternative to other conventional methods such as mill and pave in addressing surface distresses as explained above. The main attraction of this process is that resources

Figure 5: Heating the pavement surface with a preheater

are saved by the use of recycled materials and cost savings is also possible as compared to the conventional mill and pave method. However, there are limitations to this process as it is less flexible in addressing pavement with irregular shape or width and require a dedicated team of skilled operators and support workers. An understanding of the limitations of the process and machinery is essential in choosing the correct pavement candidate for this method.

Figure 6: Sacrifying the sftened heated pavement [4]

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Dear Chief Editor,

SOIL NAILING & GUNITING

I read with intense interest the seminar report on soil nailing & guniting written by Ir. Yee Yew Weng in the October 2004 issue of the Jurutera Bulletin. I'd like to commend the high quality of the report writing. Although I did not have the opportunity of attending the evening lecture due to reason of distance, there are several points I'd like to add which might be of benefit to the reader.

The statement "Soil nails need to extend to sufficient length beyond the active zone or any plane of weakness to overcome external stability…" may best be comprehended in the following manner: The soil in front of the likely failure plane is termed the active zone and that behind the failure plane the passive zone. Essentially soil nailing can be employed to tie these two zones together and thus prevent failure. The design process assumes a certain shape of failure plane which can take the form of a single plane, a twin plane (twin wedge), circular, log spiral or others. Different geometries take slightly different calculations but all in all the methods require an out-of-balance force or moment to be calculated and a system of nails deployed to resist it. In essence, the two strength aspects of soil nail performance are the inherent rupture strength of the nails themselves and the pull-out resistance of the soil nails from the resistant (passive) zone of the soil.

Eurocode 7 gives some guidance on the geotechnical matters relating to soil nailing and the pullout resistance partial factors for design are discussed in Section 2 and in Annex B. Valuable design information can also be found in the respective BBA Certificate of the soil nail product. The BBA Certificate will normally include technical information with regards to the design, materials specification (tensile strength, design strength, pull-out resistance, chemical resistance, hydrolysis, effects of temperature and durability), and construction methods of soil nailing applications.

The stabilisation of slopes using soil nail principles differs considerably from the ground anchoring approach. Ground anchorages are founded outside any potential slip planes or slip circles and are prestressed against a major structure to distribute the soil retaining force at the slope face. The facing of the soil-nailed structure is not a major structural load-carrying element but rather ensures the local stability of the soil between reinforcement layers and protects the ground from surface erosions and weathering effects.

Soil nails are installed at a much higher density and generally remain passive. They remain unstressed until nominal soil movement mobilises the tensile capacity of the soil reinforcement. Subject to adequate soil density, nail lengths, strength and bond capacity, the nailed soil volume may be likened to a reinforced gravity structure retaining and stabilising the slopes.

The designer must always remember that soil nailing is an in-situ technique and that he should consider the possible options for modifying the design should unforeseen ground conditions be encountered on site and as construction proceeds from the "top down". Ground water and infiltration of rainfall have a profound effect on soil nailing. This is especially the case when increased porewater pressure may reduce both the stability of the soil and the pull-out resistance of the nails. The designer should always try to minimise the ingress of water to the structure and also include provision for an increase in porewater pressure at some time during the life of the structure. Where inundation could occur special consideration is required to verify the suitability of the location for soil nailing. Examples of this include a wall below a major water main and main open drain for a major development.

The nails are generally made of steel, although other materials, in particular glassfibres are now becoming more acceptable. Designer should therefore look into all options on the selection of soil nail for a particular site.

Currently, most reinforced slope design has been carried out per HA68/94 or BS8006:1995. HA68/94 was published in 1994 in the UK DOT/HA design manual for roads and bridges (Volume 4, Section 1, Part 4). The manual gives design methods for the reinforcement of highway slopes by reinforced soil and soil nailing techniques. It is a limit state design standard with 60 year design life and caters for slopes exclusively $\leq 70°$.

HA68/94 is the first "unified" design method for slopes reinforced by geosynthetics or soil nails. The design method gives reinforcement layout but assumes a competent foundation. If the foundation is not competent, or if the bearing material is not significantly better than the slope material, then underlying slip mechanisms should be checked by alternative means (Bishop's Methods, etc.) and independently improved.

Like HA68/94, BS8006:1995 is a limit state design standard code of practice for strengthened/reinforced soils and other fills. BS8006:1995 is based on modern soil mechanics principles with partial safety factors back-calculated from existing experience. It is however viewed as incompatible with the upcoming Eurocode 7.

HA68/94 is better preferred by most designers as it uses a simple two-part wedge mechanism. It is a full design method giving an economical reinforcement layout.

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Dear Chief Editor,

MY VIEW TO IMPROVE OUR 'PROGRESSIVE' SOCIETY

I was travelling on the PLUS highway on the way to Singapore when I encountered a very bad experience on the road. It was Christmas eve and there were quite a lot of cars on the road. I was especially taken aback when a car which I wanted to overtake kept on hogging the fast lane and blocking my way to overtake. All I did was flashing my lights to alert the driver of that car that I was coming 'fast' and wanted to overtake. The driver blocked the road and went faster when I tried to overtake from the left. He purposedly did that because the driver allowed other cars to overtake but not me.

This is a bad attitude of Malaysian drivers. Sometimes we drive according to our temperament and emotions. This happens especially on busy and jammed roads. Motorists are getting impatient and restless. No wonder we have road bullies on our roads.

As a reponsible citizen and engineer, I am accountable to society. We have a social reponsibility. How we behave can actually change society. It is a tall order. Don't think that we are just a fraction of the Malaysian population. See, if we as reponsible individuals and intellectuals try to change society, others will follow if they see what we do is good. The proper 'way of life' will slowly sip into society. Remember there are other professional institutions as well which are propagating good values as well. They are the accountant's association, the medical association, etc. We could be taking the lead into doing all these. But, what is wrong with that?

Malaysia is gearing towards a progressive and an improved society. So let the seeds of 'civilisation' grow in our heart. One day, we are going to be a developed country. Does our standards and quality of life meet the standards of other developed nations? Let's ponder over it. Together we can make the difference. Well, of course here, I am not only talking about attitude in using the roads, there are many other things associated with civic-consciousness. For example, throwing of rubbish and unused plastics bags, spitting, abuse of public amenities (vandalism), scratching and knocking on others car when parking, etc.

So, as engineers, let us start instilling the right attitude and values in ourselves so that the nation can be propelled to a greater height. Some of us are policy makers and hold responsible positions. We can educate people by using our authority in this sense. Just ask yourself, don't you want a better tomorrow for our children and future generations!

SDR. NG KENG PENG
IEM MEMBERSHIP: G15739

"How Much Settlement Do You Allow For In Your Buildings?"

By : Ir. Yap Keam Min, FIEM, MICE, MIEAust, P.Eng, C.Eng

Abstract

Over the years, there is an increasing occurrence of damage to buildings in the country caused by ground settlement. Some of the cases are due to inexperience and the failure to understand the fundamentals of engineering.

The intention of this paper is to provide awareness to young engineers on the need to consider the allowable settlement of the building and structure-soil interaction behaviour. Engineers should recognise potential problems associated with building on difficult ground conditions. Not too long ago the term negative friction was uncommon but now, engineers are more aware of the effects of negative friction. As case histories of failures are highly sensitive, none are mentioned in this paper.

Introduction

With the tremendous growth of the construction industry in Malaysia over the last two decades, buildings are now increasingly being built on weaker grounds. There is a need for engineers to consider the allowable settlements of the structures in their designs and understand the basic structure-soil interaction behaviour. Engineers have to estimate or predict the amount of movements and whether the structure can tolerate it.

Traditionally the structural engineer designs both the super-structure and the foundation of the proposed building. Most foundation designs are so called routine designs with little consideration for allowable settlements. Experienced geotechnical engineers should be employed to design foundations of complex nature and important structures. In recent years there have been a growing numbers of these experts.

Settlement problems are not confined to high rise buildings and important structures and indeed a number of single storey houses in this country have experienced excessive differential settlements, which resulted in very expensive repair works. Many were beyond repair and had to be rebuilt.

Building on weak soil or difficult grounds does not always have to mean high safety factors. If the superstructure and foundation are studied in relation to the ground movements, an economical design may be possible.

Total and differential settlements

Design engineers should consider both the total and differential settlements but it is the differential settlement that is really of concern. Often a uniform total settlement of not more than 300mm does not cause any damage to a building except to its utility services. A classic example is the "Palacio de las Bellas Artes" or the "Palace of Fine Arts Building" in Mexico City (Lambed and Whitman) where the building has settled by more than 3m and is still serviceable. Silos and tanks for storage of fluids can tolerate large total settlements.

Differential settlement is basically when one part of the building settles more than the other part. When the differential settlement is excessive, building will distort (Figure 1) and suffer damage, which may sometimes be devastating. The most famous case of differential settlement is the Leaning Tower of Pisa, where the South side of the tower settles more than the North side.

Figure 1 : Distortion of building due to excessive differential settlement

Figure 2 : Structural failure

Figure 3 : Severe cracks due to differential settlement in the living room is not a welcomed sight

Differential settlement is normally expressed as the angular distortion, which is defined as ratio δ/l where δ is the difference in settlement between two points and l is the distance between the points.

Allowable settlements

It is generally acknowledged that three criteria should be satisfied when considering the limiting movements of a building (i) visual appearance; (ii) serviceability or function; and (iii) stability or structural failure (Figure 2). However, the amount of allowable settlements is usually governed by the avoidance of cracks in walls and finishes. Any jamming of doors and windows, breaking-up of sidewalks and drains, may signify possible differential settlements. Unsightly

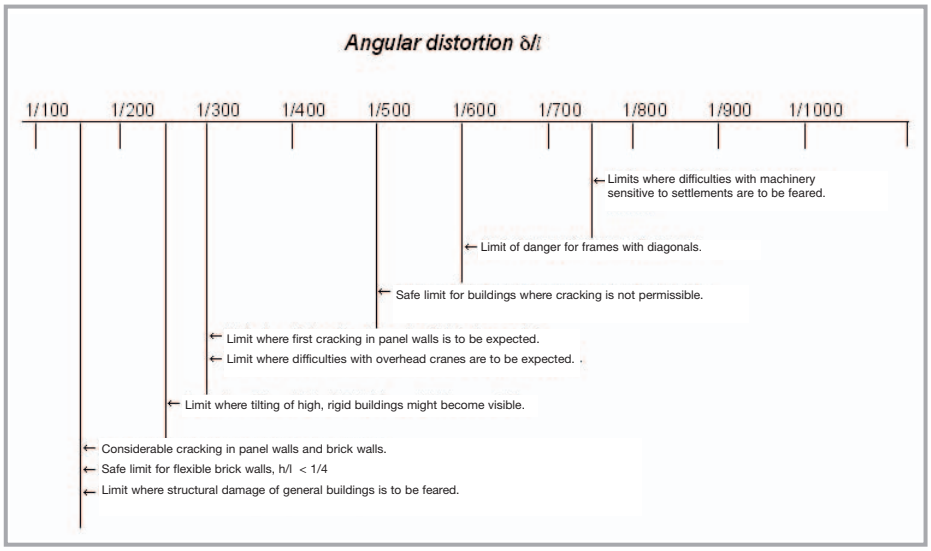

Figure 4 : Limiting angular distortions (Bjerrum, 1963)

cracks are definitely not welcomed in our living room (Figure 3). Besides, any crack whether structural or not will cause concern and alarm to the layman.

The amount of allowable settlement depends on many factors and due to its complexity, most researchers have relied on studying and observing the performance of actual buildings to develop empirical methods to determine the magnitude of settlements allowed. Perhaps one of the most famous works on the topic of allowable settlements is by Skempton and MacDonald (1956) who studied the performance of ninety-eight buildings of load bearing wall, reinforced concrete and steel frame construction founded on various foundation systems. Not all buildings that had differential settlement sustained damages, only forty buildings had been damaged in varying degrees as the result of settlements. The damages were classified into functional or serviceability, architectural and structural damage. Skempton and MacDonald gave the angular distortion limits for the cracking of walls or panels in conventional frame buildings or load bearing brickwall buildings as 1/300 and for structural damage to columns and beams as 1/150. Their recommendations for the allowable settlements are given in Table 1. However, the frame structures and load bearing brickwall buildings should have been treated separately as the load bearing brickwall is very much more sensitive to movement.

Bjerrum (1963) gave a range of angular distortion limits for various conditions (Figure 4). The values for the crack in the panel walls and structural damage are in good agreement with Skempton and MacDonald.

Sowers (1962) summarised his studies into three modes of settlements: (i) total settlement, (ii) tilting and (iii) differential movement (Table 2). It shows that simple steel frames can tolerate large differential settlements, whereas high continuous brick walls are highly sensitive to movement. The settlement limit for buildings with sensitive machine operations is stringent.

Terzaghi (1938) studied the performances of many buildings and concluded that most ordinary structures can tolerate a differential settlement of 20mm between adjacent columns. Terzaghi and Peck (1967) also suggested that the differential settlement is unlikely to exceed 75% of the maximum settlement, which means the total settlement the frame building can withstand is 25mm. This may be probably why most of the building foundations are designed so that the total settlements do not exceed 25mm

Few building codes give specific values for allowable settlements. It is interesting to note that the old U. S. S. R. (1955) building code (Table 3), which is basically from the work by Polshin and Tokar (1957) in the former Soviet Union gave permissible differential settlements which are still relevant today.

The subject of allowable settlements has to be considered in difficult ground conditions and some of the typical difficult grounds in Malaysia are as follows:

1. Ex-mining land - Normally consists of tin mining residuals, which is very soft silty clay commonly called slime (Figure 5). These grounds are highly compressible and as it is man-made,

Figure 5 : Typical slime in ex-mining land. Looks solid but is very soft just below the surface.

TABLE 1 : DAMAGE LIMITS FOR LOAD BEARING WALLS OR WALL PANELS IN FRAME BUILDINGS (SKEMPTON AND MACDONALD, 1956)

Criterion		Isolated foundations	Rafts
Angular distortion		1/300	
Greatest differential settlement :	Clays	45mm	
	Sands	30mm	
Maximum settlement :	Clays	75mm	75mm to 125mm
	Sands	50mm	50mm to 75mm

TABLE 2. ALLOWABLE SETTLEMENTS (SOWERS, 1962)		
Type of movement	**Limiting factor**	**Maximum Settlement**
Total Settlement	Drainage	15-30cm
	Access	10-60cm
	Probability of nonuniform settlement :	
	Masonry walled structure	2.5-5cm
	Framed structures	5-10cm
	Smokestacks, silos , mats	7.5-30cm
Tilting	Stability against overturning	Depends on Height and Width
	Tilting of smokestacks, towers	0.004*l*
	Rolling of trucks, etc.	0.01*l*
	Stacking of goods	0.01*l*
	Machine operation - cotton loom	0.003*l*
	Machine operation - turbo generator	0.0002*l*
	Crane rails	0.003*l*
	Drainage of floors	0.01 - 0.02*l*
Differential movement	High continuous brick walls	0.0005-0.001*l*
	One-story brick mill building, wall cracking	0.001-0.002*l*
	Plaster cracking (gypsum)	0.001*l*
	Reinforced-concrete-building frame	0.0025-0.004*l*
	Reinforced-concrete-building curtain walls	0.003*l*
	Steel frame, continuous	0.002*l*
	Simple steel frame	0.005*l*

Note l = distance between adjacent columns that settle different amounts, or between any two point that settle differently. Higher values are for regular settlements and more tolerant structures. Lower values are for irregular settlements and critical structures.

TABLE 3 : PERMISSIBLE DIFFERENTIAL SETTLEMENT BY U. S. S. R. BUILDING CODE (1955) (FROM POLSHIN AND TOKAR)		
Description of standard value	**On sand or hard clay**	**On plastic clay**
Slope of crane runway	0.003	0.003
Difference in settlement of civil and industrial building column foundations :		
for steel and reinforced concrete structures,	0.002*l*	0.002*l*
for end rows of columns with brick cladding,	0.0007*l*	0.001*l*
for structures where auxiliary strain does not arise during nonuniform settlement of foundations (l = distance between column centres)	0.005*l*	0.005*l*
Relative deflection of plain brick walls :		
for multi-story dwellings and civil buildings at $l/H \leq 3$	0.0003	0.0004
at $l/H \geq 5$	0.0005	0.0007
(l = length of deflected part of wall; H = height of wall from foundation footing)		
for one-story mill buildings	0.001	0.001
Pitch of solid or ring-shaped foundations of high rigid structures (smoke stacks, water towers, silos, etc.) at the most unfavourable combination of loads	0.004	0.004

Figure 6 : Backfill indiscriminately filled with boulders can be a nightmare for foundation engineers

Figure 7 : Brickwall is highly sensitive to movements

can be very variable. The worst condition is where limestone bedrock is overlain with very soft slime.

2. Marine soil - The top 20m of the soil strata usually consist of highly compressible silty clay with SPT N values of zero. The weak compressible soil makes foundation design very tricky. The apron and services are often overlooked and although the structure is stable, settlement of apron and drains are common.
3. Backfill - Deep fill can be a concern especially if poorly compacted. Indiscriminately filling with rock and boulders can cause serious problems for the foundation engineer (Figure 6). Modern day construction schedules do not seem to allow any time for normal consolidation. There are instances where piles are driven while the mining pools are being filled.
4. Landfills – Contains loose waste and organic matter. The decomposition of organic matter makes the landfill highly compressible and very variable.
5. Cut and fill – Often in construction work, buildings have to be constructed on cut and fill ground.

Figure 8 : Settlement of walkway and apron, common occurence in soft ground such as marine soil

The part of the building sitting on the fill portion may settle more than that on the cut area resulting in differential settlement.

The allowable settlement depends on the following:

1) Type of structure or construction material - A steel frame structure can tolerate a much larger differential settlement than a loading bearing brick wall building. A lot of houses in earthquake-prone areas are made of wood, which is flexible.
2) Use of the building - Cracks in a factory may be acceptable whereas any crack in a house is often of concern. Water retaining structures and reinforced concrete flat roofs cannot bear much differential settlement because of their requirements for water tightness. Important structures are also designed for less settlement.
3) Rigidity of the structure - Flexible structures can tolerate greater distortions. For example, simple steel frames are more flexible than continuous steel frame although they are constructed of the same materials.
4) Type of foundation - Raft foundations can tolerate greater amounts of differential settlements and are often used in highly variable grounds to reduce settlements.
5) Location - Construction of new buildings especially those involving deep excavation and piling works may lead to additional settlement of the adjacent buildings. It is important to study if the nearby structures can tolerate the additional settlements. For instance the design of a temporary structure may allow for a larger total settlement that may not be tolerated by adjacent buildings.

Structure-soil Interaction

As mentioned previously, it is necessary to understand the basic structure-soil interaction behaviour when designing for buildings located on difficult grounds. Structural engineers do not want any settlement on their buildings and obviously that's not really possible especially where buildings are to be built on weak ground. The foundation engineer has to estimate the mode and amount of settlements based on the ground condition and the structural engineer has to predict how much distortion the structure can tolerate. The foundation engineer and structural engineer have to work closely to produce the best possible design for the building.

One of the most important factors in this relationship is the rigidity of the structures. A flexible structure has little load transfer and can take greater distortion than a stiff structure. However, a rigid structure has larger capacity to transfer load and hence reduce differential settlements. An example of a flexible structure is a simple steel frame and a steel frame structure with many diagonal bracing is very rigid. (Coduta 1994)

Obviously it is costly to stiffen a structure, which may be done with bracing, shear wall and ground beams. Little (1969) gave an example of a particular building where the cost of preventing cracks by resisting movements in the structure and foundation can be easily more than ten percent of the total cost of the building. With a flexible structure, it is best to avoid having finishes and machinery, which are sensitive to movements, although such machinery can be founded on a separate foundation.

The question of whether to design a flexible structure to accommodate the movements or a rigid structure to reduce differential settlements should be based on experience and engineering judgement.

Load bearing brickwall construction, which is highly sensitive to movements (Figure 7), may not be a suitable form of construction in highly compressible soils. Skempton and MacDonald (1956) gave an example of a five-storey building of load bearing brickwall constructed on a 1.2m raft in filled ground. Damage was severe, with cracking of all the walls even though the building was founded on a thick raft. Another example of load bearing brickwall failure in Malaysia is the construction of single storey houses,

Figure 9 : Settlement of drain and services in soft soil

built on reclaimed land which have required expensive underpinning repair works. With the introduction of many new building systems such as lightweight concrete, precast concrete tilt up panels, etc, engineers should evaluate the effect of movements on these systems.

Every construction is a full-scale test; therefore the engineers can learn a lot from studying the behaviour of similar construction, especially from case of histories of failures.

Construction works such as deep excavation, dewatering, pile driving and tunnelling will benefit from experience of previous works. The design engineer should be aware of possible movements of the soil and its effect on the adjacent properties.

Conclusion

What is the allowable settlement of a building? This question was raised to many local design engineers and the author got a variety of answers, e.g. zero settlement, 12mm, 25mm; and some engineers never considered. The answer is that there is no fixed value but depends on many factors, the most important being the type and use of the building and the stiffness of the structure.

The values of the settlement limits given in the tables and figure provide a good guide to the design engineer but should be followed with good engineering judgement. It can be concluded that for a typical concrete frame building, the limit of the angular distortion for cracking in the walls is 1/300 and for structural damage, 1/150.

According to Terzaghi (1938), most ordinary buildings can tolerate a differential settlement of 20mm and a total settlement of 25mm. This is probably the basis of our foundation design where the static load test for piles normally allows for a maximum settlement of 25mm at twice the working load.

The problem of differential settlements may be solved either by designing the structure to accommodate the movement or to resist it. When designing a building where large settlements are expected, it may also be worthwhile to study the performance of existing nearby structures. You do not want to allow for large settlement when the adjacent building is a historical building.

The steel structure is most tolerable to movements whereas the load bearing brickwall is the least and therefore should be avoided in difficult soils. The engineer should also recognise the need to design for the possible settlement of the apron, walkways and drains in soft soil (Figure 8 & 9). With knowledge of the allowable settlement, it may be possible for engineers to choose the proper foundation and type of structure for an economical and safe design.

A number of building failures had occurred because of incorrect choice of foundation or structural system. The design engineer should be aware of possible settlement problems before deciding on the type of structure and foundation. As a wise man once said, identifying the problem is half the battle won. ■

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Renewable Energy – The Need For Further Incentives

By: Ir. Johan Alimin bin Samad, FIEM, P.Eng. C.Eng., FIChemE, MCFArb, ASEAN Eng., Int PE, APEC Eng.

In May 2001, the Malaysian Government announced the Small Renewable Energy Power (SREP) Programme, targeting 5% of the country's total electricity generation to come from renewable energy (RE) sources by the year 2005. This was supposed to alter the make-up of the country's fuel dependency on hydro, coal, gas and fuel oil, by accommodating a new fifth fuel source.

The Ministry of Energy, Communications and Multimedia, Malaysia, forecasts our total maximum electricity demand in the year 2005 to be about 15,417 MW [1]. Thus there is essentially a target of about 770 MW to be generated from RE sources, initially.

Under the provisos of the current SREP programme, however, each RE power plant may only sell up to 10 MW to the grid, hence there are potentially at least 77 such power plants that need to be installed nationwide to meet the policy objective.

However, it has been reported that the government has so far only approved 48 SREP projects with total capacity amounting to only 304 MW [2], which falls far short of the goal. Out of the reported 48 approved projects, TNB has disclosed that only two REPPAs (RE Power Purchase Agreements) had been signed at the end of the year 2003, totaling only 5.2 MW of capacity, with another 15 MW from two other developers in Sabah under negotiation [3].

Thus, it appears most likely that electricity generated from RE sources in Malaysia will thus fall very far short of the target set by the government.

So, what are the reasons for the apparent failure to build up renewable energy capacity, and what needs to be done to overcome it?

EFB Biomass – Malaysia's Most Promising Renewable Energy Resource

There are many sources of renewable energy such as wind, wave, solar-photovoltaic, biomass, biogas, municipal waste, and mini-hydro, which are all abundantly available in Malaysia. Harnessing each of these energy sources for economical electricity generation however, poses different challenges due to the nature of the RE source, or raw material.

Currently most SREP developers have been preoccupied with setting up RE power plants based on palm oil empty fruit bunch (EFB) biomass, due to the abundance of EFBs, the easily deployable and manageable power generation technology for this type of material, and the large number of potentially viable sites available with easy access to the grid.

EFB Biomass Power Plant Technology

Palm oil empty fruit bunches (EFBs) are already burned in most of the existing palm oil mills, generating heat which is recovered in a heat recovery boiler to produce steam, which in turn drives a steam turbine coupled to a generator. However, the electricity generated in these mills is not grid connected, and is used solely to meet the mill's power requirements.

As these units have been designed, at inception, with the purpose of providing captive power for the mill's operations alone, they are generally not suited, nor easily adaptable, for grid connected electricity supply on a competitive commercial basis.

Grid connected power generators are required to have a high rate of availability (typically 8000 hrs per annum), and be despatchable on a 24 hour basis, if they are to operate as a commercially viable independent power generator, in much the same way as Independent Power Producers (IPPs).

The majority of palm oil mills operate with varying capacities on a seasonable basis, running 12 hours a day, resulting in poor availability. Furthermore low cost design approaches at the onset result in low operating levels of efficiency.

As a result, palm oil millers building new facilities and wishing to participate in the SREP programme need to incorporate design features to ensure high efficiency, high availability and suitability to electricity despatch requirements, which generally results in comparatively higher capital investment cost.

Project Viability Considerations

Power project developers will generally seek opportunities to ideally build a plant at the lowest acceptable cost, utilising the lowest cost fuel, complete plant construction within the shortest time frame, and sell electricity at the highest price obtainable.

Contributing factors to the success of the project are discussed further below.

a) Plant Investment Cost

A 10 MWe capacity standalone EFB biomass power plant is estimated to cost around RM50–60 million. Grid interconnection costs may add another RM2–3 million to the project costs, from the need to construct a transmission line to the nearest available grid interconnection point. The owner's project management and administration costs, land costs, as well as financing costs add further to the total project cost.

b) Fuel Costs

As with most power plants, fuel cost has direct bearing on electricity production cost. Palm oil millers tend to regard EFBs as available free of cost since it is a waste product from the milling process. If the biomass power plant was built adjacent to the mill, then perhaps this assumption may be acceptable. However, this is not necessarily always the case for two reasons.

Raw EFB consumption for a 10 MWe biomass power plant is in the order of up to 650 tonnes per day (24 hour plant operation basis). Smaller mills may not be able to generate enough waste EFB to meet this daily requirement. Thus the waste EFB may need to be imported from

other mills in the vicinity, incurring additional transportation costs.

The transport cost added may be insignificant however there are other reasons not to assume that EFB is available at too low a cost. Recently EFB waste has emerged as a possible valuable resource for other downstream industries. EFB waste can now be used to make furniture products, fibre board panels, auto interiors, and biodegradable containers, to the extent that it is perhaps no longer a waste product but an emerging commodity. With the introduction of other value added uses of the material, EFB may become a properly traded commercial resource. Without proper introduction of market controls on the material, allowing its value to float freely according to market supply and demand forces may result in price fluctuations that can have pronounced economic effects on an EFB biomass power plant investment.

There is no standard price for EFBs, and so to protect an investment from being exposed too much to market fluctuations in raw material price it is prudent to have in place long term arrangements for delivery of the material at pre-determined prices as far as possible. For a 10MWe EFB biomass power plant requiring approximately 200,000 tonnes per annum of EFB this requires considerable commitment from a raw EFB supplier.

Current EFB biomass power plant economic models apparently assume the cost of EFB at between RM5–15 per tonne of raw EFB delivered to the consumer. As the demand for EFB rises, and if supply remains stagnant, then it is reasonable to assume the possibility of an inevitable increasing trend in the price.

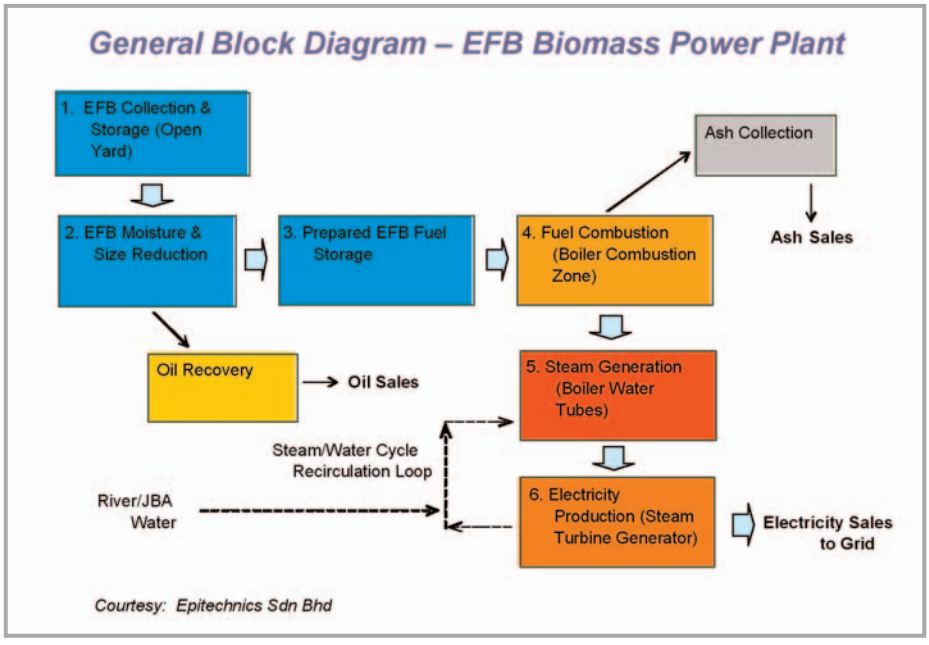
c) Plant O&M Costs

Plant operation and maintenance (O&M) costs are predictable and are based on established power industry rates. Essentially the majority of the utilities section that make up an EFB biomass power plant is similar to most thermal cycle power plants, with the exception of perhaps the raw EFB moisture reduction process and ash handling (although the latter is common also in coal power plants.)

Moisture reduction processes are not uncommon. There are biomass power plants in the USA, India and Europe that also deploy moisture reduction techniques to lower moisture content in the biomass feed stream to the boiler. However, palm oil EFB biomass is rather unique to Malaysia and the knowledge base for moisture reduction techniques for this material is largely home-grown.

The current moisture reduction technology deployed for EFB involves a rather crude process of cutting the material to a smaller size and squeezing the mass of cut pieces to drain it of moisture. The size reduction allows the squeezing process to be more effective and the resultant treated biomass is in the form of fibre strands similar to coconut husk.

The fibre form is also helpful for boiler combustion efficiency since the combustible surface area of the material is increased considerably.



Current technology providers for the moisture reduction process have spent considerable R&D efforts to successfully address moisture and size reduction targets for compatibility with commercial boilers, but the process itself is a large electrical consumer, taking up almost 30% of the total biomass power plant auxiliary electrical load.

For a 10 MWe net capacity EFB biomass power plant, the plant auxiliary electrical load approaches 2 MW, resulting in the need to build a plant with total gross capacity of 12 MWe, adding to plant investment cost.

Thus, more effort needs to be spent on further improving the moisture reduction technology on the energy demand side, to raise efficiency in this section of the EFB Biomass power plant.

d) Electricity Sales Price

It has been reported that TNB is willing to purchase electricity from EFB Biomass power plants at around 17 sen/kWh in Peninsular Malaysia and 21 sen/kWh in Sabah and Sarawak. This puts EFB biomass power plants at the higher end of the cost scale when compared with the more established fossil fuels.

It is however not evidently clear how the price has been determined as there are no mainstream market indicator prices for raw EFB as opposed to coal, natural gas and diesel. Thus the question remains as to whether it is a fair price or merely positioned by working backward from the end-consumer tariff charge, minus delivery costs, to an accommodated price.

e) Waste Streams Reutilisation

There are essentially two waste streams from an EFB biomass power plant – oily water and EFB ash.

The oily water comes from the squeezing of the raw EFB in the moisture reduction stage, since apart from water the raw EFB contains residual palm oil. Based on EFB moisture reduction plants already in operation, the oil content in the water is typically 8%.

A 600 tonne/day raw EFB moisture reduction plant, reducing moisture from 65% to 50%, would generate 390 tonne/day of oily water. At 8% oil in water content there would be an equivalent of about 30 tonne/day of oil. Assuming the oil in water is only 80% recoverable, it would still yield a 24

tonne/day by-product stream of unprocessed low grade palm oil that may still be accepted by palm oil refineries.

Even if sold at a discounted price over current CPO prices, the investment cost of an oil recovery plant to reclaim the waste oil can be justified and more importantly it provides an additional revenue stream for the power plant.

There is not enough published data on the useful benefits of EFB ash, although it is postulated that there may be further valuable uses similar to coal ash and other biomass ash residues. It can otherwise be returned to the general plantation environment as it is no more harmful as is ash from the natural burning of the palm oil tree and fruit bunch.

f) Project Economics

To stimulate growth in biomass power plants the government further enhanced the initial incentives for this sector. The current incentives as announced in the 2004 Budget, allow a 100% allowance on taxable gain for the first 10 years, and 100% exemption on duty for imported items meant for a biomass plant.

With these incentives, financial analysis indicates that an IRR of 13.5% after tax is achievable (see Table 1), making an EFB biomass power plant only marginally acceptable for a typical investor. It should be noted, however, that the IRR model postulated is rather simplified and does not take into account the cost for land, owner's project management costs, and loan interest, thus making the overall investment scenario, thereafter, much less attractive.

The main constraints in the financial model are the price of raw EFB and the electricity sales tariff.

Assuming the electricity sales tariff remains at a maximum of 17 sen/kWh but raw EFB costs increase by 50%, the IRR after tax reduces further to about 10%, making project investment largely unattractive.

Thus the uncertainty over the price of EFB over the long term is a real cause for concern and an easily evident factor that can hinder development of biomass EFB power plants.

Considering that it is likely that raw EFB costs will rise over the long term, then the next constraint to success – the electricity sales tariff – needs to be addressed, and re-positioning the cost price above the current level needs to be explored.

Figure 1 : Moisture laden Empty Fruit Bunches (EFBs)

Figure 2 : Processed EFB Fibres

Proposed New Considerations for the Renewable Energy Power Sector

There are a number of factors, as follows, that perhaps now, more than ever, need to be considered to make the renewable energy power sector a viable mainstay of the fifth fuel policy.

a) Review the limit for electricity sales from RE power generators

The current SREP programme only allows for up to 10 MW to be sold to the grid from any one facility. As economies of scale apply just as much to power plants, the larger it is, and the more electricity it can sell, the better its economic viability tends to be.

As already mentioned previously the current limit also results in the need for perhaps too many plants than are necessary, or are even suitable for the limited number of sites geographically that have viable access to a grid interconnection point, coupled with proximity to RE fuel supply sources.

b) Establish cost benchmarks for biomass fuel sources

Biomass fuels such as EFBs currently do not have an established pricing mechanism or reliable benchmark. As other uses emerge for each particular form of biomass, whether it is EFB, rice husk or other forms of biomass, market demand and shrinking supply sources will force an increase in the base cost of the material.

In the long term a price escalation is probably inevitable, however there are more serious concerns that in the short term without control mechanisms, there will be large opportunistic price fluctuations.

c) Unbundle the cost of grid interconnection

From the plant developer's view, external infrastructure costs such as transmission lines should not have to be borne in full by the power plant developer. The case for argument exists from the fact that the transmission line distributor adds a wheeling charge to the cost of electricity which is finally paid by the end consumer, thus the distributor should also partake in some of the burden of cost for delivery.

A similarity exists with infrastructure costs related to gas pipelines brought to a natural gas fired power plant. Power plant developers in such case are only asked to pay a certain contribution to the full cost of the infrastructure provided.

d) Review the electricity sales tariff at the interconnection point

The current level of 17 sen/kWh (Peninsular Malaysia), at which TNB is willing to purchase electricity from a RE power developer should be reviewed.

Firstly, there are a number of different RE sources or fuels. The tariff under the REPA needs to properly reflect the RE source or fuel, i.e. whether solar, hydro, wind, or biomass. Within the biomass classification there will also be merits for different tariff rate considerations depending on the type of biomass, i.e. EFB, rice husk, or other.

As has been mentioned earlier there appears to be no evident basis on how the current level of 17 sen/kWh for electricity from an EFB biomass power plant has been derived, especially when there is no established benchmark price for raw EFBs.

A re-evaluation of the tariff based on a detailed quantitative analysis (benchmarking EFB against all other fuels), and comprehensive economic modeling, should provide proper justification and positioning of the tariff.

Table 1 : 10MWe EFB Biomass Power Plant IRR Analysis

Export Baseload (21 yrs)	10,000	kW				
Plant Availability	8,000	hrs/yr				
Raw EFB requirement (100% Load)	650	tonne/day				
Year[1]	0	1	5	10	15	21
Investment (RM Thousands):						
Plant Capex	55,000					
Revenue (RM Thousands):						
Electricity Sales 0.17 RM/kWh	13,600	13,600	13,600	13,600	13,600	
Total Revenue	***13,600***	***13,600***	***13,600***	***13,600***	***13,600***	
O&M Costs (RM Thousands):						
Raw EFB 15 RM/tonne		3,250	3,250	3,250	3,250	3,250
Labor, O&M Consumables & Spares		1,778	1,803	1,803	1,803	1,878
Total Operating Costs		***5,028***	***5,053***	***5,053***	***5,053***	***5,128***
Operating Profit/Loss	(55,000)	8,572	8,547	8,547	8,547	8,472
Applicable Tax 28% Tax[2]		–	–	–	2,393	2,372
Profit/Loss after Tax	**(55,000)**	**8,572**	**8,547**	**8,547**	**6,154**	**6,100**
IRR before tax 14.7%						
IRR after tax 13.5%						

Notes: 1. *Intermediate years not shown*
2. *Tax exemption – 100% of Taxable Gain for first 10 yrs.*

Courtesy: Epitechnics Sdn Bhd

e) Offer Green Energy as an alternative for end-consumers

Malaysia has not yet offered Green Energy as an alternative tariff for end-consumers to opt for, despite launching Renewable Energy as a generation source.

Green Energy is offered by a number of countries now as an eco-friendly alternative for consumers wishing to disassociate themselves with conventional fossil or nuclear fuels. Essentially consumers can elect to purchase Green Energy, which is electricity specifically generated from RE sources. The tariff rates are slightly higher than conventional fuels but there are those fully committed to being environmentally conscious to make it a viable alternative to be offered.

With Green Energy available, there should also be a conscious effort to persuade conglomerates with large compound electricity bills to apportion some spending towards Green Energy, to support it and aid in its sustainability.

f) Further R&D initiatives

There is a need for further research on the uses of wastes generated from the use of biomass in power generation.

As mentioned earlier, there is little known published data on the possible valuable use of EFB ash. By contrast, rice husk ash generated from rice husk biomass power plants in Thailand is sold at a premium due to specific valuable properties of the ash.

Further efforts are also needed to improve the efficiency of plant sub-systems, in particular improving electrical demand efficiency in the EFB moisture reduction process.

CONCLUSION

For Renewable Energy to remain as a viable fifth fuel in the electricity market raw material resource base, more meaningful and effective incentives need to be introduced.

Malaysia is not the only country that will most likely not meet its current target for electricity generated from Renewable Energy sources. The UK is also set to announce a revised target and deadline to provide greater incentive for investment in renewables [4].

EFBs remain as the most promising RE source fuel for Malaysia but fairer electricity sales tariffs, or better incentives are required to ensure commitment to investment in grid connected EFB biomass power plants. ■

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The Engineer's Dilemma

By: Ir. Mah Soo (F11102)

"To be or not to be" is the question of the day. Let me assure you that the topic on one's dilemma is not limited to engineers alone. It applies to many facets of life. Well-renowned and famous authors have written many books on the dilemma faced by politicians and practitioners of the many professional disciplines. This is especially true when one is at the crossroads trying to find the right direction to go forward.

With this article, the writer would like to share his two cents' worth in response to the request for a Real Engineer to stand up and wish to be counted. As the term, a "Real Engineer", has not been clearly defined, the writer declines to expose himself to sarcastic criticisms by implying to be a "Real Engineer" in the eyes of the engineering fraternity. The intention of this article is to lighten the burden of self-skepticism on being a member of the engineering profession.

Many of us *Homo sapiens*, at one time or the other, would have pondered on the questions, "Why are we here?" and "What is our purpose in life?" People have chosen their professional disciplines during their student days. During their working life, some dreamed of achievements, some have achieved something and some have achievements thrust upon them. This sounds familiar as the quotation is an adaptation from Shakespeare's *Twelfth Night*.

So we must look at ourselves and ask ourselves, "What do we want in life?" Money though is important, is not everything. One will find bliss if one is contented and satisfied with what one has whilst one will forever live in envy if one is insatiable. Not every lawyer, accountant, engineer, or any other profession as a matter of fact, is a millionaire. Some will be very rich and famous, some comfortable to go by and some will be still struggling to make ends meet. It takes all sorts of people to make the world go round. With this the writer hopes that this would have lightened the burden and anxiety of not being the leader of the rat race pack.

The writer hopes that the practicing engineers of today is one by his or her own choice and not of circumstances or for prestige's sake. It must be the love of the subject, in acquiring knowledge and applying them in the course of our duty. This love should have eased the pain, tears and sweat whilst going through the mill in becoming an engineer.

With dedication and loyalty to the engineering profession, one would have developed some sort of *esprit de corps* among other fellow engineers and each would lend a helping hand to one another in facing any acid test on the doubts of the reputation of an engineer. With this understanding based on dedication and loyalty, members of different professional disciplines would form a congregation, organisation or institution to represent them in society. IEM is one such organisation representing the engineering fraternity. How valuable IEM in social status, commercial terms or in any other way depends on its image and perception in the eyes of its members and the public at large. The image of IEM depends largely on its members. If the members themselves do not respect IEM as their one and only representative, then their own body language would give themselves away, emanating negative vibes to anyone they come in contact with. The attendant consequence will be that the public at large will not in turn show respect to IEM in due course. So IEM is what its members make it to be. Members should stand up and be counted in giving whatever contributions required to make IEM a reputable organisation in representing the engineering fraternity. Ask what you can do for IEM and not what IEM can do for you. It is through voluntary support from its members that IEM can function well and portray a respectable image. As the old Chinese saying goes, "Local ginger is not spicy," the same image is being perceived by the local public to a certain extent and IEM members themselves at large. The writer happened to be wearing an IEM tie while on assignment in conducting courses overseas. Some of the participants asked about the IEM emblem on the tie. They showed great respect when told that the writer is a member of IEM which is an institution representing practicing engineers in Malaysia. So whether IEM has any commercial value or not has to be decided by each and everyone and by the people they come into contact with. The writer feels that it is the confidence one shows in the line of duty that creates whatever value that could be attached to it.

Leadership is the next important issue at hand. Once a leader has been chosen, all members should close ranks and support the leader in promoting the image of IEM. Many voluntary organisations faces the problem of always having armchair critics who will give negative comments and find fault at every nook and corner. If they have better ideas, they should have offered their services to serve and contribute. Constructive criticisms are welcome as they act as a check and balance for future improvement.

Legacy is a better reward for one's actions instead of huge monetary gains. The writer has retired twice; the first time from Tenaga Nasional Berhad followed by a four year tenure with one of the Independent Power Producers. During the said period, the writer did not become a multi-millionaire but felt contented and satisfied in knowing that he has given his full professional services answering the call of duty in contributing towards the two companies' performance. The legacy of establishing certain good systems of work practices and gaining recognition among peers in having good working ethics and competency in knowledge sharing gives the writer great satisfaction. This is especially so when one knows that during one's tenure, one's services have contributed towards the good performance as shown by measurable results. It is sad to know that some in management do not believe in proven legacy resulting in performance taking a deflection southwards after a lapse of only one and a half years down the line. Anyway the people who are presently in control will have to face the music.

The writer hopes that this article will help fellow engineers banish negative thoughts when they have chosen engineering as their profession, even though one might not be driving a fancy car such as a Ferrari or own big bungalows by the sea or in posh residential areas just yet. It is always better to look at the positive side of everything. Who knows good fortune may be smiling on you just around the corner.

The writer hopes that engineers whether they are in the top management or at the working level should show professionalism in their work especially in the core values and ethics and in mentoring the budding young ones to nurture succession towards a professional engineering fraternity. Last and not least, the writer sincerely hopes that all engineers would join IEM and contribute voluntarily both in effort and in kind towards making IEM an institution that all engineers in Malaysia could be proud of. ■

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Scaling Greater Heights After Retirement

By: Ir. Chin Mee Poon, Standing Committee on Publications

2 March 2004 was a big day for Ir. Toh Ah See, better known as A.S. Toh. On that day, he received an MBR award from our Prime Minister Dato' Seri Abdullah Ahmad Badawi.

MBR? It's the Malaysia Book of Records. It may not carry the same prestige as the Guinness Book of Records, but it's not easy to get oneself listed in it, except perhaps by attempting to consume the greatest volume of *teh tarik* within a specific time or things like that. Yet Ir. Toh has got, not one, but two listings in the Book: for being the oldest to trek the Mt. Everest North Face, and for doing the highest altitude trekking at 5,807m above sea level.

Mountain trekking is in the blood of Ir. Toh. With his trademark gray hair, he has the look of a wise philosopher, but unless you know him well, you won't be able to imagine that within his slight build he has the will power and tenacity to conquer great heights that many a tougher-looking guy may dread to tread.

Yet Ir. Toh is a late starter in mountain trekking. He has a natural inclination towards outdoor activities and adventures, having close acquaintance with the forest as a small boy. However, his busy schedule as a consulting engineer kept him away from his hobbies until 1995 when he sold off his entire stake in Bina Runding Sdn. Bhd., the consulting engineering company he founded in 1971. Once freed of the hustle and bustle of business life, he began to indulge in all the things he had always wanted to do dearly, such as driving a funny looking white ball into a tiny hole (and they call it *golf*), and drinking to each other's health with a group of friends in a pub. Soon the 18 holes as well as the 19th hole failed to give him enough excitement. He then picked up, first, scuba diving, and later, mountain trekking. I happen to be one of his regular diving buddies, though my urge for the mountains is not as strong as his.

Since 1999, Ir. Toh has trekked Mt. Kinabalu in Sabah, Mt. Kilimanjaro in Tanzania, part of the Annapurna circuit in Nepal, the north face of Mt. Everest in Tibet, the Aconcagua Base Camp in Argentina, and the great steppes of Mongolia.

I first got to know Ir. Toh almost 30 years ago when I was working in JKR in Johor Baru. I got to know him better when I joined Pre-Stressed Concrete (Malaysia) Sdn. Bhd. in 1978 after completing my term of contract in JKR. However, it was after his retirement and my discovery that we had some common interests that we really got to know each other well.

Born in Muar in 1939, Ir. Toh received his early education in Chung Hwa Primary School and St. Andrew Secondary School in Muar. He did his Sixth Form in St. John's Institution in Kuala Lumpur. He graduated with a civil engineering degree from the University of Malaya in 1965.

After spending one year with a private firm, Ir. Toh joined JKR in 1966. He left JKR in 1971 to start his own business. He was so enterprising that he in fact started two businesses at the same time: Bina Runding Sdn. Bhd. and Pre-Stressed Concrete (M) Sdn. Bhd. He was actually a pioneer as one of the first engineers in the country to have one leg in consultancy and the other in construction. But true to his character, he avoided any conflict of interest in all his dealings in both areas. The rest, as they say, is history.

Ir. Toh has other interests as well. He likes to travel and is a keen photographer. These two hobbies go together very well and he takes a lot of pictures when he travels. He has also taken up underwater photography to capture images of the enchanting denizens of the coral reefs.

Ir. Toh writes well. He does not write travel stories only but on issues of public interest as well. Most of his writings were published in local dailies.

Ir. Toh receiving an MBR award from the PM

He has established a personal website, www.nakedeyeview.com.my, to keep his writings and photographs in a place that is easily accessible not only to himself but to his friends and anyone who may be interested.

There is a soft spot in Ir. Toh's heart. He cannot stand mother nature and our living environment being abused by mindless beings. He cannot even stand the sight of beasts such as camels and horses being subject to unduly heavy burden. He considers this as a form of torture.

Ir. Toh at Camp 2, Mt. Everest North Face, Tibet

Ir. Toh trekking on ice in Mt. Aconcagua

Ir. Toh and his beloved wife Lucy have two children. Son Wei Ming is an electrical & electronic engineer. He is married to Selina Yong, an accountant. Su Mei the daughter is more like the father. She is such a staunch environmentalist that she refuses to drive in order not to pollute the air.

At the age of 65, Ir. Toh has many plans. He wants to take up ice climbing. He is planning to climb Mt. Rainier in Washington State in the USA to brush up the skill. After that he will climb a mountain in Antarctica. His goal is to climb in every continent. He also plans to organise a trekking event to raise funds for charities.

Ir. Toh likes to see more young people taking up mountain trekking. He believes the sport not only brings people closer to nature to enjoy crisp air, the pristine environment and spectacular views, it also strengthens one's willpower and rewards trekkers with the most profound sense of achievement and satisfaction upon overcoming the challenges in scaling greater heights.