BULETIN CREaTE

DISEMBER 2021 • Bil. 8 • JKR 29201-0032-21

PUSAT KECEMERLANGAN KEJURUTERAAN DAN TEKNOLOGI JKR (CREaTE)

KATA-KATA ALUAN

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

Alhamdulillah, syukur kepada hadrat Ilahi dengan limpah kurnia dan hidayahNya, Buletin CREaTE Bil.8 edisi Disember 2021 berjaya diterbitkan. Tahniah dan terima kasih saya ucapkan kepada semua penyumbang artikel serta syabas kepada Sidang Redaksi Buletin CREaTE di atas usaha dan komitmen dalam menghasilkan Buletin CREaTE ini.

Penerbitan Buletin Create ini adalah sebagai wadah pembelajaran secara berterusan, selari dengan Pelan Strategik Jabatan Kerja Raya 2021 – 2025, Pusat Kecemerlangan Kejuruteraan dan Teknologi JKR (CREaTE) amat komited untuk menjadi sebuah pusat kecemerlangan kejuruteraan dan teknologi dengan membangunkan modal insan yang kompeten, kreatif dan inovatif dalam bidang kejuruteraan dan teknologi. Penguasaan dan kebolehan menulis artikel terutama berunsur teknikal adalah satu kemahiran yang diperlukan bagi melaksanakan penyelidikan dan pembangunan di CREaTE. Perkongsian hasil penyelidikan melalui penulisan artikel dan perkongsian ilmu merentasi jabatan dan luar jabatan diperolehi dengan melaksanaan penyelidikan secara jabatan dan kolaboratif bersama rakan strategik iaitu Institusi Pengajian Tinggi, pemain industri dan agensi swasta.

Buletin edisi kali ini memuatkan beberapa artikel antara lainnya adalah Akreditasi Makmal, Extension of Scope (EOS) MS ISO/IEC 17025:2017 yang telah diperolehi daripada Skim Akreditasi Makmal Malaysia (SAMM) untuk setiap makmal di Bahagian Inovasi, Penyelidikan dan Pembangunan Kejuruteraan, CREaTE. Artikel lain yang turut dimuatkan adalah perkongsian dapatan kajian dan solusi yang berinovatif, serta penyampaian perkhidmatan jabatan.

Saya berharap ilmu yang dikongsikan melalui artikel-artikel yang dipaparkan dalam Buletin ini dapat dimanfaatkan oleh seluruh warga JKR dan budaya perkongsian ilmu dapat diperkasakan seiring dengan kehendak profesion kejuruteraan.

Ir. RAZHIAH BINTI WAHAB
Pengarah Kanan
Pusat Kecemerlangan Kejuruteraan dan Teknologi JKR (CREaTE)

ISI KANDUNGAN

Sidang REDAKSI

AKREDITASI MAKMAL EXTENSION OF SCOPE (EOS) MS ISO/IEC 17025:2017

Ir. Nor Azian binti Aziz
Muhammad Afiq bin Tambichik
Ir. Sarina binti Ismail
Makmal Penyelidikan Struktur, Konkrit dan Alam Sekitar
Bahagian Inovasi, Penyelidikan dan Pembangunan Kejuruteraan

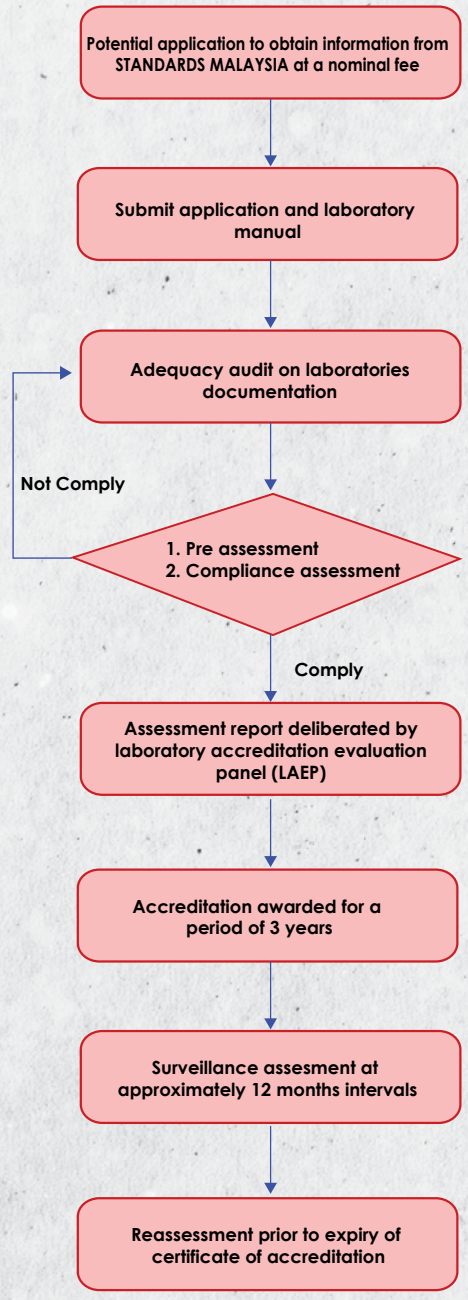
PENGENALAN

Pusat Kecemerlangan Kejuruteraan dan Teknologi JKR (CREaTE) berstrategi untuk memastikan bahawa tahap perkhidmatan pengujian bahan oleh makmal CREaTE mencapai tahap akreditasi yang ditetapkan. Selaras dengan itu, CREaTE komited untuk memperolehi Extension of Scope (EOS) bagi Skim Akreditasi Makmal Malaysia (SAMM) melibatkan penambahan tiga belas (13) bilangan pengujian bahan yang mematuhi MS ISO/IEC 17025:2017 pada tahun 2021. CREaTE juga sentiasa memastikan supaya sistem MS ISO/IEC 17025:2017 ini dijadikan sebagai amalan dan budaya dalam melaksanakan kerja pengujian bahan di makmal CREaTE.

PENILAIAN EXTENSION OF SCOPE (EOS) BAGI SIJIL AKREDITASI MAKMAL MALAYSIA (SAMM)

Sebanyak empat (4) makmal penyelidikan di Bahagian Inovasi, Penyelidikan dan Pembangunan Kejuruteraan (BIPPK), CREaTE telah terlibat dengan sesi penilaian EOS. Ianya terdiri daripada Makmal Penyelidikan Struktur & Konkrit dan Alam Sekitar (MPSKAS), Makmal Penyelidikan Jalan (MPJ), Makmal Penyelidikan Geoteknik (MPG) dan Makmal Penyelidikan Mekanikal (MPM). Sesi penilaian EOS tersebut telah dilaksanakan pada 10 dan 11 Februari 2021 oleh Jabatan Standard Malaysia (JSM) secara dalam talian (online) berikutan pematuhan kepada Perintah Kawalan Pergerakan (PKP) yang sedang berkuatkuasa. Terdapat proses akreditasi SAMM adalah seperti yang ditunjukkan dalam Rajah 1.

Proses akreditasi SAMM bermula dengan mengemukakan borang permohonan, dokumen manual kualiti dan operasi makmal kepada JSM pada bulan Julai 2020.



Rajah 1: Proses Akreditasi Makmal (SAMM)

Proses akreditasi SAMM bermula dengan mengemukakan borang permohonan, dokumen manual kualiti dan operasi makmal kepada JSM pada bulan Julai 2020. Selanjutnya, JSM memaklumkan kepada CREaTE berkaitan maklumat yang diperlukan serta bayaran yang dikenakan mengikut kategori. Selepas dokumen yang diserahkan telah diaudit dan didapati lengkap, JSM memaklumkan kepada CREaTE akan tarikh sesi penilaian EOS. Makmal-makmal yang terlibat seterusnya telah menjalani *Pre Compliance* Audit pada awal November 2020.

Lanjutan daripada sesi penilaian EOS yang telah dilaksanakan, CREaTE telah diberikan masa selama tiga (3) bulan bagi menyediakan pematuhan kepada penilaian EOS tersebut. Laporan pematuhan penilaian EOS yang telah dinilai dan diakreditasi oleh Jawatankuasa Penilaian Akreditasi Makmal telah melayakkan CREaTE dianugerahkan sijil pengiktirafan oleh JSM untuk tempoh sah laku selama tiga (3) tahun. Penilaian audit pengawasan *(surveillance assessment)* akan dilaksanakan pada tempoh setiap dua belas (12) bulan manakala, penilaian audit kajian semula *(reassessment)* akan dilaksanakan sebelum tempoh sah laku sijil tamat.

Makmal Penyelidikan Elektrik di bawah Cawangan Kejuruteraan Elektrik, Ibu Pejabat JKR Malaysia telah diakreditasi oleh Jabatan Standard Malaysia (JSM) dengan SAMM ISO/IEC 17025:2005 No. 486 sejak tahun 2010 lagi bagi skop pengujian bahan. Tambahan skop *(Extension of Scope)* bagi makmal-makmal yang terlibat dan senarai *Approved Signatories* (AS) adalah seperti yang ditunjukkan dalam Jadual 1.

Jadual 1: Butiran pengujian bahan dan *Approved Signatories* (AS)

Makmal Penyelidikan Struktur, Konkrit dan Alam Sekitar	Jenis Ujian / Sifat yang diukur / Julat Pengukuran	Kaedah / Peralatan / Teknik Ujian Piawai
Concrete 1. Noor Azlan bin Abdullah 2. Ir. Muhamad Yusri bin Zainal	*Compressive Strength of Concrete Cube/Cylinder*	MS EN 12390-3:2012
	Compressive Strength of Concrete Core	MS EN 12504-1:2013
Metallic Materials 1. Noor Azlan bin Abdullah 2. Ir. Muhamad Yusri bin Zainal	*Tensile Test of Metallic Materials*	ISO 6892-1:2019 (Method B)
Makmal Penyelidikan Jalan	**Jenis Ujian / Sifat yang diukur / Julat Pengukuran**	**Kaedah / Peralatan / Teknik Ujian Piawai**
Bitumen 1. Ir. Syahida Binti Aripin	*Penetration of Bituminous Materials*	ASTM D5/D5M 20
	Softening Point of Bituminous (Ring & Ball) Test	ASTM D36/D36M 14 (2020)
Asphalt 1. Mokhydin Bin Rosmani	*Marshall Stability & Flow of Asphalt Mixtures*	ASTM D1559-82 ASTM D6927-15
	Bulk Specific Graviti & Density of Non Absorptive Compacted Asphalt Mixtures	ASTM D2726/D2726M-19
	Thickness or Height Compacted Asphalt Mixtures Specimens	ASTM D3549/D3549M-18
	Preparation of Asphalt Mixtures using Marshall Apparatus	ASTM D6926-20

Makmal Penyelidikan Mekanikal	Jenis Ujian / Sifat yang diukur / Julat Pengukuran	Kaedah / Peralatan / Teknik Ujian Piawai
1. Ir. Dr. Abdul Murad bin Zainal Abidin 2. Ir. Dr. Tuan Suhaimi bin Salleh 3. Noryati binti Mustapa	*Steady-State Thermal Transmission Properties*	ASTM C518 - 17
Makmal Penyelidikan Geoteknik	**Jenis Ujian / Sifat yang diukur / Julat Pengukuran**	**Kaedah / Peralatan / Teknik Ujian Piawai**
Soils 1. Ir. Zuraini binti Zainal 2. Nurul Eilmy binti Zainuddin 3. Nur Amalina binti Mat	*Determination of Moisture Content (Oven Drying Method)*	MS 1056-2:2005 Clause4.2 BS 1377-2:1990: Clause 3.2
	Determination of Liquid Limit (Cone Penetrometer method-Definitive Method)	MS 1056-2:005 Clause 5.3 BS 1377-2:1990: Clause 4.3
	Determination of Plastic Limit *(Mould and roll by finger)*	MS 1056-2:2005 clause 6.3 BS 1377-2:1990: Clause 5.3

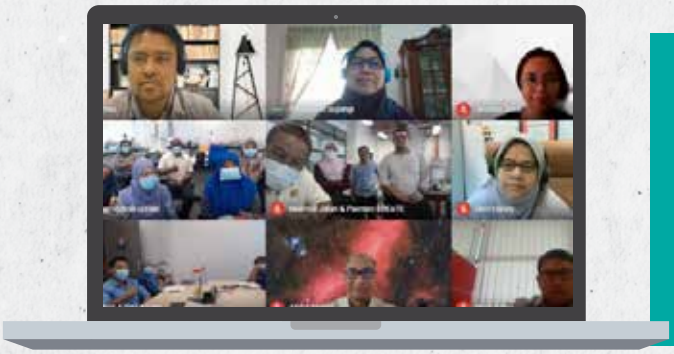
Kaedah penilaian EOS yang dilaksanakan secara dalam talian *(online)* perlu mematuhi proses yang ditetapkan seperti mana dalam Rajah 2.

Rajah 2: Carta Alir Kaedah Pengauditan

Lead Assessor dari JSM telah menemuduga pegawai, kakitangan makmal dan pegawai pengurusan termasuk membuat semakan terhadap dokumen-dokumen berkaitan makmal seperti manual kualiti pengurusan, teknikal dan operasi setiap pengujian yang dijalankan, dokumen penyelenggaraan alat-alat pengujian, keputusan pengujian, dan laporan pengujian.

SESI PENILAIAN EOS DIJALANKAN SECARA DALAM TALIAN DI MAKMAL-MAKMAL YANG TERLIBAT:

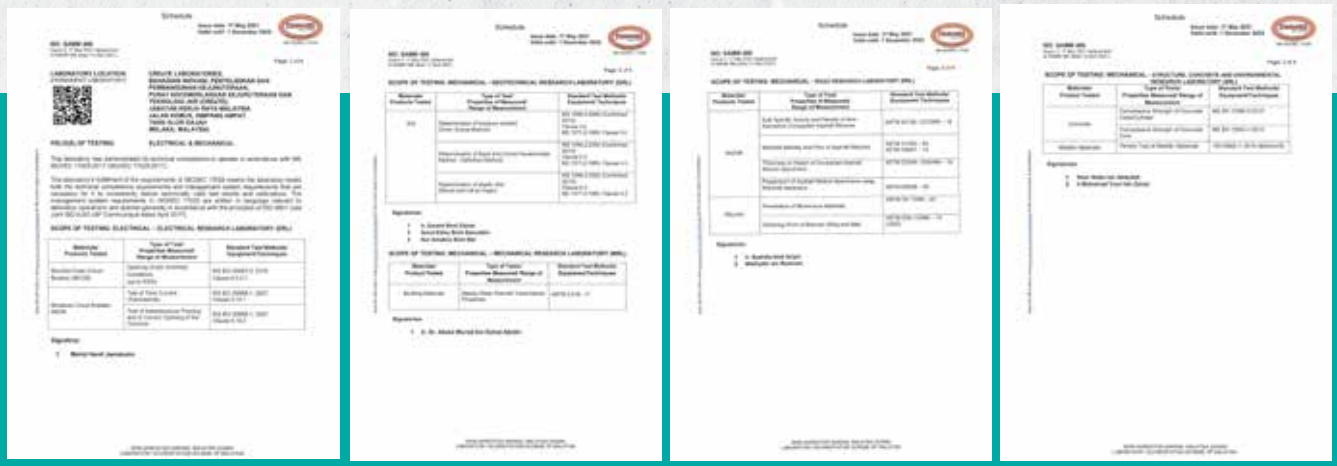
Rajah 3: Sesi penilaian EOS di Makmal Penyelidikan Geoteknik dan Makmal Penyelidikan Struktur & Konkrit, dan Alam Sekitar



Rajah 4: Sesi penutupan penilaian EOS yang dihadiri semua pegawai dan kakitangan dari Makmal Penyelidikan Struktur & Konkrit, dan Alam Sekitar, Makmal Penyelidikan Jalan, Makmal Penyelidikan Geoteknik dan Makmal Penyelidikan Mekanikal

KEJAYAAN MEMPEROLEHI AKREDITASI

CREaTE telah berjaya memperolehi *Extension of Scope (EOS)* bagi Skim Akreditasi Makmal Malaysia (SAMM) melibatkan penambahan tiga belas (13) bilangan pengujian bahan yang mematuhi MS ISO/IEC 17025:2017 secara rasminya pada 17 Mei 2021, seperti sijil-sijil akreditasi yang ditunjukkan dalam Rajah 5.



Rajah 5: Sijil-sijil akreditasi bagi Makmal Penyelidikan Eletrik, Makmal Penyelidikan Struktur & Konkrit, dan Alam Sekitar, Makmal Penyelidikan Jalan, Makmal Penyelidikan Geoteknik dan Makmal Penyelidikan Mekanikal

PENUTUP

Bagi menjalankan fungsi pengujian makmal dan memenuhi amanat Ketua Pengarah Kerja Raya Malaysia agar CREaTE muncul sebagai *Testing and Certification Body*, CREaTE akan terus berusaha untuk meningkatkan bilangan pengujian bahan yang mendapat taraf akreditasi SAMM pada masa akan datang agar berupaya menjadi *testing body* yang dipercayai seiring dengan kehendak pasaran.

PENGURUSAN KURSUS SWASTA BAGI WARGA JKR

Ir. Jusmairomaizani binti Jusoh
Unit Smart Skill
Bahagian Kompetensi,
Pensijilan, Akreditasi dan Kejuruteraan

PENGENALAN

Kursus swasta adalah kursus dalam Negara yang dianjurkan oleh pihak luar selain Pusat Kecemerlangan Kejuruteraan dan Teknologi JKR (CREaTE) di mana permohonan peruntukan dibuat melalui CREaTE. Ia merangkumi pelbagai bidang kursus dalam bentuk latihan, persidangan ataupun seminar bagi meningkatkan kemahiran pekerja dalam perkhidmatan awam.

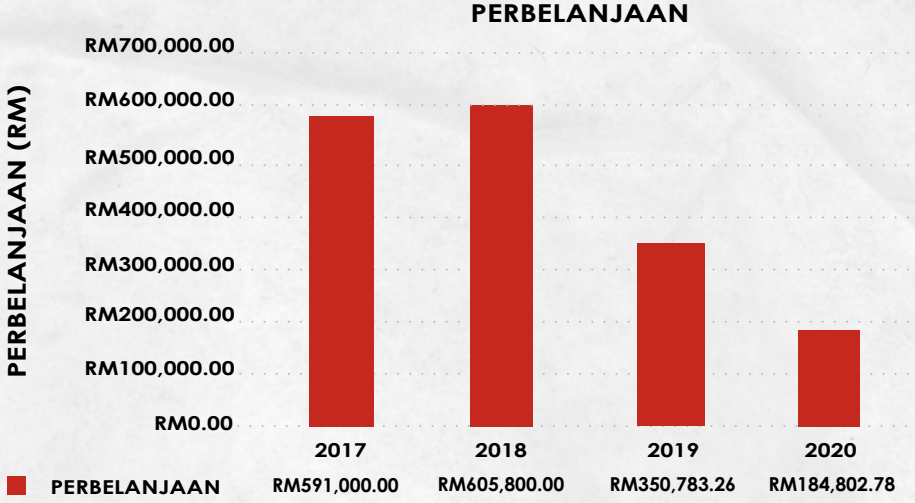
Walaupun pada dasarnya pihak CREaTE berperanan menganjurkan kursus berbentuk teknikal dan teknikal generik, kursus anjuran swasta mengambil peranan membantu pegawai JKR dalam kursus-kursus bukan teknikal supaya pegawai dapat menimba dan memantapkan lagi ilmu pengetahuan dan menjadi lebih kompeten dalam bidang tertentu.

Terdapat kursus/persidangan/seminar yang dianjurkan oleh pihak swasta pada setiap tahun seperti oleh Pertubuhan Arkitek Malaysia (PAM), *the Board of Quantity Surveyors* (BQSM), *the Board of Engineers Malaysia* (BEM) dan *the Institutions of Engineers Malaysia* (IEM) yang memerlukan penglibatan daripada pegawai JKR dan bertaraf antarabangsa. Sehubungan dengan itu, sejumlah peruntukan diperlukan untuk membiayai tujuan tersebut.

Sejak penubuhan CREaTE pada 1 September 2016, Bahagian Kompetensi, Pensijilan, Akreditasi dan Kejuruteraan (BKPAK) telah ditugaskan untuk menyediakan peruntukan dan melaksanakan pengurusan permohonan kursus anjuran pihak swasta yang dipohon oleh pegawai-pegawai dari Jabatan Kerja Raya Malaysia untuk pembangunan insaniah mereka.

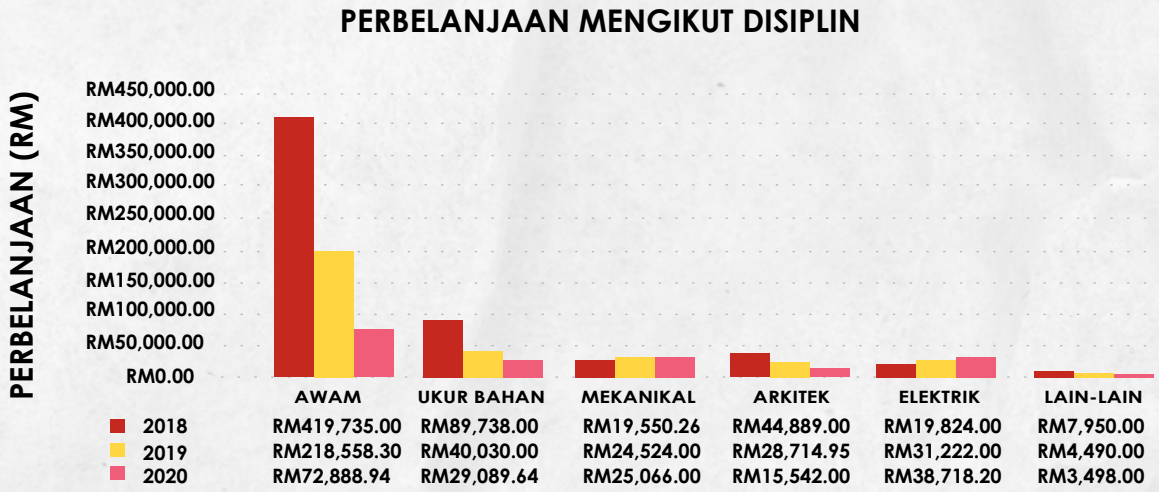
PERUNTUKAN KURSUS SWASTA

Kursus swasta juga merupakan antara penyumbang perbelanjaan terbesar di BKPAK. Rajah 1 menunjukkan perbelanjaan kursus swasta bagi tempoh tahun 2017 hingga 2020. Penurunan perbelanjaan kursus swasta pada tahun 2019 adalah disebabkan oleh pengurangan peruntukan akibat peruntukan sedia ada telah digunakan untuk melaksanakan kursus-kursus di CREaTE seiring dengan pertambahan bilangan kursus. Pada tahun 2020, perbelanjaan bagi kursus swasta didapati berkurangan berikutan berlakunya pandemik Covid-19 yang melanda negara ini.



Rajah 1: Perbelanjaan Kursus Swasta Mengikut Tahun

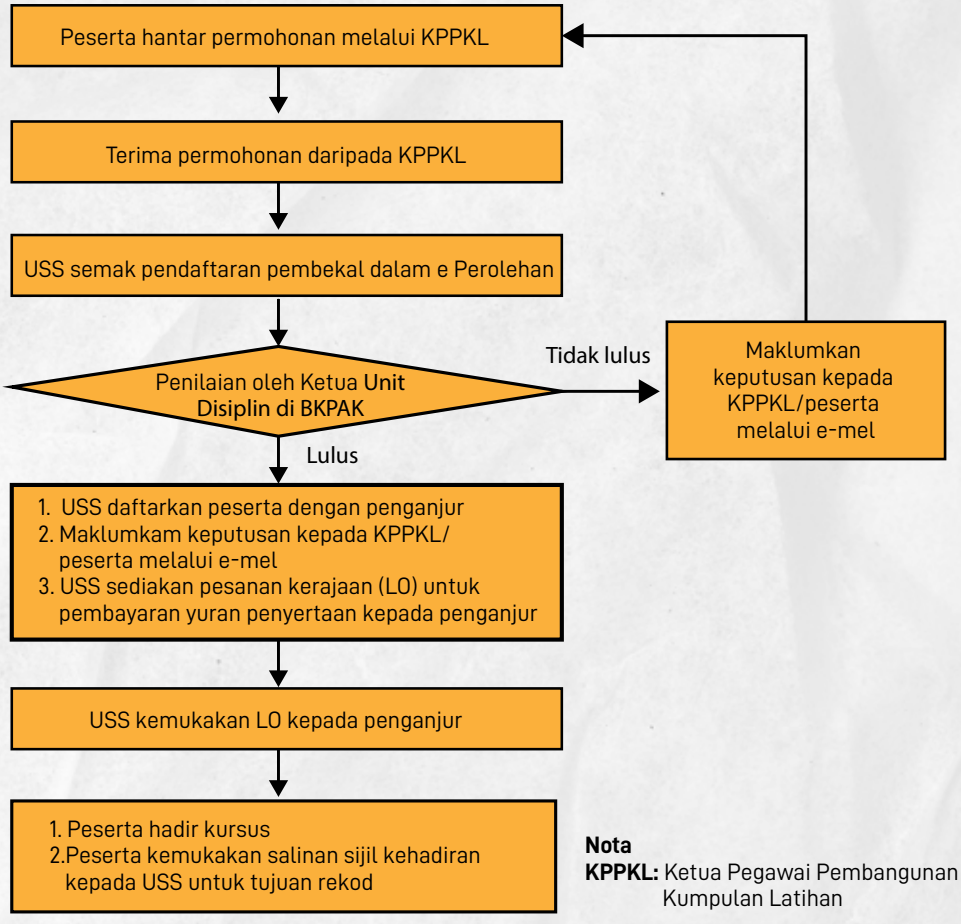
Bagi mengimbangi perbelanjaan kursus swasta mengikut setiap disiplin pegawai di JKR, bermula dari tahun 2017, BKPAK telah mengambil insiatif untuk membuat pembahagian peruntukan swasta yang diterima berdasarkan kepada peratusan bilangan pegawai mengikut disiplin di dalam sistem MyKJ pada setiap awal tahun. Rajah 2 menunjukkan perbelanjaan mengikut disiplin dari tahun 2018 hingga 2020.



Rajah 2: Perbelanjaan Mengikut Disiplin Bagi Kursus Swasta

PENGURUSAN PERMOHONAN KURSUS SWASTA

Pengurusan pemohonan kursus swasta ini diuruskan oleh Unit Smart Skills (USS), BKPAK. Rajah 3 menunjukkan carta alir pengurusan permohonan kursus swasta secara terperinci.



Rajah 3: Carta alir permohonan kursus swasta

HALA TUJU UNTUK KURSUS SWASTA CREaTE

Hala tuju CREaTE untuk kursus swasta adalah seperti berikut:

a. Menghasilkan pegawai yang mahir dan kompeten setelah mendalami pelbagai ilmu dalam bidang tertentu;
b. Menjadikan pegawai yang lebih komited dalam pekerjaan dan mempunyai tahap kepimpinan yang tinggi;
c. Berkongsi ilmu yang diperolehi dari kursus swasta kepada kakitangan JKR yang lain;
d. Menghasilkan penceramah bukan teknikal yang mahir dan boleh membimbing dan menjadi tenaga pengajar di CREaTE yang secara tidak langsung dapat membantu menjimatkan peruntukan latihan; dan
e. Menyediakan modul kursus-kursus yang ditambah baik dengan mengambil kira pendekatan yang digunakan dalam kursus-kursus anjuran swasta.

KESIMPULAN

CREaTE akan memastikan peningkatan bilangan pegawai-pegawai JKR yang menghadiri kursus-kursus swasta secara berterusan sebagai nilai tambah ke atas tahap kemahiran pegawai. Secara tidak langsung kursus-kursus swasta, seperti contoh-contoh yang ditunjukkan dalam Rajah 4, ini dapat meningkatkan tahap profesionalisme pegawai-pegawai JKR yang terlatih dan menguasai bidang kepakaran di peringkat nasional dan antarabangsa.

Rajah 4: Brosur kursus-kursus swasta

INNOVATION

IS A PRACTICAL WAY OF SOLVING AIR HANDLING UNIT (AHU) STRUCTURE-BORNE NOISE PROBLEM

Ir. Ts. Dr. Tuan Suhaimi bin Salleh
Unit Inovasi Kejuruteraan
Bahagian Inovasi, Penyelidikan dan Pembangunan Kejuruteraan

Abstract

Potential creativity is a source of inspiration for new ideas, topics or fields of study, thus encourages innovation. However, in terms of individuals or methods, we do not look at sources, but rather at information, which is the basis for new ideas. It is the awareness that provides the potential for innovation which then create momentum for the new ideas or fields of study.

Keywords: New ideas; information; innovation; momentum

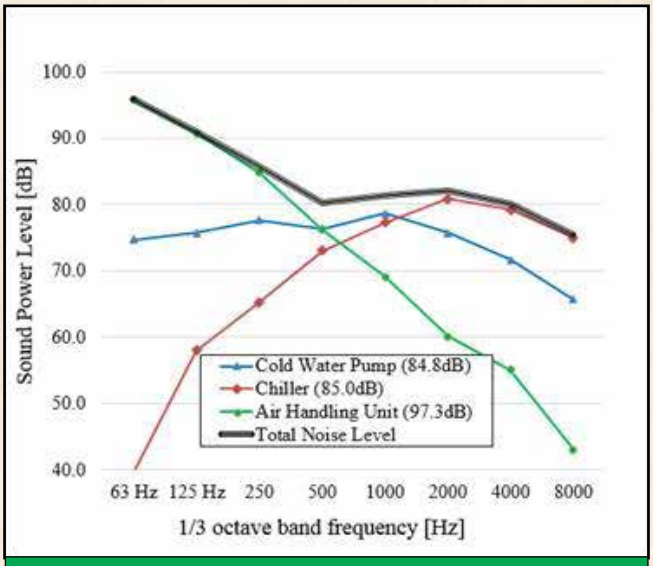


Figure 1: Sound power levels of cooling equipment in a mechanical room

Introduction

The most successful measure for noise reduction is to place indoor equipment rooms as far away from noise-sensitive areas as possible [1]. Mechanical equipment rooms especially Air Handling Unit (AHU) are, however, usually situated at intermediate floors in high-rise multi story building, near the occupied areas which they serve. Reasonable constructive layers for walls, ceilings and floors should be chosen in such cases until the amount of noise inside the mechanical equipment rooms is reducible.

We could understand from Figure 1, Air Handling Unit (AHU) is the key unwanted sound contributor in buildings. It was also found that the contribution of the concrete plinth structure to noise transmission is not negligible as predicted in a real case [2].

An innovative idea from forensic study

It was reported that the operation of the AHU unit at the 1st Floor of the Government Medical Facility in Kuala Lumpur caused tremors on the walls and floors of the building [3]. Body movements of the operating AHU unit that is connected to the chilled water pipes, electric wire trunk and main supply air ducts, which are installed very close to the walls of the AHU room, as shown in Figure 2, caused vibration disturbances in building structure such as floors and walls. The presence of equipment rooms at middle or top floors is usually unavoidable. Noise from mechanical equipment such as chillers, circulation pumps and air handling units can travel through the structure in these spaces to adjacent occupant spaces. By choosing proper vibration isolators from the machinery excitation transmitted as impact sound and vibration, structure-borne noise can be isolated.

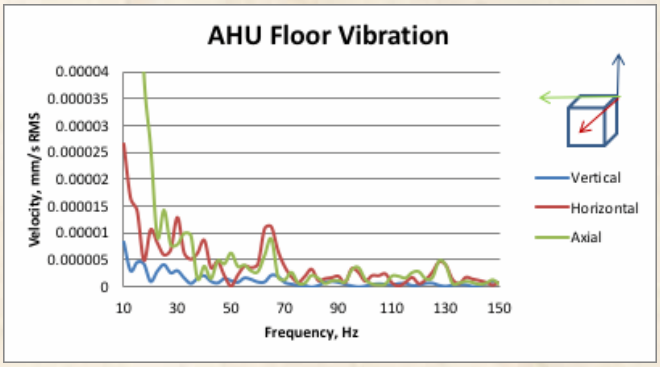
Usually, the concrete plinth is mounted in a fixed and irremovable position, causing issues with the ducting orientation, the routing of chilled/condenser water pipes, and the openings in the plant room wall for the supply and return air ducting. The concrete plinth also contributes to the building structure an

additional load. A more flexible support system appears to be necessary with the limited space constraints imposed on mechanical equipment. Figure 3 illustrates the proposed innovative support system for AHU used in the study.

On-site picture

a) The body of the AHU unit is too close becomes into contact with the wall; a significant contributor to the vibration effect on the building walls and floors.

Vibration graph



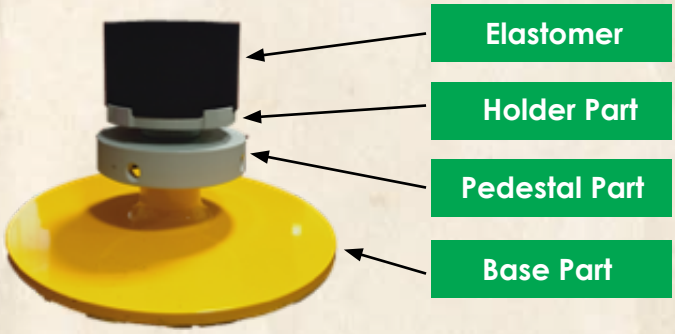
b) Vibration effect on floor due to improper installation of AHU unit in plant room during construction.

Figure 2: Providing a flexible support system for AHU seems important

On-site picture

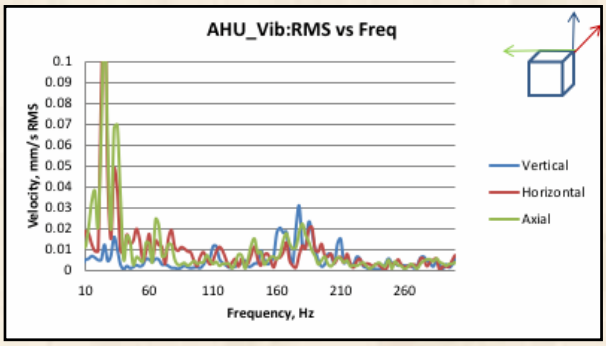
a) The AHU unit installed with innovative support

Details

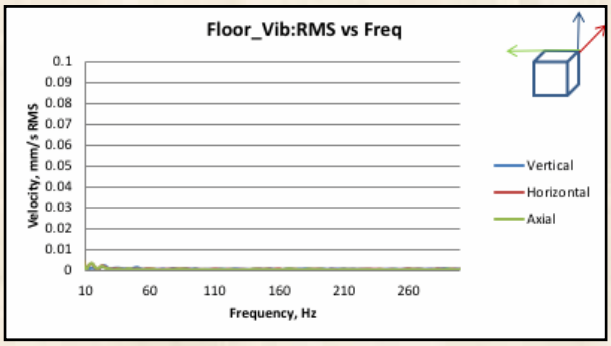


b) Innovative support

Vibration graph



c) AHU vibration during operation



d) Vibration effect on floor was signifcanly reduced by using innovative support

Figure 3: Innovative support system for AHU

Discussion

It is recognized that vibration waves can typically be detected in floor structures with the normal vibration insulation material at low frequencies, as shown in Figure 2. High vibration levels in the AHU are expected because of the vibration from the blower motor and the blower fan, as well as turbulence induced by air mixing and air resistance through air filters and cooling coils (Figure 3c).

However as shown in Figure 3d, innovative supports capable of flattening the transverse RMS vibration amplitude demonstrate that they play a significant role in minimizing structure-borne noise. It can be seen that innovative support has been able to prevent vibration from being transmitted to the concrete floor, where there is almost no vibration in any direction.

Conclusion

Innovative support can absorb and decrease the vibration amplitude emanating from the working AHU, and it has advantages, such as;

1. Play an important role in mitigation structure-borne noise and capable to eliminate the vibration in all directions.
2. The plug-and-play concept used for installation may help to eradicate the shoddy work as discussed in this article.
3. Aligns with Industrialized Building Systems (IBS), which is an approach to improving the efficiency and sustainability of construction, as well as reducing workplace safety and health risks.

References

1. Tuan Suhaimi Salleh. 2016. Acoustic Comfort Strategies in Air Conditioning and Mechanical Ventilation System, Proceedings on Noise and Vibration Research, The Acoustical Society of Japan (ASJ), Document Ref No: N-2016-27
2. Mete Oguc, Deniz Hadzikurtes. 2015. Acoustic Evaluation of Floating Floor Applications in Mechanical Rooms, Proceedings 10th European Congress and Exposition on Noise Control Engineering (Euronoise 2015), 2521-2524
3. JKR Technical Report. 2015. CKM/SD/NV/LT/02/2015 (in Malay)

PENGENALAN KEPADA SISTEM SOLAR – JENIS PANEL PHOTOVOLTAIC (PV)

Mohd Shukri bin Dolah
Ir. Dr. Mohamed Shahriman bin Mohamed Yunus
Makmal Penyelidikan Elektrik
Bahagian Inovasi, Penyelidikan dan Pembangunan Kejuruteraan

Pengenalan

Tenaga solar merupakan tenaga yang dihasilkan melalui proses penukaran cahaya matahari kepada tenaga elektrik. Penukaran ini dilakukan dengan menggunakan solar panel yang mengandungi sel *photovoltaic* (PV). Sel *photovoltaic* terdiri daripada kepingan semi konduktor yang diperbuat daripada silikon. Cahaya matahari bertindak menggerakkan atom dan zarah di dalam sel *photovoltaic* dan seterusnya menghasilkan tenaga elektrik. Sistem pemasangan solar *photovoltaic* merupakan satu teknologi penghasilan tenaga semulajadi melalui sumber tenaga matahari.

Potensi Teknologi Solar

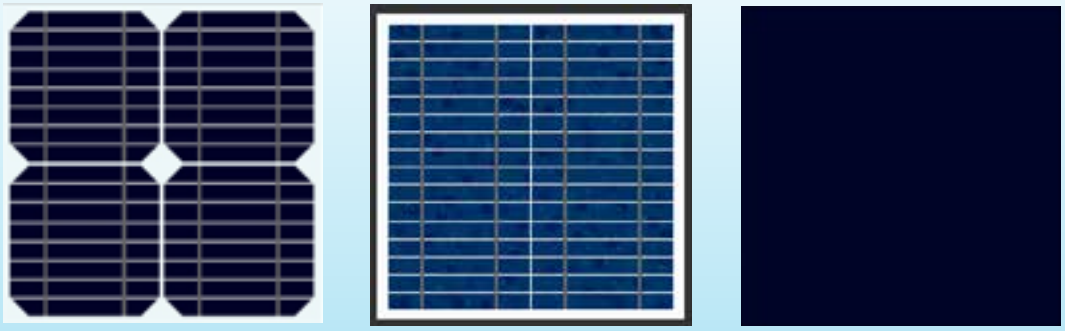
Pelbagai dasar dan pelan tindakan telah dicadangkan dan dibincangkan di kalangan pelbagai jabatan kerajaan, organisasi bukan kerajaan (NGO) dan sektor perindustrian dalam meningkatkan kesedaran dan penghasilan tenaga baharu. Kajian daripada Almaktar, Rahman & Hassan, 2015, menyatakan bahawa hasil kekurangan rizab minyak dan gas dalam tempoh 15 tahun yang akan datang menyebabkan kerajaan mula cenderung kepada penghasilan tenaga boleh diperbaharui. Di samping itu, hasil kajian daripada Muhammad-Sukki, Ineguez, G.Macmeekin, Brian & Barry, 2011, menyatakan bahawa salah satu aplikasi tenaga solar yang digunakan secara meluas dalam penghasilan tenaga boleh diperbaharui adalah dengan menggunakan solar fotovolta, iaitu proses penghasilan tenaga dari cahaya matahari kepada tenaga elektrik.

Denholm *et al.*, 2010, menyatakan bahawa tenaga solar boleh diperolehi melalui pelbagai cara di antaranya melalui pemasangan panel di atas bumbung, perletakan panel solar di kawasan tanah rata melalui aplikasi ladang solar, pemasangan secara integrasi hibrid dan pemasangan secara kendiri (*off-grid*) yang tidak memerlukan penyambungan dengan grid elektrik utama. Manakala, Mahpar, 2019, telah mendapati bahawa faktor keluasan bumbung bangunan-bangunan di Malaysia yang luas dengan kecerunan antara 10 hingga 30 darjah merupakan faktor yang menyokong dan membenarkan penerimaan cahaya matahari yang maksimum.

Jenis-jenis Panel PV Solar

Terdapat banyak jenis panel PV solar di pasaran, tetapi kebanyakannya dibahagikan kepada tiga jenis utama iaitu:

i) Panel Solar *Monocrystaline;*
ii) Panel Solar *Polycrystaline;* dan
iii) Panel Solar Filem Tipis *(Thin Film Solar Cell)*



(a) (b) (c)

Rajah 1: (a) Panel Solar *Monocrystalline*, (b) Panel Solar *Polycrystalline* dan (c) Panel Solar Filem Tipis (TFSC)

Berdasarkan Rajah 1, untuk menghasilkan panel PV solar yang mempunyai kecekapan yang tinggi, beberapa faktor dan item perlu dipertimbangkan:

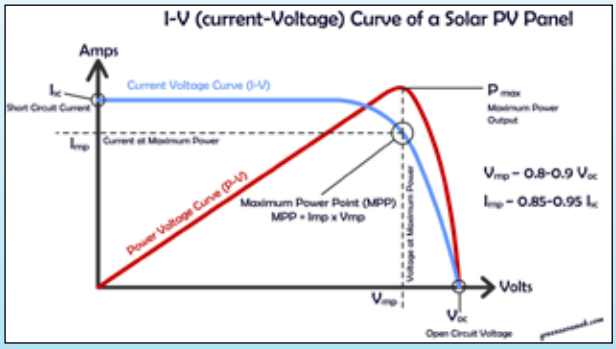
- *Material* – Jenis bahan yang digunakan (*monocrystalline silicone, polycrystalline silicone, cadmium telluride* atau lain-lain) iaitu kesan bagaimana cahaya menukar kepada tenaga elektrik;
- Pendawaian – integrasi antara kabel dan busbar pada panel solar yang mengumpul dan mengalih tenaga elektrik;
- Refleksi – Jika cahaya dibiaskan daripada panel solar, maka kadar kecekapannya akan berkurang. Lapisan kaca di atas sel solar silikon merupakan aspek yang amat penting;
- Kebolehan menyerap cahaya pada dua sisi sel; dan
- Kebolehan menyerap pelbagai *wavelengths of light*.

Secara asasnya, tidak ada panel PV solar yang cekap 100%. Panel PV solar biasa yang boleh didapati secara komersial adalah jenis pelbagai silikon persimpangan tunggal (kedua-dua mono dan poli kristal) yang hanya mempunyai kecekapan maksimum 33% di bawah keadaan ujian standard. Ia dipanggil Had Efisiensi *Shockley Queisser*.

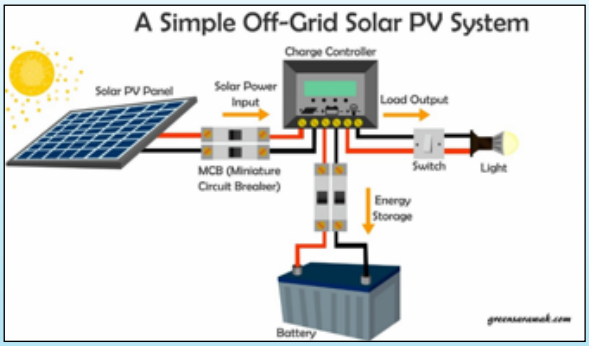
Kecekapan panel PV solar adalah dilihat berdasarkan kepada keupayaan sesuatu panel untuk menukar cahaya matahari kepada tenaga elektrik. Ini amat penting kerana panel yang mempunyai kecekapan yang tinggi akan menghasilkan lebih tenaga dengan ruang yang kecil. Kebanyakan panel PV solar mempunyai kecekapan sekitar 15% hingga 20% namun, dengan adanya penyelidikan dan pembangunan berterusan oleh pengeluar, kecekapan panel solar adalah semakin tinggi, iaitu dengan kadar kecekapan melebihi 20%.

Graf Arus-Voltan Pada Panel PV Solar

Rajah 2 menunjukkan graf Voltan-Arus pada panel solar yang bermula pada Arus Litar Pintas (Isc) di mana arus adalah maksimum namun voltan adalah sifar. Arus tetap sama dengan kenaikan voltan sehingga titik di mana peningkatan voltan yang lebih tinggi akan menunjukkan penurunan arus sehingga mencapai Voltan Litar Terbuka (Voc) dengan arus sifar. Titik Pmax adalah titik kuasa maksima yang bersamaan dengan Voltan pada Kuasa Maksimum (Vmp) dan Arus pada Kuasa Maksimum (Imp).



Rajah 2: Graf Voltan-Arus dan Kuasa-Voltan pada panel PV solar. (Dipetik dari sumber greensarawak.com)



Rajah 3: Contoh Pemasangan Sistem Solar Secara *Off-Grid*

Kesimpulan

Secara dasarnya kesimpulan yang diperolehi adalah seperti berikutnya:

1. Permintaan tinggi terhadap pemasangan sistem solar oleh pengguna di kediaman dan bangunan serta saranan polisi kerajaan tentang penghasilan tenaga dari sumber alam bagi menjimatkan kos serta mengurangkan penggunaan bahan sumber asli sedia ada.
2. Sistem PV solar tidak dapat memberi kesan yang maksima tanpa komponen utama yang lain bagi penjanaan tenaga elektrik. Komponen lain seperti bateri, pengawal pengecasan solar dan alatan pengukuran seperti meter pelbagai turut diperlukan dalam pengaliran cas yang sempurna. Tenaga solar telah dianggap sebagai salah satu sumber alternatif tenaga boleh diperbaharui yang boleh dipercayai dalam penyediaan tenaga lestari.
3. Sistem PV Solar *Off-Grid* adalah salah satu sistem yang biasa bagi mereka yang ingin menjana kuasa kepada alat elektrik jauh dari grid utama atau mereka yang memerlukan peralatan mudah alih dan tinggal jauh dari grid kuasa utiliti.

Rujukan

1. Farah Ayiesya Binti Zainuddin (2016), Meningkatkan Kecekapan Fotovoltaik Menggunakan Kombinasi – Termal
2. Mihnea Rosu-*Hamzescu Sergiu Oprea Microchip Technology Inc (2013), .Practical Guide to Implementing Solar Panel MPPT Algorithms*
3. Shahrul Nizam Bin Mohammad (2013), *Potential of Solar Farm Development At Utm Campus For Generating Green Energy*
4. https://greensarawak.com/ (2021), *A quick look in things to know before going Solar*
5. https://www.energysage.com/ (2021, *Solar energy: what you need to know about solar panels*

MEASUREMENT UNCERTAINTY (MU) IN THERMAL CONDUCTIVITY TEST OF BUILDING MATERIALS - PART 1

Dr. Siti Nor Azila binti Khalid
Ir. Dr. Abdul Murad bin Zainal Abidin
Makmal Penyelidikan Mekanikal
Bahagian Inovasi, Penyelidikan, dan
Pembangunan Kejuruteraan

INTRODUCTION

Thermal conductivity of a building material can be defined as the ability of the material to conduct heat, which is a critical parameter that will affect thermal comfort of occupants and energy performance of a building. Therefore, it is crucial that the thermal properties of a material be determined during design stage, and this can be evaluated by way of thermal conductivity testing. However, in the real world, achieving absolute accuracy in testing is near impossible due to uncertainties in measurement which are ever present. Measurement uncertainty (MU) is defined as a parameter that is associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand (a quantity that is measured). The aim of the first part of the article is to give a brief explanation on thermal conductivity testing and highlight the sources of uncertainty that are present during the test.

THERMAL CONDUCTIVITY TESTING FOR BUILDING MATERIALS

In order to understand the presence of MU in the thermal conductivity testing, it is proper to start with a brief explanation of the testing procedure itself. The thermal conductivity test is applicable to any number of different materials of various thicknesses and conductivity levels. The Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus by The American Standards for Testing Materials (ASTM C518-17), is used as a guide. The section gives a brief description on the procedures of the testing and the equipment used.

Before a proper thermal conductivity test is conducted, a standard reference material (SRM) is used for calibration purposes, as shown in Figure 1. This material is calibrated by the National Institute of Standards and Technology (NIST). A typical building material to be tested is an open cell elastomeric foam open cell, used as an acoustic insulation for heating, ventilating, air-conditioning and refrigeration (HVAC/R), shown in Figure 2.

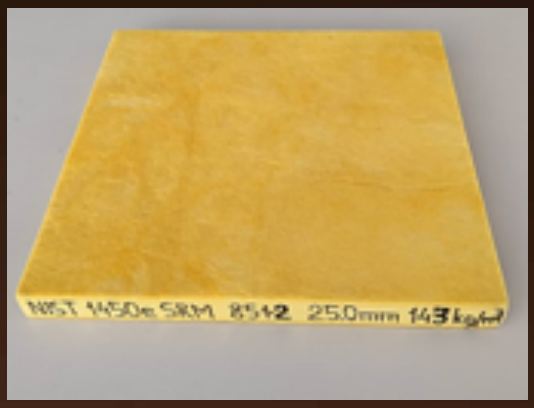


Figure 1: Standard reference material

Figure 2: Sample specimen

The specimen must be conditioned as required by the standards prior to the actual test. The sample is first stored in the climate chamber. The condition inside the chamber is then set at a temperature of 22°C and relative humidity of 50% for a period of 24 hours as required by the ASTM C518-17 Standards, before being taken out for the testing, shown in Figure 3.

Figure 3: Conditioning sample in climate chamber

Figure 4: Heat flow meter

The dimensions and thickness of the specimen were then measured using calipers and ruler before it is inserted into a heat flow meter, shown in Figure 4. The heat flow meter consists of two (2) isothermal plate assemblies that are outfitted with dedicated cooling system, the schematic of which is shown in Figure 5. It also has a central and peripheral groups of thermoelectric elements, which are controlled independently to eliminate radial temperature gradients in the plates.

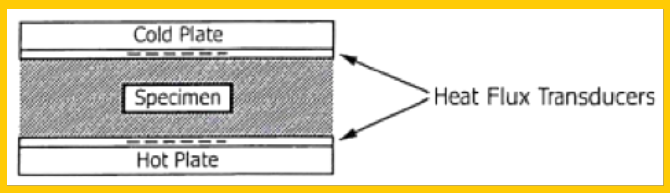


Figure 5: Heat flux transducer position

SOURCES OF UNCERTAINTY

The thermal conductivity of a material is expressed in the equation (1):

$$\lambda = \frac{Q}{A}\,\frac{L}{\Delta T} \qquad (1)$$

Where,

λ = Thermal conductivity (Watt per metre Kelvin, W/mK);
T = Temperature (Kelvin, K);
Q = Heat flow (Watt, W);
A = Area (m2); and
L = Thickness (metre, m)

The presence of uncertainty during testing and its relation with equation (1) is shown in Figure 6. Heat conduction is taking place between hot (T2) and cold (T1) plates in the heat flow meter through the sample, termed as conducting solid.

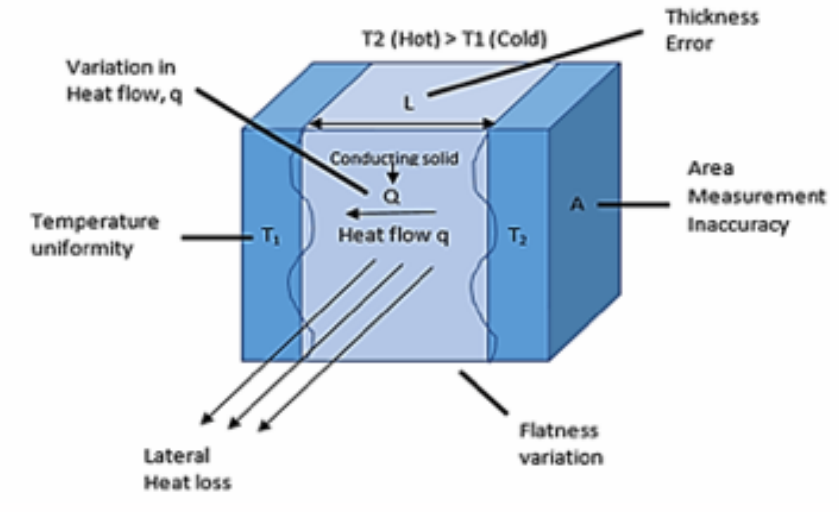


Figure 6: Heat conduction in heat flow meter (Source: Metcal S25 Training Hub)

The thickness, L, of the sample may vary along the length of the sample, which may give rise to thickness error. The surface of the sample may also not be entirely flat (flatness variation) which may result in no full surface contact with the plates. There is also inaccuracies in the area measurement, A, of the hot and cold plates. Additionally, the may be non-uniformity of surface temperatures of the hot plate (T1) and the cold plate (T2). All the non-uniformities will affect the uniformity of the heat flow through the sample and thus, affect the accuracy of the thermal conductivity.

In addition to the uncertainties in the precision of the heat flow meter and the test specimen, other uncertainties that are stated in the ASTM C518 Standards are a) uncertainty in the precision of the standard reference material used as calibrating specimen, b) uncertainty in the precision of other measuring device like calipers, and c) uncertainty due to the fact that the calibrating specimen and the test specimen are not identical, thus not having identical heat transfer properties.

CONCLUSION

Results of testing or measurement that are free from error or uncertainties are nearly impossible to achieve in the real world. At the same time, quality and reliability of testing results will be undermined when there is substantial doubt on the correctness if the MU is not tackled with due diligence. Therefore, it is important that sources of MU are identified and minimized in order to maintain the integrity of the test. In Part 1 of the article, a brief explanation of the thermal conductivity testing procedure was given, and the uncertainties that present due to precision of heat flow meter were discussed.

Other sources of uncertainties, and how the estimation of measurement uncertainty is done for the thermal conductivity test will be explained in the Part 2 of this article.

REFERENCE

1. ASTM Standard C518, 2017, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, ASTM International, West Conshohocken, PA, 2017, DOI: 10.1520/C0518-17, www.astm.org.

PENGUJIAN PRESTASI LAMPUJALAN JENIS HIGH PRESSURE SODIUM VAPOUR (HPSV)

Surya binti Sa'ad, Mohd Hanif bin Jamaludin
Ir. Dr. Hj. Mohammed Shahriman bin Mohamed Yunus
Makmal Penyelidikan Elektrik
Bahagian Inovasi, Penyelidikan, dan Pembangunan Kejuruteraan

PENGENALAN

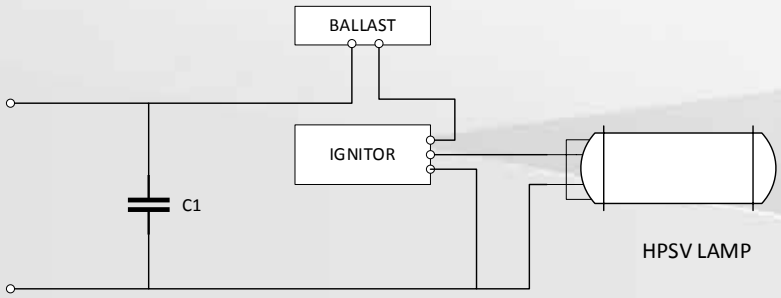
Lampu Jalan terdiri daripada beberapa jenis iaitu *Mercury Vapour , High Pressure Sodium Vapour* (HPSV), *Metal Halide* (MH) dan *Light Emitting Diode* (LED). Fungsi lampu jalan ini adalah untuk kemudahan penglihatan kepada pengguna dan untuk memastikan keselamatan kawasan persekitaran pada waktu malam.

Rajah 1: Contoh lampu jalan jenis HPSV

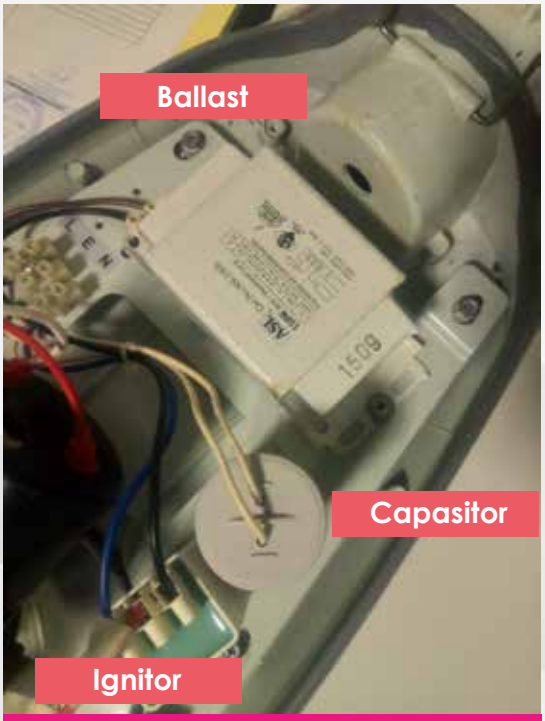
Lampu jalan jenis HPSV ialah sejenis lampu yang memancarkan cahaya putih keemasan.

KOMPONEN LAMPU JALAN JENIS HPSV

Rajah 2 dan Rajah 3 menunjukkan litar dan komponen bagi lampu jalan HPSV. Komponen lampu adalah terdiri daripada *Ballast, Capacitor, Ignitor* dan HPSV



Rajah 2: Litar Dalaman Lampu Jenis HPSV

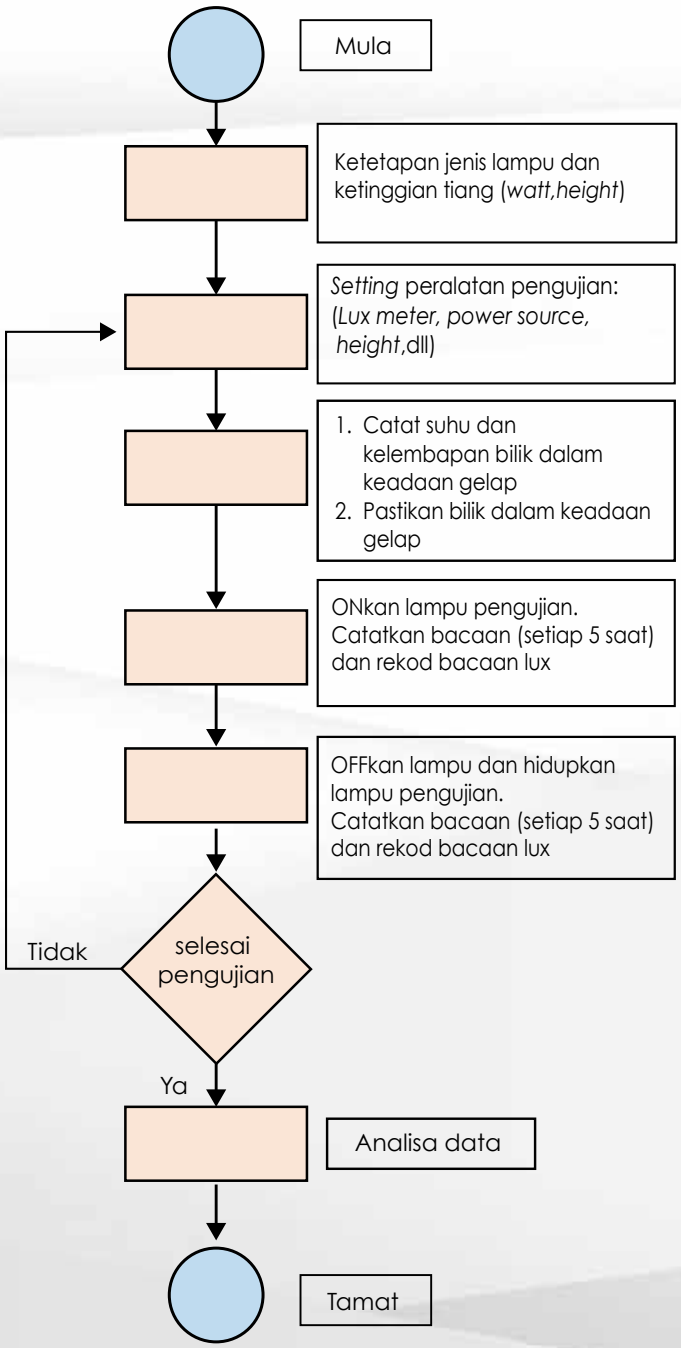


Rajah 3 : Komponen Dalam HPSV

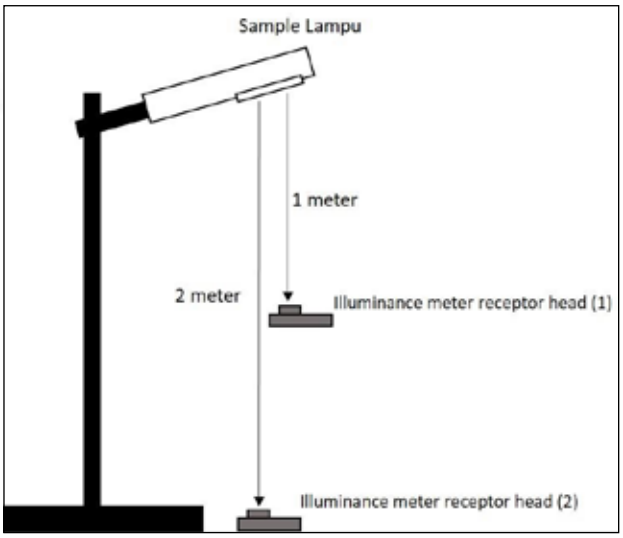
PENGUJIAN OPERASI LAMPU JALAN JENIS HPSV

Bagi memastikan operasi pencahayaan lampu jalan HPSV ini, satu kajian telah dijalankan oleh Makmal Penyelidikan Elektrik CREaTE untuk menguji ciri-ciri pencahayaan.

Pengujian dilakukan dengan menggunakan sampel lampu jalan jenis HPSV berkadaran 250W. Rajah 4 menunjukkan kaedah pengujian lampu jalan di makmal manakala, Rajah 5 adalah susunatur peralatan bagi pengujian pengukuran *illuminance* lampu jalan yang digunakan di dalam kajian ini.



Rajah 4: Carta alir pengujian lampu jalan di makmal



Rajah 5: Pengukuran *Illuminance* bagi lampu jalan di dalam Makmal

KEPUTUSAN PENGUJIAN DAN ANALISA

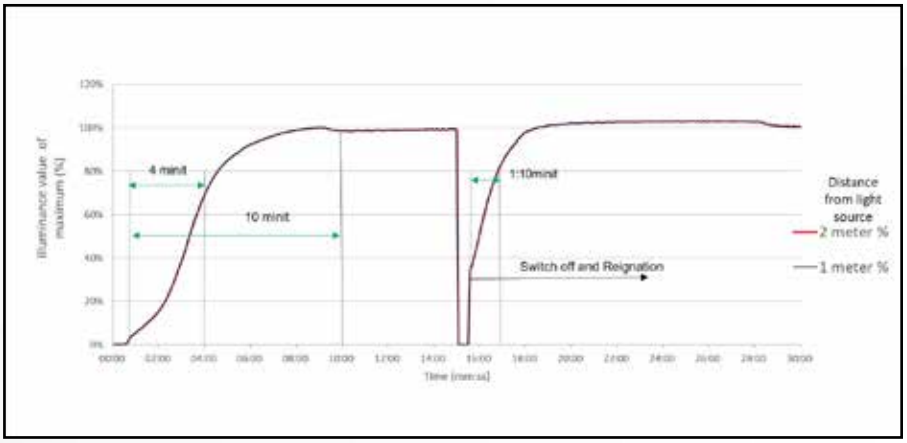
Data yang ditunjukkan dalam jadual 1 adalah hasil pengujian sampel yang telah dijalankan. Data tersebut merujuk kepada: 250W HPSV *Street Light (at* 240V)

Jadual 1: Maklumat sampel yang diuji dan kecerahan maksima

ILLUMINANCE MEASUREMENT	
Brand:	NIKKON
Model:	250 WATT
Voltage	240V
MAXIMUM LUX	
2 METER	1 Meter (Lux)
1169.00 Lux	5240.00 Lux

Jadual 2: Keputusan pengujian

SUMMARY		2 METER			1 METER		
		LUX	%	TIME (MIN)	LUX	%	TIME (MIN)
Starting from cold	*value of Lux in 4 minutes*	940	80%	04:00	4200	80%	04:00
	80% of nominal lux	940	80%	04:00	4200	80%	04:00
Switch off and Reignation	*value of Lux in 1 minutes*	496	42%	01:00	2225	42%	01:00
	80% of nominal lux	940	80%	01:10	4200	80%	01:10



Rajah 6: Lengkungan Pencahayaan *ON – OFF*

Merujuk kepada Rajah 6, lengkungan graf menaik dan dalam masa empat (4) minit kecerahan lampu telah mencapai 80% lumen. Lengkungan terus menaik dan mencapai kecerahan 100% lumen pada masa sepuluh (10) minit berikutnya, sebelum proses gangguan bekalan (suis dimatikan dan dihidupkan semula) dilakukan. Graf menunjukkan terdapatnya penurunan peratusan nilai lumen yang mendadak apabila lampu dipadamkan dan dihidupkan semula. Selepas lampu dihidupkan semula, dalam masa satu (1) minit lampu mencapai kecerahan 80% lumen dan kemudiannya pada minit ke 18, kecerahan lampu mencapai 100%.

KESIMPULAN

Pengoperasian lampu jalan jenis HPSV memerlukan masa yang lama untuk mencapai kecerahan 80% lumen dan apabila dipadamkan atau ada gangguan bekalan elektrik, lampu ini mengambil masa sekurang-kurangnya 70 saat untuk mencapai kecerahan 80% lumen.

Lumen lampu jalan juga dipengaruhi oleh ketinggian tiang lampu. Jika tiang lampu semakin tinggi maka, lumen yang berada di atas jalan juga semakin berkurang.

RUJUKAN

1. *https://www.lightingassociates.org/i/u/2127806/f/tech_sheets/high_pressure_sodium_lamps.pdf.*
2. *High Pressure Sodium Lamps A Pacific Energy Center Factsheet,Pacific Gas and electric Company*
3. *Street light for Local Road , National Ligthing Product Information Programme, NLPIP, 2011*

Sewage Treatment Process in SEQUENCE BATCH REACTOR (SBR) PLANT

Ir. Khairul Faizi bin Saim
Unit Awam (Bangunan & Struktur)
Bahagian Kompetensi, Pensijilan, Akreditasidan Kejuruteraan

Introduction

There are two categories of sewage treatment plant (STP). Non-mechanised STP and Mechanised STP. Non-mechanised STP are, Imhoff Tank, Trickling filter and Oxidation pond while Mechanised STP are Sequencing Batch Reactor Plant (SBR), Oxidation Ditch, Rotating Biological Contactor and Aerated Lagoon. Figure1 to 4 show some of the common sewage treatment plants in Malaysia.

Figure 1: Rotating Biological Contactor

Figure 2: Oxidation ditch

Figure 3: Extended Aeration Plant

Figure 4: Sequence Batch Reactor Plant

Suruhanjaya Perkhidmatan Air Negara has outlined the need for treatment and disposal of the wastewater. The unit process in the wastewater treatment facilities should generally cover the physical and biological process. The concerned areas are as follows:

a. Screening of Coarse solids;
b. Biological treatment (aerobic);
c. Clarification by sediment process;
d. Drying of digested sludge; and
e. Disposal of sludge.

SBR Mechanised Plant

Sequencing batch reactors (SBR) or sequential batch reactors are a type of activated sludge process for the treatment of wastewater or sewage. It is used for small communities where land area is limited. This mechanical plant can be manned for a maximum of two or three hours per day depending on its population equivalent capacity. The aeration processes are often better at handling organic loading, as there is a greater detention time for the organic to have the biological degradation.

Aerobic treatment requires supplying enough oxygen to support aerobic bacteria. The amount of aeration needed depends on whether it is desired to just reduce odour, or completely remove the oxygen demand of the organic matter, or to supply enough oxygen for nitrification of ammonia to nitrate. Oxygen is bubbled through the mixture of wastewater and activated sludge to reduce the organic matter (measured as biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

A sequencing batch reactor (SBR) is fill and draw activated-sludge treatment system. The unit processes involved in the SBR and conventional activated-sludge system are identical. Aeration and sedimentation/ clarification are carried out in both systems. However, there is one important difference. In conventional plants, the processes are carried out simultaneously in separate tanks, whereas in SBR operation the processes are carried out sequentially in the same tank. All SBR systems have five steps in common that are carried out in sequence as follows:(1) fill, (2) react (aeration), (3) settle (sedimention/ clarification), (4) draw(decant), and (5) idle. Sludge wasting is another important steps in the SBR operation that greatly affects performance. Wasting is not included as one of the five basic process steps because there is no step time period within the cycle dedicated to wasting. The amount and frequency of sludge wasting is determined by performance requirements, as with a conventional continuous-flow system. In an SBR operation, sludge wasting usually occurs during the settle or idle phases. A unique feature of the SBR system is that there is no need for a return activated-sludge (RAS) system. Because both aeration and setting occur in the same chamber, no sludge is lost in the react step, and none has to return from the clarifier to maintain the sludge content in the aeration chamber.

SBR Proces Description

i. Manual Coarse Screening

The influent wastewater from the source is passed through the first stage of treatment in the Manual Course Screen. All the screenings such as wood, cloths get trapped in the basket and the filtered wastewater flows into the raw sewage pump pit. The trapped screenings are collected manually. The collected screenings are then to be disposed. The design criteria used are that the settling velocity is 0.112 ft/sec, and the horizontal velocity of the fluid is 0.2 m/sec.

ii. Raw Sewage Pump Pit

After the process of coarse screening the wastewater is pumped from the raw sewage pump pit to the treatment processes. The dimension of the raw sewage pump pit is to be calculated with a retention time of 10 minutes at peak flow. The pump pit house is completed with 2 numbers of pumps where one pump will be in operation under normal working conditions and the other will be on standby. The levels are controlled using float switches.

iii. Grit And Grease Chamber

The grit and grease chamber is designed to retain all the grit , sand or oil at the top or bottom of the tank which to be collected manually once a week.

iv. Main Tank (Aeration and Sedimentation)

The sewage is introduced into the aeration tank where an aerobic bacterial culture is maintained in suspension. The reactor contents are referred to as the mix liquor. The air required for biodegradation is supplied by fine bubble non-clog membrane diffusers which are installed at the bottom of the aeration tank. This is to ensure uniform supply of oxygen levels, same time the mix liquor in a completely mixed condition. After a specified time, excess sludge (biomass) is wasted to the sludge digestor. The dissolved BOD will be reduced to 96% in the aeration tank during the process.

Conclusion

There are some disadvantages of SBR, which include higher capital cost for aeration equipment, higher operating cost (particularly energy for pumps or aerators), higher maintenance requirements, and possibly monitoring requirements for checking the dissolved oxygen level in the liquid. There are various methods and types of equipment for aeration, and selecting the most efficient equipment and methods may be difficult. Consultation with knowledgeable professionals is advisable.

Reference

1. Metcalf and Eddy, Wastewater engineering, treatment and disposal, 3rd edition 1991.

THE EFFECT OF LIGHTING TOWARDS SAFETY

Suhaila Abdul Rashid
Bahagian Pengurusan Aset dan Fasiliti

Abstract

Built environment is an important space where the way we shaped them will influence our behavior and psychology. A good or positive environment will increase usage of space and safety. While, a negative environment will contribute to unsafe feeling and will increase fear. Numerous researches have highlighted that lighting is one of the features in creating a safer environment. Safe City Program and Crime Prevention Through Environmental Design (CPTED) has included lighting as one of the strategies. This study focuses on CREaTE as a case study area and the findings of the study have shown that lighting is part of important elements in the premise.

Keywords: lighting, safety, built environment

Introduction

Sustainable Development Goals (SDGs) is a national agenda which was adopted by the government and Goals 11: Sustainable Cities and Communities aim at making cities inclusive, safe, resilient and sustainable. In order to create a sustainable city or built environment, safety is part of the thrust, and safe environment will enhance the quality of life. One of the main features or strategies which has been recognized and implemented is lighting (Park et al, 2020).

Lighting is not only an important feature in the building but also for public spaces and spaces in between buildings including walkway, parking area and small pocket space.

Lighting as Safety Features

Previous research opined that lighting could contribute to safety and positive effect (Fotios et al, 2015) due to its ability to perform a long-range detection of possible threats (Boyce et al, 1995). Illumination is also required for pedestrian to detect hazard and change in elevation.

CPTED and Safe City Program which was introduced and implemented by Local Authorities in Malaysia has adopted the strategies which feature lighting as one of the key physical elements. There are several lighting features that enhance safety which includes: colour, illumination (average amount of light), glare and obstruction (Graig et al, 2018).

Adequate and good quality lighting is not only crucial for safety but important for identifying hazard as there are still workers who occupy the area until midnight. Risk could be reduced with adequate lighting.

Methodology

A case study (Yin, 2008) approach was selected with mixed method (Creswell, 1999) to evaluate the problem, where structured observation and in-depth interview were the techniques. The structured observation consisted of visual and behavior. Physical elements were observed for visual. Meanwhile, behavior observation was related to the movement pattern of user. In-depth interview (Vrij et al, 1995) was conducted to evaluate the problem by selecting respondent among user in the case study area. Respondents were selected among workers in CREaTE as shown in Table 1.

Table 1: Respondents for in-depth interview

Respondents	Justification	Number of respondent
CREaTE staff	Normal working hours	6
Lodge workers	Shift (until 12.00 pm)	2
Maintenance workers	Normal working hours	2
Participants	Limited time	2
Total		**12**

Findings and discussion

As the training centre, the development of CREaTE consists of offices, laboratories, lodge, dining hall, surau, quarters and ancilliary facilities such as refuse chamber, bus parking and parking area. The operation hour is from 9.00 to 5.00pm which is similar to other premises operation hour. The operation hour is exceptional for CREaTE Lodge which is occupied until night time, while the dining hall is operated based on demand. Therefore, there are a variety of timeframes of user which need to be considered.

Based on the observational analysis findings, certain areas need to be reassessed and to be evaluated in terms of lighting. Obstruction on lighting was found due to canopy of trees which was not properly maintained. Tree planting is one of the important features that affect lighting quality. There is one location that needs to be maintained because the tree's canopy has blocked the light and has affected visibility. Shadow could be reduced with proper maintenance of trees around street lighting. This is supported by interview findings where respondents had highlighted the location that they felt are with inadequate lighting. As the location of CREaTE JKR is farther from the main road and surrounded by hillside, more attention should be given especially where there could be potential hiding point for offender or intruder such as at the back of quarters and in front of CREaTE Lodge.

Table 2: Finding from both techniques

Location	Observation	In-depth interview
Block A to dining hall	Changes of level More hiding spot	Lack of lighting
Block B	Quality of light	Lights are not working
Refuse chamber	Lack of lighting	Lack of lighting
Surau	Trees that obstruct the light Composition of built form	Lack of lighting due to planting

Table 2 illustrates the locations that require further improvement. These are the locations that users pass by and are exposed to danger from wild animals and a feature that invites offender. Most respondents informed that they depended on lights from the buildings.

Figure 1: View towards main entrance of CREaTE Lodge (source: fieldwork, 2021)

Figure 1 shows lighting in front of CREaTE Lodge. This is an important area where participants and staffs use at night. More consideration should be given to the area due to the location of this entrance facing the hillside and less surveillance.

Figure 2: Outdoor lighting around CREaTE Lodge (source: fieldwork, 2021)

Figure 2 shows how lighting and proper maintenance of lighting affect the quality of visibility at night. This is an important feature which should be continuously maintained.

Respondent (R01) informed of the presence of wild animal near CREaTE Lodge recently and this could also be a threat to worker's safety as the building is in front of hillside and forest. Other respondent (R04) highlighted that there are four locations which are dark. Findings from the observation have confirmed that the area such as the refuse chamber needs to be improved even though it is only used by certain group of users. Meanwhile, respondent (R03) felt uncomfortable with dark area.

Figure 3: Identified location with poor lighting (source: fieldwork, 2021)

Figure 3 illustrates the location with poor lighting as mentioned by respondents and observation. Result shows that some respondent felt safe of the surrounding at night however, those who were familiar with the area but need to stay up late felt unsafe due to lack of lighting at certain areas. Comparison between occupation of space between respondent shows that those who needed to access more than one building felt unsafe as they needed to use the walkway, other blocks and parking area before leaving the office at night. This is supported by behaviour observation where even though the distance between blocks is near, pedestrian needs to walk alone which increase fear and potential harm. This is relevant for both male and female respondents.

Feeling safe is important for quality of life as there are diverse groups of user in the area. Based on observation, there are female workers at Lodge who work until nighttime. As a training centre, safety is crucial not only for workers but also for those who come for short term stay.

Conclusion

Based on the above discussion, it is concluded that lighting in outdoor area of CREaTE JKR needs to be improved and, it is one of the important aspects which needs to be given attention. Safety should be part of the design element from planning stage by considering geographical context to be integrated in the design. Proper maintenance of objects or elements that obstruct the quality and visibility of lighting should be the priority.

Future development and extension in this area should consider lighting as part of the safety elements rather than just a physical feature. Lighting standard for outdoor environment should be referred to and implemented. Building composition and spaces in between each block needs to include safety consideration for nighttime use. Further detail study on outdoor environment lighting for CREaTE JKR and measurement of outdoor lighting is recommended.

References

1. Creswell, J.W (1999), Mixed Method Research: Introduction and application. Academic Press
2. Fotios, S. A., Unwin, J., Farrall, S. (2015). Road lighting and pedestrian reassurance after dark: A review. Lighting Research & Technology, 47, 449-469. doi:110.1177/1477153514524587
3. Graig, G & Malesic, LC (2018), Pedestrian Lighting: Establishing Lighting Levels for Safety & Security, retrieved from www.jdbengineering.com
4. L van Rijswijk, (2018), Illuminating for Safety: Investigating the Role of Lighting Appraisals on the Perception of Safety in the Urban Environment, Environment and Behaviour, Sage Publications
5. Park,Y & Max Garcia (2020) Pedestrian safety perception and urban street settings, International Journal of Sustainable Transportation, 14:11, 860-871,
6. Vrij, A, & Winkel, FW. Characteristics of the built environment and fear of crime: A research note on interventions in unsafe locations. Deviant Behavior: An Interdisciplinary Journal 1991; 12: 203–215.
7. Yin, R (2008), Case Study Research: Design and Methods, Sage Publications

VERTICAL GREENERY SYSTEM at CREaTE

Jamilah Halina binti Abdul Halim
Dr. Nor Shahrene binti Mohd Ibrahim
Makmal Penyelidikan Senibina
Bahagian Inovasi, Penyelidikan dan Pembangunan Kejuruteraan

Introduction to Vertical Greenery System (VGS) and Its History

Vertical greenery system (VGS) can be defined as greenery integrated into built forms in the city includes balcony gardens, sky terraces and green roofs (Chiang & Tan, 2009). VGS can also be defined as the way that plants can be grown on, above, or in the walls of the building (Bass & Baskaran, 2003). VGS is also known as vertical landscaping, vertical gardening and green wall. Thus, VGS is basically a technique used to grow plants on vertical surfaces.

Vertical greenery is nothing new. The first vertical garden system is believed to be the Babylon Hanging Garden, which was constructed by King Nebuchadnezzar II, who ruled between 605 and 562 BC. In 1983, Prof. Stanley Hart White, a landscape architect invented a modern VGS, which is the 'Vegetation-Bearing Architectonic Structure and System' or 'botanical brick panel' (modern version of VGS). Later in 1988, Dr. Patrick Blanc, a botanist innovated the 'green wall' into the invention of the modern 'vertical hydroponics garden' or 'green wall' using felt fabric pocket system with automated watering and nutrient system made at the Museum of Science and Industry in Paris. In 2007, the 'Green curtain' installed at Kyocera factory in Okaya, Japan is installation of vertical greenery on large scale. Green initiatives using VGS upsurges because city leaders are recognizing that a cleaner environment is needed both to provide residents with good quality of life and to compete in the global economy. Now, VGS is installed inside the building as well as externally as part of building façade. A brief history of VGS is shown in Figure 1.

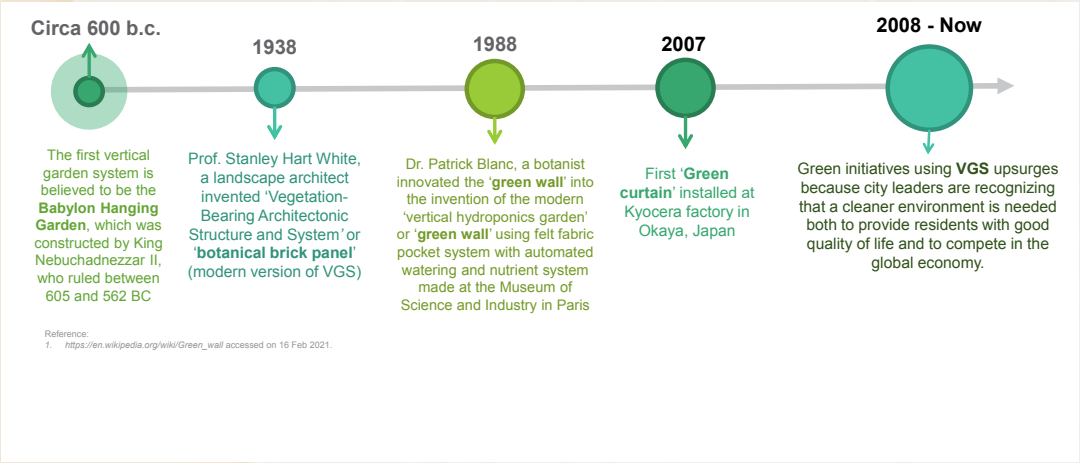


Figure 1: Brief history of vertical greenery system

In Malaysia, VGS has been spreading as part of building façades to gain green points for sustainable buildings' rating. VGS in Malaysia is also regarded as part of a public art as well as part of the building landscape, which could elevate the price and quality of any development.

Component of VGS

There are many variations of VGS available in the market as shown in Figures 2 and 3. However, VGS basic components remain the same, which are plants, soil or growing media, and supporting structure, including the irrigation and nutrient for plants such as manures.

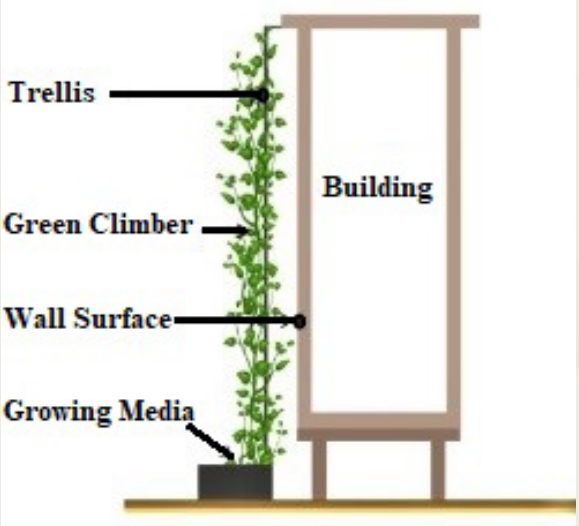


Figure 2: Components of VGS for support system

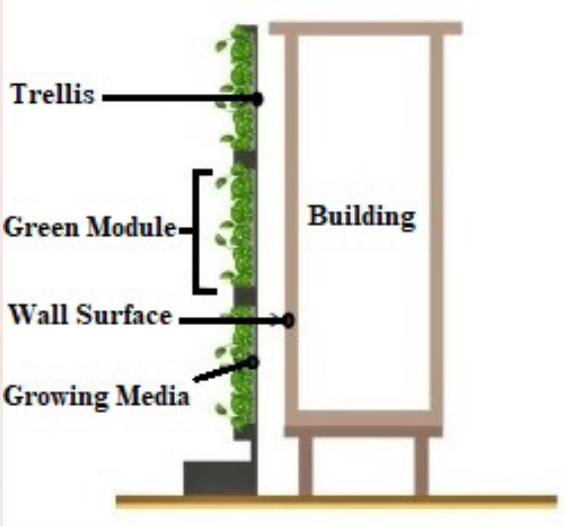


Figure 3: Components of VGS for carrier system

Categories of VGS

Figure 4: VGS support systems

Figure 5: VGS carrier systems

There are two broad categories of VGS, which are the 'support system' and the 'carrier system', as shown in Figures 4 and 5. The 'support system' is designed to guide plants up on the vertical surface and is commonly known as 'green façade'. It allows climbing plants and grown cascading ground covers to grow up the façade on specially designed support structures. The 'carrier system' is designed to contain the media for the planting on the vertical surface.

The selection of system is guided by the type of plants to be planted. There are a few common types of VGS available in the market, which are the cassette system, planter system, pocket system and support system, shown in Figures 6 to 8. The cassette system consists of modular units containing growing media that can be easily mounted on structural frames as standalone system or attached to wall surface. The planter system consists of individual pots mounted at regular intervals onto a structure or frame. When placed closely together, they form a continuous wall of greenery. The pocket system comprises of moisture retention fabrics that is used to hold the plants in place on a board. These plants are placed in pockets made of the fabric.

The support system consists of plants in planters placed at regular interval. Wire mesh and cables attached to them allow plants to climb up, creating a green screen. Sometimes plants chosen are ground covers that grow in tiers creating a green curtain on the façade, as shown in Figures 9 and 10.

Figure 6: VGS using cassette system

Figure 7: VGS using planter system

Figure 8: VGS using pocket system

'Green curtains' are usually installed on the exterior wall and made of planter boxes with rope installed onto frames and external wall, with decorative or edible climbing plants, such as morning glory and bitter gourd.

Figure 9: 'Green curtains' installed at building in Malaysia

Figure 10: Green curtains' installed at Kyocera Factory in Japan

Benefits of vertical greenery

Vertical greenery has a lot of benefits. One of the most well-known benefits is that it lowers the maximum surface temperature to 11.58°C, reduce ambient temperature from 3.3°C and provides cover shielding. Living wall reduces temperature better than that by green façade.

Vertical greenery can provide sound insulation because it can reduce noise levels up to 10dB while bringing greenery to the community. For vertical greenery at communal areas in high-rise building, VGS creates a good ambience for social interactions.

Vertical greenery is also explored by landscapers and architects as a means to beautify a space, as a public art on building and structures that add values to any property, development area or street.

VERTICAL GREENERY SYSTEM (VGS) INSTALLATION AT CREaTE

A dining area was identified at Level 2, Block A, CREaTE as a potential area to install VGS at CREaTE. In late November to mid December 2020, MPS with approximately 30 officers from CREaTE have developed two types of VGS planter system, shown in Figures 11 and 12, as part of a hands-on program. Through the program, sixteen chairs, five tables, and two types of vertical greenery system had been built. One of the VGS is a VGS-planter system mounted onto wall and two movable vertical garden racks were placed near the railing.

The objective of building both VGS onto the wall and rack is to enhance the area, add green value, introduce aesthetics to a pocket space in Block A, reduce glare at the area, improve air quality and create a good ambience for users dining here.

Figure 11: Two vertical garden racks placed at Block A

Figure 12: VGS-planter system installed on the wall of dining area, level 2 at Block A

Each movable vertical garden rack has dimensions of 1.8 x 0.2 x 2.3 meter (length x width x height) and made of rectangular hollow steel, powder coated in black paint, with wheels for portability, and has a gutter filled with river stones to collect water at the bottom. The racks are placed with small plants in 16 x 16 x 14 centimeter (length x width x height) white rectangular plastic planter pots, which are exactly size of the rack spacing. Approximately 48 pots were placed at random intervals onto the rack for aesthetics.

Meanwhile, the VGS-planter system is a grid wall made of 2 x 2 inch BRC mounted to the wall using wooden frame in the dining area, at level 2, Block A. 35 black plastic planter pots measuring19 x 38 x 19 centimeter (length x width x height) were hung to the grid wall using plastic hooks. At the bottom is a plastic gutter with river stones that holds excess water from pots.

Figure 13 shows the types of plant chosen for the vertical garden rack.

English ivy variegated (hedera helix)

Snake plant (sansevieria trifasciata)

Spotted aloe vera (aloe vera var. chinensis)

Rattlesnake calathea (calathea lancifolia)

Pokok ati ati (coleus blumei)

Peacock plant (calathea makoyana)

Red flame ivy (hemigraphis colorata)

Elephant bush Variegated (portulacaria afra variegata)

Lipstick plant (aeschynanthus lobbiana)

Pokok kerang nenas (tradescantia spathacea)

Figure 13: The types of plant chosen for the vertical garden rack

Lessons Learnt and Way-forward

A simple perception study was done from December 2020 to February 2021. One of the major findings from this study is maintenance issue of the VGS constructed. Both of these systems were devoid of an automatic irrigation system due to minimum budget allocated for the programme hence, the irrigation system could not be installed from the beginning. Thus, officers would spray all plants twice a week. The maintenance of both systems were relatively easy as officers could change the plants accordingly if any of the plants died.

It has also been learnt that the most important factor contributing to a beautiful and successful VGS is the choice of plants for the system. Most of the plants chosen have a high survival rate as most have survived to this date, except for a few plants which needed to be re-potted such as the english ivy (hedera helix), which had to be replaced with the red flame ivy (hemigraphis colorata).

As a way forward, the Architectural Research Laboratory (MPS) would like to recommend that studies be conducted on the issues and challenges of maintaining both systems and the survival rate of plants selected for the system. Currently, MPS is also collaborating with Universiti Malaya to develop a vertical greenery system for government buildings.

References:

1. Tabassom Safikhani, Aminatuzuhariah Megat Abdullah, Dishan Remaz Ossen, Mohamad Baharvand, Thermal Impacts of Vertical Greenery System, Environment and Climate Technologies (2014)
2. Badrulzaman Jaafar, Ismail Said, Mohd Nadzri Md Reba, Mohd Hisyam Rasidi , Impact of Vertical Greenery System on Internal Building Corridors in the Tropic., Procedia – Social Behavioral Sciences 105 (2013) (p.558-568).
3. A Handbook on Developing Sustainable Highrise Gardens, Bringing Greenery Skywards, National Parks Board (2017) Singapore.
4. Sheila Conejos, Michael Yit Lin Chew and Fikril Hakim Bin Azril (2019). Green maintainability assessment of high-rise vertical greenery systems, Facilities, Vol. 37 No. 13/14, 2019, pp. 1008-1047.
5. Michael Yit Lin Chew, Sheila Conejos and Fikril Hakim Bin Azril (2018). Design-for-Maintainability (DfM) of High-Rise Vertical Greenery Facades, Building Research and Information, Vol. 47 No. 4, pp. 453-467.
6. Michael Yit Lin Chew and Sheila Conejos (2016). Developing a Green Maintainability Framework for Green Walls in Singapore, Structural Survey, Vol. 34 No. 4/5, pp.379-406

WEATHERING ASSESSMENT ON ROCK SLOPE AT SECTION 139.9, GERIK JELI EXPRESSWAY

Sharan Kumar A/L Nagendran
Nurul Eilmy binti Zainuddin
Ir. Zuraini binti Zainal
Makmal Penyelidikan Geoteknik
Bahagian Inovasi, Penyelidikan, dan Pembangunan Kejuruteraan

INTRODUCTION

Numerous landslides have occurred due to weathered steep slopes and structurally controlled events have paved the way to minimise failures. In rock slope investigation, the rock mass weathering assessment procedure is straightforward and depends on the rock structures and physical visual impression. Visual assessment plays a vital role in determining the overall slope stability for engineering evaluation and overall characterisation of the geological structure, joint surface conditions, and weathering profiling. The study area is located at Section 139.9, Gerik – Jeli Expressway, FT004 (Figure 1). This assessment was carried out by the Geotechnical Research Laboratory, Centre of Excellence for Engineering and Technology (CREaTE) together with Universiti Sains Malaysia (USM).

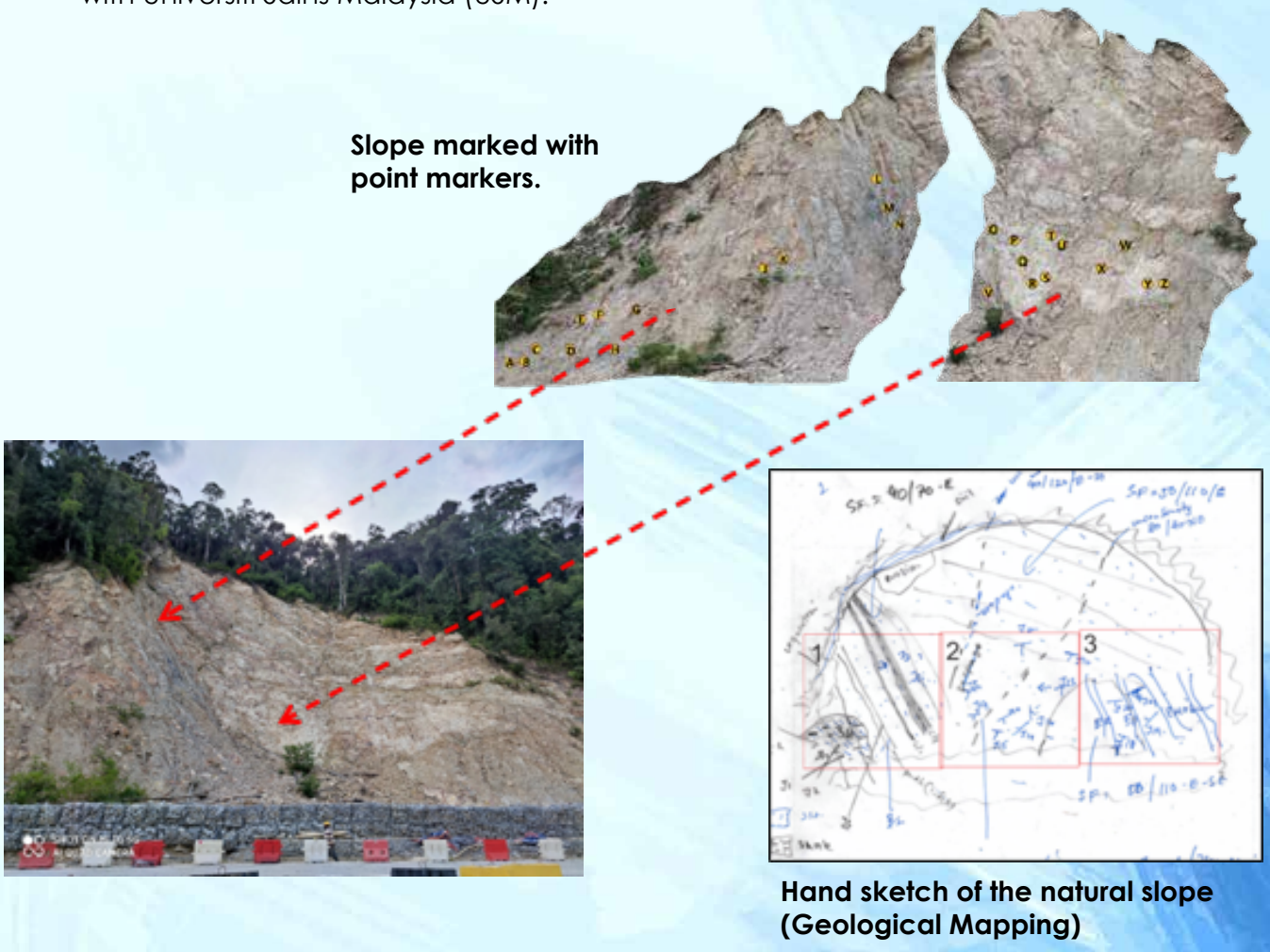


Figure 1: Overview of the study area

OBJECTIVES

The objectives of the study include the following:

i. To determine the primary index and mechanical properties of the rock slope using the conventional geomechanics approaches; and
ii. To evaluate the rock slope vulnerability based on different weathering grades regions.

METHODOLOGY

A methodology suitable to achieve the objectives is represented by the following activities:

i. Conventional engineering geological mapping (Figure 1) and standard in situ rock testing to assess rock mass strength, including Schmidt hammer rebound test was carried out;

ii. Uniaxial Compressive Strength (UCS) was conducted to identify the rock mass strength; and

iii. The validity of laboratory results was done by comparing them with the grade of weathering values. The slope stability assessment was carried out following the Suggested Method by the International Society of Rock Mechanics and Rock Engineering (ISRM) 1978.

Field weathering inspection

Weathering plays a vital role after rock morphology. The field weathering inspection starts with the marking of 25 slope points (Figure 1) and covers only the slope foot due to poor slope conditions and inaccessibility. The degree of weathering for this slope is measured based on the existence of iron stains and fracture strength. Table 1 shows the rock grade, UCS and grade of weathering.

Table 1: Rock grade & UCS (Marinos and Hoek 2000) and Grade of Weathering (ISRM, 1978)

Rock grade and its Uniaxial Compressive Strength (Marinos and Hoek, 2000)				Grade of Weathering (ISRM, 1978)	
G	**Term**	**USC (MPa)**	**Field estimation of strength**	**Description**	**Grade of Weathering**
R6	Extremely strong	>250	The specimen can only be chipped with a geological hammer	No visible sign of rock material weathering, perhaps discoloration on major discontinuity surfaces	I (Fresh)
R4	Strong	50-100	Specimen requires more than one blow from a geological hammer to fracture it	Discoloration indicates the weathering of rock materials and discontinuity surfaces. All rock materials may be weaker externally than in its fresh condition.	II (Slightly weathered)

Rock grade and its Uniaxial Compressive Strength (Marinos and Hoek, 2000)				Grade of Weathering (ISRM, 1978)	
R3	Medium-strong	25-50	Cannot be scrapped or peeled with a pocketknife; specimen can be fractured with a single blow from a geological hammer	Less than half of the rock material is decomposed and/or disintegrated into the soil. Fresh or discoloured rock is present either as a continuous framework or a corestone.	III (Moderately weathered)
R2	Weak	5-25	Can be peeled with a pocketknife with difficulty, shallow indentation made by a firm blow with point of the geological hammer	More than half of the rock material is decomposed and/or disintegrated into the soil. Fresh or discoloured rock is present either as a discontinuous framework or a corestone.	IV (Highly weathered)
R5	Very strong	100-250	Specimen requires many blows of a geological hammer to fracture it		

Based on the field inspection, the weathering mechanisms are controlled physically and chemically. Physical weathering is visible in the form of biological weathering. The moderate-scaled vegetation in the proposed rock slope decreases the rock strength. The visible sheet erosion at the slope foot becomes the weak spot for slope instability. Oxidation of silicate minerals in sandstone forms the iron staining. The reaction is summarized as follows:

Fe_2SiO_4 (Iron Silicate) + $4H_2CO_3$ (rainfall) ⟶ $2Fe_2$ (rust) + $4HCO_3^-$ + H_4SiO_4.

Schmidt hammer test

The test is non – destructive and repetitive to obtain an accurate value of rebound number, N. A total of 50 points of Schmidt hammer rebound were evaluated in the natural slope (Figure 2). After the Schmidt hammer rebound numbers are taken, the outliers need to be identified and neglected to achieve an average data trend. The accepted Schmidt hammer rebound values are then converted to uniaxial compressive strength values.

Figure 2: The Schmidt hammer N-type used

Table 2 represents the summary of UCS ranges and rock grade classification.

Table 2: A summary of Uniaxial Compressive Strength range of study areas and their rock grade classification (after Marinos & Hoek, 2000)

Localities	UCS ranges (MPa)	Average UCS (MPa) / Rock Grade Classification
Section 139.9, Gerik – Jeli Expressway	17 - 106	49 R3 (Medium Strong)

Laboratory Uniaxial Compression Test (UCS)

Uniaxial Compression Test (UCS) of intact rock is often needed for inspecting the engineering design properties of rock. The test is carried out on intact rock with no discontinuities and yields data on the rock materials properties. The length to diameter ratio of 2:1 is a minimum for cylinders. Figure 3 shows the rock coring work at the site and UCS laboratory test conducted for this study.

Figure 3: Rock coring at field and UCS laboratory testing

Based on the uniaxial compression test results in Table 3, the maximum stress recorded ranges from 19.56 MPa to 130.95 MPa. C2 shows the lowest maximum stress values, and the core plug was destroyed, which also represents the weak type of rock.

Table 3: The distribution of maximum stress values and their rock grade classification

Core Run	Area (mm2)	Weight (kg)	Dry/Wet	Max load (kN)	Max Stress (MPa)	Rock Grade
C1	1661.9	0.483	Dry	217.63	130.95	R5 (Very Strong)
C2	1683.7	0.458	Dry	32.94	19.56	R2 (Weak)
C3 (1)	1661.9	0.491	Dry	71.47	43.00	R3 (Medium Strong)
C3 (2)	1683.7	0.497	Dry	45.59	27.08	R3 (Medium Strong)

Discussion

Significant findings from the field and laboratory tests are inter-related qualitatively and quantitatively. The groups of weathering grade in this study area clearly show the thin-bedded sandstone and shale which is represented by grade three (III). The low values of Uniaxial Compression Strength indicate the weathered sediment resulted from past failed slope events and loose residual soil rock from the crest, represented by grade of weathering of grade four (IV) to grade six (VI) (Figure 4). Region A is more weathered compare to Region B because it is composed of sandstone and shale, whereby most of the sandstone suffered discolouration. The Region B area is composed of slightly weathered sandstone. Discolouration can be found in several sandstones. However, for the lower part, it is highly weathered due to residual soil.

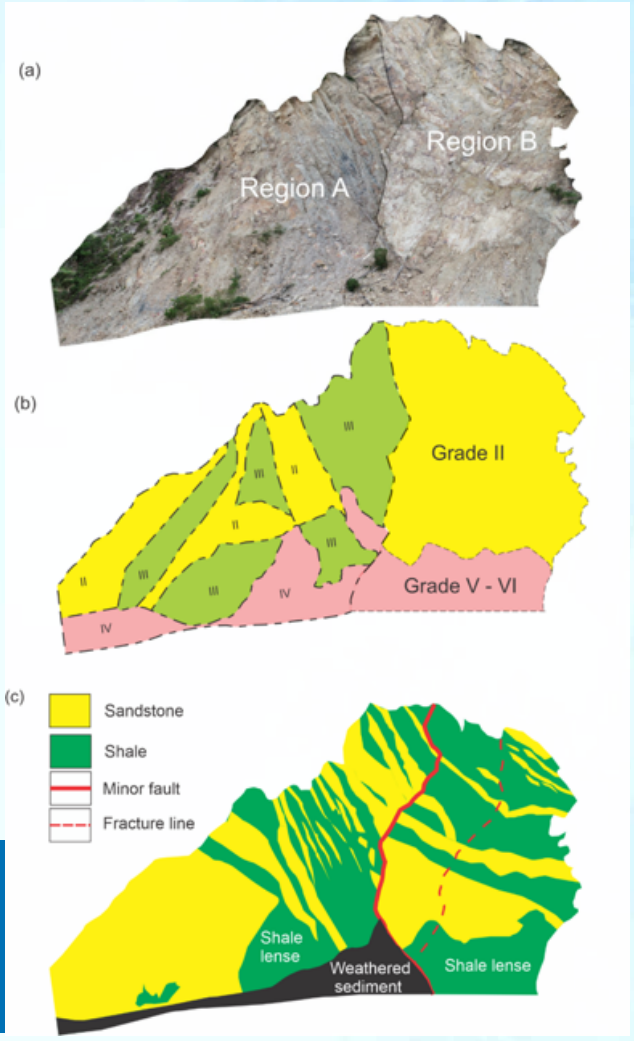


Figure 4 : The distribution of weathering profile of representative interbedded sandstone and shale at a natural slope

Conclusion

In conclusion, the rock slope stability near the natural slope in Section 139.9, Gerik – Jeli Expressway, is controlled by geological factors. The Uniaxial Compression Test (UCS) highlights the natural slope which represents the weak to very strong rock grade. The laboratory UCS results and the UCS Schmidt hammer rebound test results, emphasize and show the similarity in the intact rock strength tested on the field and hence, the laboratory test results is validated. The grade of weathering controls the values from the Schmidt hammer rebound test.

PUSAT KECEMERLANGAN KEJURUTERAAN DAN TEKNOLOGI JKR (CREaTE)
Jalan Kemus, Simpang Ampat
78000 Alor Gajah
Melaka, Malaysia

www.createjkr.gov.my
@CREaTEJKR