MyConcrete Volume 12, Issue 5 June 2021

# The Bulletin of the American Concrete Institute – Malaysia Chapter

(e-Bulletin)

# MyConcrete:

## The Bulletin of the American Concrete Institute – Malaysia Chapter

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# CONTENT

# EDITORIAL NOTE

We are happy to present the fifth issue of volume twelve of MyConcrete bulletin. American Concrete Institute – Malaysia Chapter (ACI – Malaysia Chapter) publishes MyConcrete as its official bulletin. The bulletin reports case studies and cutting-edge research on concrete technology on a monthly basis.

This issue of the bulletin publishes three articles, i.e., industry article, technical report, and a case study. The first article focuses on the concrete mix design from an industry perspective. Basic tests of concrete in industrial applications are also mentioned in the article. Next article reports application of ultra-high performance concrete (UHPC) in strengthening concrete structures. Experimental study on concrete slab strengthening using UHPC is reported in the article. The last article reports a case study on Darul Hana Bridge, Kuching-Sarawak. It reports application of advances construction chemicals in the bridge construction.

The editorial team would like to thank the individuals and industries contributed articles for this issue of MyConcrete bulletin. The editorial team would like to invite concrete technologist and engineers to contribute articles for the upcoming issues of MyConcrete bulletin. We also would like to thank UFT Structure RE-Engineering Sdn. Bhd. as a premium sponsor and Adept Technical Services Sdn. Bhd. as a loyal sponsor for this issue. The sponsorship for upcoming issues is also open for the concrete companies. The team hopes to get more sponsorship for the upcoming issues.

Thank you very much. Stay at Home, Stay Safe.

Dr. A. B. M. Amrul Kaish
Editor, MyConcrete Bulletin

# INTRODUCTION TO ACI MALAYSIA CHAPTER

American Concrete Institute - Malaysia Chapter (ACI-Malaysia) is a non-profit technical and educational society representing ACI Global in Malaysia, which is one of the world's leading authorities on concrete technology. Our members are not confined to just engineers; in fact, our invitation is extended to educators, architects, consultants, corporate, contractors, suppliers, and leading experts in concrete related field. The purpose of this Chapter is to further the chartered objectives for which the ACI was organized; to further education and technical practice, scientific investigation, and research by organizing the efforts of its members for a non-profit, public service in gathering, correlating, and disseminating information for the improvement of the design, construction, manufacture, use and maintenance of concrete products and structures. This Chapter is accordingly organized and shall be operated exclusively for educational and scientific purposes.

Objectives of ACI-Malaysia are:

- ACI is a non-profitable technical and educational society formed with the primary intention of providing more in-depth knowledge and information pertaining to the best possible usage of concrete.

- To be a leader and to be recognized as one of Malaysia's top societies specializing in the field of concrete technology by maintaining a high standard of professional and technical ability supported by committee members comprising of educators, professionals and experts.

- Willingness of each individual member/organization to continually share, train and impart his or her experience and knowledge acquired to the benefit of the public at large.

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# NOTICE

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Members who have paid their subscription will receive their digital membership certificate.
See sample below.


# Internship Programme For ACI Student Members

## On the 24th AGM the following members offered internship to ACI Student Members

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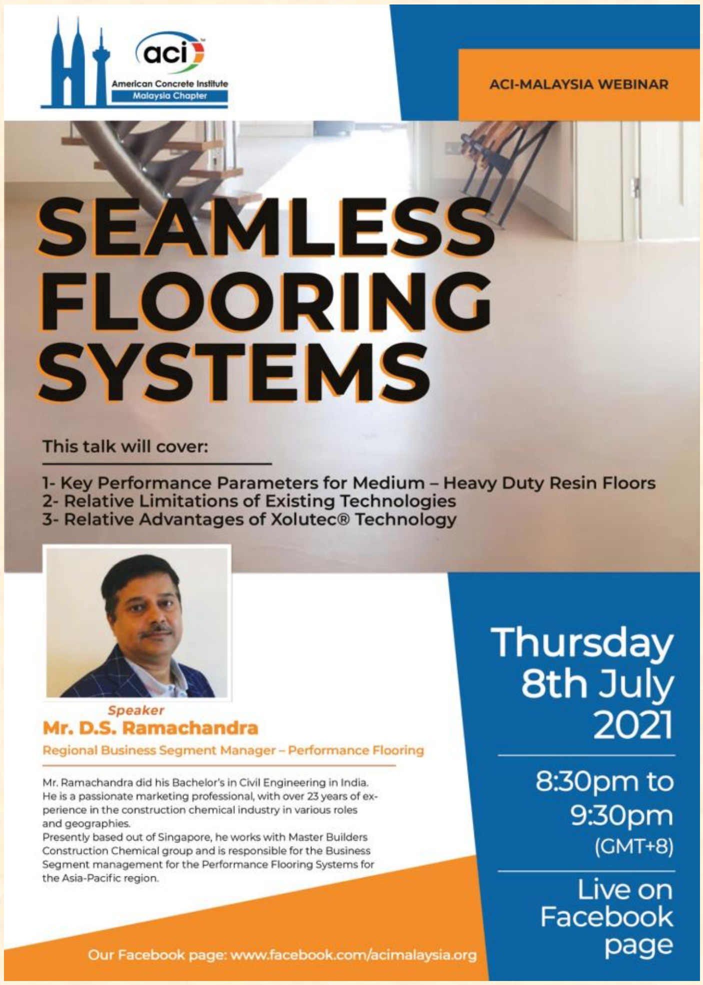
# UP COMING EVENTS

## Free Webinar - The Tech-Talk Hour




## Free Webinar - An Evening with ACI-MY

Speaker: Mr. James Lim / Mr. Smith Yong
Topic: Waterproofing Series EP
Date: July 2021(Date to be announced later)
Time: 8:30pm - 9:00pm

For more info:
www.acimalaysia.org
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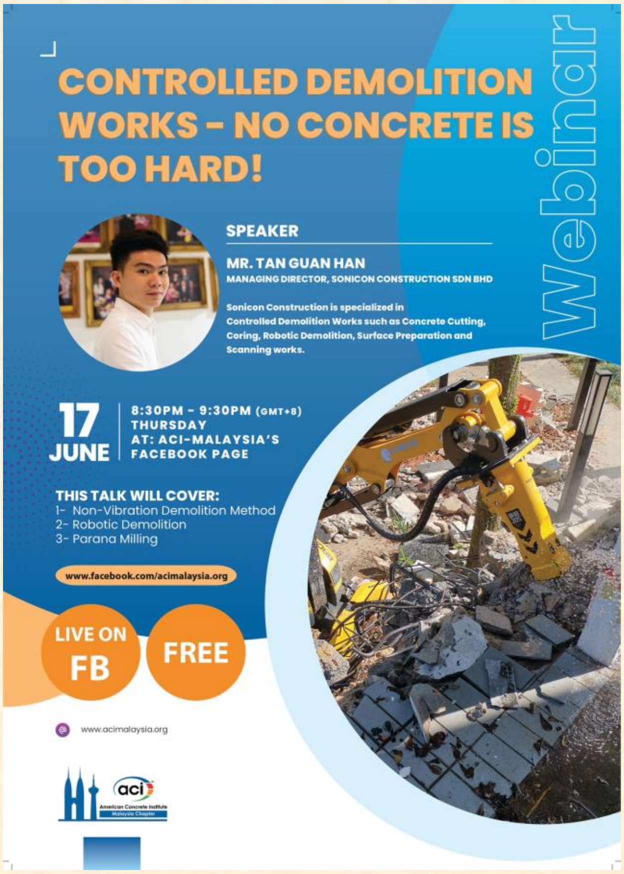
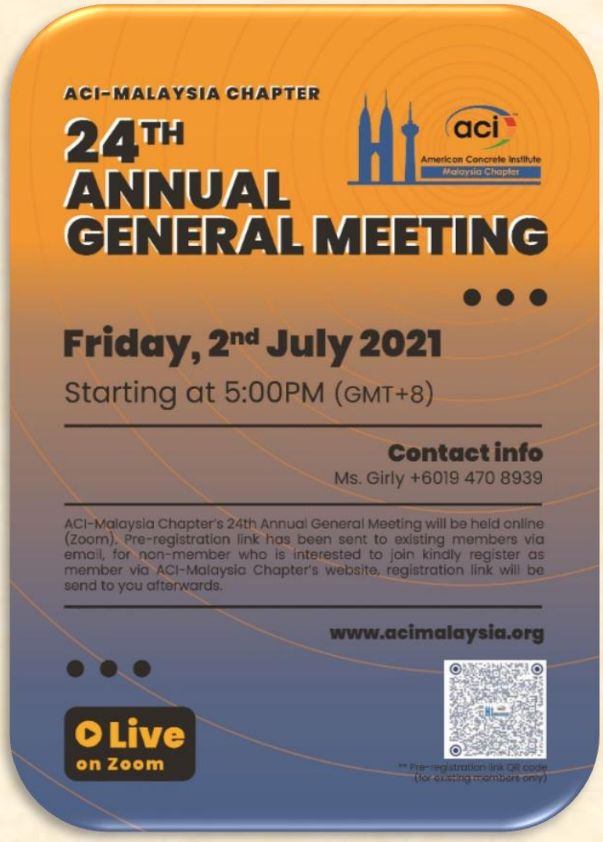
# PRECEDING EVENTS




# PRECEDING EVENTS



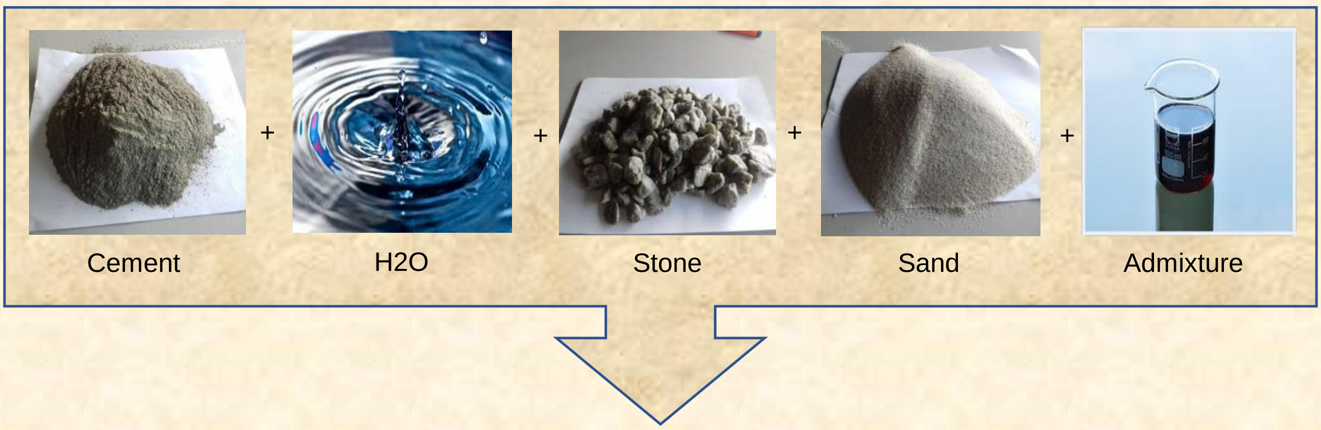

# ARTICLE

## Concrete Technology 101

Written by: Mr. Martin Gerard Joachim David

Concrete is perhaps the most important construction material other than steel for the construction fraternity. It is easy to develop a specific type of concrete at the university laboratory but the story is vastly different when the same concrete is placed at the construction site in a bigger volume. So it is important to understand the different components of concrete and how the different components interact within the concrete mix.

Traditionally, concrete is made of cement (Ordinary Portland Cement – OPC) + Water + Sand (Fine Aggregate) + granite stones (coarse Aggregate). For ready mix concrete, concrete admixtures such as retarder and superplasticiser are normally added to allow for transportation and maintain concrete specification.




Cement (OPC) is the binder or the glue that bonds the fine and coarse aggregates together when both are mixed together.

Water acts as the activator of the cement and help the transportation of the cement in a paste form around the aggregates so that a bond is created between the different ingredients inside the mix.

The sand (fine aggregates) fills the voids in between stones (coarse aggregates). When the cement paste is set and given enough time to cure, concrete in its hardened state is formed.

Concrete before Hardening

Hardened Concrete

For the understanding of concrete enthusiasts, a basic design of concrete mixes is explained below:

First of all, concrete that uses Ordinary Portland Cement (OPC) as the binder, can achieve a design strength of up to 60 N/mm². Beyond this, special additives will have to be added.

Generally, concrete strength starts with grade 15 N/mm². For every increase of 5 N/mm², it is considered one grade higher.

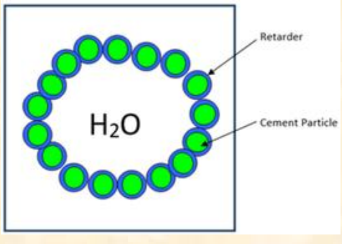
Now certain "Rule of Thumb" needs to be known and they are briefly explain as follow: -
· 10kg/cement 1N/mm²
· Water to cement ratio (WC ratio) not more than 0.5 (unless otherwise prescribed).
· Approximately 20% of cement will not hydrate in the mix and will act as fillers.
· Sand to stone ratio (SA ratio): 0.4 to 0.45
· 1m³ of concrete is about 2400 kg/m³

Assuming a Grade 30N/mm² concrete is required the calculation for the mix per m³ is as follows: -
· Cement 30 x 10 = 300kg/m³
· Added 20% to compensate for the cement not hydrated.
**· Therefore cement content is 360 kg.**
**· Water (wc ratio) is 0.5 x 300kg = 150 kg/m³.**
· The cement and water weight are added to become 510 kg.
· Since 1m3 of concrete weighs around 2400 kg, the weight of the stone + sand is 1,890 kg.
· Now how much sand and how much stone to be used?
· So we use the SA ratio of 0.45. We multiply 0.45 x 1890 kg (sand + stone)
· Therefore sand will be 850.5 kg and stone will be 1039.5 kg.
· In summary the theoretically grade 30 concrete mix will be

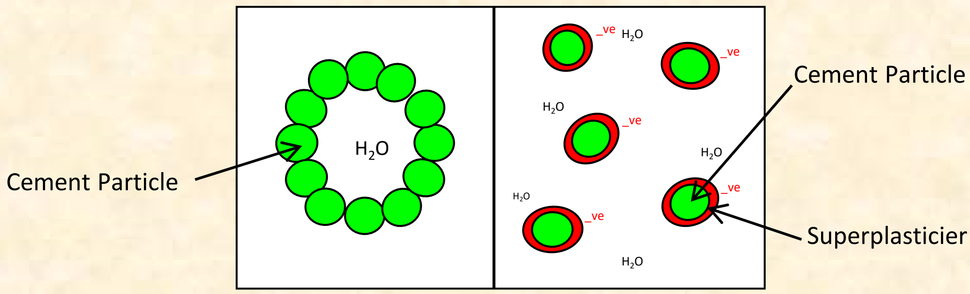
**Cement : 360 kg**
**Water : 180 kg**
**Sand : 850.5 kg**
**Stone: 1039.5 kg**

Now we have to look at the basic admixtures which are retarders and superplasticiser. Without them, commercial supply would be impossible.

Concrete without retarders start to set after 30 minutes once it is mixed and around 1½ to 2 hours for final set. This will make transportation and workability impossible unless the batching plant is located within the construction site. In most cases they are not. So retarders will have to be added into the concrete mix to prolong the initial set to approximately 2 hours and final set approximately 5 to 6 hours. The retarder works by lining the cement particles thereby not allowing the water to activate the cement. After the retarder time has become worn off, it will then allow the water to be in contact with cement and start the activation process. Keeping in mind that overdosing may cause issue with non-setting.



The superplasticiser is mainly acting as a water reducer where by you can maintain workability without increasing water content and compromising on the strength of the concrete. How this works is that the superplasticiser lines the cement particles with a negative charge thereby repelling particles from each other, thus avoiding clumps and releasing trap water in the cement clumps. Water can be reduced by 25% approximately.




**Without Superplasticizer** | **With Superplasticizer**

In today's technology, concrete is produced in automated or semi-automated batching plants. The pictures below give an idea on the production flow.

Controls

Charging

Mixing

The concrete is place by either Direct Pour, Crane Pour or Pumping

Direct Pour

Crane Pour

Pumping

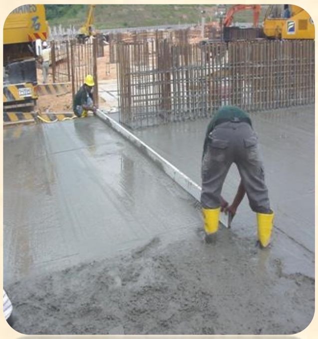
Vibration of Concrete

Once the concrete is place, a poker vibrator is used to vibrate to compact the concrete and to release the air trapped inside the concrete.

In order to work on the concrete, the concrete must not be too wet or too dry.

Too Wet

Too Dry



Workable

In order to check the concrete before placing to ascertain the design slump which indicates it has been produce according to design specification.

A slump check is done.

Cube Test =

*Compressive Test*

This article aims to provide a basic understanding of the concrete mixes. For more specific mix design, a more in depth understanding of concrete and others influencing factors are as important to achieve the intended outcomes. You may consult the professionals.

MyConcrete Volume 12, Issue 5 June 2021

# TECHNICAL REPORT

## *Strengthening Concrete Structures Using Ultra High Perfor111ance Concrete (UHPC)*

**Wee Teo**

**School of Energy, Geoscience, Infrastructure and Society (EGIS), Heriot Watt University Malaysia, Jalan Venna P5/2, Precinct 5, 62200 Putrajaya, Malaysia**

## ABSTRACT

Various UHPC strengthening interventions were conducted in this study to investigate the behaviour of composite reinforced concrete (RC) slabs strengthened with UHPC. The aim of the research is to explore UHPC as patch material for repairing deteriorated concrete structures. The results showed that UHPC safeguard against diagonal cracking compare to conventional RC slab. The UHPC exhibited excellent energy absorption with extensive deflection hardening and ductility during the post cracking range.

### INTRODUCTION

Ultra-high performance concrete (UHPC) is an advancement in concrete technology. It is a mix of reactive powder concrete (RPC) with steel fibres, which was firstly developed by Richard and Cheyrezy [1]. Typically, UHPC offers excellent mechanical characteristics with high compressive strength of from 150 to 200 MPa without heat curing [2]. Because of its superior properties, UHPC is often used in protective structures, as non-penetrable coverings and in elements that must be durable against aggressive environments and severe loadings such as earthquakes, impacts or blasts.

Many researchers have investigated the structural responses of UHPC members. For instance, Graybeal [3] conducted full-scale tests of UHPC bridge girders with different overall spans and shear spans. On the other hand, V oo et al. [ 4] studied the shear, strength of UHPC beams without stirrups. Their results showed that UHPC significantly enhances strength and improves ductile behaviour. Furthermore, Yang et al. [ 5] and Yoo et al. [ 6] reported how the longitudinal steel ratio affects UHPC beams. Their studies demonstrated that the rebar and steel fibres effectively control crack width and ductility.

Recently, UHPC has been considered as a potential material for retrofitting and strengthening concrete structures. Concepts for using UHPC to strengthen parts of structures where the outstanding properties of UHPC could be fully exploited have been proposed by Briihwiler and Denarie [7], as illustrated in Figure 1. To validate the concepts, four unique full-scale site applications were discussed. Their findings were very encouraging. The use of UHPC has shown great potential and UHPC development is mature for use in either cast in-situ or precast applications using conventional standard concreting equipment.

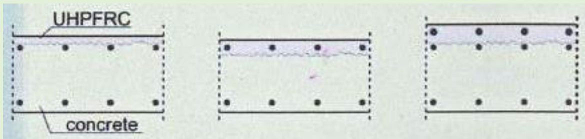



Figure 1: Composite structural elements combining UHPFRC and normal concrete [7]

Oesterlee [8], Habel et al. [9] and Noshiravani and Briihwiler [ 1 OJ evaluated the behaviour of RC members strengthened with UHPC overlays under bending. Their results indicated that UHPC overlays enhance the structural performance in terms of ultimate loads, stiffness and cracking behaviour. Zohrevand et al. [ 11] reported the use of UHPC within critical punching shear area of the RC slabs. It shown that the partial use of UHPC improves the shear capacity and significantly influences cracking patterns in punching shear area compared to the reference RC slab.

Study on the composite UHPC-concrete section are still in its infancy. This article is intended to share summary of the experimental studies carried out by the author on the composite UHPC-concrete slabs. For full extent of the work can be obtained from its original paper [12].

## EXPERIMENTAL INVESTIGATION ON UHPC STRENGTHENING INTERVENTION

To investigate the effectiveness of UHPC strengthening intervention, five rectangular concrete slabs were carried out in this experimental programme. All slabs are 1600 mm long with a clear span of 1200 mm. They were tested under three-point load condition, as shown in Figure 2. Details of crosssectional dimensions and reinforcement of each slabs are shown in Figure 3. All slabs were reinforced with five T 12 mm diameter high tensile steel bars (5T12) at top and bottom. No transverse shear reinforcement was provided, but to avoid anchorage failure at the end supports, three R6 mm diameter mild steel links were installed.

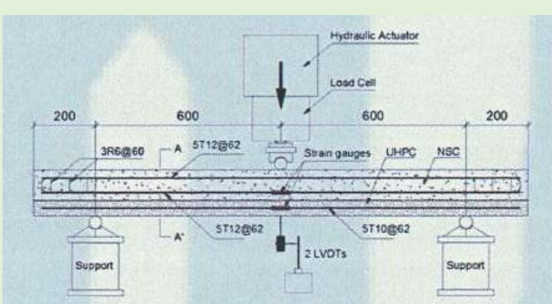



Figure 2: Experimental setup

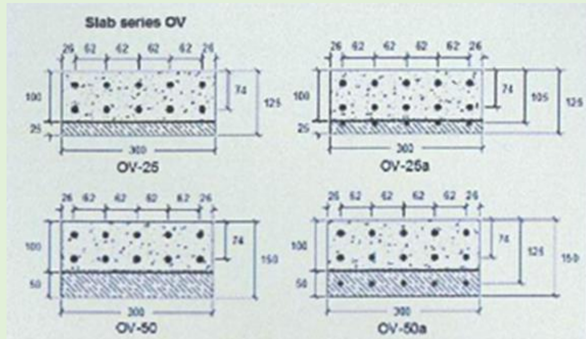



Figure 3: Details of strengthening configuration, sectional dimensions and reinforcement

Five slabs were manufactured, one control and four strengthened specimens, as showed in Figure 3. The strengthening intervention is provided by means of UHPC overlay at the tension zone. Two thicknesses of UHPC overlays were considered, namely 25 mm and 50 mm. Two slab specimens of each overlay thickness were prepared. One without reinforcement and another had five T 10 mm diameter high tensile steel bars as longitudinal reinforcement (5T10).

The average cylinder compressive strength of the normal strength concrete at 28 days was 23 MPa. On the other hand for UHPC was 153 MPa. The full mix proportion and constituents used in this study can be found in [12]. The type of steel fiber used in the UHPC is a straight fiber with 13 mm long and 0.2 mm diameter ( aspect ratio = 65) with average tensile strength of 2300 MPa. After several attempts on different percentages of steel fibers, it was found that 3 % of steel fibers achieved the best performance and was therefore chosen for this study.

## DISCUSSION OF RESULTS

Figure 4 shows the final crack patterns and modes of failure exhibited for each slab in the OV series. Regardless' of UHPC overlay thickness, all the strengthened slabs failed in shear in the normal strength concrete section. Through all loading stages, there were no apparent signs of distress or extensive cracking in the slabs. The UHPC overlay actually helped delay the development of diagonal shear cracks. Once a diagonal shear crack formed, ultimate failure prevailed. In some cases, the composite interface between the UHPC and NSC suffered debonding failure, as clearly indicated in Figure 4.

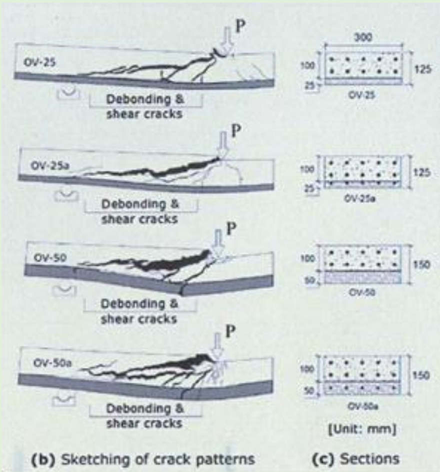



**Figure 4:** Failure modes and crack patterns

**Table 1:** Test results

| Specimens | Ultimate Failure Load, $P_u$ [kN] | Modes of Failure |
|---|---|---|
| RE-0 | 61.08 | Shear |
| OV-25 | 73.47 | Shear |
| OV-25a | 77.97 | Shear |
| OV-50 | 77.97 | Shear |
| OV-50a | 95.06 | Shear |

The ultimate failure loads are summarised in Table 1. Based on our observations, the thickness of the UHPC overlay did not significantly influence the ultimate strength and failure modes underwent. Slabs OV-25 and OV-50 both failed in comparatively similar ways at ultimate loads of73.57 kN and 77.97 kN, respectively, only a 6% marginal difference. This is mainly because ultimate failure in both slabs was controlled by debonding failure at the composite interface. Despite that failure, the ultimate strengths of both slabs were about 24 % higher than that of RE-0. It must also be noted that the tendency for fracture failure in the UHPC layer was higher with thicker overlays, as found in slabs OV-50 and OV-50a.

Experimental results also showed that presence of longitudinal steel bars within the UHPC layer increased the ultimate strength of the slab as long as sufficient cover was provided for effective bond development. Asshown in slab OV-50a achieved an ultimate load of95.06 kN, an increase of22% over that of slab OV-50. On the other hand, the strength of slab OV-25a was only 6% greater than that of OV-25. This is in agreement with the findings of Habel et al. [ 13], the minimum thickness of the UHPC layer is limited by the size of the reinforcing bars and the UHPC cover over them, so that effective force transfer between the reinforcing bars and UHPC can be developed.

The load versus mid-span deflection curves of the slabs in OV series are shown in Figure 5. From the figure, it indicated that with UHPC overlays at the tension zone, the overall stiffness of the strengthened slabs improved significantly compared with reference slab RE-0. Extensive deflection hardening and ductility during the post cracking phase was seen in all strengthened slabs as well. Also the thickness of the UHPC overlay greatly influence the stiffness of the slabs. It was found that thicker UHPC layers lead to increase stiffness, as clearly observed in slabs OV-25 and OV-50. Slab OV-50a with reinforced UHPC layer did not seem to differ from slab OV-50 in initial stiffness. But the reinforcing bars in the UHPC layer helped to extend the ultimate resistance capacity of the slab and lead to lesser deflection.

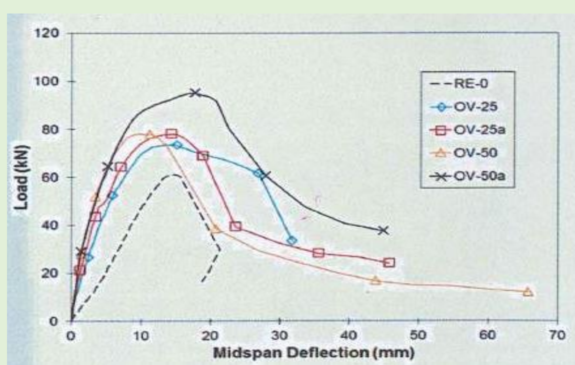



**Figure 5:** Load versus mid-span deflection curves

## CONCLUSION

The results from this preliminary studies showed very promising. It demonstrated the potential of UHPC as an excellent and effective strengthening material for structural application. More research are still needed, especially to develop further understanding on the composite bond interface between UHPC and normal concrete.

The test results indicated that slabs strengthened with UHPC overlays at tension zone failed in shear. It showed diagonal shear cracks in the normal strength concrete section followed by debonding at the UHPC-concrete interface. The results indicated that the UHPC overlay improves the overall stiffness of the slabs and delays the development of shear cracks. With addition of reinforcing rebar in the UHPC layer, further enhancement could be observed in the ultimate strength. However, sufficient concrete cover is required to ensure effective full bond development.

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# CASE STUDY

CONTRIBUTED BY: MAPEI (M) SDN BHD

*Sarawak State is also known as the "Land of the Hornbills" →*

## Darul Hana Bridge, Kuching-Sarawak

### About the Darul Hana Bridge

The **Darul Hana** "Golden Anniversary" **Bridge** Project was awarded in 2013, the 50th anniversary year of Sarawak and Sabah joining in the formation of Malaysia.

The uniquely "S"-curved, 330 m-long pedestrian bridge over the Sarawak River is supported by ables from two 45 m tall and 48o **outward-angled steel towers [ 1 ]** and topped with stylised **hornbills. [ 2 ]**

Two covered **viewing platforms [ 3 ]** provide pedestrians with resting spots and panoramic views across the city's focal heritage points.

The Golden Anniversary Bridge is designed with a 3.25m wide walkway exclusively for pedestrians and wheelchairs for the disabled, with easily manageable gentle gradients.

It will become an integral part of the planned Legacy Park and Halaman Heritage Trail.

## The Project Needs

The bridge is a visually stunning and iconic addition to Kuching's landscape.

The designer wanted a topping for the crossing that was not only functional but also attractive and durable in order to enhance user experience.

The specifications were…

- Aesthetically attractive,
- Anti-slip surface,
- Chemical-resistant,
- Provide protection for walkway concrete panels,
- UV- and weather-resistant, Impose minimal loading on the bridge.

## The Proposed Solutions & Why MAPEI was selected

Various solutions for the topping were proposed by manufacturers. These were…

a) Imprint concrete
b) Pebble wash
c) Epoxy coating system
d) Polyurethane coating system (MAPEI)

The MAPEI solution was selected because we were able to show that it satisfied all the designer's criteria whereas proposals (a) and (b) would have added significant loading on the bridge and there were concerns about UV_x0002_stability for proposal (c).

Golden Bridge-1

## Pictures, before work commencement…

Golden Bridge-20


*Checking substrate conditions*

## Picture, the works…

Golden Bridge-21

*Getting ready to apply* ***Primer SN*** *on the concrete bridge deck*

Golden Bridge-22

After applying **Primer SN**

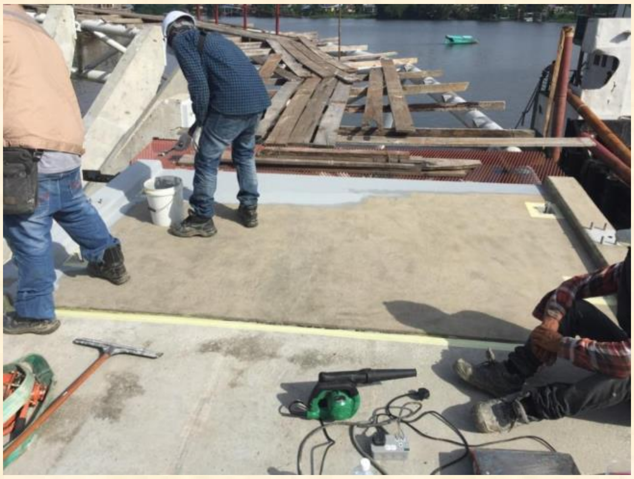
## Picture, the works...

Golden Bridge-23

*Primer SN was mixed with quartz and applied in a scratch coat, and then broadcast with sand to create a non-slip, surface texture*

Golden Bridge-24

Golden Bridge-25



Golden Bridge-26

*Application of the first coat of Mapecoat CF-AP*

Golden Bridge-27

*Coated with Mapecoat CF-AP*

## Picture, the works…

Golden Bridge-28

Golden Bridge-29

*Application of the second coat of **Mapecoat CF-AP***

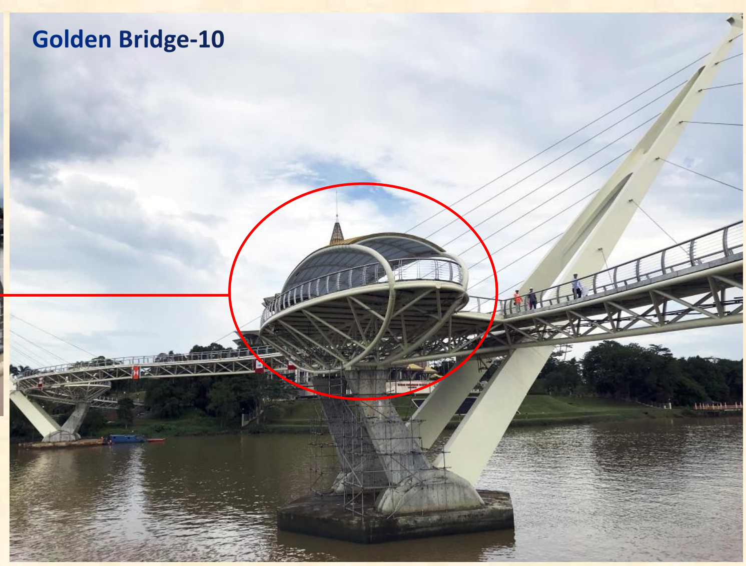
Golden Bridge-30

*Application of **Mapefloor Finish 57** to provide a good abrasion- and chemical- resistant finish*

# Picture, works completed…




*Completed coating works on the bridge deck*


*Completed coating works on the viewing deck*

## Picture, works completed…

*Views of the bridge at sunset*


Golden Bridge-15

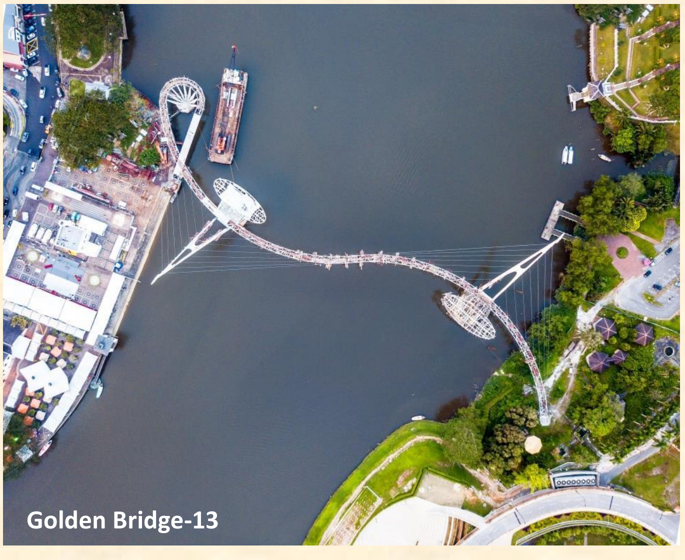

Golden Bridge-14

*The view of the bridge at night-time*


Golden Bridge-17


Golden Bridge-16

*Light changes on the bridge at night-time*


Golden Bridge-13


Golden Bridge-5

*Full view of the bridge after completion*

# MEMBERSHIP


WE ARE A
CARING
ASSOCIATION
Benefits of Joining Us?
Benefit #1
Access to the ACI
Membership Directory
Benefit #2
Digital subscription to
Concrete International Magazine
Benefit #3
Three ACI University
tokens
Benefit #4
Printable ACI
Membership Certificate
We believe a
long lasting business
relationship is built
on friendship.
About Us
America Concrete Institute-Malaysia Chapter (ACI-Malaysia) is a non-profit technical and educational society representing ACI Global in Malaysia, which is one of the world's leading authority in concrete technology.
Our membership is not only limited to engineers, in fact it includes educators, architects, consultants, corporate bodies, contractors, suppliers and experts in cement and concrete related fields.
Contact Us
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Petaling Jaya Commercial City (PJCC)
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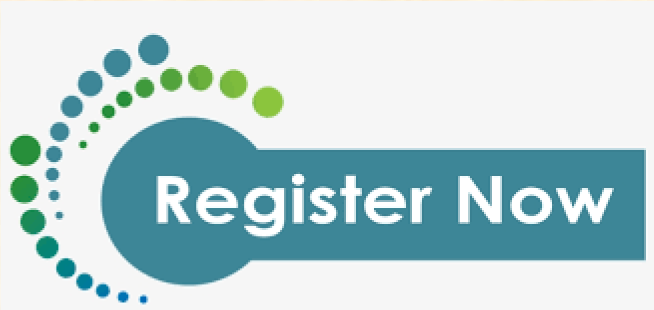
Email: info@acimalaysia.org




We look forward to your kind support and, more importantly, to your participation and registration as a member of ACI-Malaysia Chapter. It is our firm belief your involvement and together with your commitments will go a long way in our quest to uphold all our objectives to mutually benefits for all members.

American Concrete Institute - Malaysia Chapter
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Malaysia.

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Website: **www.acimalaysia.org** eMail: **info@acimalaysia.org**

# Membership Application Form

**Type of Membership (please tick "☑" one option only)**

| | **Joining Fees (Total)(RM)** | (Entrance Fee + | Subscription Fee per annum) |
|---|---|---|---|
| ❒ Organizational Member: | A Firm, Corporation, Society, Government Agency or other organizations. **RM800.00** | (RM500.00 + | RM300.00) |
| ❒ Associate Member: | An individual who is not a member of **ACI International** but American Concrete Institute – Malaysia Chapter only. **RM200.00** | (RM100.00 + | RM100.00) |
| ❒ Student Member: | **RM30.00** | (RM30.00 + | RM0.00) |

To be admitted as a **Chapter Member**(*), return this form together with **Crossed-cheque** (any outstation cheque to include Bank Commission)/ **Online Bank Transfer/ Cash Deposit** made payable to:

Account Holder Name: **American Concrete Institute – Malaysia Chapter**
Bank: **Hong Leong Bank Berhad (HLB)**
Account Number: **291.0002.0936**

*Once payment has been made, it is important to send **Remittance Slip/ Deposit Advice/ Bank Transfer Receipt** to our Administrative Office for confirmation, via these channels:*

WhatsApp: **+60 (14) 2207.138** (*ACI.my Administrative-2*); or
eMail: **admin@acimalaysia.org**

**(*) Benefits** provided by **ACI International** for Chapter Members:
1. Digital subscription to Concrete International magazine;
2. Access to the ACI Membership Directory; and
3. 3-Tokens to ACI University Courses;
4. Printable ACI Membership Certificate

**Important Notes**:
- ❖ Benefits will be accessible via Temporary Password sent to your email account either in the month of **June** or **December**, depend on time slot of **Chapter Member List** update to **ACI International**;
- ❖ All benefits are subject to change without prior notice.

## Personal Particulars:

Are you a Member of **American Concrete Institute International** (ACI International)?
❒ No.
❒ Yes. (Please provide your ACI Int'l Membership Number: ____________ Since (Year): ________ )

Name: ____________ (First) ____________ (Last)
Salutation / Title: ____________ (Mr./ Ms./ Mdm./ Ir./ Ar./ Dr./ Prof./ ) Other: ____________
NRIC/ Passport No: ____________ Nationality: ____________
Mobile Number: +60 (1 ) - ____________ Email: ____________
Company / Organization: ____________ Designation: ____________
Postal Address: ____________
____________
Postal code: ____________ State: ____________
Tel.: ____________ Fax: ____________ Email: ____________
I am introduced to ACI-Malaysia Chapter by: ____________

............................................ Applicant Signature
.................................... Date

***For Office Use Only***

Membership No: [ | - | | | | ] Receipt No.: ____________ Date: ____________
Verified by: ____________ (Name: ____________ ) Date: ____________

❒ NF/ RF ❒ PoP ❒ DB ❒ MRR ❒ GgIC ❒ RvnT ❒ InvT ❒ I&R ❒ MF/PoP/I&R-F

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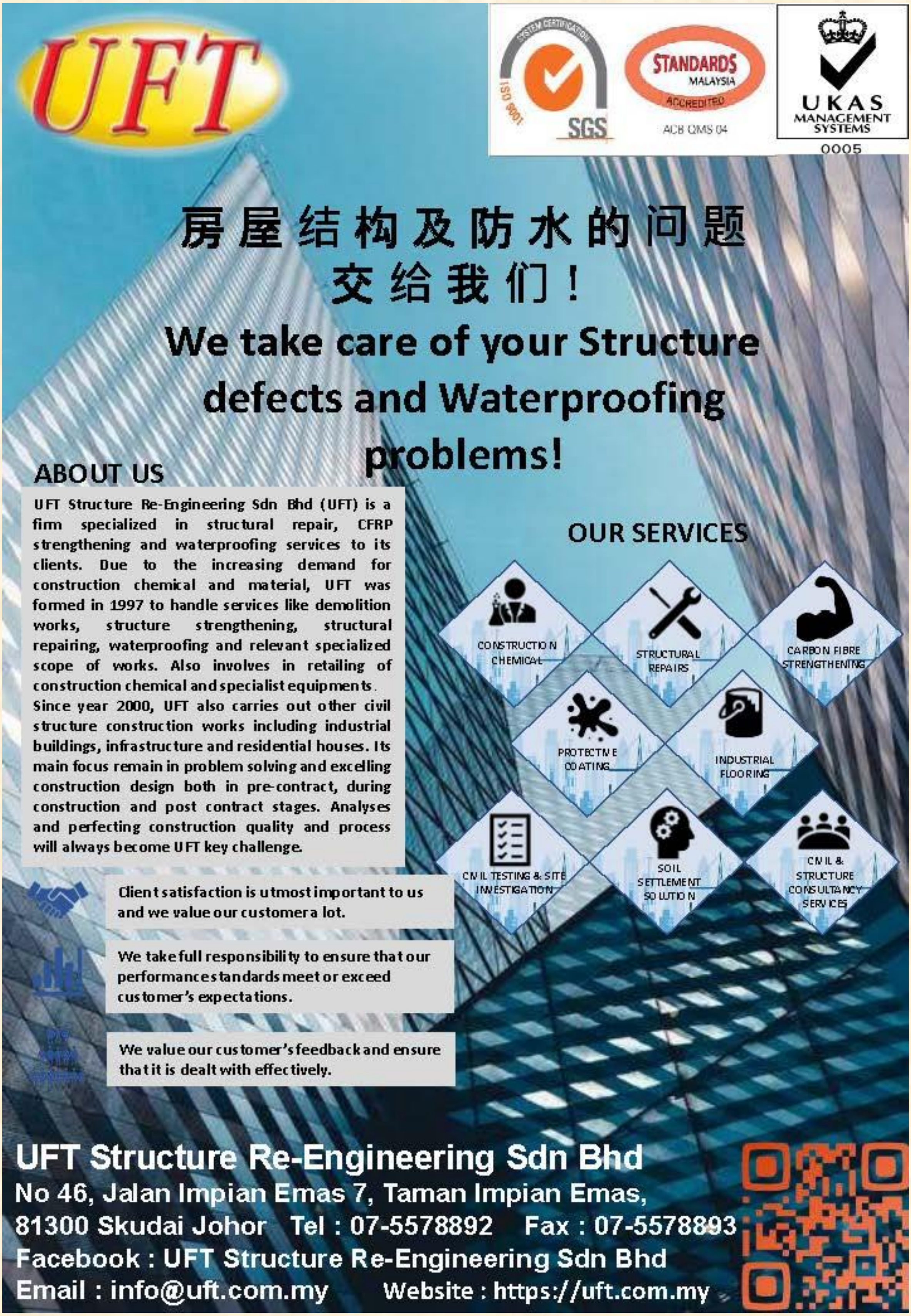

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