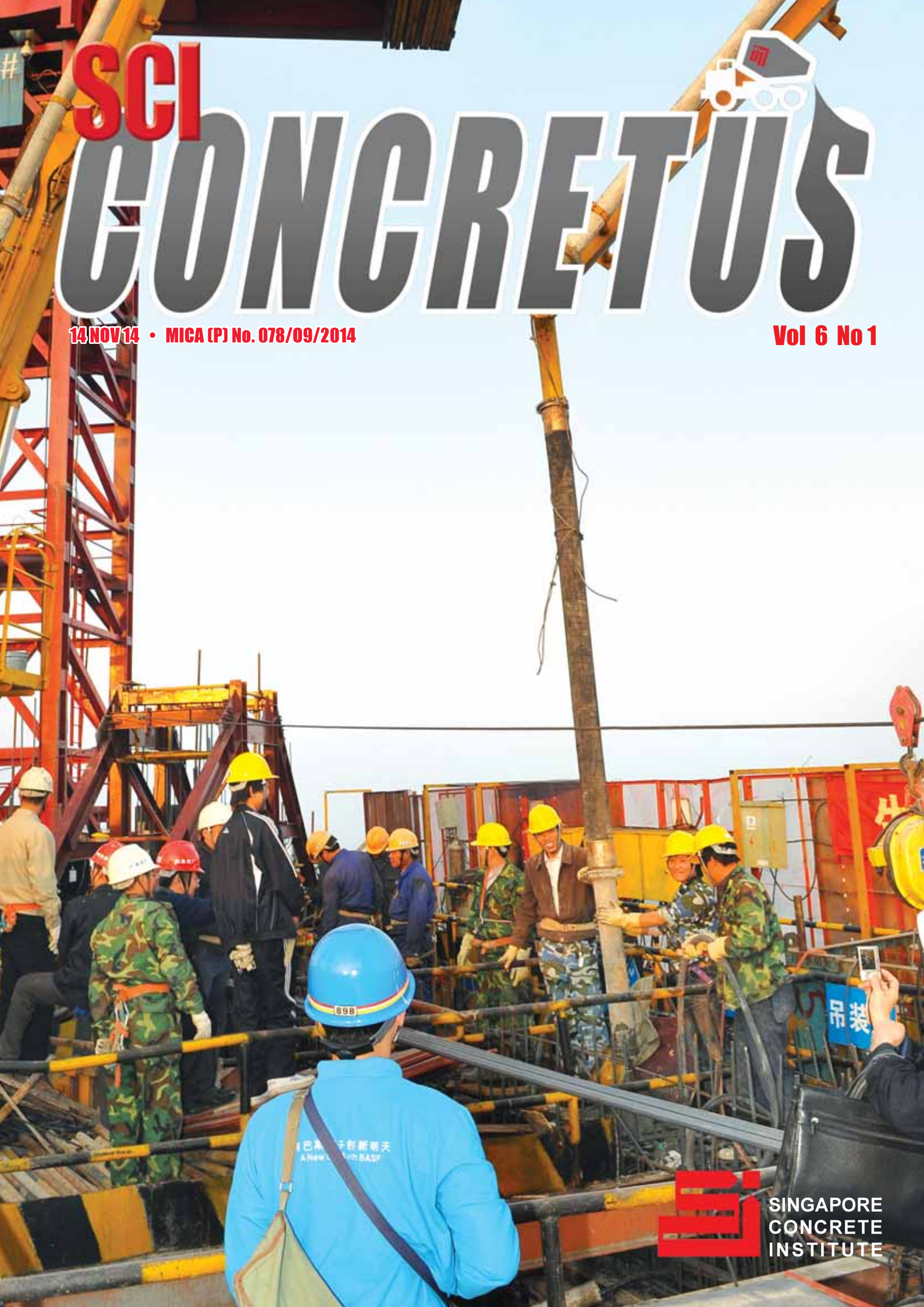

SCI CONCRETUS

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Vol 6 No 1

SINGAPORE CONCRETE INSTITUTE

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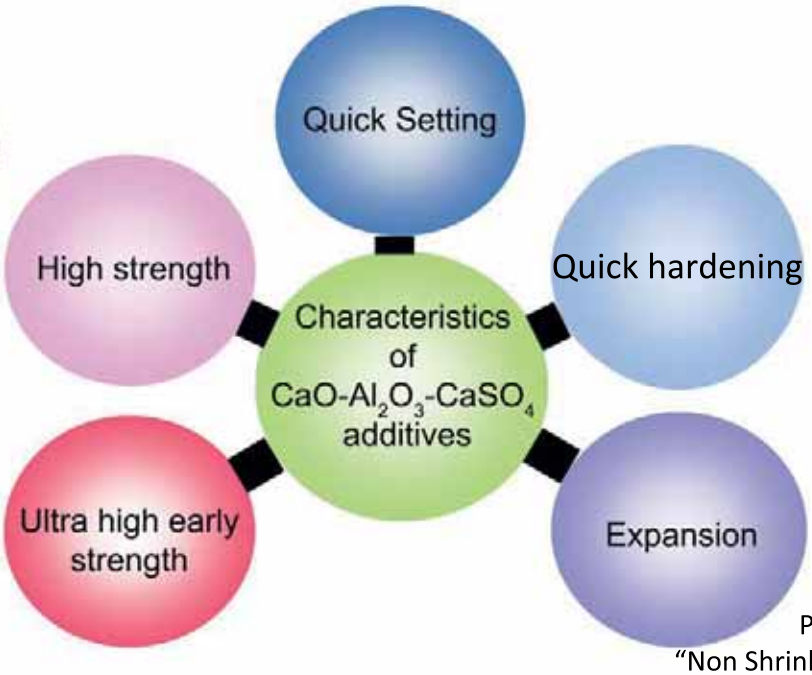
"Shotcrete accelerator"

Sigma Series
"High Strength Additives"



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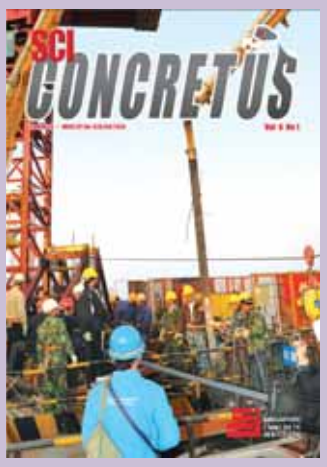

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President's Message

In conjunction with our 36th Anniversary Celebration of Singapore Concrete Institute this year, the publication of the seventh issue of the Concretus reflects importance of enhancing productivity in construction.

The theme of this year's celebration, "Enhancing Productivity in Construction" is to reinforce the importance of productivity and quality of construction. The concern of all stakeholders in the construction industry is well reflected in current issue of SCI Concretus.

Our readers should find these articles a timely update on the various developments to address the need for enhancement in productivity.

The SCI Excellence Awards 2014 to HDB for "A catalyst solution to transform the industry toward high productivity – HDB's New Generation Precast Floor System and Joint Connection for Higher Production and Construction Productivity", to Pan united concrete for "Largest Concrete Pour in Singapore using SCC for Tanjong Pagar Centre Raft Foundation" and to HDB for "Re-engineered Public Housing Design Approach iR2 for Greater Construction Productivity" are in-line with our emphasis for greater productivity in construction. The SCI Waterproofing Excellence Award 2014 is awarded to Maxiseal Pte Ltd to assure the continuous innovation and improvement of construction quality in Singapore.

On behalf of the SCI Board of Directors, I would like to thank all our sponsors, SCI members, partners and supporters for the continuous support in providing generous financial contributions and technical knowledge towards the publication of Concretus. We look forward to your continuous support in making the Concretus a useful resource for the benefits of all our esteemed readers.

Thank you.

Er Koh Beng Thong
President

Singapore Concrete Institute
14 November 2014

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IF CONCRETE CAN SPEAK - NOW IS THE HOUR…

Dr Tam Chat Tim (ceetamct@nus.edu.sg)
Associate Professorial Fellow
Department of Civil & Environmental Engineering
National University of Singapore

The lyrics of the well known NZ folk song, once sung by Frank Sinatra, "Now is the hour when we must say goodbye" and for me (concrete), the current concrete specification. BCA has notified stakeholders that the new approach based on EN standard only will be accepted as from 1 April 2015.

The way I, concrete, has been specified for the past decades is more prescriptive than in terms of performance. Often, the prescriptive criteria do not enable all the desired performance, expected of me (concrete), to be achieved. The reason for me to be so specified arises from the way me (concrete), has been used in construction being historically derived from expertise and experience of builders and designers before design codes and testing standards were developed. Allow me to briefly recall my family tree in recent years – concrete as a building material.

In UK, my current status was first codified in the D.S.I.R. Code of 1934, later as BS 114, Code of Practice for Reinforced Concrete in 1948. It was only in 1972, when CP 110 introduced the concept of limit state design for my role in concrete structures. This was followed subsequently by an update as BS 8110 in 1985. It also led to a separate British Standard for the way I am to be specified, which is BS 5328: 1981, Methods for specifying concrete, including ready-mixed concrete. For the next 30+ years, there was no major change in the way I am specified until the arrival of EN standards. Currently in Singapore my role in concrete design code is CP 65 (based on BS 8110) and SS 289 (based on BS 5328). They will both be replaced by SS EN 1992 together with SS EN 206 and SS 544 (based on BS 8500) and the new EN standards on constituent materials and testing methods, some of these are similar to existing SS and others are new standards for which there is no current equivalent. All these standards will form the basis for the way I (concrete) have to be specified, assessed and verified for conformity to the relevant standards. A much more performance-based approach is adopted in the new standards. Some new features include the adoption of a single standard for all common cements (SS EN 197-1), used of recycled concrete aggregates and reclaimed water for concrete production (SS EN 12620), and high consistence classes as SCC (SS EN 206). The range of my cube compressive strength has been raised to 105 MPa. Hence, I shall need to have more than the current limit of cement content to 550 kg/m3 in order to reach current upper strength level of 60 MPa.

The arrival of engineered chemical admixtures (SS EN 934-2) has opened up many venues for innovative ways for me to achieve high performance in strength, consistence and durability. With the wide range of cementitious materials and new admixtures available, only performance approach in specifying how I should perform provides the most cost effective designed concrete. Hence specifiers will need to have a sound knowledge of the range of constituent materials and their capabilities to provide the type of performance required, the method of conformity assessment and the acceptance criteria taking into consideration measurement uncertainties in testing. Most requirements are in terms of characteristic value for which single test result serves at best, as an identity check for conformity.

Now is the time not only to say goodbye to the current ways of specifying me (concrete), it is also time to bring all stakeholders up-to-date to the changes and new developments in materials technology. The way to assess me in terms of conformity to strength has to change as my performance in terms of strength is subject to third party certification. Site sampling is now under the provision of identity testing for conformity. Any doubt on my in-situ strength can now be clearly assessed by core testing with or without NDT data under SS EN 13791 and SS 592 (based on BS 6089: 2010), Assessment of in-situ compressive strength in structures and precast concrete components – complimentary guidance to that given in SS EN 13791.

I am looking forward to my new world of concrete specification which will provide opportunities of innovative approaches to meet the new challenges of future concrete construction. Let us all join hand to bring about a better world of concrete for sustainable infra-structure development.

Chart 1 - Concrete Related Standards

Concrete structure

Standards for precast concrete products

Design standard

SS EN 1992 (Eurocode 2)
Design of concrete structures
(see Chart 2)

Execution standard

EN 13670 [2]
Execution of concrete structures

Assessment of structures

SS EN 13791
Assessment of concrete strength in structures

[1] **EN 12504**
Testing concrete in structures

Materials and Product standards

SS EN 206-1
Concrete
SS 544
Concrete - Guidance for specifiers and producers

SS EN 197
Cement
SS EN 15167
Ground granulated blast furnace slag

SS EN 934-2
Admixtures for concrete

SS EN 12620 (Amd 1:2009)
Aggregates for concrete

EN 13055-1
Light-weight aggregates

EN 450
Fly ash for concrete

EN 13263
Silica fume for concrete

[1] **EN 1008**
Mixing water for concrete

EN 12878
Pigments

[1] Test standards

EN 12350
Testing fresh concrete
EN 12390
Testing hardened concrete

EN 196
Testing cement

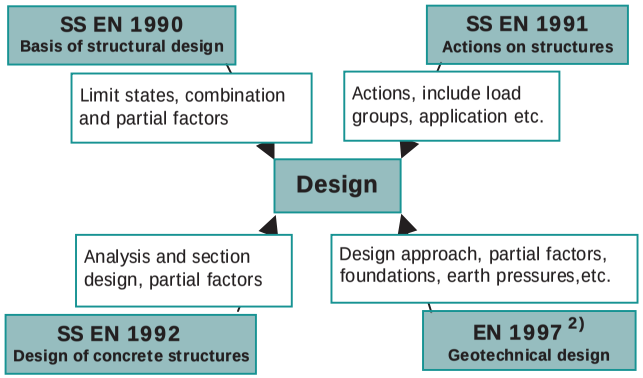
EN 480
Testing admixtures

Testing aggregates

EN 932	General properties
EN 933	Geometrical properties
EN 1097	Mechanical and physical properties
EN 1367	Thermal and weathering properties
EN 1744	Chemical properties
ISO 565	Test sieves
Others:	Petrographic examination, Testing ASR, ACR, etc:

ASTM C (295, 586, 1105, 1260, 1293)
BS (812 Parts 104, 123, 7943)
SS 73 Part 17 Appendices A & B
Rapid test methods for chloride content

Chart 2 - Eurocodes Required for Concrete Design



NOTES –

For the design and construction of building structures, the SS / EN Eurocodes are to be used in combination with execution, material, product and test standards.

[1] The test methods listed above have been reviewed for their suitability to be adopted for use in Singapore. Local users are advised to refer to these EN / ASTM / BS directly. See Guidance on Singapore testing temperature in the relevant SS EN.

[2] SS EN in preparation

APPLICATION OF DENKI KAGAKU KOGYO TECHNOLOGY FOR THE CONTROL OF ETTRINGITE FORMATION IN CONCRETE

Leon Poh, Irfan UL Haque, Koji Okuyama

1. Introduction

Denki Kagaku Kogyo (DENKA), a Japanese Chemical Company was established in Japan in 1915. The company embarked on cement production in 1954. In 1968, DENKA commercialized the first expansive additive for cement. Calcium Sulfoaluminate(CSA) is essentially based on K-type cement concept in the American Society for Testing and Materials ASTM C845/C815M-12.

Outline of Oumi Plant

Mine of limestone

Since 1980, DENKA has been producing rapid hardening additives based on Amorphous Calcium Aluminate (ACA). Denka also possesses a state-of-the-art technology to control setting and hardening of ACA. Due to its excellent characteristics, CSA and ACA have been used worldwide especially in Japan and Europe, as raw materials for premixed dry mortars for various applcations. In view of shrinkage compensation characteristics, CSA is used as an additive for ready mixed concrete cast on site.[1),2),3)]

DENKA currently has the technology to effectively control ettringite formation. In addition, Denka's technology can also be used for various purposes, such as shortening of construction work, improving concrete quality and durability of concrete structures.

The applications of CSA and ACA in Japan are as follows:

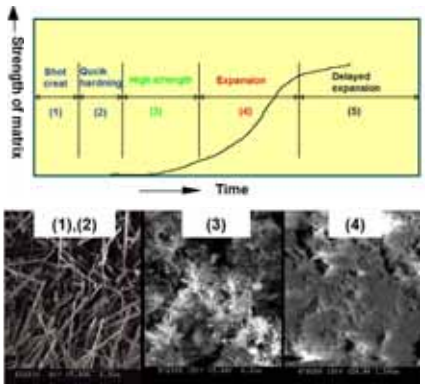


Figure.1 Formation of Ettringite

2. Calcium Sulfoaluminate - Expansive Additive (CSA)

2.1 Description[4),5)]

During cement hydration, generally there are two methods to compensate for volume shrinkage. One is a foaming agent, which affects the volume of the cement-hardening body which compensates shrinkage. This is due to the hydration of cementitious materials which causes foaming in cement, such as aluminum and carbonate foaming. This process may have certain risks such as hydrogen embrittlement, the destruction of steel materials and carbon monoxide or dioxide poisoning. However, this depends largely on the extent of hydrogen and carbon dioxide formation in the foam.

Injection of quick hardening non shrink grout

The other is CSA, an expansive additive, which uses only available water in mix proportion for hydration. This results in the formation of ettringite hydrate after the mixing process. Relatively few adverse effects occur after hardening because the

Mixing and injection of quick hardening non shirink grout

Apparent condition of installation of mold

Reconstruction of pier (Tōhoku earthquake and tsunami)

Water treatment plant

Concrete slab in bridge

ettringite is similar to the reaction of calcium aluminate and gypsum in ordinary cement. With the addition of a suitable dosage to the cementitious binder, the CSA system will effectively reduce dry shrinkage. CSA can also be used for pre-cast concrete products by the addition of a higher dosage to induce chemical pre-stressing.

Concrete railway

2.2 Applications

CSA is commonly used as an additive for premixed dry mortar to reduce dry shrinkage and for aesthetic improvements of the cementitious structure and keep its formation rigid.

As an additive, CSA is used directly in ready-mixed concrete for dry shrinkage reduction, and in other concrete products for chemical pre-stressing. By inducing chemical pre-stressing (or higher compressive strength) for pre-cast concrete products does make it possible for producers to design products with less thickness of members.[6] The Japan Society of Civil Engineers Concrete Standard Specifications lays down a standardized protocol for the use of expansive additive for high durability concrete structures[7]. Specially processed CSA is also used as an effective application to shorten the time for demolding.

3. Quick-Hardening Material

3.1 Description

Calcium Aluminate (CA) such as alumina cement is known for its superior hardening properties. However, since the hydrate forms after hardening, it becomes metastable resulting in the combined water detaching itself from the hydrate over a period of time. This in turn results in a hardened body making it porous in the process[8]. The compressive strength of the material decreases subsequently after some time especially under high temperature. Denka's processed amorphous calcium aluminate (ACA) can be used to maintain a long-term stable hydrate as compared to CA, forming ettringite as a hydrate after the hardening process. Based on this evidence, there are no deterioration on compressive strength as well as durability of the product.

3.2 Applications

Typical applications for processed ACA are the construction of roadbeds, railroads and manholes when time for repairing work is limited[9]. Conventionally, Aluminum Cement (AC) base or epoxy-resin grout materials has been commonly used for repair and maintenance works. However, generally AC's compressive strength may decrease over a period of time.

Other examples are expansion and contraction joints of bridges and potholes, and the construction of overlays such as the reinforcement of top surfaces by increasing its cover thickness. In Japan, because

Box culvert

of heavier vehicle weight, some of the existing bridges do not satisfy the current design requirements, thus, this results in excessive damage to the bridges. Because of these factors, there is a need to carry out first cycle maintenance work to shorten traffic suspension period. In this view, ultra-rapid hardening concrete to achieve 24 N/mm^2 in 3 hours is being standardised[10].

4. Shotcrete Accelerator

4.1 Description

Accelerators are materials that quicken cement hydration significantly resulting in rapid setting time. DENKA's accelerators result in a final setting time in the range of tens of seconds to 10 minutes and are used mainly for stopping ingress water from structures and for spraying concrete when rapid setting time and high initial strength are required, including a high compressive strength and long-term durability[11),12),13)].

Hume pipes

4.2 Applications

Japan's geological features are different from other regions and are more complex in nature. Furthermore, the required properties on shotcrete are high because of ambient weather conditions such as high temperatures in summer and the low in winter. As Denka's accelerator hardens and develops strength rapidly, it is highly suited for all weather conditions. In view of these factors, our processed ACA basis accelerator (powder form) dominates the market in Japan.

Repairing for the apron

Repairing for the bridge, expansive joint

5. Summary

At DENKA, we are constantly striving to serve the discerning needs of the construction industry through the use of our applied technologies and leading edge solutions. We will continue to spare no effort to serve the varied requirements of the construction industry especially in the demand for shortening the construction cycle and improving overall concrete quality. In line with this, DENKA Infrastructure Technologies Pte Ltd was established as a subsidiary of DENKA Chemical Holdings Asia Pacific Pte Ltd in Singapore in 2014[14] and a fully equipped laboratory was established in Johor, Malaysia in 2014.

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Ascent Facilities Engineering Pte Ltd

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- Structural Steel Corrosion
- Building Materials Evaluation
- Performance Specification
- Evaluation of Mock-ups
- Material Durability Assessment

Areas of Application

- Structural Surveys
- Defect Assessment
- Remedial Recommendations
- Prediction of Time to Corrosion
- Life Cycle Costing
- Due Diligence Audits
- Project Management Services

Our Clients

Our Clients include Developers, Facility Owners, Contractors, Trusts Managers from the Building and Infrastructure, Pharmaceutical and Oil & Gas Industries

Introduction

Formed in 2004, Ascent Facilities Engineering Pte Ltd offers an integrated consultancy service in advising the performance of building materials, structures and facilities. Our capabilities stem from knowledge and experience covering 22 years of practical and professional experience uniquely from overseas and local projects. Both directors are ex-staff of Taywood Engineering Ltd, internationally recognized amongst UK consultants in providing engineering consultancy services related structural surveys, diagnosis and retrofitting

Services

We assess the current condition and future performance of commercial and residential buildings, civil structures and industrial facilities.

- **Durability Investigations for Concrete Structures:** The causes of reinforcement corrosion may be due to agents like chloride and carbonation. Reinforced concrete can also come under attack by chemicals having high acidity. It can breakdown due to the presence of reactive aggregates (Alkali-Aggregate-Reaction and Alkali-Silica-Reaction) and cracking of concrete can occur through high thermal differentials and restraints arising from casting of concrete.
- **Corrosion Investigations for Steel Structures:** We evaluate the causes of corrosion on steel structures due to exposure to harsh environmental condition during its service life. Many of these structures therefore start to corrode due to the breakdown of the protective paint layer resulting in galvanic corrosion taking place.
- **Building Facade Condition Audits and Investigations:** Curtain

Company Profile

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• www.ascentfe.com •Email: admin@ascentfe.com

wall and other façade systems deteriorate during their service life. We investigate the problems such as seepage, delaminations of finishes, loosening of façade components associated with the building facades and often find that such problems could be the result of expiring of service life, wrong detailing, poor workmanship, bi-metallic corrosion from two different metals.

- **Prediction of Time to Corrosion and Life Cycle Costing:** The data obtained from our field investigations are used in computer models to predict the time to corrosion. This information is useful for planning the maintenance schedule and allows the asset manager to set aside budgets for active maintenance of the structure, rather than wait for defects to surface. In many instances, when defects surface, the rate of deterioration often spiral exponentially. Repairs become costly at this stage. The prediction of time to corrosion therefore helps the asset manager to prepare a cost-effective life cycle cost for his structure.
- **Specification and Repair Proposals:** We determine the causes and recommend ways to prevent the problems from worsening. Many repair methods are available in the industry from structural strengthening to cathodic protection systems and we propose repair proposals based on the knowledge of the current condition and life expectancy required.

We have successfully completed many projects on the above and welcome you to visit our website at www.ascentfe.com where you may download a range of our project profiles for your information.

Ascent Facilities Engineering Pte Ltd have carried out projects in Singapore, Peoples' Republic of China and Seychelles Island.

Our Directors have participated in Conferences as speakers in:

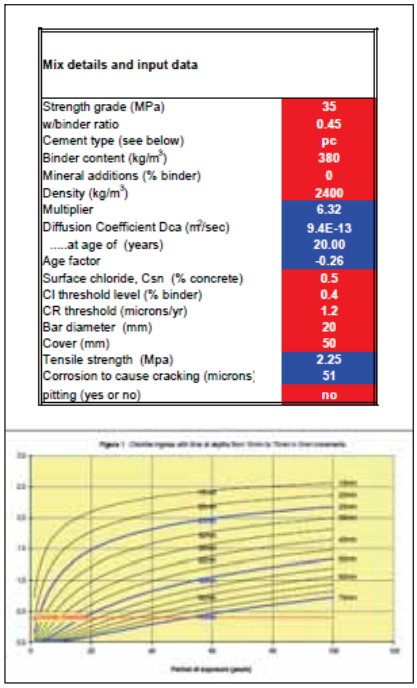
- 3rd Asian Concrete Federation (ACF) International Conference on Sustainable Construction, 2008 - Vietnam
- 10th Annual Conference on Inspection, Appraisal, Repairs and Maintenance of Structures, 2006 – Hong Kong (Recipient of Highly Commendable Paper AWARD 2006)

Collective Experience

Prediction of Time to Corrosion for Reinforced Concrete Structures

Modeling of the Time to Corrosion is done through the use of computer software programmes

Example of Application of Computer Models



Field data such as concrete strength, reinforcement cover, bar size, surface chloride content, chloride threshold level are used.

Durability investigation of Jetty and prepare Life Cycle Costs using different Remedial Methods

Evaluation of causes of spalling concrete problems, proposing remedial options and estimating of life-cycle-costs for maintenance for high value structures such as jetties and tunnels

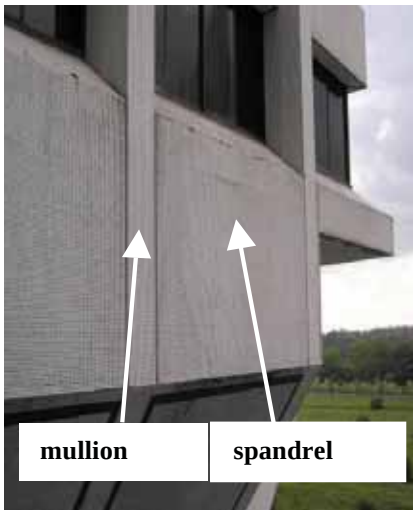
Half Cell Potential measurement and other tests can be used for the durability investigation. Using different options of repairs, the initial capital costs and subsequent cyclical costs over the service life can be estimated.

Life-Cycle-Cost studies allows the Client to choose between different remedial options vs costs. Some options may involve higher initial capital cost but the overall total cost may be lower over the service life of the structure

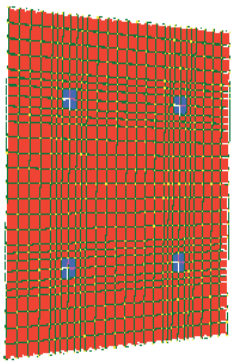
Repair Recommendations are validated Quantitatively using Finite Element Analysis Programme

Evaluation of a façade repair system using cementitious materials with anchor pins and fabric mesh

Material	Properties
Anchor with epoxy resin	Pull-out load for 30 mm embedment (when grouted with epoxy resin) : **2500 N** (before applying the recommended safety factor of 4) Tensile load for 30 mm embedment (when grouted with epoxy resin) : **1770 N** (before applying the recommended safety factor of 4) Spacing of anchors : **600 mm**
Fibreglass Mesh	Thickness : **2 mm** Density : **15.7 kN/m^3** Maximum Tensile Stress : **1.85 N/mm^2** Maximum Strain : **5%**
Cementitious Binder	Thickness : **3 mm** on either side of the mesh Density : **24.0 kN/m^3** Maximum Tensile Stress : **2.8 N/mm^2** Maximum Compressive Stress : **25.0 N/mm^2**



View of precast spandrel and mullion



Snapshot of model of repair system of repair system

The proposed façade repair system is checked for suction, shear and deflection against service loads such as wind and temperature

Based on the designed repair system of anchors, mesh and cementitious repairs, the proposed façade repair system (right) is checked for suction, shear and deflection against service loads such as self-weight, wind and temperature

Third Party Investigation on Problems affecting Concrete Structures

The effects of crack lines are often a cause of concern to all parties in a construction project. Investigation is called for an independent assessment on the cause and rectification.

Cracks on Newly Cast Concrete

Evaluation of the impact of crack lines on the strength of concrete and durability implications

Repair Proposals and Specifications

We have designed, specified and supervised numerous repair projects employing corrosion protection, injection and patch repair methods

Reinforcement Corrosion on Existing Concrete

The specification of corrosion repairs using sacrificial anodes for a reinforced concrete tunnel

Specialists Consultancy on Appraisals of Existing Building Facades

Increasingly, the importance of durability and safety in the maintenance of building facades are evident as many owners now include such appraisals as part of their maintenance programme

Inspection and retrofitting of existing curtain wall and stone/tile cladded facades

Typical defects noted including the loosening of aluminium finishes

Condition investigations and repair proposals of construction defects in concrete in Energy Power Station in Indonesia, pharmaceutical facilities and buildings in Singapore.

Inspection of steel pipe rack and platforms for corrosion and proposal of remediation measures

Inspection revealed corrosion treatment and replacement of some I beams required

Technical due diligence audits and life-cycle-costs study for various buildings prior to acquisition

Audits on buildings were carried to inform Clients on non-compliance issues, defects and actions for consideration. Life-Cycle-Cost Studies on the building, mechanical and electrical systems were carried out over a 25 year period.

Condition audits and compliance to building codes on facilities

Extent of audits cover the structural, architectural, fire, mechanical & electrical systems of the assets

proceq

silver schmidt

For decades, Proceq's Original Schmidt Concrete Test Hammer has been the industry standard for a rapid assessment of the condition of a concrete structure. Test objects to which this method is applied may range from freshly prepared test cubes to historical wall segments. Now, Proceq has taken a significant step forward by launching a hammer that is even more accurate and user-friendly. Independent testing at the renowned Federal Institute for Materials Research and Testing, BAM Berlin (Bundesanstalt für Materialforschung und –prüfung, Germany) has confirmed that the SilverSchmidt has less dispersion than all of its predecessors over the entire compressive strength range.

Below is a summary of the benefits of the SilverSchmidt Concrete Test Hammer:
- **Ergonomics:** The SilverSchmidt body lies very comfortably in the hand. The display is highly readable under any conditions.
- **Robustness:** A two-layer seal prevents dust and dirt from penetrating to the interior of the instrument.
- **Impact direction independence:** The forward and the rebound velocity of the hammer mass are both measured in close proximity to the point of impact. The rebound value requires no angular correction.
- **Measurement accuracy and repeatability:** The new measurement principle and the redesign of the mechanics enable the SilverSchmidt to outperform its predecessors.
- **Objective evaluation:** A larger number of measurement points can be easily collected by the instrument and automatically evaluated according to statistical criteria.
- **PC connection:** The application "Hammerlink" allows all data to be uploaded via USB (PC version only). Firmware upgrades are also possible over this connection.

Proceq is confident that the SilverSchmidt hammers will become the new industry standard, just like their Original Schmidt Hammer has been for the last 50 years.

DY-2 FAMILY
PULL-OFF TESTING

Pull-off testing is one of the most widely used test methods in the construction industry. It is indispensable for the diagnosis of structural damage to buildings as well as for checking complete renovation work. Proceq announces an expansion to its existing Dyna pull-off tester portfolio with the DY-2 Family (DY-206, DY-216 and DY-225), a new generation of automated pull-off tester.

Complete range of applications covered

The three models of the DY-2 Family differentiate by a maximum pulling force. While DY-216 (15.5 kN, 3485 lbf) is covering most applications, DY-206 (6 kN, 1349 lbf) has an increased accuracy for low strength applications such as testing adhesive strength of mortars and renders. DY-225 (25 kN, 5620 lbf) can be used for very high strength applications such as testing of fibre reinforced polymers bonded to concrete structures or testing the bond strength of repair and overlay materials.

Constant load rate

One of the major influences on the result of a pull-off test is the operator influence in the application of a constant load rate. The newly introduced DY-2 models with their integrated, feedback controlled motors remove this variable completely, by providing a fully automated test at a constant load rate which can be verified.

Unique in parameter setting

The DY-2 is further unique in that it records every single test parameter required by the specification: Time and date of the test, test disc size, maximum load applied, automatic calculation of bond strength, applied load rate with graphical record, complete time of test as well as the failure mode.

For the very first time, the operator is able to provide a complete record of the pull-off test, proving that the test was carried out in accordance with the applicable standard.

CONSTRUCTION

made in switzerland

www.proceq.com

Our businesses

The Group operates three core businesses:

- Basic Building Resources
- Port & Logistics management, and
- Shipping

PAN-UNITED CORPORATION LTD

From the Founder's foresight in starting Hiap Soon to his bold expansionary moves in the marine sector and later the unprecedented venture to build a Chinese port, Pan-United Corporation is today a listed Asian giant. Its businesses now spread across five countries: Singapore (the Headquarters), Malaysia, Indonesia, Vietnam and China.

Basic Building Resources (BBR)

The Basic Building Resources (BBR) division was formed in 1994 to supply basic building resources to the Singapore construction industry.

The BBR division, one of Asia's top five companies, cemented its reputation as reliable and premier supplier of ready-mixed concrete (RMC) and cement, offering quality and innovative products to add value to the Group's core services. The division delivered more than 5.0 million cubic meters of RMC to public infrastructure projects, such as the Republic's MRT projects like the Downtown Line Phase 3, Thomson Line, as well as HDB housing projects. Iconic projects like Terminal 4 at Changi Airport, Mega Shipyard at Tuas and many private and commercial residential and institutional projects.

The BBR division provides materials and services through its subsidiaries:

- Cement from United Cement Pte Ltd
- Granite aggregate and sand from Pan-United Industries Pte Ltd
- Ready-mixed concrete from Pan-United Concrete Pte Ltd
- Refined petroleum products from Inter Terminal Services
- Trading from Pan-United Asphalt Pte Ltd

PanUnited

PAN-UNITED CONCRETE PTE LTD

Started in 1999, Pan-United Concrete Pte Ltd has grown to be Singapore's largest Ready-Mixed Concrete (RMC) supplier, providing unparalleled services and quality by customizing a full range of concrete mix designs for cost-efficient solutions to clients in the public and private sectors.

Our resources

Our batching plants are strategically located in Singapore main land. They are all fully computerized, wet-mix batching plants. We have large fleet of concrete mixer trucks, comprising of 7m³ trucks, 8m³ trucks and 9m³ trucks to meet the demand of our customers.

Innovation centre

The Innovation Centre provides research & development and quality assurance on the raw materials and finished concrete products. Our Innovation Centre is Singlas Accredited modern laboratory, fully equipped with the latest technology equipments and the test for raw materials and Ready-Mix Concrete products are conducted in accordance with SS EN specification.

Pan-United Concrete Pte. Ltd. is the first company in Singapore to be awarded certification production quality standards (SS EN 206) by the Building and Construction Authority. All concrete for buildings and civil engineering structures supplied from Ready-Mix Concrete plants in Singapore must be certified under the Singapore Accreditation Council's certification scheme.

PanUnited

Self Compacting Concrete (SCC)

In 2014, Pan United achieved another new milestone in completing a high volume Self Compacting concrete pour for the tallest building in Singapore, the Tanjong Pagar Center.

The enormous pour with a concrete volume of more than 13, 500m³ was completed over a short span of 42 hours, involving up to 55 mixer trucks on site per hour. This has broken the record to be the highest supplied quantity by a single ready-mixed concrete company in Singapore.

CONCRETE PRODUCTS

We have supplied SCC to many projects such as MRT, private and commercial building and some HDB projects. SCC is a highly workable concrete that can flow through densely reinforced and complex structural elements under its own weight and adequately fills all voids without segregation and without the need for vibration. SCC increases the speed of construction, reduces labour demands and noise pollution.

PanUnited

Our Products & Services

Installing temperature control monitoring system

Temperature Controlled Concrete

Such concrete prevents thermal cracks and other temperature related defects to concrete. We provide Temperature Controlled Concrete for most of the thick foundation projects and underground projects. This is to control the maximum peak temperature and temperature differential between the interior and the surface of the concrete.

- Shotcrete
- Colored Concrete
- Lightweight Concrete
- Pan-U Green & Eco-Concrete
- Ultra High Strength Concrete

PanUnited

MC-BAUCHEMIE - INNOVATION IN BUILDING CHEMICALS

Customised Concrete for the Emscher River Conversion Project

For more than 100 years the Emscher River has been carrying waste water away from the major conurbations of the Ruhr region (Germany). This was a logical technical solution in previous times, but now no longer a contemporary one due to the negative effects on the environment. To change this situation, in 1991 the Emschergenossenschaft (public water board), North-Rhine Westphalia and the relevant municipalities decided to convert the river, and all its tributaries, into a "near-natural" waterway. How? By creating a separate, subterranean sewer system for the drainage of waste water. A project for a generation, it was started by the Emschergenossenschaft in 1992 and is scheduled for completion in 2017.

Within this project, the construction of the subterranean sewer system, which will remove the waste water from the river, is an extremely difficult task and comes with high concrete quality standards imposed by the Emschergenossenschaft.

This challenge has been expertly overcome by the two ready-mixed concrete producers Heinr. Elskes GmbH & Co. KG, Duisburg, and Herkules Transportbeton GmbH & Co.KG, Essen, with the support of the MC Team led by Frank Stengel, Key Account Manager for Construction Chemicals.

ENCLOSED SEWER SYSTEM

To transform an open waste waterway, which the Emscher still currently constitutes, back into a nearnatural river, the waste water will in future be diverted into an enclosed system of sewers. The main sewer required for this will start directly underneath the Dortmund-Deusen treatment plant and will run along a route 51 kilometres long to the Emschermündung treatment plant in Dinslaken. Given that some sections will have twin pipelines installed, the total sewer line is 73 kilometres long. These will be manufactured using reinforced concrete pipes with the final section consisting of segmental lining and constructed using the tunnel propulsion building method (pipe jacking). "The depth of this construction work will go down as far as 40 metres", says Frank Stengel. After the free-flowing section of 27 kilometres, at Gelsenkirchen, a lifting system will be constructed, which will elevate the waste water to a new level, thereby avoiding even greater depths. Two additional pump stations are being built at Bottrop and in Oberhausen to transport the waste water into the various treatment plants. The waste water sewer system will be continuously filled and is not accessible to people. Future inspections will therefore be performed using a robot. "As you can imagine, this concrete will be required to meet extremely high standards", says Mr. Stengel, a qualified engineer, "all the more so since Emschergenossenschaft has specified a 100-year design life." The specialists in the MC laboratory joined forces with the two concrete producers to develop a highly acid-resistant concrete. The degree of resistance was tested by an independent laboratory in Berlin, KIWA MPA Bautest GmbH, prior to acceptance.

CUSTOMISED CONCRETE FOR PUMPING STATIONS

The requirements for the pumping station concrete are equally onerous and specific. As well as a polycarboxylat ether (PCE), the admixture Centrilit NC will be incorporated in the mix design. Centrilit NC is a pozzolanic aluminosilicate that enhances the density of the concrete and makes it highly resistant to chemicals. "The acid-resistant concrete made with Centrilit NC and a PCE

from MC is highly workable, very cohesive, is well suited for pumping, and registers outstanding scores in the acidity test", explains Guido Hübener, Managing Director of Duisburg-based company Melius Baustofftechnik GmbH, the construction materials lab for the Elskes company. "With the properties as described, we can assume that the required operating lifetime will be achieved", he adds.

APPLICATION TECHNOLOGY DEMANDED

As well as the reliability and quality of the admixtures, it is essential to have concrete-related technical support on-site. "It is important to provide active on-site project support, as this is the only way to deliver optimum results to our partners", says Key Account Manager Mr. Stengel. With the large-scale Emscher Diversion Project, for example, it is essential that the admixtures can be delivered just-in-time consistently and over a long period. The value of these services is recognised by MC's partners: "The technical support and the supply capacity of MC were crucial factors for us in deciding to work with MC on the Emscher Project", explains Salvatore Gumina, authorised signatory at Herkules Transportbeton.

CAPTION PIPE JACKING

Awesome power: The underground tunnel system (pipe jacking) enables the reinforced concrete pipes and segmental lining to be laid without excavation

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EXCEL PRECAST PTE LTD

WE DELIVER PROMISES

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Excel Precast Pte Ltd (Excel) as a reliable precast concrete manufacturer commit to deliver the promises to the clients within the planned schedule and specified quality products.

Excel started in 1999 and now is Singapore's premier supplier of high quality and innovative precast concrete product solutions, designed to meet the needs of the building and construction industry.

We operate from three plants in Singapore and Malaysia, using the state of the art technology, production techniques and management systems.

Our total production capacity of 15,000 m3 per month makes Excel Precast one of the largest precast manufacturers in Singapore.

At Excel Precast, we produce a diverse range of customized prestressed and precast products including featured concrete. Taking pride in our ability to exceed the expectations of our customers and find solutions that meet their requirements.

We have a diverse market sector that includes Government (HDB) and private residential, commercial, industrial, institutional, military and civil engineering projects.

An award-winning company

The company has received numerous certifications and awards such as ISO 9001:2008, IS014001:2004 and OHSAS18001:2007, bizSAFE Star, bizSAFE Partner. Moreover, Excel had been awarded the 2011 Successful Entrepreneur Platinum Award, the Circle of Excellence COEIREI 2011 /2012 Singapore's Top 10 Building Material Firms Award, Singapore SME 1000 Award 2011 for highest turnover growth, the 2011 and 2013 Enterprise-50 Awards. Recently Excel was also awarded Built Environment Industry (BEI) Asia Award 2013.

One of Excel's key success factors is its client-centric mentality. Besides it's well-known of delivery excellence product quality within timely schedule, Excel also often provides practical solutions to its clients for ease of their construction projects.

Building Information Modeling (BIM)

Excel Precast is one of the BIM Leaders in Singapore as a precaster that implement BIM Software.

Complete precast projects can now be modeled using 3D Building Information Management (BIM) software that allows consultants, designers, and manufacturers to develop and visualize the multiple facets of precast construction.

Projects can be created digitally within the virtual world of BIM software to advance productivity, project management and construction. Design issues can be easily identified and resolved prior to manufacture and installation. Potential project complications can be examined within the BIM environment and resolved prior to issuing drawings for construction.

Green Products

Excel is also one of the pioneers for green concrete precast products. One of the projects using green concrete is the IES Annex Building at Bukit Tinggi Road. The structural components like columns were being introduced.

Research and Development

Closely associated with Excel's commitment to quality is its research and development (R&D) methodology. R&D in Excel studies the innovative concrete products, implementing new technology for productivity improvement and manufacturing high quality Prefabricated Bathroom Unit (PBU).

Prefabricated Bathroom Unit (PBU)

As a reputable and reliable precaster in Singapore, Excel Precast Pte Ltd possesses in-depth knowledge of PBUs and their various critical design parameters.

Our mission is to provide the client a system of PBU production that focuses on: durability, reliability, quality, technically sound, and cost-effectiveness, hence delivering total satisfaction for the client.

Durability

Using proven precast concrete technology, Excel Precast Pte Ltd is down-to-earth in its approach to ensure durability in all of its PBUs. With precast concrete as its main structural body, the PBU is made to last. It will not corrode, neither will it rust. This system will guarantee peace of mind for the client choosing PBUs from EXCEL PRECAST Pte Ltd.

Reliability

We take pride in managing the production team to provide an integrated system of manufacturing and installation of all the various components that make up a bathroom, from the structural precast concrete body, to the internal plumbing system, to the tiling process, to the carpentry works etc.

Such a system requires a complete know-how and understanding of making a PBU off- site in a sheltered factory. We take manufacturing to a new height, where all key trades are working in unison, all key design parameters are accounted for, and all processes are monitored. Such reliability is crucial when delivery schedule to the job site is critical. With our system of PBU production, we removed essentially the many variables that lead to delays and uncertainty.

Quality

Our PBUs will achieve a level of quality in its workmanship which is second to none. Such claims can be seen by our mock up units. Our core team of specialized workforce are highly trained in all aspects of the PBU production chain, leading to PBUs that are free from defects, something that is unlikely when individual contractors are called upon to work at the job site perform their own trades.

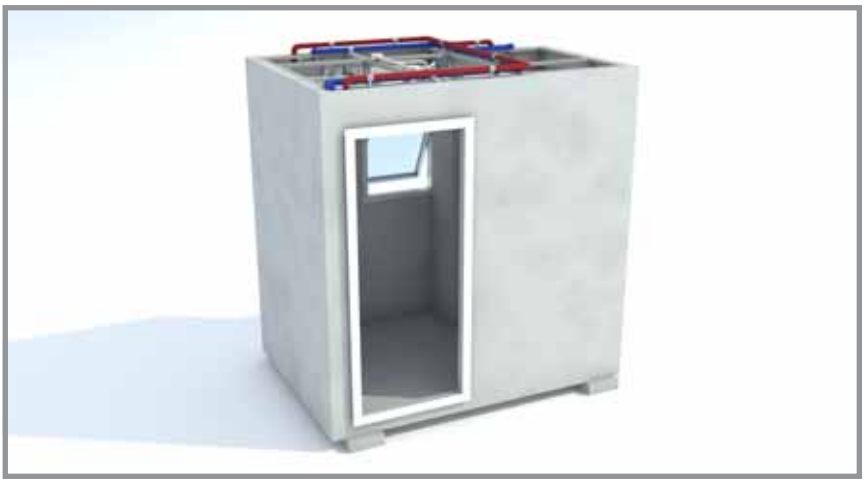
Technical expertise

EXCEL PRECAST Pte Ltd's knowledge and experience in the PBU field is exemplary. Our PBU-team has had experience in various projects which uses PBUs. We have the vision to continually improve on existing concepts, and inventing new ones. Proprietary features are often added into our PBUs for ease of installation at site. Developers, consultants and main contractors often accept our suggestions and opinions for PBUs because our in-depth know-how of the product. Our production team is dedicated to ensure defect-free PBUs, adopting modern management systems in the PBUs' production process.

Cost-effectiveness

Our PBUs will often be cost-effective, even as we are able to provide innovative solutions to ensure quality, durability and reliability. Our manufacturing system can cater for materials to be supplied by the clients, where a whole new separate system of managing customer-supplied-items are in place. Our PBU range offers cost-no-object luxurious light weight models utilizing exotic materials, to the affordable heavier precast concrete models, with or without customer-supplied-items options.
Make the right choice

It makes perfect choice to adopt PBUs in a residential development as the call for productivity only gets more intensive in recent years. Singapore's Building & Control Authority (BCA) has been actively championing higher productivity by



encouraging the use of new products and methodologies.

The use of PBUs is one key component in achieving the higher productivity. With so many trades in one small area, the bathrooms are the most challenging and difficult areas to coordinate at site. However, when such activities are managed off-site, better quality and higher turn-around time can be attained. When choosing a partner to supply PBUs, it is important to select the team that has all these attributes:

- Durability
- Reliability
- Quality
- Technical Expertise
- Cost Effectiveness

It takes finesse, insight, and know-how, to produce workable PBUs; not just a production facility. We at Excel Precast Pte Ltd would like to assure you that our PBUs will satisfy all of your requirements. We look forward to have a no obligation consultation with regards to the implementation of PBUs for your residential developments or building projects. Selecting us is clearly the right choice.

Commitment

As a growing company with proven prestigious awards, Excel Precast always delivers promises and will strive as a key player in the precast concrete construction industry and is established with one of the most advanced infrastructure to answer the needs for quality precast construction, effectively, efficiently and speedily.

NSL
Eastern Pretech

Eastern Pretech Pte Ltd

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Think Precast …Think Eastern Pretech
Your Precast Concrete Partner & Supplier

The Ultimate Prefab Bathroom Unit Supplier
Fabricate For Comfort and Easy Living
Proven Technology & Knowledge From Finland

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Eastern Pretech

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35th SCI Anniversary Gala Dinner Theme: "Sustainable Precast Concrete in Singapore"

Held on 15th November 2013 and more than 350 professionals attended the dinner at Sustainable Precast Concrete in Singapore.

Highlights of the event:

Presenting the plaque to main sponsors


SINGAPORE
35
November 15,
MAPEI
35

ALFRED A. YEE, P.E., HON. DR. ENG.

Dr. Alfred A Yee is President of Yee Precast Design Group Ltd. in Honolulu, Hawaii and Director of Precast Design Consultants Pte. Ltd. in Singapore. He obtained his Bachelor of Science degree (Civil Engineering) from Rose-Hulman Institute of Technology and his Master of Engineering degree (Structural Engineering) from Yale University. In recognition of his work in concrete technology and proven unique concepts for land and sea structures, particularly in the field of precast concrete design and construction, the Rose-Hulman Institute of Technology conferred upon him an Honorary Doctor of Engineering degree in 1976. In 1955, Dr. Yee participated in organizing one of the earliest precast/prestressed concrete mass production facilities in the United States. He has developed innovative structural concepts, devices and construction techniques that are widely used in prestressed/precast concrete construction of mid and high-rise building structures, bridges and marine concrete vessels. He has designed and administered the construction of thousands of structures in North America, South America, the Pacific islands, Asia, Australia, and the Middle East over the past 60 years.

Dr. Yee is the author of numerous technical articles and has delivered lectures to many international professional organizations and universities on the subject of precast and prestressed concrete. His articles published in the Prestressed and Precast Institute (PCI) received awards for outstanding technical papers in all three categories: (a) Excellence in Research and Design (b) Construction Methodology and (c) Latest Technology and State-of-the-Art. Dr. Yee had served on the Board of Directors of the PCI in the past and for a number of years on the Connection Details and Seismic Design committees. He also served on the American Concrete Institute (ACI) Committee 357, Concrete and Marine Offshore Structures and has designed and supervised construction of ocean-going prestressed concrete barges and prestressed concrete ocean platforms for oil exploration and chemical processing plants.
In 1976, Dr. Yee was made a member of the prestigious National Academy of Engineering (NAE) (USA).

In 1995, the State of Hawaii Legislature presented Dr. Yee with an Official Proclamation honoring him for the invention of the NMB Splice Sleeve and recognizing the successful role this connection device played in reinforcing Precast Concrete Structures to withstand the devastating 1995 earthquake in Kobe, Japan.

In 1997, Dr. Yee was awarded the PCI Medal of Honor for his extraordinary contributions to the precast/prestressed concrete construction industry, especially for his innovative design of precast/prestressed concrete high rise buildings along the Pacific Rim which have survived some of the highest intensity earthquakes in the world. In 2004, Dr. Yee was named a Titan of the Precast/Prestressed Concrete Industry in recognition of his outstanding contributions to the Industry; for prominence in industry innovation and change; for positive leadership in industry-altering development and expansion; and for advancing and accelerating the growth of the North American Precast and Prestressed concrete industry.

In 2007, Dr. Yee was appointed to the International Panel of Experts by the Building & Construction Authority (BCA) of Singapore to assist in the effort to review and strengthen its regulatory framework. He has served as Honorary Structural Consultant to the Singapore Housing & Development Board for seven consecutive 3-year terms to launch a massive precast concrete housing program for over 85% of the Singapore population.

In 2009, the Hawaii Council of Engineering Societies honored Dr. Yee with the HCES Lifetime Achievement Award in recognition of his significant contributions to the development of engineering in the State of Hawaii and noteworthy impact on the local engineering community.

In 2010, Dr. Yee, as lead author, presented a paper on the "The Sail @ Marina Bay" a tall slender 70-storey composite precast residential structure with an aspect ratio of 11.14. The structure was also designed to conform with seismic zone 2A category in accordance with the International Building Code.

In 2013, Dr. Yee received Singapore Concrete Institute's Lifetime Achievement Award.

Internationally, Dr. Yee's firms are presently involved in the design and construction administration of mid and high-rise building projects including commercial, residential, industrial buildings and special purpose structures such as precast concrete long span and cast-in-place blast-resistant aircraft hangars and numerous ocean-going concrete barges, caissons and platforms. His most significant project in progress at present is the design, construction, and operations of the world's first Ocean Thermal Energy Conversion (OTEC) plant facility with a capacity to produce 20MW including electric power, fresh water, and liquid hydrogen.

ER LAU JOO MING

SENIOR ADVISOR HOUSING AND DEVELOPMENT BOARD
PRESIDENT OF PROFESSIONAL ENGINEER BOARD

- *1973, Engineer, HDB*
- *1989 to 2005, Chief Structural Engineer, HDB*
- *2006 to 2009, DCEO(Building Group)*
- *2009 to 2012, MD HDB Building Research Institute*
- *2009, Senior Advisor*
- *2009, President, Professional Engineers Board*
- *2010, Member of Development Advisory Panel, MOF*
- *2012, Adviser, MOHH*
- *2012, Adjunct Professor, Nanyang Technological University*
- *Board member ,NHG*

ER Lau Joo Ming is the Senior Advisor of Housing & Development Board(HDB), Singapore. He drives the development of a strategic research plan for HDB, provides advices to technical issues, participates in technical reviews for HDB projects and guides the HDB's young professionals. Prior to his position as Senior Advisor, he was the Managing Director of the HDB Building Research Institute (HDB BRI) in 2009 till 2012. HDB BRI is the research arm of HDB and envisions being the global leader in housing research, innovations and solutions for a sustainable living environment. In 2006, Er. Lau was the Deputy Chief Executive Officer of the Building Group (BG) of HDB, managing four departments involved in the planning, procurement, project management, quality assurance and maintenance management of HDB estates. Er Lau Joo Ming was the Chief Structural Engineer of the Housing & Development Board (HDB).

Er Lau led a team of Architects and Engineers in driving the realisation of The Pinnacle@Duxton project completed in 2009. The Pinnacle@Duxton is an iconic housing project in Singapore's public housing history, with many unique features that set it apart from other HDB housing projects. It is the first 50-storey public housing project in Singapore, housing 1,848 apartments in 7 towering blocks. This project was awarded the 2010 Best Tall Building Asia & Australasia by the Council on Tall Buildings and Urban Habitat.

Besides HDB, he is the President of Professional Engineer Board and an Adjunct Professor at Nanyang Technological University. He lectures in MSc class in the School of Civil Engineering. He is member of Development Projects Advisory Panel, set up by MOF to enhance the assessment and management of large and complex infrastructure projects. He is also the Adviser to the Ministry of Health Holdings Hospital Infrastructure Project Group.

Willie Kay
Managing Director
WAK Consultants Pte Ltd

1968 - 1975	*Taylor Woodrow Material Research Lab*
1975 - 1990	*Fosroc UK / Fosroc International*
1990 - 1997	*MBT*
1997 - present	*WAK Consultants / WAK Technologies*

His career spans over 45 years all based within the specialist construction material industry and 36 years based in Asia.

After 2 years of basic concrete techniques training, Willie joined Taylor Woodrow in their Materials Research Laboratory. He was responsible for many projects particularly in processing work in Concrete Repairs and Resin Developments ending up as Divisional Manager.

Within Fosroc, Willie had many roles in England and Scotland particularly in supply of materials to the Concrete Platform industry.

In 1978, he was Singapore bound and quickly involved himself in the HDB precast concrete program.
To ensure productivity of the precast plant high early strength concrete was needed and with the Fosroc team Admixtures were developed and supplied to solve this issue.

Other projects included Kenyir Dam in Malaysia and Saguling Dam in Indonesia.

The first phase of MRT with precast beams and epoxy beating pad was another development. All products now being made in Singapore.

Transferred to India for two years again involved in major infrastructure projects like the Narmada Irrigation Project.

In 1990 Willie returned to Singapore, first with MBT then with WAK Consultants.

Projects were numerous including the Petronas Towers in Kuala Lumpur, High Speed Rail in Taiwan, Chap Lek Kok Airport Hong Kong and World Trade Centre Colombo.

One major project was working to stabilize the soil when Nicol Highway collapsed. Based on Knowledge gained from the Jubilee line collapsed at Heathrow it was known that foamed grout was an effective way of stabilizing ground. Willie and his team swung into action and worked 36 hours non-stop until mobilizing other applicators.

Currently WAK Consultants is involved with QA / QC of concrete, specialist monitoring systems for concrete and specialist contracting in the Tunnel Industry. Fellow of Singapore Concrete Institute and UK Concrete Society, member of Institute of Concrete Technology, life member of Indian Concrete Institute.

Joint chairmen with Prof Tam on adoption of ENZOG. Published over 20 papers worldwide.

SECAD – The Answer to Greater Productivity through Technology Innovation

Project Team Leader:
Er. Dr. Johnny Wong
Group Director, Building Research Institute
Housing & Development Board

INTRODUCTION

Faced with the challenge of continually meeting the housing needs of the nation's rising population, HDB has embarked on the construction of taller buildings to deliver more homes in land scarce Singapore. One of the measures adopted to help achieve timely delivery of high quantity and quality flats was through precast construction methodology. With over three decades of experience in precast concrete technology, HDB has succeeded in developing and refining its own concoction of semi-precast system for optimal buildability in the development of these high-rise buildings. Nevertheless, in order to achieve greater productivity, there was a need to streamline the design process in order to facilitate manufacture and construction of the precast systems.

THE CHALLENGES

Back in the mid 90s', structural design work for construction projects was not as 'easy' as today. Structural engineers had to carry out analysis work using different 2-D analytical tools, sketched out structural element sizing and steel reinforcement details for drafting team to draw out manually. This would mean hundred of drawings in A1 size. Following this, engineers would have to spend long hours to check through drawings produced by drafting team to ensure there were no discrepancies during the transfer of design inputs. To top it off, the adoption of precast and prefabrication design imposed more challenges to engineers as the concepts were relatively new to the industry back then.

Hence, an "all-in-one" software equipped with precast and prefabrication capability that can perform analysis, design and detailing – generating the drawings automatically, was so much needed by the engineers, especially so when there was huge demand of public housing back then. However, there was no such readily available software in the market. Housing & Development Board (HDB) of Singapore took the lead and developed the first-of-its-kind structural engineering software, SECAD.

SOLUTIONS

SECAD is powered by a robust 3D finite element analysis engine to facilitate efficient and effective high rise building design, analysis and detailing in accordance to Codes of Practice adopted by the industry. Key unique attributes that give SECAD its cutting-edge are:

a) Capability to **automatically translate design and analysis output into drawings** showing detailing of building components for construction purposes

In the past, a design engineer had to use several softwares to carry out structural analysis and design, followed by providing sketches of structural details to the draftsmen. The draftsmen would then prepare the structural drawings based on the sketches and also relevant details extracted from the electronic prefab databases. This process was tedious and unproductive as more time and attention was required to ensure that no errors were made during transfer of design information and other structural parameters into the construction drawings. Typically, for production of construction drawings, a drafting team of 16 draftsmen was required to support one design engineer per project.

There was a need to look into integrating design, analysis and detailing through computerisation and automation to increase design and construction productivity to support Singapore's public housing building

SECAD's win of SCI Excellence Award 2013

programme. However, there was no such readily available solution in the market then. Therefore, HDB embarked on a study to develop its own one-stop smart solution – **S**tructural **E**ngineering **C**omputer-**A**ided **D**esign or SECAD. Other than design and 3D analysis capability, the development team had successfully integrated the fragmented precast/prefabrication and standardization databases into one single resource library. Hence, once a building model is ready, the software will automatically select precast components and prefabrication details from the resource library that best suit the design. Construction drawings are then automatically generated in format that is ready for project submissions to relevant authorities and direct adoption by downstream stakeholders in the value chain e.g. contractors, precasters and fabricators. SECAD is the first and till date the only structural design software that is capable of performing advanced precast design and detailing.

Since implementation of SECAD in 1997, the number of draftsmen required to support one design engineer has reduced from 16 to 10, achieving manpower savings of 35% which represents 1500 man-hours savings per project. This helps to reduce project development cost and thus, contributing towards affordable housing for the Nation.

b) **Integration with comprehensive resource library which houses HDB's 50 years of research & development knowledge and experience** in precast and prefabrication technology, conventional

Figure. 1 - A Typical Workflow using SECAD

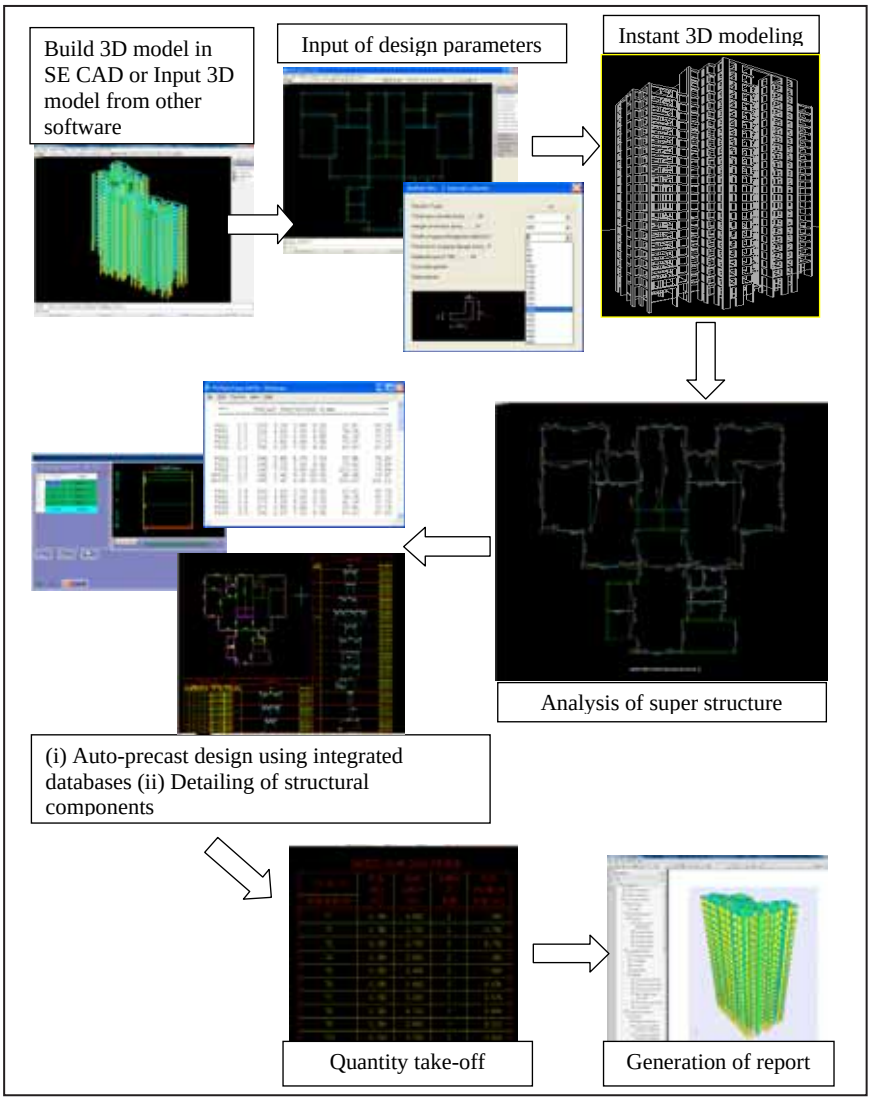


Figure. 2 – Project References (completed HDB precast residential projects designed using SECAD)

The Pinnacle@Duxton (50-storey development)

The Coris@Sengkang (16-storey development)

Central Horizon@Toa Payoh (40-storey development)

cast-in-place design and construction, and standardization of drawings and detailing

The most unique feature of SECAD lies in its **integration with comprehensive resource library which houses HDB's 50 years of research & development knowledge and experience in precast and prefabrication technology, conventional cast-in-place design and construction, and standardization of drawings and detailing.** It formed a powerful centralized **HDB knowledge bank** for users to tap into HDB's decades-long R&D knowledge and experience in both cast-in-situ and precast building design. The seamless integration of **HDB knowledge bank** in SECAD helps expedite the whole design process and ensure quality design output. In addition, Singapore enjoys the multifaceted benefits of wide-scale high-rise precast implementation.

HDB plays a pivotal role in the implementation of precast and prefabrication technology. Being a pioneer in the precast arena, HDB sees and enjoys the benefits of achieving greater productivity and sustainable design through the adoption of precast technology. Hence, HDB developed the use of the prefabricated steel reinforcement and precast components.

To facilitate the adoption of prefabricated system, HDB have gone to great lengths to establish several databases such as column cages, beam cages, slab meshes, precast prestressed planks, precast façade, etc.

These databases were initially stored separately and used disjointedly, resulting in inefficiency and incoherence in deployment. SECAD had successfully integrated these fragmented databases seamlessly into one single knowledge bank. With SECAD, once a building model is ready, the software will automatically select the precast components and detailing that best suit the design, while keeping the option for user to make changes.

With the prefabricated system built in the databases of SECAD, it makes easy for the adoption of precast and prefabricated technology. Increasing the prefabrication content of public housing designs over the years has had a profound positive impact on the construction productivity of HDB work sites. It is reflected in the significant improvements to work qualities and productivity of HDB construction. Its site labour productivity of 1.0 m2 per man-day coupled with an accident frequency rate of 0.75 accidents per million man-hours worked, far exceeds the national average. This augurs well with the current government policy of cutting down our dependence on foreign workers.

Recently, SECAD and its HDB knowledge bank has been identified by the Ministry of National Development as one of the tools that is able to help boost construction productivity in Singapore.

c) **Compliance to stringent structural design codes**

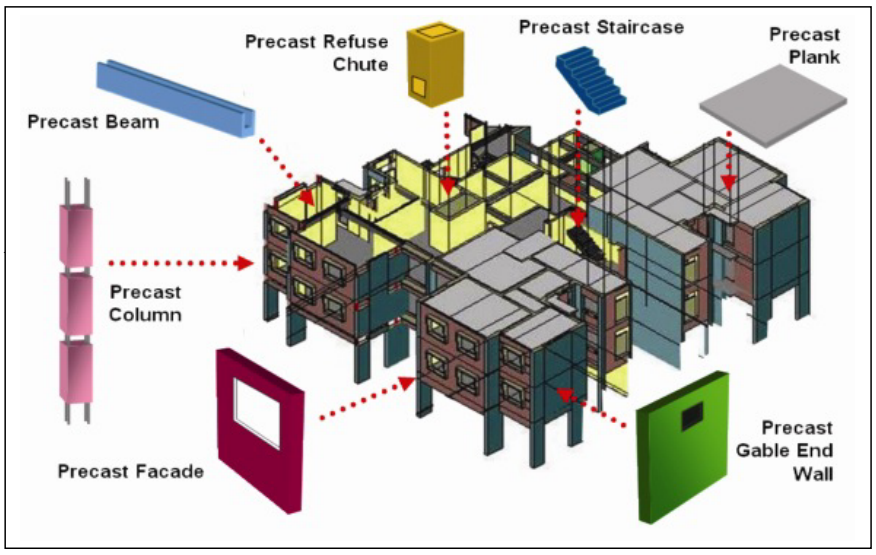
SECAD was developed based on practical needs by its intended users in mind. Each of the key steps required for structural design and drafting have been computerised and automated. Over the years, the software has been progressively enhanced to incorporate advanced technical features, comply with latest industry standards, improve its user interface and fine tuning based on users' feedback. For every enhancement, a series of user-acceptance tests and stringent validation process will be carried out prior to rolling out to the industry. This is to ensure delivery of high quality product standards to the users.

SECAD provides robust design according to two established codes of practice for structural concrete ie Eurocode and British Standard. Building and Construction Authority of Singapore has announced the official withdrawal of British Standard and replacement with Eurocode on 1 Apr 2015. Design considerations and workflow for different structural components have been built into the software to provide automatic analysis and design for any building profile and layout. This has greatly reduced the manpower resources needed for time-consuming hand calculation and tedious reiterations of different scenarios. Leveraging on advanced computing technology, accurate analysis and design outcomes are produced.

Not only SECAD meets stringent design requirements according to codes of practice, SECAD value-adds by providing customised standard detailing and reference drawings that give it an edge over other softwares. The standard detailing and reference drawings are the proud outcomes of HDB's decades long research and development work in streamlining process in both design and construction areas to address site constraints and eliminate re-work.

The customised standard detailing and reference drawings formed part of the built in resource library to guide young and new professionals. SECAD's prowess of integrating design requirements with actual

Figure. 3 - HDB's Precast and Prefabrication System



Schematic diagram of standard precast components used in HDB's building projects – detailing of precast components is built into SECAD for ease of adoption and instant drawing production

Standard precast components include precast walls and precast facades

construction practices benefits the industry with cost effective and reliable designs.

d) Compatibility and Interoperability

In recent years, the government has identified Building Information Modelling (BIM) as one of the main technology drivers to boost productivity. With BIM, workflows shift from sequential to parallel in order to facilitate collaboration and information exchanges across disciplines to reduce duplication and redundancy. BCA has mandated the use of BIM in all project submissions by Jul 2015.

SECAD has been upgraded to be equipped with BIM capability. SECAD is equipped with BIM capabilities that facilitate sharing of data and information across disciplines efficiently. It is capable of communicating with softwares of other disciplines such as architectural, mechanical & electrical. Teams from different disciplines can share the same building model and data to speed up and streamline workflow. With the sharing of data, end users will save time and effort in building modelling works as SECAD allows transfer of the 3D architectural model created upstream by architects to C&S consultants to continue with the structural analysis and detailing. This capability of mutual sharing of modelling data greatly minimises chances of discrepancy, saves time and effort for team from creating a separate structural building model from scratch.

In addition, SECAD has the capability of auto-generating comprehensive project report comprising 3D model, analysis output, structural design calculations, detailing and drawings by the end of the project. This is to facilitate project submission in BIM format as required by BCA.

ADVANTAGES OF USING SECAD

SECAD transformed the whole design process and serves as a vital link between various stakeholders in the construction value-chain, from design office to contractor and precaster/mesh fabricator. It brings multifaceted advantages to the building industry and creates significant impact to the Nation as a whole.

1. Maximising high quality output, minimising resources

With SECAD, the work processes between the design engineers and draftsmen have been streamlined. Manual and duplicative input of similar design information at different stages is eliminated as it has the capability to share the same data input by design engineer and draftsmen. This eliminates the checking process to ensure that there are no errors in the data entry and transfer of design information. The time spent by the project team on the previous unproductive processes can be put to better use focusing on ensuring better designs and higher quality drawings.

SECAD has revolutionised the way design and drafting works were done in HDB. A summary on comparison of design workflow before and after using SECAD is tabulated as follows:

S/N	Before using SECAD	After using SECAD	Key Difference
1	Need to deploy more than one software to do analysis and design	The whole design process, from analysis and design, to detailing and drawing production, all are performed using ONE software	SECAD is an all-in-one solution for professionals to perform the whole design process
2	Analysis was done using 2D analytical software	Analysis is based on 3D finite element analysis	3D analysis provides more accurate and precise results for efficient design
3	Engineer to manually sketch out element sizing and detailing for drafting team to transfer to final drawings	No more manual sketches needed from Engineer – process is streamlined and automatically performed by SECAD	Process is automated in SECAD
4	Manual transfer of engineer's design data to drawings	Automatic transfer of design data to drawings	(i) Intergrated design and drafting processes (ii) Discrepancies are minimised with automatic transfer of design data to drawings
5	Manual select and transfer of best fit design from a suite of precast and prefabrication databases and standard detailing reference drawings which were stored separately	Automatic select and choose by SECAD the best fit design based on requirements from a suite of precast and prefabrication databases and standard detailing reference drawings which were integrated seamlessly within the software	(i) Discrepancies are minimised with automatic transfer of ready detailing from databases to drawings (ii) Professionals saved time in checking of drawings which were previously prepared manually
6	Engineer to go through many rounds of manual iterative calculation process to reach ultimate design	SECAD has built-in intelligent computational function to perform iterative calculations for best design	(i) Professionals saved time in doing tedious and time-consuming iterative calculation works (ii) SECAD provides more accurate and precise results as compared to manual calculation
7	Same structural model was drawn by different draftsmen for illustration of different layouts e.g. typical floor, precast plank floor plan, beam schedule etc. Hence, more draftsmen were required for one design project to produce structural drawings.	Work load can be shared easily during modelling stage ie each draftsman can be tasked to prepare one part of the whole building and eventually to be joined as one using SECAD functions	Teamwork and productivity is greatly enhanced by using SECAD. *"The whole is greater than the sum of its parts."*

SECAD offers a one-stop solution to structural analysis, design and detailing works. The successful implementation of SECAD has enabled HDB to achieve quantum leap in both design and drawing office work productivity. Error in transfer of design data and discrepancy between drawings is totally eliminated.

Most importantly and uniquely, with the seamless integration of SECAD's powerful centralized knowledge management system into the design workflow, users can tap into HDB's 50 years of research & development knowledge and experience in both cast-in-situ and precast building design, precast and prefabrication technology, standardization of drawings and detailing method with ease.

With SECAD, once a building model is ready, the software will automatically select the precast components and detailing that best suit the design, while keeping the option for user to make changes. This has greatly streamlined the design processes, enhanced the quality of design output and increased productivity by having lesser manpower to cope with high building programmes.

2. Equipping professionals with precast technical know-how

HDB is the leader in driving precast and prefabrication implementation in Singapore's building industry. Through wide scale precast implementation in its public housing projects, HDB benefited from an increase in construction productivity, higher quality finish, reduced dependency on manual labour and safer working environment. Precast construction has its environmental benefits include reduction of air pollution and material wastages. Currently, the level of precast content in Singapore's public housing construction is one of the highest in the world; with more than 70% precast content out of the total concrete volume utilized per building project. National average for precast adoption is below 20%.

With the increased level of prefabrication and precast implementation, it is pertinent that construction details produced at the upstream during design phase are accurate and buildable.

With the outsourcing of design works for HDB projects to the private sector, most of the private consultants have little or no experience in precast design and construction and they were not familiar with HDB's precast detailing standard. There is no other software available in the market to perform comprehensive precast design. Recognising SECAD's capabilities in precast design and construction, many private consultants (both Singapore and Malaysia) have acquired SECAD software licenses to learn about buildable precast design and also to assist them in their design work. With the in-built 3D analysis capability and HDB's resource library, the consultants relied heavily on SECAD to avoid reinventing the wheel and achieve timely delivery of design projects.

With the prefabricated system built in the databases of SECAD, it makes easy for the adoption of precast and prefabricated technology, especially for private sector that is still not so familiar with the technology. By providing building professionals with a user-friendly and effective tool, they will be encouraged to come on board. In addition, precast technology emphasises on modularity which in turn will bring about more buildable designs for the industry.

3. Achieving greener construction and higher construction productivity

Precast system is green technology that reduces reliance on workers, reduces material wastages, generates lesser noise and pollution during the construction process, and promotes safer working environment. Hence, to adopt greener construction and achieve higher productivity, one must adopt the sustainable solution of implementing precast system.

Being a pioneer in the precast arena, HDB sees and enjoys the benefits of achieving greater productivity and sustainable design through the adoption of precast technology. To be able to convince other building professionals to take up precast, HDB reckons the importance of technology and knowledge transfer. Hence, by making available precast design and detailing databases in the SECAD, it helps the building professionals shorten learning process and to be more open to adopting precast technology in their designs.

By leveraging on precast and prefabrication technology, we are able to minimise wastage of materials and maximise quality production. On top of that, as precast components are fabricated off-site, it generates less heat and noise on site as compared to conventional cast-in-situ method. Besides, having to work at construction site with limited storage space for raw materials, precast and prefabrication technology helps save materials storage space and give a cleaner working site environment. Most importantly, precast technology cuts down wet trades on site. This will greatly reduce reliance on construction workers who are mostly come from foreign countries and hence, ease the labour crunch issue.

In recent years, the government places great emphasis in driving productivity growth due to labour crunch. One way is through greater use of precast and prefabrication in the construction industry. SECAD is instrumental in transforming public housing design landscape in Singapore from conventional cast-in-situ to highly productive and sustainable precast building design and construction.

SECAD is the enabler to realising quantum leap in construction productivity!

ACCOLADES

SECAD's prowess has been widely recognised, both locally and regionally. It has successfully obtained Productivity Improvement Project (PIP) grant from BCA. To top it off, SECAD has been conferred with the following awards in 2013:

(i) Singapore infocomm Technology Fe-deration (SiTF) Award (Gold Award under infocomm Productivity category);

(ii) Singapore Concrete Institute (SCI) Award; and

(iii) Asia-Pacific ICT Alliance (APICTA) Award (Merit Award under Government category).

SECAD's win of APICTA Award 2013

Designed for Disassembly Building Systems in Singapore

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INTRODUCTION

It is well known that the construction industry consumes a massive amount of raw materials and energy to meet the growing demands of construction activities. Both the extraction of these raw materials and the emission of pollutants have placed a heavy burden on the environment. The intention of designing buildings for disassembly is to maximize materials conservation from building end-of-life management and createadaptable buildings to avoid building removal altogether.

This concept is very relevant to Singapore given that many buildings are demolished due to redevelopment as they are unable to remain useful with alternative land use zoning and changing housing and infrastructure needs of a greying and increasing affluent population. Buildings typically comprise a combination of pre-assembled components and on-site assembly of materials and components. If "wet assembly" is dominant in the construction of the building, e.g. cast-in-place concrete, then it does not readily lend itself to disassembly. However, if the buildings are designed for disassembly (DfD) with management of all resource flows in the full life-cycle from extraction, to manufacturing, to design, to construction, to operation, to renovation, to the eventual end-of-life then sustainability in the built environment can be achieved. Through the concept of DfD, we can create buildings to reduce the new materials consumption and waste in their construction, renovation, and demolition, and use the existing stock of buildings as stocks of future building materials. DfD involves the design of buildings to facilitate future change and eventual dismantlement (in part or whole) for the recovery of systems, components and materials.

THE CHALLENGES

HDB has been spearheading the use of prefabrication in Singapore construction industry for over forty years. With the recent shortage of traditional supplies of construction materials along with issues of construction waste generation, it is timely for HDB together with NUS embark on research and development on the application of DfD to high rise buildings in Singapore, taking into consideration the tropical environment and types of materials used locally. The main challenge of the project is to develop DfD framework systems suitable for high-rise buildings. The design process involves designing DfD assemblies, components, materials, construction technique, and information management system. In addition, structural and durability appraisal along with appropriate deconstruction sequence are also important to achieve the goals of DfD.

SOLUTIONS

With regard to the aforementioned chal-

lenges faced by the project, several novel types of demountable connections were designed. Full scale testing was conducted at the Structural Laboratory of the National University of Singapore to study the ultimate, serviceability, and demount-ability performance of the proposed DfD connections. As a part of testing, a half scale DfD prototype mockup was constructed. The main intention of the DfD prototype was to simulate the phases of DfD structures (i.e. initial construction, deconstruction, and reconstruction phases), and to provide field observations on possible difficulties associated with each phase of DfD that may arise.

The results showed DfD implementation for high-rise residential building is possible with further improvements on serviceability performances of the DfD components and assemblies.

The project also made use of the Building Information Modeling (BIM) to provide efficient information management system for DfD application. The information management system contains all the relevant information of the DfD components such as geometry, materials, detailing, and library of DfD connections which can be used for further optimization analysis such as carbon foot-print, energy and cost analysis as part of the evaluation system.

The present project also proposed an appraisal framework for component durability for DfD application. However, as durability demands long term study and the gathering of information, the decision was to focus on early age shrinkage and carbonation. Based on these two deterioration mechanisms, a performance-based durability design through the reliability-based approach was performed to estimate the total/residual service life of DfD precast components. The methodology utilized for evaluating and predicting residual service life based on the two typical mechanisms of deterioration can be easily extended to other types of deterioration mechanisms.

ADVANTAGES OF PROPOSED SOLUTIONS

(a) Environmental Benefits

Reusing of the existing building materials, components, and assemblies through DfD is the way forward to reduce the environmental impact arising from the construction activities. In addition, it also reduces our reliance on raw virgin materials and the need to process them to finished products, which has a large impact on the environment.

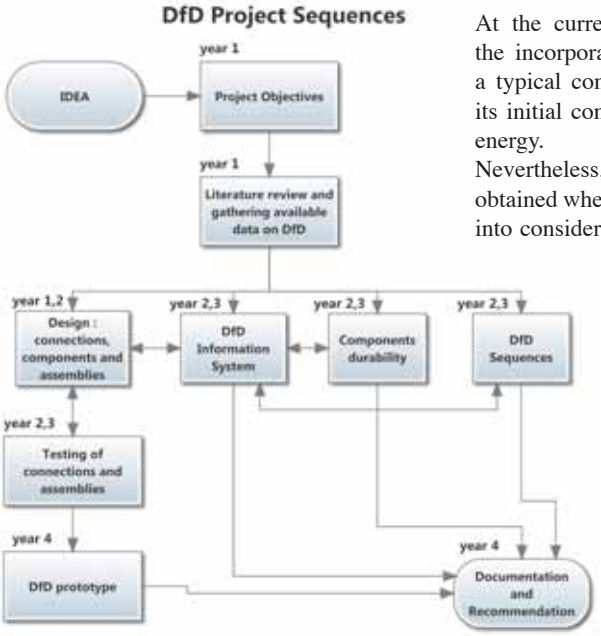
(b) Strategic significance to sustainability

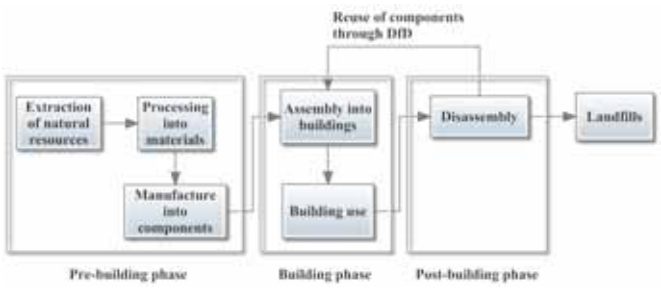
Through DfD, optimum use of construction material in the full life-cycle from extraction, to manufacturing, to design, to construction, to operation, to renovation, and to eventual end-of-life could be assured. On top of this, from Singapore perspective, reusing the existing buildings materials and components could further reduce our reliance on foreign imports of raw construction materials. Aside from the mentioned benefits, there will be a reduction in the waste generated through construction, renovation, and demolition activities.

(c) Economic impact

The concept of DfD building system will create additional business opportunities for the -construction and prefabrication industry in terms of building design, construction, deconstruction, reconstruction, and structural appraisal. Enormous savings in energy could also be generated from a massive reduction in the usual import of raw materials, concrete production, demolition, and disposal of construction and demolition waste. The availability of these sustainable building components will ensure that the construction sector can continue to play its important role in meeting Singapore's evolving infrastructure needs as the City states progresses up the ranks of global cities.

4. Sequence of events from idea to realization (timeline, milestones)





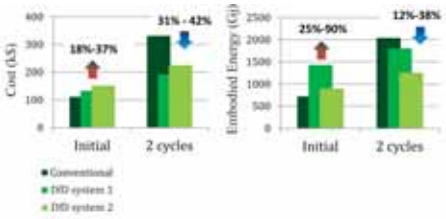
a) General overview of DfD adaptation strategy

Close-loop building management cycle incorporating DfD principles

b) Illustration of cost and environmental benefits of DfD adaptation

Assumption :

- Two floors of a typical residential apartment block. Only superstructure is considered
- Full precast construction
- Full disassembly with additional cost included
- Only structural members are considered
- Same layout for current and future buildings.
- Analysis based on material volume estimated through BIM



1. Conventional sequence (2 cycles)

Initial construction [Demolition [2nd Construction [Demolition [Landfill

2. DfD sequence (2 cycles)

Initial construction [De-construction [Re-construction [Demolition [Landfill

At the current stage, it is realized that the incorporation of the DfD concept to a typical concrete structure will increase its initial construction cost and embodied energy.

Nevertheless, significant savings could be obtained when subsequent cycles are taken into consideration. For example given the above, cost savings up to 42% and reduction in the embodied energy of up to 38% could be obtained in 2 cycles of building construction.

Disclaimer:

The project is still considered under conceptual stage and may not be implemented in the future without further developments and improvements.

ADOPTION OF STEEL-FIBRE REINFORCED CONCRETE BORED TUNNEL LINING FOR SINGAPORE LAND TRANSPORT AUTHORITY DOWNTOWN LINE STAGE 3 – FIRST IN SOUTH EAST ASIA

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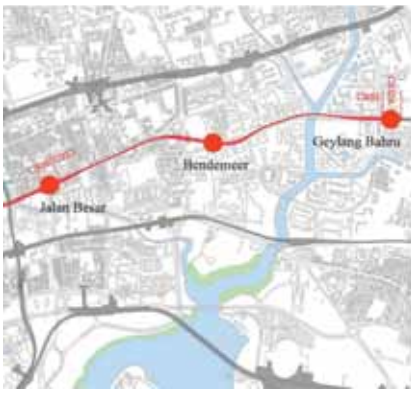
INTRODUCTION

LTA DTL3A will construct the first Steel Fibre Reinforced Concrete (SFRC) tunnel lining in South-East Asia. The 2km stretch is being constructed between the Jalan Besar and Geylang Bahru Stations. Using SFRC as opposed to the traditional Steel Bar Reinforced Concrete (RC) tunnel segmental lining translated to increased productivity, enhanced long-term durability, and greater impact resistance. In addition, manufacturing and installation costs were reduced by approximately 10% with the use of SFRC.

THE CHALLENGES

Traditional RC segmental lining precast construction has several practical limitations and challenges as follows:



- Mass production of RC segmental linings typically require additional fabrication units to accommodate the assembly of rebar cages, consequently increasing manufacturing, labour and material costs.

- The addition of labour intensive rebar bending, cutting and fixing in the segment moulds result in longer manufacturing cycle time and higher labour costs, hence lower productivity.

- Prefabrication of the rebar cages requires ample factory space for mechanical bar-bending machines, jigs, and storage. See Figure 1.
- Skilled workers are needed to cut and bent steel rebars conforming to the requirements of BS 8666. See Figure 2.
- Segment steel moulds are fabricated with

Figure 1. Prefabrication and storage of rebar cages.

bolt holes, recesses for bolt pockets, grout socket and dimples around the recesses. Placement of steel rebars around mould

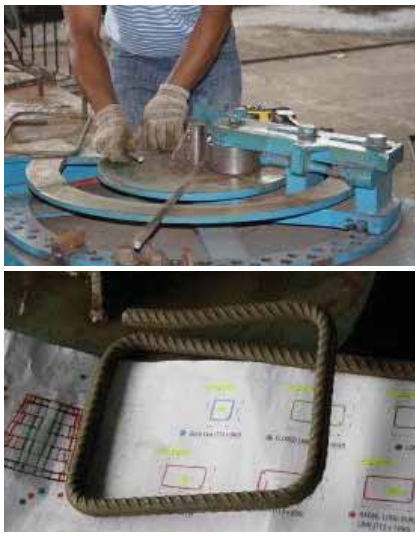


Figure 2. Worker using bar-bending machine to form links.

recesses, corners, and edges can often be problematic (See Figure 3). Rebar congestion is common and can inhibit the flow of fresh concrete which requires greater vibration and compaction effort. Hence, greater power consumption.

• RC segmental lining requires strict provision of nominal concrete cover for fire protection and durability requirements. It is also labour intensive to fix spacers to steel

Figure 3. Workers placing rebar cage around mould.

rebar and manual adjustment around bolt holes, recesses for bolt pockets, and grout sockets. See Figure 4. 0

• RC segmental lining is more susceptible to micro-cracking under loading which expose steel rebar to both external agents (e.g. groundwater infiltration and aggressive substance attack) and internal agents usually encountered in a tunnel (damp moisture and carbonation). On the onset of steel rebar corrosion, it propagates to entire rebar cage causing potential concrete spalling and reduction of structural capacity and durability. As the result, RC tunnels require regular maintenance regime during operational life. See Figure 5.

Figure 4. Covers around rebar cage inside segment mould.

• Design guidelines are available but there is no international code of practice for SFRC design. Therefore, a performance based design was carried out in collaboration with NTU.

East-West Line *North-South Line* *North-East Line*

Figure 5. Photos of Existing RC Tunnels Condition.

SOLUTIONS

SFRC is concrete incorporating discrete, discontinuous steel fibres. See Figure 6. Worldwide interest in the use of SFRC segmental lining in tunnel construction is raising as a result of the advantages SFRC can offer and the cost-savings achieved compared to the use of traditional RC segmental lining. The material's resistance against micro-cracking assures a remarkably low maintenance costs. The use of this material also simplifies the construction process and increases productivity.

Figure 6. Photos of SFRC.

Singapore Land Transport Authority (LTA) appointed ARUP to implement testing, design, and obtain approval for the use of SFRC materials in underground Mass Rapid Transit bored tunnels permanent segmental lining. LTA is the first rail developer and ARUP is the first consultancy in South East Asia to research this new alternative material in collaboration with Nanyang Technological University of Singapore.

A comprehensive testing regime on cubes, prisms, and full-scale segments were tested to validate the structural performance and behavior of SFRC materials in compression, flexural, tensile splitting and fire exposure (See Figure 7, Figure 8 and Figure 9). The Building and Construction Authority has been supportive in this initiative.

Design Approach

In Singapore, the design of tunnel precast concrete segmental linings follows the developer's design criteria and Singapore

Figure 7. SFRC Flexural Tensile Tests in NTU.

Figure 8. Segment Tests under Flexure in NTU.

Figure 9. SFRC Joint Testing in NIU.

Code of Practice. The segment is considered as a short column subject to bending moment and axial load. A design comparison of SFRC Segmental Lining based on RILEM TC 162-TDF and SS CP65 unreinforced concrete was carried out. The RILEM recommendation has been incorporated into BS EN 14651:2005 and is valid for SFRC with compressive strengths of up to C50/60. Figure 10 illustrates a simplified stress-strain relationship for the SFRC based on the RILEM recommendation. The compression side of the stress block follows SS CP 65. The residual tensile strength has been calculated based on test values from LTA-NTU testing. It was demonstrated that both approaches are comparable with regards to compression flexure capacity and hence in compliance with Singapore Standards.

Finite element modelling of segment joints has been carried out to evaluate SFRC joint

bursting behavior and compared with the LTA-NTU testing. See Figure 11.

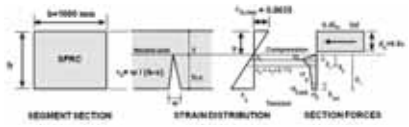


Figure 10. Simplified stress block for SFRC.

ADVANTAGES OF PROPOSED SOLUTIONS

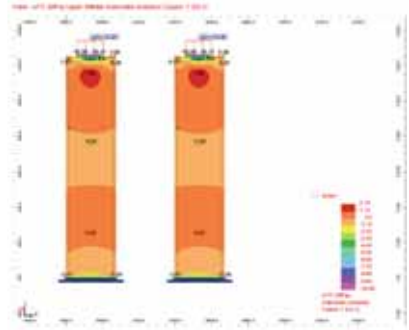


Figure 11. SFRC Joint Bursting Cheek.

The advantages of using SFRC in segmental tunnel linings are presented below:

- Increased Productivity

The use of SFRC facilitates rapid automated segment carousel production line and steam curing with consequent reduced factory space and number of moulds. Once the moulds are stripped they can be rapidly cleaned and returned for refilling. It is not necessary to install, align and fix a rebar cage within the segment mould (See Figure 12). The elimination of reinforcement also reduces the segment factory worksite area as the bar bending fabrication yard is eliminated. Table 1 below shows comparison of production rate of SFRC Segmental Tunnel Lining using conventional system and automated segment production.

Moreover, the segment production cycle time is reduced resulting in an increase in segment productivity of up to 25% as shown in Table 2 below.

Table 1. RC Se meat Conventional Production System vs SFRC Segment Carousel Production System.

	RC Segment Production using Conventional System	SFRC Segment Production using Carousel System
Daily Production capacity with 5 sets of mould	8 rings	10 rings
Workers per day	30 workers	30 workers
Man-day per ring	4 man-days	3 man-days
Curing Time	3 days including moist curing in moulds, application of curing compound, epoxy coatings on extrados and sides etc)	8 to 10 hours

- Impact Resistance

Table 2. SFRC VS RC Segments Production Rate.

	SFRC Segmental Tunnel Lining	Past Project RC Segmental Tunnel Lining
Production Rate	Ave 10 rings / day	Ave 8 rings from DTL/CCL

Steel fibres are multi-directional reinforcement and because they are evenly distributed throughout the segment, including the edges and corners (where conventional bars cannot be placed due to cover requirements), they can provide better resistance against impact and abrasion loads during segment handling and transportation from production factory to launching shaft, and eventual assembly in the Tunnel Boring Machine (i.e. less repairs to edge of segments, chipping, and spalling).

- Crack Control

Steel fibres arrest micro-cracking propagation, and formation of macro cracking. Tensile forces are transferred across the crack by the fibres resulting in lower stress concentrations at the crack-end, thus inhibiting crack growth. There is also reduced early age thermal cracking, and long term shrinkage cracking.

- Corrosion Resistance/Durability

Corrosion of reinforcement generally occurs when the passivity of the surrounding concrete is lost over a small area such as a crack or defect, and this small area becomes anodic to the surrounding steel. In structures reinforced with conventional bars it becomes possible for a small anode to draw on a very large cathode area, permitting corrosion to develop provided water and oxygen are present.

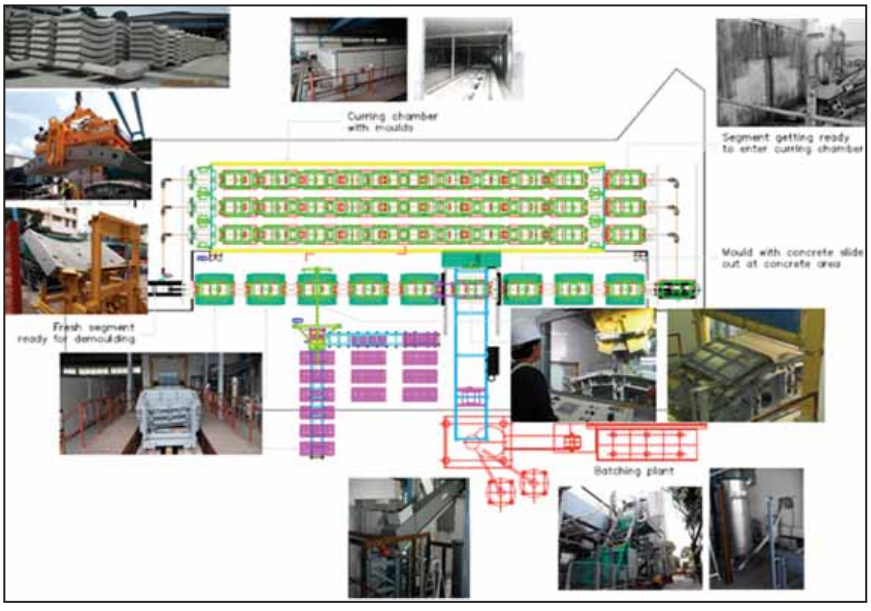
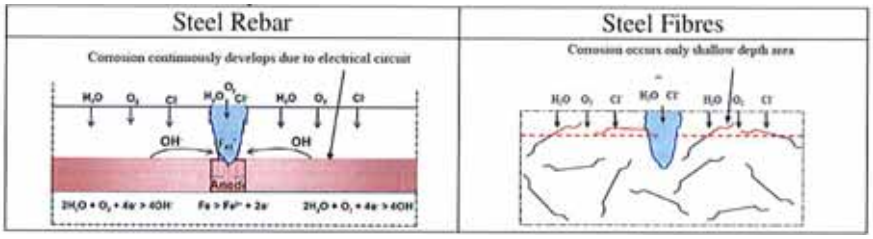


Figure 11. SFRC Joint Bursting Cheek.

In the case of SFRC not only does the use of steel fibres reduce the incidence of such cracking but, more importantly, even in the event that cracking does occur the discrete size of the individual fibres limits the cathode area available to sustain the reaction. The durability of SFRC with regard to chemical attack is therefore considerably enhanced (See Error! Reference source not found.).

Concrete cover to steel is not a critical component. As fibres are non-continuous and discrete, they provide no mechanism for propagation of corrosion activity; therefore, rust

Table 3. Comparison of corrosion resistance between RC and SFRC.



does not penetrate into the concrete (See Figure 13). Also, reduce stray current corrosion.

Segments reinforced with steel fibres are durable and highly resistant to chloride attack. Any chloride penetration via microcracks does not lead to widespread corrosion of reinforcement.

- Cost Savings

Figure 13. Fibre distribution and orientation in the tunnel segments.

The savings on production costs pertain mainly to steel materials, labours, equipments, worksite area, and higher production rate in segment production by eliminating the need for manufacturing, handling, storing and positioning of rebar cages. SFRC segments are less prone to edge of segments chipping, and spalling during segment handling and transportation, resulting in savings in repair cost.

While SFRC's resistance to micro-cracking and discontinuous nature enhance tunnel lining durability and reduce operational maintenance cost.

Being the first project in the region to adopt SFRC tunnel segments and having to set up many facilities from scratch in Singapore, the DTL3 experience shows cost of manufacturing and installation of SFRC segments is approximately 10% cheaper than using traditional RC segments, excluding preliminary cost. There will be potential upside for greater savings as more projects adopt SFRC segments/structures in the future for better economy of scale, and when there is more competition in the industry as more manufacturers and specialist laboratories are equipped for SFRC production. In the long term, it is anticipated that the maintenance cost of SFRC tunnels will also be relatively lower than traditional tunnels.

4. Sequence of events from idea to realization (timeline, milestones)

Preliminary Design Stage (March - July 2009)

- Establish preliminary performance criteria of SFRC for Singapore DTL3A.
- Prepare design statement for SFRC design.
- Prepare proposal for SFRC testing.
- Presentation to BCA on SFRC testing proposal.
- Application for Innovation Fund for LTA-NTU joint testing.

Pre-final Design Stage (July - November 2009)

- Update SFRC testing proposal/requirements in preparation for commencement of SFRC testing.
- Consultation with NTU on SFRC mechanical properties testing.
- Consultation with PSB on SFRC fire testing including fire curve, specimen size, instrumentation, tentative programme and test duration.
- Presentation to LTA Steering Committee.
- Inaugural meeting on contract for SFRC mechanical properties testing.
- Inaugural meeting on contract for SFRC fire testing.

Final Design Stage (December 2009 - April 2010)

- SFRC fire testing at PSB.
- Various SFRC testing carried out at NTU.
- LTA-NTU joint testing completed.
- Presentation of LTA-NTU joint testing result to AC and joint agreement on SFRC design principles.
- Final LTA-NTU joint testing report completed.
- Final design of DTL3A SFRC Tunnel Segmental Lining.

Statutory Approval and Contract Award

- SFRC Testing Results Presentation to BCA : 15 November 2010
- AC Endorsement : 18 April 2011
- BCA Approval : 19 May 2011
- Contract Award : 22 May 2011

Construction Stage (May 2011 – Present)

- SFRC Concrete Trial Mix Design: March 2012 – August 2012.
- Production of SFRC Tunnel Segmental Lining : Commenced on 19 October 2012, 50% of tunnel rings completed as of 25 September 2013.
- First TBM launch and SFRC segment installation : Commenced on February 2013

5. Please insert any other relevant documents/charts/photos etc which will assist in illustrating your case.

Figure 14. TBM Assembly inside Launch Shaft.

Figure 15. SFRC segment transportation from storage yard to launch shaft.

Figure 15. SFRC segment transportation from storage yard to launch shaft.

36th SCI Annual General Meeting 25th April 2014

SCI Annual General Meeting is organized once a year to select new board of directors. The 36th Annual General Meeting was organized on 25th April 2014 at NUSS Suntec City.

SCI Supports The Institutions Of Higher Learning For Academic Excellence

Singapore Polytechnic : SCI Gold Medal S$700
****Paid from the proceeds of the S$15,000 Non-Endowment Fund donated by SCI in 2010.**

Nanyang Technological University : Singapore Concrete Institute Book Prize S$200

National University of Singapore : Gold Medal S$100 Book Prize
****Paid from the proceeds of a capital sum of S$15,000 donated by SCI in 1997.**

SCI Social Networking Night at NUSS, Suntec City Guild House on 18th September 2014

PanUnited

The networking night for 2014 was organized on 18th September 2014. This event was sponsored by Pan-United Concrete Pte Ltd and 40 participants attended the event with lots of camaraderie spirit and socializing mood.






SCI was Supporting Association for BEX ASIA 2014 02-04 September 2014

SINGAPORE CONCRETE INSTITUTE

BCA ACADEMY
of the built environment

BCA-SCI 1½ DAY JOINT WORKSHOP ON

RECYCLED AND SECONDARY AGGREGATES AND THEIR USE IN CONSTRUCTION

INTRODUCTION

Over 30 billion tonnes of non-renewal resource in the form of aggregates are used per annum worldwide in the construction sector. A significant amount of this can potentially be replaced by recycled and secondary aggregates (RSAs). Funded jointly by BCA's Sustainable Construction Capability Development Fund and the Singapore construction industry, a state of art review of global knowledge from over 4000 publications on RSAs and their use in construction, undertaken by Prof R K Dhir OBE and his team over 2½ years, has recently been concluded. In this workshop, he will discuss the salient aspects of this review relating to potential use of recycled aggregates (RA), glass cullet (GC) and sewage sludge incinerated bottom ash (SIBA) in concrete, geotechnical, road pavement and other applications.

OBJECTIVES

The workshop aims to provide understanding of:

- The state of the art review of global research covering major RSA waste streams.
- Characteristics of the selected RSA materials and discovering their potential for use.
- What has been achieved globally and can be used and potential for further applications.
- Dismantling barriers to the use of RSA in construction.
- Environmental Issues and the status and role of the related standards and specifications.
- Case studies to demonstrate potential for use of RA, GC and SIBA materials.
- Potential for developing innovative and sustainable further use of RSA materials.

WORKSHOP TOPICS

DAY 1 (MORNING SESSION):

RECYCLED AGGREGATES

- Overview of 40 years global research
- Availability/processing of RA
- Properties and composition of aggregates
- Use and performance of RA in concrete, geotechnical and road pavement and other applications
- Standards and specifications
- Environment impact and life-cycle assessment
- Case studies
- Barriers to RA use
- Way forward to maximising RA use

DAY 1 (AFTERNOON SESSION):

GLASS CULLET

- Case for recycling GC in construction
- Overview of 54 years global research
- Procurement, processing and marketing
- Characteristics and implications
- Use as cement, filler and sand in concrete
- Use in ceramics, bricks, tiles, porcelain
- GC use in geotechnical and road pavement
- Case studies
- Environment Impact
- Standards and Specifications
- Way forward to maximising GC use

DAY 2 (MORNING SESSION):

SEWAGE SLUDGE INCINERATED BOTTOM ASH

- Potential for use
- Overview of 30 years global research
- Physical, chemical and mineralogical characteristics
- Use as cement component;
- Lightweight materials;
- Filler and sand in mortar and concrete
- Ceramics
- Applications in geotechnical and road pavement areas
- Environmental Issues
- Case studies
- Standards
- Maximising value-added use of SIBA

SPEAKER

PROFESSOR RAVINDRA K DHIR OBE, BSc PhD CEng MMIM Hon FICT HonFICI FGS
Director Applying Concrete Knowledge, UK
Professor of Concrete Engineering, University of Birmingham, UK
Adjunct Professor, Trinity College, Dublin, Ireland
Adviser, Centre for Concrete Construction, National Institute of Technology, India
Emeritus Professor of Concrete Technology, University of Dundee, UK

Known for his deep-seated and untiring commitment to the dissemination of research for the construction industry to benefit, and a dedicated teacher, Professor Dhir is an internationally acknowledged scholar and practitioner in the area of concrete technology and sustainable construction. His innovative approach to develop cutting edge research having collaboration with industry won him numerous prestigious awards, including the Order of the British Empire for services to the construction industry. Author and editor of numerous: books (56), technical reports (74) and peer-reviewed journal and conference papers (377), he is the Past-President of the Concrete Society UK and member of Editorial Board of the Magazine of Concrete Research.

DATE & TIME

25 Sep 2014, 9.00am-6.00pm
26 Sep 2014, 9.00am-1.00pm
(Registrations starts at 8.30am)

VENUE

BCA Academy

FEE *(inclusive of GST)*

S$565.00* / S$620.00

** BCA Young Leaders, BCAA Alumni card holders, SCI members, group of 3 or more and early birds application made on or before 1 Sep 2014.*

Lunch and tea breaks are included for Day 1. Morning tea break is included for Day 2. 30-page Digest (summary of the report) for each RSA material will be made available to all participants.

TARGET AUDIENCE

- Developers
- Architects
- Professional Engineers
- Design Engineers
- Accredited Checkers
- Builders
- QA/QC Engineers
- Ready-mix Concrete / Recycled Aggregate Producers
- Researchers

CPD POINTS

PEB: Pending
BOA-SIA: Pending

BCA ACADEMY
200 Braddell Road Singapore 579700
Tel: 6248 9999 Fax: 6258 0558
www.bcaa.edu.sg

SINGAPORE CONCRETE INSTITUTE

BCA ACADEMY
of the built environment

BCA-SCI 1½ DAY JOINT WORKSHOP ON

RECYCLED AND SECONDARY AGGREGATES AND THEIR USE IN CONSTRUCTION

REGISTRATION FORM

BCA-SCI 1½ day Joint Workshop on
Recycled and Secondary Aggregates and their Use in Construction

Event Code: 78068

For Official Use	
Application No.:	
Official Receipt No.:	
Processing Officer: (signature/date)	
Cashier: (signature/date)	

Date & Time: 25 Sep 2014, 9am-6pm & 26 Sep 2014, 9am-1pm (Registration starts at 8.30am)
Venue: BCA Academy
Fee (incl of GST): ☐ S$565.00* ☐ S$620.00 (Please tick one)
* Discounted fee is only applicable for: BCA Young Leaders, BCAA Alumni card holders, SCI members, group of 3 or more and early birds application made on or before 1 Sep 2014.
☐ Early Bird ☐ Group Discount ☐ BCA Young Leaders Card No.: ☐ BCAA Alumni Card Holders ☐ SCI members Membership No.:

PARTICIPANT PARTICULARS

(1) Name of Participant: (as in NRIC/Passport/FIN) Birth Date: (DD/MM/YYYY) Hp No.: Email Address:
NRIC/Passport/FIN No.:
Designation:

(2) Name of Participant: (as in NRIC/Passport/FIN) Birth Date: (DD/MM/YYYY) Hp No.: Email Address:
NRIC/Passport/FIN No.:
Designation:

(3) Name of Participant: (as in NRIC/Passport/FIN) Birth Date: (DD/MM/YYYY) Company UEN No.:
NRIC/Passport/FIN No.:
Designation:

COMPANY DETAILS

Company Name: Tel No.:
Mailing Address: (for individual applicant, please provide residential mailing address) Hp No.:
Fax No.:

CONTACT PERSON PARTICULARS (if different from the above)

Name (Dr/Mr/Mrs/Ms): Email:

PAYMENT

Enclosed is a Cheque No.: (Cheque should be crossed, marked "account payee only" and payable to **Building and Construction Authority** and mailed to **BCA Academy, 200 Braddell Road, Singapore 579700** for S$ OR Deduct from GIRO Account No.: The GIRO Account Number must be the same bank account number as indicated in the Direct Debit Authorisation form submitted to BCA.)
(Note: Only company cheque or company GIRO will be accepted if the company is applying for funding or subsidy)

TERMS AND CONDITIONS

By submitting and signing this application form, the company and individual applicant agree to the following:
a. The company and individual applicant warrant that the particulars given in the application form are accurate.
b. The company and individual applicant warrant that this particulars given in the application form are accurate.
c. The Building and Construction Authority (BCA) can disclose to other government agencies any information relating to this application.
d. Payment for the course must be made before the course commencement date; there will be no refund of course fee.
e. Any Direct Debit and Direct Credit Authorisation for GIRO applications privately signed and passed to BCA will apply to payments made under this course.
f. BCA Academy shall at its discretion allocate a space to the registered applicant, revise the course fees without prior notice, cancel or postpone the course.
g. BCA Academy reserves the right to accept or reject the application for whatever reason.
h. BCA Academy reserves the right to amend any details relating to the course, revise the course fees without prior notice, cancel or postpone the course.
i. No attachment is allowed.
j. Request for withdrawal or replacement must be made in writing. Requests are subject to approval by BCA Academy.
- Written request for withdrawal that reaches BCA Academy
- Written request for replacement must reach BCA Academy before the course commencement date. There will be no additional charges for suitable replacement.
- Written request for withdrawal that reaches BCA Academy
- At least 2 weeks but more than 3 working days before the course commencement date: 10% administration fee is payable.
- Less than 2 weeks but more than 3 working days before the course commencement date: there will be no refund of course fee.
- 3 working days or less before the course commencement date: 25% administration fee is payable.
k. The Continuing Professional Accreditation (CPD) points indicated for any course offered by BCA Academy is subject to change and final approval by the relevant professional accreditation bodies.
l. Funding and subsidies offered by BCA / BCA Academy or third party organisations for the courses are subject to approval. The company must make the application for funding and subsidies. Neither BCA nor BCA Academy is to be held liable and the company agrees to pay BCA the applicable funding amount if funding and subsidies are either rejected or approved at a reduced amount, not granted at all or if funding is revoked, for whatever reason.
m. All information, materials, services, intellectual property and other property and rights provided by BCA and BCA Academy, either express or implied. BCA and BCA Academy makes no warranties of any kind, either express or implied, as to any matter, and all such provided on an "as is" basis. BCA and BCA Academy hereby disclaim all warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.
n. The materials supplied to the company and individual applicant for the course ("Materials") are for their personal reference only and the company and warranties, including warranties of non-infringement. The company and individual applicant shall defend, and indemnify BCA and individual applicant is not supposed to otherwise use the Materials. The company and individual applicant shall defend, and indemnify BCA and BCA Academy and its officers, employees and agents from and against any and all liability, damage, loss or expense (including reasonable attorneys' fees and expenses) imposed upon BCA and BCA Academy in connection with any claim arising out of the company and individual applicant's use of the Materials.

To be completed by Company and Individual Applicant

COMPANY APPLICANT
Name:
Signature:
Date:
Company Stamp (For company application)

INDIVIDUAL APPLICANT
Name:
Signature:
Date:

78068.070814.0003

BCA ACADEMY of the built environment

ENQUIRIES
Tel: 6248 9999 • Fax: 6258 0558 • Email: bca_academy@bca.gov.sg • Website: www.bcaa.edu.sg

Singapore Concrete Institute Supported the 39th Our World in Concrete and Structures Conference and awarded Atsushi Saito.

PREMIER CONFERENCES

Singapore Concrete Institute sponsored the SCI Award in this year conference which was presented to Atsushi Saito for his original paper titled
"Study on application of water supply curing system to electro-chemical repair"
Atsushi Saito*, Takahiro Nishida , Shu Yamamoto, Nobuaki Otsuki and Akira Shono

SCI was Supporting Association for Concrete Show Asia 15-17 Octorber 2014

PBU MANUFACTURER ACCREDITATION SCHEME

The PBU (Prefabricated Bathroom Unit) Manufacturer Accreditation Scheme was launched at the workshop titled "PBU-Prefabricating Our Future" held on the 6 August 2014 organized by the BCA Academy. It is developed jointly by BCA and SCI. However SCI will administer the scheme and award the Certificate of Accreditation. From 1 November 2014, projects are mandated by Building Control (Buildability and Productivity) Regulations to adopt Prefabricated Bathroom Units (PBUs) in residential (non-landed) sites, including Executive Condominiums, and the residential (non-landed) component of mixed-use sites sold under the GLS programme. The PBU Manufacturer must obtained the BIP (Building Innovation Panel) In-Principle Acceptance prior to application for accreditation. The accreditation assessment emphasise on capabilities, processes and specific quality criteria for PBU. The scheme ensures quality assurance and control in production of PBU. It sets the process for PBU manufacturers to produce high quality PBUs and maintain the good quality standards.

EVALUATION CRITERIA

The requirements under each criterion are identified for system audit and in-process assessments. Each criteria is fine-tuned to assess the production processes and for continual improvement to the quality plan.

- Quality Management System
- Plant and Design Capabilities
- Human Resource
- Quality Control In Production
- Storage, Delivery and Maintenance
- Corrective and Preventive Actions

BENEFITS OF THE ACCREDITATION

Accredited manufacturer can expect the following results in their quality management system and production processes:

- Effective quality plan implemented
- Good human resource management
- Sufficient resources allocation and efficient utilisation
- High quality control and quality assurance
- Timely inspections and tests
- Regulated control of nonconforming product
- Realistic corrective & preventive action


PBU MANUFACTURER ACCREDITATION SCHEME

APPLICATION FORM

INSTRUCTIONS

DECLARATION

SECTION A: APPLICATION

SECTION B: COMPANY INFORMATION

Waterproofing Accreditation Scheme

Singapore Concrete Institute's Accreditation Scheme for Waterproofing Specialist Contractors was launched in September 2004. The aim of the Scheme is to ensure competency in workmanship. Thus, it raises the quality and capabilities of the waterproofing specialists serving the industry. It also provides recognition to contractors who are committed to deliver quality works. This scheme is managed by the Singapore Concrete Institute (SCI) as part of the effort to promote greater self-regulation by the industry.

The accreditation criteria were developed jointly by the SCI and BCA (Building and Construction Authority) with inputs from Waterproofing specialists and the Waterproofing Trade Association. Real Estate Developers' Association of Singapore (REDAS) had given their support on the scheme and would encourage its members to specify the use of accredited contractors for their projects. The waterproofing specialist must be registered in the Building and Construction Authority's CRS (Contractor's Registry System) according to their respective financial grade under the waterproofing workhead CR13 prior to application for accreditation.

Accreditation Grading And Accreditation Process

There are three categories of grading that is W1, W2 and W3. Waterproofing specialists will be assessed using the accreditation criteria during the accreditation audit. Subsequently, the accredited contractors will be assessed annually for compliance in order to retain their grading.

Accreditation Criteria

The accreditation criteria are based on three main areas. They are:

- Financial & Track Records
- Human Resources
- In-house Quality Management System

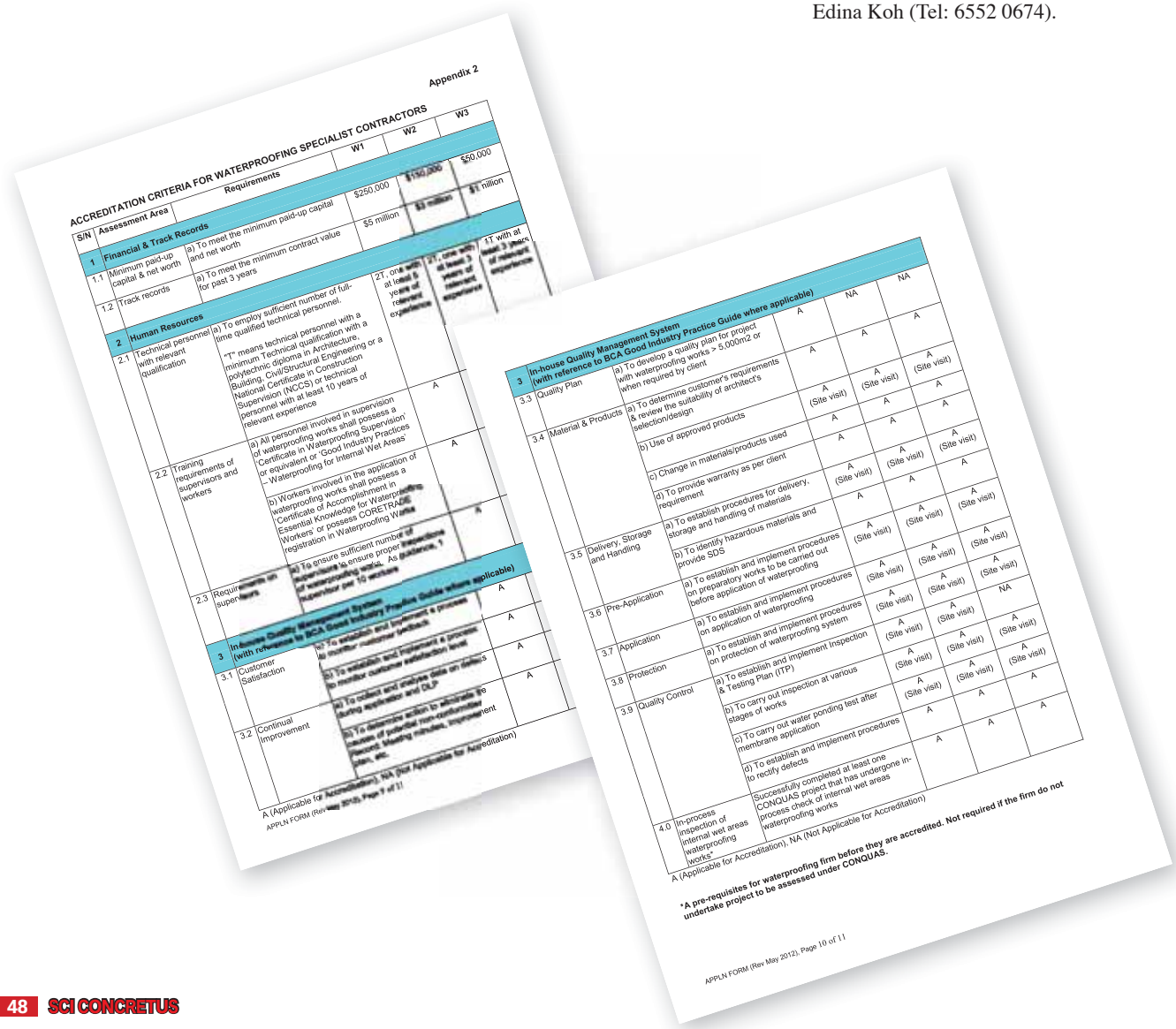
Benefits of Accreditation

The benefits of the scheme include:

- To recognise contractors who are committed to deliver quality waterproofing works, the Building and Construction Authority (BCA) has agreed to award full points for the in-process check of internal wet area waterproofing for projects assessed under CONQUAS, if the waterproofing work is carried out by a SCI waterproofing accredited firm. On-site verification is not required.
- This will certainly add value to the SCI Accreditation Scheme as main contractors will be encouraged to engage accredited firms to carry out waterproofing works for their projects.
- Improved marketability and competitiveness
- Supported by REDAS
- Enhanced public image of firms
- The assessment for internal wet area waterproofing process will be waived and the two points (in architectural score for CONQUAS) allocated automatically if the appointed contractor for such works is accredited under the SCI Waterproofing Accreditation Scheme.

Enquiry

For more information, please contact Ms Edina Koh (Tel: 6552 0674).



Accredited Waterproofing Firms

UNISEAL SINGAPORE PTE LTD
31 Mandai Estate, #06-06,
Innovation Place, IMMEDIA,
Singapore 729933
Tel: 67550055
Fax : 67531398
maychoo@uniseal.com.sg

BESTCOAT CONTRACT SERVICES PTE LTD
10 Admiralty Street, #06-29,
North Link Bldg,
Singapore757695
Tel: 67523005
Fax : 67533208
sandy@bestcoat.com.sg

CEMENTAID (SEA) PTE LTD
12 Neythal Road,
Singapore 628578
Tel: 6896 9801
Fax : 68969807
gabrielleung@cementaid.com

CHIN LEONG CONSTRUCTION SYSTEMS PTE LTD
No. 2 Tanjong Penjuru, Singapore 609017
Tel: (65) 6265 2788 Fax: (65) 6266 0081
Joyce.Ong@clp.com.sg

CRG CONTRACTORS PTE LTD
30 Toh Guan Road, #07-00
Singapore 608840
Tel: 68633977
Fax: 68634552
crg88@singnet.com.sg

MAXBOND ASIA PACIFIC (WP) PTE LTD
9 Tagore Lane, #03-13, 9@Tagore,
S'pore 787472
Tel: 64573168
Fax : 64573868
jeffrey@maxbond.sg

LEE CONSTRUCTION PTE LTD
50 Kallang Avenue, #01-01,
Noel Corporate Building, S339505
Tel: 68422345
Fax : 68424812
mianne@leeconstruction.com.sg

HENG BOON SENG CONSTRUCTION PTE LTD
3 Pemimpin Drive, #07-05, Lip Hing
Industrial Building, S576147
Tel: 62590988
Fax : 62593822
dorispeh@hbsc.com.sg

ASIABUILD ENTERPRISES PTE LTD
80 Playfair Road, #07-11, Kapo Factory
Building Blk B, S367998
Tel: 62854988
Fax : 62843677
project@asiabld.com

BCS-PROKON CONTRACTORS (PTE) LTD
53 Ubi Avenue 1, #03-28, Paya Ubi
Industrial Park, S408934
Tel: 67445841
Fax : 68410632
bcswp@singnet.com.sg

LH WATERPROOFING SPECIALISTS PTE LTD
27 Mandai Estate Tower 2
#05-05 Innovation Place
Singapore 729931
Tel: 63142322
Fax: 63142022
lhwps@singnet.com.sg

GOLDFIELD CONSTRUCTION PTE LTD
48 Toh Guan Road East, #06-132,
Enterprise Hub, S608586
Tel: 68966600
Fax : 63166600
admin@goldfield.com.sg

ENG SENG TECH PTE LTD
24 Woodlands Industrial Park E
Singapore 757801
Tel: 63687737
Fax: 63657477
willie@engsengtech.com.sg

PRO-WERKZE (S) PTE LTD
39 Opal Crescent
Singapore 328427
Tel: 62940018
Fax: 62940017
prowerkze@yahoo.com.sg

MAXISEAL PTE LTD
7030 Ang Mo Kio Ave 5, #05-19, North
Star@AMK, Singapore 569880
Tel: 68942393
Fax: 62970481
kenix@maxiseal.com.sg

QIN JIN BUILDING SERVICES PTE LTD
Blk 644 Hougang Ave 8 #01-277
S530644
Tel: 63853572
Fax: 6385 1076
qinjinbuilding@hotmail.com

ACP BUILDING SERVICES PTE LTD
63 Hillview Avenue #07-03
Lam Soon Industrial Building
Singapore 669569
Tel: 67695190
Fax: 67695928
kim@acp-bldgsvc.com

ADF WATERPROOF PTE LTD
25 Mandai Estate, #05-12, Innovation
Place Tower 1, Singpore 729930
Tel: 67496382
Fax : 67696285
delonsh@gmail.com

CAPSTONE ENGINEERING PTE LTD
48 Toh Guan Road East, #05-149,
Enterprise Hub, S608586
Tel: 64698983
Fax : 64688831
hr.admin@capstone-engineering.com.sg

HOE KIM TILING & BUILDING PTE LTD
82, Lor 23 Geylang, #02-01
ATRIX, Singapore 388409
Tel : 63460585
Fax : 63460653
joanne@hoekimtiling.com

KHIAN HENG CONSTRUCTION PTE LTD
294 Lavender Street,
Singapore 338807
Tel : 62557355
Fax : 62537696
patricksoo@khianheng.com.sg

SOURCE WATERPROOFING PTE LTD
7 Kaki Bukit Road 1, #01-05, Eunos
Technolink, Singapore 415937
Tel: 67444693
Fax: 67444367
source46@singnet.com.sg

YJ WATERPROOFING PTE LTD
51 Jalan Pemimpin #04-03
Mayfair Industrial Bldg,
Singapore 577206
Tel: 62556880
Fax: 62556881
slp@yjwp.com.sg

WATERPROOFING EXCELLENCE AWARD

The inaugural Waterproofing Excellence Award was launched on 15 November 2013 at the SCI 35th Anniversary Gala Dinner at the Swissotel Merchant Court, Singapore. To-date, two SCI accredited waterproofing firms namely, Bestcoat Contract Services Pte Ltd and Maxiseal Pte Ltd , were awarded the Waterproofing Excellence Award. This distinction award recognises SCI accredited waterproofing specialists for their commitment and achievement in delivering high quality waterproofing workmanship. It promotes leading SCI accredited waterproofing firms who have consistently excel in their waterproofing workmanship, setting high quality standards for their workmanship and improve the waterproofing process.

The award winners are selected base on the criteria below and the acceptance of the award is voluntarily. There is no need for nomination and application. SCI have implemented this special award for their accredited waterproofing firms to enhance the industry professionalism and increase their quality workmanship of waterproofing performance. In appreciation of the SCI accredited waterproofing specialists, SCI would like to raise the waterproofing performance even higher through the continuous audit of these firms by their participation in the Waterproofing Accreditation Scheme.

EVALUATION CRITERIA

1.The waterproofing firm must be accredited under the SCI Waterproofing Accreditation Scheme.

2.The SCI accredited waterproofing firm have completed at least 5 CONQUAS/QM projects within a period of 3 years.

3. All completed CONQUAS/QM projects within the last 3 years must achieved 100% pass in the internal wet area water-tightness tests.

BENEFITS OF THE AWARD

- The Waterproofing Excellence Award is given to the firm as a distinction of excellence in quality waterproofing workmanship and for their support of the SCI Waterproofing Accreditation Scheme.
- For CONQUAS project engaging SCI accredited waterproofing firm with Waterproofing Excellence Award, an extra provisional Bonus Point will be considered for the Architectural Score.
- The award-winning firm is given an award certificate and issued with the Waterproofing Excellence Mark.

Precaster Accreditation Scheme

Background

The Singapore Concrete Institute's Precaster Accreditation Scheme was launched on 1st January 2007. The Scheme aims to improve the quality and productivity of precasters serving the construction industry. It also provides recognition to precasters who are committed to quality and productivity of the production plant and products. The scheme is opened to local and overseas precasters which have their fabrication yard located outside Singapore. This scheme is managed by the Singapore Concrete Institute (SCI) as part of the effort to promote greater self-regulation by the industry. The accreditation criteria were developed jointly by the SCI and the Building and Construction Authority (BCA) with inputs from the precasters.

Accreditation Categories & Criteria

There are three Categories of Accreditation:

Category PC1

Precaster that has the financial and plant management, available facilities and human resources, traceable track record, drawing, quality and productivity capabilities to produce precast concrete element(s) in their respective product group with a total contract value more than or equal to S$30 million in the past 3 years.

Category *PC2*

Precaster that has the financial and plant management, available facilities and human resources, traceable track record, drawing, quality and productivity capabilities to produce precast concrete element(s) in their respective product group with a total contract value more than or equal to S$5 million but less than S$30 million in the past 3 years.

Category PC3

Precaster that has the financial and plant management, available facilities and human resources, traceable track record, quality and productivity capabilities to produce precast concrete element(s) in their respective product group with total contract value less than $5 million in past 3 years.

The accreditation criteria are based on the assessment areas as follows:

- Management and Facilities
- Track Record and Production Drawings
- Quality Control in Production

Product Groups

Precasters will be classified into the following six groups:

GS1 - Precast Concrete Products (No Prestressed Reinforcements)

GS2 - Prestressed Repetitively Produced Products, including all products in GS1

GS3 - Prestressed Structural Products, including all products in GS1 and GS2

GC1 - Bridge, Railway and Roadwork Structural Products

GC2 - Sewerage and Drainage Products

GA - Non-Structural Products

The detailed product group table is available in Annex 1 Item 4.0 of the revised application form. The rationale of product grouping is to assist the industry to identify the precasters that are suitable for the particular project.

Precaster Accreditation Process

Precasters will be assessed using the accreditation criteria during the initial accreditation audit. Subsequently, the precaster will be assessed annually for compliance in order to retain its grading.

The benefits of the scheme include the following:

- Accredited Precasters can pride themselves to be recognised as among the best in the industry, having achieved the required standards in its class of accreditation
- The Accreditation Register will be a good source for selection of reliable precasters.
- The scheme will encourage continual improvement and professionalism as Accredited Precasters aspire to upgrade to higher categories.
- The use of precast elements supplied by SCI accredited precasters will be given one bonus point to the structural score in CONQUAS 8th edition.
- The classification of accredited precasters into the 6 product groups helps the industry to identify the appropriate precasters for a particular project.

Precaster Accredited Firms

Accredited Precasters PC 1

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Fax: 65810482
rosie@sunway.com.sg

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Fax: 607-2417127
kherold@chuanluck.com

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Tel : 64845854
Fax : 64846405
ngkokkeong@cnqc.com.sg

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Taman Impian Emas, 81300 Skudai,
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Tel: 607-5576509
Fax: 607-5576463
rodiah@klpile.com

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Johor.
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Fax : 607-5562598
unibaseprecast_mkt@yahoo.com

Accredited Precasters PC 3

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Enquiry

For more information, please contact Ms Edina Koh (Tel: 6552 0674).

The 40th Conference on OUR WORLD IN CONCRETE & STRUCTURES

Singapore, 26-28 August 2015

Secretariat: CI-Premier Pte Ltd, 150 Orchard Road #07-14, Orchard Plaza, Singapore 238841

Tel: 65-6733-2922 E-mail: ci-p@cipremier.com

web: www.cipremier.com

On 26-28 August 2015, OWICS will present to you and celebrate its 40th successive year. To mark this auspicious occasion, Emeritus Professor Seng Lip Lee will be the guest of honour.

Dr C T Tam, another doyen of OWICS who has attended all except one of the series will deliver the CONFERENCE LECTURE and A/Prof Gar K C Ong, National University of Singapore will continue as the Conference Chairman consecutively for the last eleven years.

The OW15 conference will feature at least 10 prominent renown professors and professionals, many of whom have supported OWICS for over 15 years like Prof Franco Mola, Italy; Emeritus Professor Shoji Ikeda, Japan; Emritus Professor G M Sabnis, USA, Mr Chris Stanley, UAE; Mr C R Alimchandani, India; Mr Willie Kay, Singapore and Kiat Huat Seow, Singapore.

The OW15 Conference will continue the 12 'Highly Commendable Paper Awards sponsored by the Support Organisations and the Industry. 3 special Awards in the memory of good friends, the late Tibor Javor (Czech), late Ken Francis (HK) and late HoePeng Lim (Singapore) are also presented .

Other Higlights!
-the special party to mark the 40th year of OWICS.
-the Concrete Industry Dinner
-the Concrete Dinner Quiz
-the ACI Project Competition
-Construction Site Visit on 26 August (on advanced request)

TOPICS

01- Concrete design & analysis for buildings & structures
02- Concrete mix design, quality control and production
03- Concrete technology, ready-mix, SCC, RCC
04- Concrete plant, equipment and machinery
05- Concrete repairs and rehabilitation
06- Concrete materials, composites
07- Concrete construction and safety
08- Concrete application in roads, bridges, tall buildings, tunnels, underwater, underground, etc

SPECIAL SESSIONS on selected and special topics –Organisers are invited.

IMPORTANT DATES

- Abstracts deadline (in one A-4 page) 30 Mar '15
- Notification of acceptance 30 Apr '15
- Full text in required format to be received by 30 Jun '15
- Conference Dates 26-28 Aug '15

PUBLICATION POLICY

Please note that it is part of the requirements of submission of abstract that the author or one of the co-authors will attend the Conference and present the paper.
Papers accepted for inclusion in the Conference Proceedings will have to be registered, with a text-inclusion fee (SGD400 for each accepted paper). All registered participants would be issued with a copy of the proceedings. It is also an understanding that the Organisers hold the copyrights of the papers published in the Proceedings, which will carry an ISBN reference. The proceedings would be submitted to the relevant indexed organisation after the conference.

CONCRETE AWARDS

All accepted papers (except keynote and invited papers) will automatically be reviewed and assessed for consideration in the Concrete Awards Scheme (non-competitive) for its originality and level of excellence, provided the text is received before 30 June 2014.
More than 10 such awards are available.
In the memory of a dear friend, the LIMHOEPENG Award will be created and added to the scheme.

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Employment Records

Employer's Name				Designation	
Address					
				Postal Code	
Tel. No.		DID/Ext. no.		Mobile No.	
Working Experience	Please state number of years in construction industry				

Qualifications: Academic (please attach photocopy of certificates):

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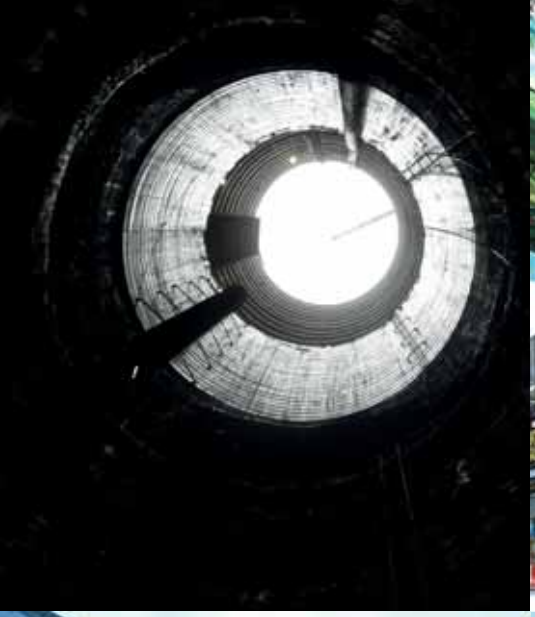

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