

BASF's Green Waterproofing System – CONIPUR

By Sunny Lim,
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Whatever the nature of the structure, one of the biggest challenges in the construction industry is to select the most suitable waterproofing material and system. Some applications may require the waterproofing system to withstand mechanical stresses and chemical exposure. There may also be a need for ease of application and fast turnaround especially for fast-track construction with tight schedule. Thus, selecting the right material and waterproofing system is more than just about durability, it also demands high quality and versatile solution that minimises whole-life costs and installation with minimal downtime. Structures with appropriate waterproofing system to protect it from defects from ingress or leakage of water also enhances its values.

BASF's CONIPUR waterproofing membrane systems comprise of CONIROOF, CONIDECK, CONIBASE and CONIBRIDGE employs the state-of-the-art fast curing spray applied polyurethane waterproofing system to provide complete waterproofing protection from rooftop to basement of buildings and for infrastructures such as tunnels and bridges. The CONIPUR waterproofing membrane has received the Green Label certificate from the Singapore Environmental Council (SEC), which is a non-government organisation that tasks to raise the level of environmental awareness and action



CONIDECK for car park deck protection

within industry and the community. The Green Label certificate is recognised by members of the international Global Ecolabelling Network (GEN).

This waterproofing membrane meets the SEC's requirement of having extremely low Volatile Organic Compound (VOC) with non-detectable halogenated organic solvent, epichlorohydrin and heavy metals. In the drive towards sustainable construction, the Building Construction Authority of Singapore

(BCA)'s GREEN MARK scheme recognises the use of Green Label certified product and merit points are allocated for its use.

The CONIPUR waterproofing membrane is sprayed through a computer controlled spray equipment, which maintains a preset compositions and pressure to obtain a high quality waterproofing membrane. It cures within 20 seconds to form a solid impervious monolithic membrane and, therefore, able to shorten the project timeline as other trades of work can follow on. The advanced equipment can spray an average output of 1,000 m² per 10 working hours with a four men work team. It also offers a unique benefit of conforming to all types of irregular or complex surfaces and profile of structure as it can be easily sprayed onto the surface. This removes the need for laps and preformed sections which are avenues for water ingress.

No special attention is needed for detailing work when using CONIPUR waterproofing membrane system so it speeds up the application by up to 20 times and is more reliable than traditional preformed membrane systems. It is suitable for both new and existing structures which required refurbishment providing exceptional robustness and optimum protection against the penetration of water.



CONIROOF for roof garden waterproofing



The CONIPUR waterproofing systems can be applied to a variety of substrates – from dense concrete to lightweight metal. As with all building operations, if the preparation of the substrate is poor, problems will arise in the future. Therefore, substrate preparation is the key to the successful installation of the system. The system adapts to different types of substrates by using polyurethane or epoxy resin preparation coats and primers, which are specially formulated for substrates such as dry and damp concrete, asphalt, timber, cement board, steel and aluminum. A low viscosity solvent free epoxy resin based primer is usually applied on dry concrete. Its low-viscosity allows it to penetrate into the pores and microcracks on the concrete surface. On a well prepared surface, the concrete adhesion strength of the CONIPUR waterproofing system can achieve more than 3.0 MPa with cohesive failure on the concrete substrate.

One of the main challenges for waterproofing work in a fast track project is the application of waterproofing membrane onto new concrete with less than seven days curing. The CONIPUR waterproofing system has a special primer that allows the waterproofing membrane to be sprayed onto a three day-old concrete without delamination and blistering.

In Singapore, the CONIPUR waterproofing membrane system is applied for the entire 250,000m²



environmental deck of Resort World at Sentosa, which is the largest project for CONIPUR system. The Resort World at Sentosa is a fast track project, which targets to open in early 2010 and the CONIPUR waterproofing system is selected due to its fast application, track records, quality and robustness. It was also selected to waterproof the tunnel at Sentosa Gateway Avenue that houses the utilities supply to the Resort World. Another challenging fast track project completed was the underpass below Paterson Road that links the new Orchard Ion Mall and Wheelock Place. The underground concrete structure was always damp and

with the use of the special primer, the CONIPUR waterproofing membrane was sprayed on time.

In 2006, the entire 25,000 m² curve roof of Vivo City Shopping Centre was sprayed with CONIPUR waterproofing membrane system. More than 80,000m² was applied to the exterior of a 20m high water tank and rooftop of the Changi Water Reclamation project. The CONIDECK, which is a heavy duty vehicular trafficable waterproofing system, was successfully applied to the MacRitchie Reservoir's exposed car park deck and to the car park decks of Orchard Ion Mall. **SCI**

Post-tensioned Slab-Column Connections Subjected to Cyclic Bi-directional Lateral Loading

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Overview

Three identical specimens representing a portion of interior slab-column connections were tested to failure. The columns were rectangular with a column aspect ratio of five, and the slabs were prestressed with unbonded tendons. The main variables were loading conditions. The first specimen (PI-0) was tested under gravity load only to study the symmetrical punching capacity of a connection with rectangular column.

The second specimen (PI-1) was tested under gravity and uni-directional cyclic lateral loading to study the effect of cyclic moment transfer about the strong axis.

The last specimen (PI-2) was tested under gravity and bi-directional cyclic lateral loading to study the effect of cyclic moment transfer about two orthogonal axes. During the application of lateral loadings, the gravity load to shear strength ratio was kept constant at 0.30. The gravity load is equivalent to 100% of dead load plus 25% of live load. The detail of the test setup is shown in Fig. 1



Connection Strength and Drift Capacity

All the specimens failed in punching shear mode. The maximum shear force (V), unbalanced moments (Mux and Muy), and drift ratio (DRx and DRy) are summarised in Table 1.

At the ultimate limit state, the unbalanced moment about the strong (major) column axis was about twice that of the unbalanced moment about the weak (minor) column axis. In addition, it can be seen from Table 1 that a specimen loaded in uniaxial direction (see PI-1) will fail at a higher moment (Mux) compared to when it is also loaded in the other direction (Muy of PI-2). Hence, bi-directional loading reduces the connection strength considerably. In term of drift capacity, specimen PI-1 failed at a drift ratio of 2.50% whereas specimen PI-2 failed at a drift ratio of 1.50%. Thus, bi-directional loading reduces the drift capacity of the specimen more than uni-directional loading.

Table 1 – Experimental results

Specimen	V	Mux	Muy	DRy	DRx
	kN	kNm	kNm	%	%
PI-0	511.8	-	-	-	-
PI-1	164.0	185.5	-	2.50	-
PI-2	170.6	162.1	79.8	1.52	1.49

Connection Ductility

Pan and Moehle (1989) proposed an arbitrary procedure to determine the connection ductility as illustrated in Fig. 2. In their method, the envelope of moment – drift ratio curve is idealized as an elastoplastic bilinear curve. The elastic portion intersects the actual curve at 2/3 of the maximum moment. The drift ratio at yield DRy is then taken as the drift ratio at the intersection between the elastic and plastic portions, whereas the ultimate drift ratio DRu is taken as the value that corresponds to 100% of maximum moment value. Megally

and Ghali (2000) used a similar procedure as Pan and Moehle (1989) to determine the connection ductility; however, the ultimate drift ratio is taken at 80% of the peak moment value instead of at 100% of moment value. For comparison purposes, both values of connection ductility (μ and μ_{80}) are presented in Table 2.

Comparing specimen PI-1 and PI-2, the connection ductility μ ($=DR_u/DR_y$) in the y-direction is reduced considerably due to the bi-directional cyclic lateral loading. Hence, it can be concluded that bi-directional cyclic lateral loading significantly reduces the connection ductility. However, it seems that column rectangularity has minor effect on connection ductility as specimen PI-2 produces about the same values of connection ductility in x- and y-direction. This finding was also found in tests by Tan and Teng (2005). The reason is that once the connection fails in one direction, the strength in the other direction also dropped or even lost. Thus, the values of connection ductility in the two orthogonal directions become similar. If the loads were applied uni-directionally in the two orthogonal directions, the results would be different significantly as shown in the tests by Anggadajaja and Teng (2008).

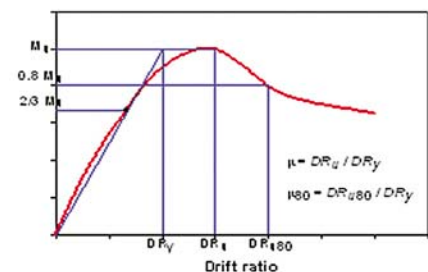


Fig. 2: Definition of connection ductility

Table 2 – Connection ductility

Specimen	μ		μ_{80}	
	x-dir	y-dir	x-dir	y-dir
PI-0	-	-	-	-
PI-1	-	2.17	-	2.82
PI-2	1.31	1.31	1.96	1.75

Connection Stiffness

As the connections go beyond elastic range, and due to cyclic lateral loadings, their stiffness deteriorates. To measure the rate of stiffness deterioration, stiffness parameter K as illustrated in Fig. 3 is adopted. The stiffness parameter K is calculated at the first cycle of each target drift ratio and plotted against drift ratio as depicted in Fig. 4. It was shown that the connection stiffness in the strong (major) column direction is much higher than the stiffness in the weak (minor) column direction. In addition, biaxial cyclic lateral loading reduces the connection stiffness significantly.

Acknowledgment:

This research was made possible by funding from the Ministry of Education and the Building and Construction Authority (BCA). The prestressing materials and equipment were made available by VSL Singapore Pte Ltd. **sci**

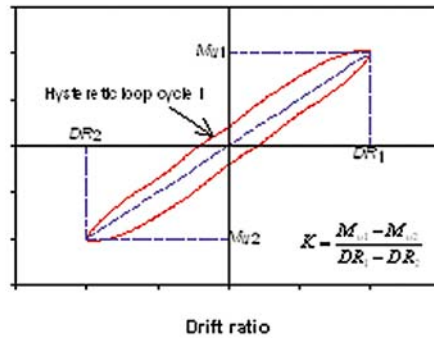


Fig. 3 – Definition of stiffness parameter K

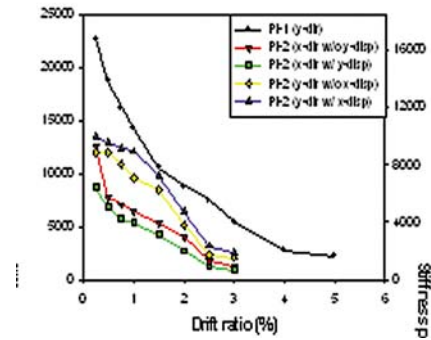


Fig. 4 – Stiffness parameter vs drift ratio

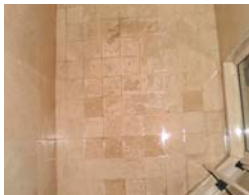
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Pre-stressed Structural Concrete: Trends in Selected Construction Methods

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Prestressing, introduced in the first half of the 20th century by visionary engineers and entrepreneurs, has permitted a progress in concrete construction which would have been simply impossible without it. Many outstanding structures are testimony to this procedure.

Post-tensioned concrete bridges have seen an extraordinary development over the last 50 years. They established themselves firmly in a leading position in bridge construction up to spans of the order of 250-300m. This development has transformed a range of bridge spans to concrete which was formerly exclusively in the hands of structural steel. Indeed, in terms of bridge surface concrete has taken the lead over other construction materials in many countries. Much of this success has been due to (a) local availability of concrete materials, (b) development of specific construction methods and specialised erection equipment, (c) improved knowledge in design of structural concrete as reflected in modern codes, and (d) availability of modern post-tensioning technology.

Norway has been a pioneer in introducing post-tensioned concrete into offshore platform construction. These structures include giant gravity based platforms, floating platforms, and more recently floating movable platforms in the form of concrete vessels. Again, post-tensioned concrete permitted to break successfully into a domain previously held exclusively by steel construction.

Another domain in which post-tensioned concrete has acquired a proven track record are structures such as reservoirs, tanks and containments for storage of dry and liquid materials and for protection against safety hazards. These containment structures will receive significant attention over the next years or decades in view of the increasing energy demands.

Although perhaps less spectacular, application of post-tensioning in building construction - mainly in floors - has been a leading type of use of post-tensioning in many countries in South East Asia and North America. In many of these countries, the use of post-tensioning in buildings exceeds the one in bridge construction

Trends in Buildings

The USA, Australia and many countries in South East Asia and South America use more than half of the prestressing steel for the post-tensioning of building floors. Typical applications are office buildings, shopping centres, hotels and even some residential construction. Post-tensioned floors are a proven and competitive construction method for buildings in these regions. Some of the well recognized advantages of the post-tensioned floors in buildings are:

- (1) Longer spans of floors creating large open space in buildings and offering significant flexibility and comfort to the user;
- (2) Reduced material consumption for concrete (-20%) and reinforcing steels (-65%), and hence, reduced labour (-60%) and crane needs;
- (3) Fast cycle times for formwork and reduced need for back-propping because of the load balancing produced by the post-tensioning tendons when stressed;
- (4) Post-tensioned flat slabs can be used even for quite large spans permitting easier installation of electrical and mechanical equipment with reduced overall floor-to-floor height;

- (5) Post-tensioning tendons installed across supporting columns and walls offer significant redundancy under accidental loading and can prevent progressive collapse.

Flat plates are often the optimum choice for the floor system in terms of overall economy of the entire building because this saves overall construction height and reduces building volume. Post-tensioned concrete also offers about 20% reduced CO₂ emissions when compared with reinforced concrete construction. Long span flat concrete plates are, however, relatively heavy when compared with beam and slab systems or other construction methods. Recently, special circular void formers have been proposed for use in cast-in-place flat concrete plates. These void formers are installed in the plate, primarily in regions with low shear force, i.e. away from columns or wall support, see Fig. 1. They permit the placing of bi-directional post-tensioning tendons. These void formers reduce concrete volume, weight and CO₂ emission by up to 30%. Therefore, they are also interesting for buildings in seismic regions.

Cast-in-place concrete members brings further advantages in particular for large scale, fast-track building projects. Precast concrete elements are used as lost formwork to reduce or avoid the need for conventional formwork. They provide an immediate work platform for placing of reinforcing steel and tendons, and finally act compositely with the cast-in-place post-tensioned concrete to form an efficient monolithic structural member with high quality surface.



a) Void formers installed in formwork



b) Finished floor slab

Figure 1. Void formers for cast-in-place building floors

Trends in Precast Segmental Bridges

Precast segmental construction has taken a dominating role in concrete bridge construction in particular for large scale and fast-track projects. Precast segmental bridge decks, mostly box girders with internal and/or external post-tensioning tendons, have become a preferred construction method up to spans of about 100-120m. Short-line match casting of segments permits to follow almost any bridge deck alignment even in very constrained space in urban areas. Precast segmental box girders are competitive and are now preferred over precast beam solutions in many parts of the world. Without the availability of precast segmental construction technology, many of today's fast-track urban projects would likely be built in steel.

In the past, precast segmental construction was almost exclusively used for highway bridges, but more recently some notable examples of railway bridges have been constructed. These examples include many light rail structures built in urban areas. Only in Dubai over 60 km of precast segmental light rail viaducts were erected over the last three years. However, precast segmental construction is also feasible for high speed railway structures as demonstrated by the Avignon viaducts.

Figure 2 presents these two exceptional examples of railway bridges.

Despite the successful use of precast segmental construction in many countries, some owners and engineers remained reluctant to use this construction method. This was mainly due to some reservations on the use of external tendons, in general, and the protection of internal tendons across segment joints, in particular.

Trends on Extradosed Segmental bridges

As mentioned above, the maximum span range of precast segmental bridges is limited to about 100-120m. This span range can be extended without changing the depth of the deck by adding extradosed tendons which support the deck. Extradosed tendons are external tendons placed outside of the envelope of the box girder somewhat similar to stay cables, but typically at a shallower inclination to the deck. Extradosed segmental bridges typically have a relatively stiff deck when compared with conventional cable-stayed bridges.

The typical span range for extradosed concrete bridges is 100 – 200m, with some composite examples reaching 300m. Typical girder depths at pier and mid-span are Span/35 and Span/55, respectively. The height of the pylon above deck is of the order of Span/12.

The extradosed deck is typically erected by balanced cantilever construction with progressive installation of the extradosed tendons.

The main advantages of the extradosed bridge construction include increased deck slenderness, improved geometry control during construction, improved in-service stiffness of the deck, and reduced stress amplitudes in the tendons when compared with stay cables allowing a more efficient utilization of the tendon at higher loads than stay cables. In practice, the stress range from live load is of the order of 20 – 50 MPa for highway loading, and therefore, the permissible upper load has been set at 60% UTS, i.e. between the corresponding levels of stay cables and external tendons of 45% and 80% UTS, respectively. However, system acceptance tests are required at the order of 140 MPa fatigue stress range. With these parameters, extradosed tendons are less sensitive to vibrations than stay cables. This type of bridge may also be suitable for railway structures.

Early types of extradosed tendons consisted of a bundle of 7-wire strands inside a HDPE pipe, injected with cement grout after stressing, i.e. similar to external tendons. However, such grouted systems perform marginally in fatigue tests with stress ranges of the order of 140 MPa. Therefore, non-grouted extradosed tendons are now used, initially introduced in Japan and now also elsewhere.

With their particular features, extradosed bridges are well adapted for the use of saddles at the pylon. With such saddles the tendons are continuous from one deck anchorage through the pylon to the opposite tendon end anchorage at the deck. Hence, there is no need for sizeable chambers inside the pylon for installation and stressing of tendons. The pylon dimensions can therefore, be optimised for structural requirements.

A new generation of saddles has now become available where each individual strand is guided inside an individual hole through the saddle. This significantly improves fatigue and ultimate tensile strength of the tendon in the saddle, and makes it comparable to the performance of the tendon anchorages. Specific details and shaping of the individual holes permit transferring some differential force from the strands/tendons through the saddle into the pylon. With optimised details friction coefficients between tendon and saddle of 0.4 or above may be developed in tests. Fig. 3 illustrates such a modern extradosed tendon saddle with a recent application. **sci**



a) Dubai LRT



b) Avignon TGV Viaducts, France



a) Extradosed segmental bridge, South Korea



b) Extradosed tendon saddle (VSL system)

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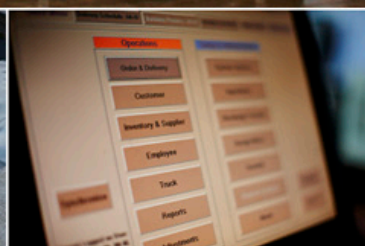


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Top-Mix Concrete’s “DuraCrete” brand of green concrete has been granted the Green Label accreditation by the Singapore Environment Council (SEC) and is a low carbon green concrete with VCEM GGBS replacing a minimum 30% of Portland cement content in the concrete design mix.

DuraCrete is also the first Green Label certified concrete product in Singapore that has conducted an independent Carbon Footprint Assessment. The embodied carbon content in DuraCrete is also much lower than normal concrete using Portland cement.

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Wet shotcrete, normally limited in Singapore to primary underground support, is now proving to be a major contributor in design changes to numerous tunnel projects worldwide. Secondary lining permanent shotcrete, incorporating a sprayed waterproofing membrane is fast becoming the proposed alternative to cast in-situ tunnel lining. The benefits of this innovative technology are numerous and include thinner section linings with obvious space saving advantages, immediately contained water ingress and major savings in construction plant, time and cost.

This monolithic construction is now referred to as 'Composite Lining' and incorporates both primary shotcrete support and secondary shotcrete permanent lining with a sprayed

waterproof membrane sandwiched between. Exhaustive tests have proven an absence of shear failure on the interface between the membrane and the shotcrete and confirmed that the lining functions as a single shell. The importance of these design improvements is more significant in drill and blast headings although there are still benefits to be obtained in TBM (Tunnel Boring Machine) drives where Cross Passages, Feeder Tunnels, Escape Shafts and other small diameter headings need to be hand mined, primary supported and concrete lined.

Owners and specifiers alike in Singapore have always been concerned about specification changes for underground works, especially those involving shotcrete, where quality is somewhat dependent on the ability of the nozzleman and where ignorance has often produced a negative attitude

towards permanent shotcrete lining. It will therefore come as a welcome arrangement that SRMEG (Society for Rock Mechanics & Engineering Geology) in association with BCA (Building Construction Authority) and ACI (American Concrete Institute) has undertaken the first 'Nozzleman Certification' course here in Singapore.

Furthermore, EFNARC (European Federation of National Associations of Specialist Contractors and Material Suppliers to the Construction Industry) has also implemented similar certification albeit in the Hagerbach Training Tunnel in Switzerland. Both of these programmes are aimed at improving skill and awareness throughout the industry and will surely improve customer/contractor relationships as well as pave the way for approval of new technology such as 'Composite Lining'. **SCI**



Spraying shotcrete in a tunnel lining

The low-cost alternative for any type of infrastructural foundation

Cement-GeoCrete/InfraCrete (GC/IC) soil stabilization is a process that combines soil, cement, GC/IC agent and water to produce a hard, flexible and durable paving material that can be used for the foundation or base of road and airport pavements, parking and storage areas. Stabilized material will significantly increase performance of foundation such as:

- shear strength – able to resist shear stresses developed as a result of traffic loading;
- modulus (stiffness) – able to respond elastically and minimize permanent deformation when subjected to traffic loading;
- resistance to moisture – able to maintain its physical volume and mass when subjected to load or moisture;
- durability – able to maintain material and engineering properties when exposed to environmental conditions such as moisture and temperature changes

Why GeoCrete/InfraCrete agent?

GC/IC is a whitish powder consisting of alkaline and alkaline earth elements or complex compounds. It promotes cement hydration processes and inhibits the action of fulvic acids and carbonic acids. The structural changes and the formation of minerals occurring during cement hydration greatly increase the compression strength, the static and dynamic elasticity modulus, the bending tensile strength, and the frost resistance of the soil, and also stabilises humus-rich soils. Apart from heightening the above-mentioned parameters, GC/IC also promotes the immobilisation of pollutants that cause injury to the environment. These include heavy metals as well as organic parameters, which get permanently embedded in the new crystal structures in the soil.

SEM recording (10 μm) show major difference between stabilization with cement only and cement-GC/IC mixture where crystallization process formed interlocking soil matrix what prevent cracking significantly and increase performance.

Soil-cement-GC/ICe mixture Soil-cement mixture

Stabilized bases courses treated with cement only; usually combine high stiffness with a high risk on premature cracking. This undesirable combination was regarded as a major handicap for stabilizing. The use of GC/IC, in combination with cement, reduces the dangerous of premature cracking significantly.

The major variables that control the properties and characteristics of soil-cement-GC/IC mixtures are the type of soil or aggregate material, the proportion of cement and GC/IC agent in the mix, the moisture conditions, and the degree of compaction. It is possible, simply by varying the cement content and GC/IC agent, to produce soil-cement that ranges from a basic modification of the compacted soil (termed cement-modified soil) to fully-hardened soil-cement that is strong, durable, and water penetration resistant.

Due to its versatility, soil-cement-GC/IC is widely used as either a low-cost pavement subgrade or base material for many infrastructure applications, including:

- Rail and truck terminals
- Parking areas
- Truck docks
- Materials handling and storage areas
- General foundations
- Roads and highways
- Airport runways
- Building pads
- Container ports
- Warehouses

What materials can be used for Soil-Cement-GC/IF base?

The soil material in soil-cement-GC/IF can be almost any combination of sand, silt, clay, shell, gravel, or crushed stone. By-product materials, including cinders, fly ash, foundry sands, and screenings from quarries and gravel pits, can all be utilized as soil material. Old granular-base roads, with or without their asphalt surfaces, can also be recycled into an excellent soil-cement-GC/IC base. In many cases, these materials already exist at infrastructure sites and eliminate the need for importing select materials for construction.



How is Soil-Cement-GC/IF base built?

Soil-cement-GC/IF construction is simple. Many contractors have the equipment and know-how to build soil-cement-GC/IF efficiently and economically. Prior to the start of construction, a survey is made of the construction site and design parameters for the soil-cement-GC/IC, such as thickness and strength, are determined. Next the soil materials are sampled and tested; usually a commercial laboratory is required for this work. After plans and specifications are prepared, construction is ready to begin.

Soil-cement-GC/IC can be mixed in place or in a central mixing plant. There are five basic steps in mixed-in-place construction:

- Initial shaping and grading of the site
- Application of the cement and GC/IC agent in either dry or slurry form
- Mixing the cement and water with the soil material
- Compacting and fine grading
- Curing

Central mixing plants or pugmills can be used where granular borrow material or select aggregate is involved. The mixed material is then hauled to the placement area in dump trucks and spread on the prepared subgrade using a grader, dozer, paver, or jersey spreader. Compaction, fine grading, and curing are the same as for mixed-in-place construction. With soil-cement-GC/IC there is no mellowing period for the cement to react or other delays in construction. Traffic can be maintained throughout construction and in most cases the site is available for use immediately after final grading and curing.

Why Use Soil-Cement?

The use of soil-cement-GC/IC can be of great benefit to both owners and users of infrastructure facilities. Its cost compares favourably with that of granular-base pavement. When built for equal load-carrying capacity, soil-cement is almost always less expensive than other low-cost site treatment or pavement methods. This low cost has made soil-cement-GC/IC an attractive alternative to designers of heavy-duty infrastructure pavements. In addition, soil-cement-GC/IC has considerably more load-carrying capacity than conventional pavements, requiring less thickness to carry a given load. Pavement engineers praise soil-cement-GC/IC's performance, its low first cost, long life, and high strength. Soil-cement-GC/IC is constructed quickly and easily – a fact appreciated by owners and users alike. **SCI**



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Construction materials and building practices have changed in the last ten years to become more energy efficient and environmentally conscious. By considering your construction options, you can simply increase the efficiency, safety and quality of your project without putting undue stress on our natural reserve. By making your projects "greener", you help to reduce pollution, save guard the natural environment, and create a sustainable future for our next generation.

Build Green

One of the central environmental considerations is the quantity of waste produced when a building is developed, refurbished or demolished. By recycling materials produced (recycled aggregates) from construction and demolition works are a practical and resource efficient model to maximize the value and the sustainability of the building. Beside the environmental benefits, using renewable resources can have positive economic impact by reducing the material transport and disposal cost, as well as by diminishing the extraction of raw materials, the amount of waste at landfill sites and the entire life-cycle costs of building materials.



Cert. No.: 022-015
Eco-Friendly Building
Material/Low
Emission Concrete/
Cement/30%
Recycled Content

Recycled concrete aggregates and waste materials for sustainable green products

JOE, "Light Weight Concrete Panels produced with 30% of Recycle Concrete Aggregates (RCAs)", is Singapore Green Label certified (No: 022-015), eligible for BCA Green Mark Point and in compliance with Conquas for Buildability (0.90). JOE is reinforced with Steel Wire for superior Bending Strength which improve Safety for High Wall, External Wet, Internal and Parapet usage

Advance Engineering Machines made JOE perform obtained outstandingly in the Fire-Test, Sound-Test, Compressive Tensile Strength, Section Tensile Strength, Bending and Tensile Strength, Anchorage-Test etc. Additionally, JOE helps saving cost of lintel, stiffener, labor and time. **SCI**

Features & Benefits

- Eligible for BCA Green Mark Point
- Buildability(0.90)
- Steel Wire Reinforcement for SAFETY
- Customized Length(up to 4.3m)
- Superior Bending & Compressive Tensile Strength
- No Lintel (up to 4.3m height)
- No Stiffener (up to 6m span)
- Flexible & Easy M & E
- Skim Coat Finishing

Construction Benefits



Steel Wire Reinforcement for SAFETY



Flexible & Easy M & E



Customized Length(up to 4.3m)



Skim Coat Finishing



No Lintel (up to 4.3m height)
No Stiffener (up to 6m span)

JOE's vision is to be a green builder to save our planet, because there is only "Just One Earth"



green concrete panel

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Cert. No: 022-015
Eco-Friendly Building Material/Low Emission Concrete/ Cement/30% Recycled Content

Project references



Mandai Link



Jurong Data Center



4 Storey Apartment at Braddell Road



Khoo Teck Puat Hospital