Green Sense Concrete

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Introduction

Concrete has the obvious environmental impacts embodied in the quarrying of raw materials; the energy used in its production and associated carbon dioxide (CO2) emissions. Various governments have made steps to address this issue of global warming and are actively involved in initiatives to reduce the environmental impacts of the production of concrete (including cement). Some of these followed in Asia Pacific are:

- More efficient use of resources in concrete production, including re-used materials and by products from other industrial processes (such as ground granulated blast furnace slag and pulver fly ash, etc);
- Better re-use of waste and other secondary materials such as water, aggregate, fuel or other cementitious material;

  A pioneering concept has been made by BASF to combine a construction chemicals industry has a host of products / technology to offer to produce "Green Sense Concrete". A few of the green concepts that are being followed world wide are explained below:
- Hyperplasticized Concrete
- High Volume Flyash Concrete
- Pervious Concrete

Hyperplasticized Concrete

As speed is almost the most important issue which developers and contractors are grappling with in order to complete projects in time, this invariably gives rise to requirements of stripping the form work earlier. With the advent of latest generation of Polycarboxylate ether (PCE) based superplasticizers for concrete (often termed as "hyperplasticizers"), it is now possible to cut down the costs and achieve high strengths [1], without having to use significant quantities of expensive mineral admixtures.

These admixtures have a dual action on the cement particles (Fig. 1). The molecules are such that they have a side chain in addition to the main chain which imparts the electro-static as well as steric repulsion. This double action helps in achieving lower water cement ratios, even to the tune of 0.24. Thus the reduction of w/c ratio and water content in the mix with the help of hyperplasticizers, paves the way for higher strengths.

A typical mix that followed in Asia Pacific context is appended in Table 1.

Grade of Concrete	60 MPa	
	Traditional Mix	**Hyperplasticized Mix**
Cement	430	380
Flyash	80	160
Silica Fume	35	0
Total Binder	545	540
Total Aggregates	1782	1782
Water	152	146
Admixture	1.5%	1.0%
W/B Ratio	0.28	0.27
Slump after 2 hours (mm)	120	120
Comp. Strengths		
1 Day	19.02	18.60
3 Days	39.46	38.43
7 Days	58.47	58.22
28 Days	72.34	71.11
Depth of water Penetration (DIN 1048)	Nil	Nil

Table 1 : Results of a typical "Green Sense Concrete" concept at site enabling higher percentage of SCM

The hyperplasticized not only helped in cutting down the cement content leading to a sustainable practice [2] but also

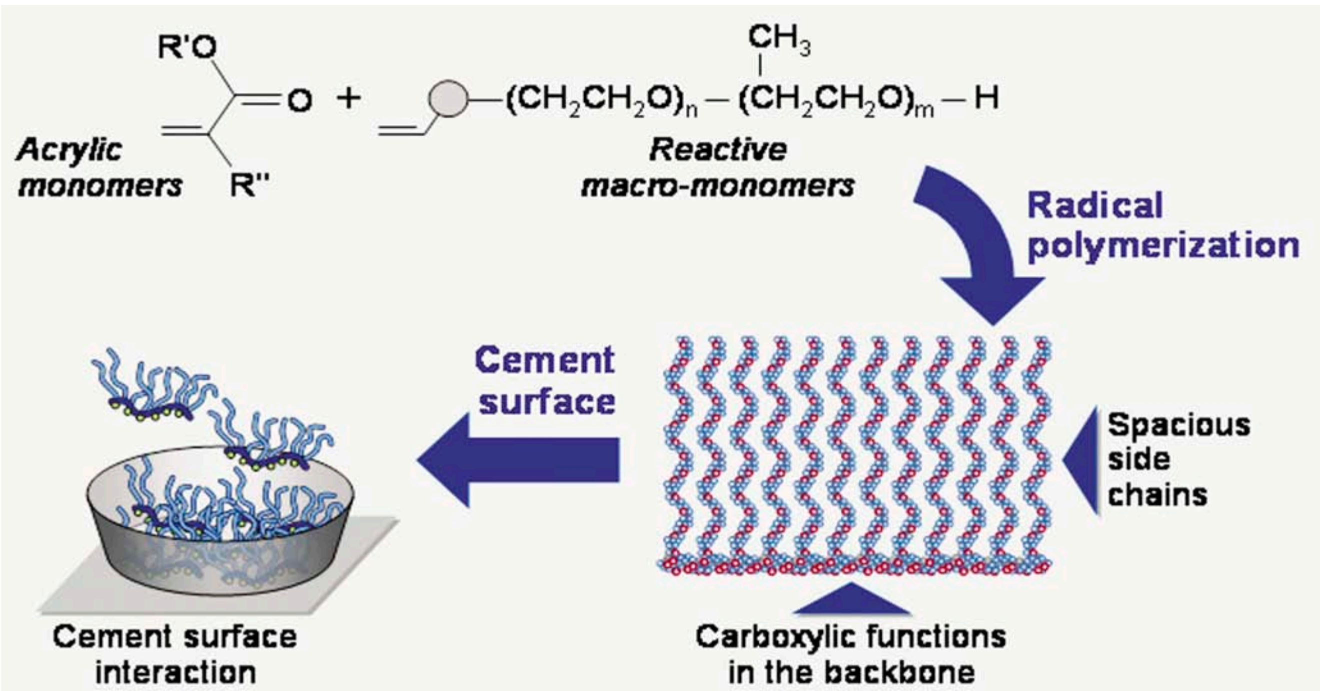


Fig .1 : Versatile polymer technology based on poly carboxylate ether.

achieved a cost saving equivalent of approximately S$ 1.3 per m3 of concrete.

A latest innovation in this line is the advent of Smart Dynamic Concrete (SDC) – a low fines self consolidating concrete where the essential components use a robust mix design with low cementitious fines, a tailor-made PCE superplasticiser – GLENIUM - and an exclusive, latest technology viscosity modifying admixture (VMA) - RHEOMATRIX - with self-organising molecules which enables unmatched concrete robustness.

Fig. 2 : A core from pervious concrete

HVFA Concrete

The use of high volume fly ash (HVFA) concrete fits in very well with sustainable development. High volume fly ash concrete mixtures contain lower quantities of cement and higher volume of fly ash (up to 60%). One of the key issue or reluctance in accepting HVFA concrete is the use of very low w/c ratio and the rate of gain of strength, because the replacement of fly ash slows down the hydration process, depending quite significantly on the fly ash activation process.[3]

Use of hyperplasticizers (based on tailor-made PCE chemistry) can help in improving the strength levels to higher level at even low water cement ratios. Table 2 depicts a typical example from a trial for a HVFA mix with and without Hyperplasticiser.

Grade of Concrete	M 30		
	HVFA Mix	Hyperplasticized HVFA Mix	
Cement	204	204	180
Flyash	136	136	180
Total Binder	340	340	360
Total Aggregates	1830	1830	1835
Water	140	140	144
Admixture	1.20%	0.7%	0.7%
Admixture Type	BNS	PCE	PCE
W/B Ratio	0.41	0.41	0.39
Comp. Strengths			
3 Days	7.30	12.20	10.02
7 Days	19.70	22.52	19.30
28 Days	37.80	41.78	36.54
56 Days	48.60	52.30	48.00
90 Days	53.50	56.44	54.36

Table 2 : Results of a typical the "Green Sense Concrete" concept applied at a trial for enabling High Volume Fly Ash Concrete

Pervious Concrete

Also known as porous, no-fines or permeable concrete, pervious concrete (Fig. 2) is one of the fastest growing applications in the ready mix concrete industry, especially in the United States. Pervious concrete has the unique ability to allow water to flow through easily, which results in concrete pavements that have no runoff from stormwater. [4]

Though it may be new in some areas of the country, pervious concrete has been installed since the 1970's in certain parts of the U.S. as an alternative to complex drainage systems and water retention areas. Typical uses and applications include:

- Parking lots
- Streets, road shoulders
- Edge drains

Pervious concrete is a mixture of portland cement, coarse aggregate, water and admixtures. Because there is little or no sand in the mix, the pore structure contains many voids allowing water and air to pass through. Unfortunately, the lack of sand in pervious concrete also results in a very harsh mix that negatively affects mixing, delivery and placement [5]. Common experiences with traditional pervious concrete include:

- Difficulty getting the mix out of the truck
- The need to add water on site (inconsistent mix quality)
- A short working time (minimal workability life)
- Difficulty placing and compacting the mix

To overcome the difficulties, pervious concrete is optimised with use of tailor made hyperplasticisers (PCE based Glenium chemistry) for better quality, Hydration Control Admixtures (HCA like DELVO admixtures) extend the workability window and life of fresh pervious concrete mixes, reducing or eliminating the need to re-temper. Since pervious concrete is a harsh mix, use of Viscosity Modifying Admixture (VMA), adds body and helps lubricate these mixes. The combination of these products has significantly improved the mixing and handling of pervious concrete.

	Type of Placement	
	Low Compactive Effort	High Compactive Effort
Cement	267	237
Flyash	89	60
Total Binder	356	297
Water	100	89
W/B Ratio	0.28	0.30
Coarse Aggregate (12.5 mm MSA)	1543	1543
Hyperplasticizer (Glenium)	0.4 - 0.8%	0.4 - 0.6%
Delvocrete Stabilizer (HCA)	0.5%	0.5%
VMA	0.3%	0.3%
Compressive Strength (MPa)	15	24

Table 3 : Typical Mix proportions for different pervious concrete applications

Conclusion:

Because Green Sense Concrete is optimised for cost and performance, many tangible benefits can be realised by the entire construction team. We list them across the value chain:

Producer

- Optimised and economical concrete composition cost
- Faster truck discharge
- Desired setting time, slump retention, and strength performance
- No water needed at jobsite – less performance issues

Contractor

- Highly flowable slump concrete: 8.0 in. (200 mm) – if desired
- Good workability, pumpability and finishing characteristics
- Faster placement and production

Owner

- Desired durability performance
- Lower shrinkage and cracking potential
- Contributes toward LEED credits

Environmental Agencies / Community

- Less cement / CO_2 / energy used per unit of concrete produced
- Less by-product materials targeted for landfill

References

[1] Kawai, T., State-of-the Art Report on High-Strength Concrete in Japan

[2] LEED Reference Guide for Ready Mixed Concrete Industry (RMC Research Foundation-NRMCA-PCA publication)

[3] The Concrete Centre's Report 'Concrete – The Green Guide to Specification' & "Sustainable Concrete"

[4] NRMCA's Publication CIP (Concrete In Practice) 38 - Pervious Concrete

[5] Huffman, D., – article in "The Construction Specifier" December 2005 - Understanding Pervious Concrete. SCI

ADVERTORIAL

MC Ensures Clean Water in Singapore- Dam Projects

In Singapore, the supply of sufficient quantities of drinking water represents one of the biggest challenges for the small city-state.

The highly developed island microstate relies on water imports. In order to improve self sufficiency and protect the groundwater, the treatment of wastewater will be continued in addition to utilising rain water more effectively.

Until only a few years ago, about 60% of the drinking water required in Singapore was furnished from groundwater and collected rainwater. The PUB now aims at increasing this amount substantially. In principle, tropical rainfall is sufficient in providing what is needed. However, the climate change between periods of monsoon and dry spells means that heavy rainfalls are usually followed by long dry periods. bar any rainfall. The heavy downpours that fall during the monsoons usually produce large quantities of rainwater, which tend to flow directly into the sea.

In the future the PUB wants to prevent this and intends to collect the precious water in dams before it can enter the sea. To this end, construction of water reservoirs are planned near the mouths of the rivers Punggol and Serangoon to increase the recapture of the precious rainwater. The tender of this technically-demanding project specified high-performance concrete that is water-impermeable and resistant to damaging processes.

For the supply of concrete admixtures, technical competence had to be proven by providing a reference list of comparable projects. MC was awarded the contract due to being able to fulfill all specific technical competence of MC staff. Deciding factor for being awarded the contract was the large number of successfully completed construction projects in the area of water management worldwide. Centrilit Fume SX, Muraplast 120S and MC Special DM are used to produce a total of 45,000 m^3 of high performance and other concretes. The construction of the dams is carried out producing individual sections and connection joints, waterproofed with MC injection technology.

For years, the PUB has been very committed in achieving its objective of improving Singaporeans' quality of life by ensuring clean rivers and waterways. MC was able to contribute to their success with expertise and efficient product systems.

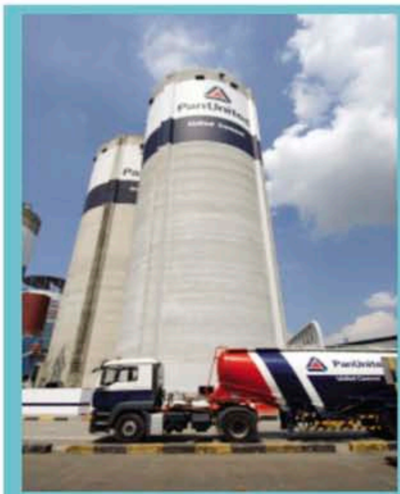
Project management of both projects lay in the capable hands of Willie Kay and his committed team, including Tony Yap and Alan Tan. SCI

Ensuring sustainable clean water for Singapore

ADVERTORIAL

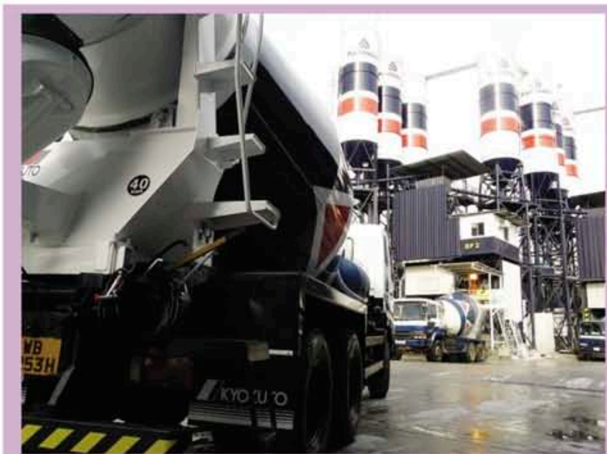
BASIC BUILDING MATERIALS

The Basic Building Materials (BBM division) manufactures and supplies basic building materials such as cement, aggregate products and ready-mixed concrete (RMC). As the largest cement and RMC supplier in Singapore, PUC is active in many major infrastructure developments, including MRT Circle and Downtown Lines, PSA Pasir Panjang Terminal expansion and the Marina Bay Financial Centre.



UNITED CEMENT

Our team has wide expertise in managing a variety of ready-mixes, including temperature-controlled low-heat concrete, high-density concrete and our newly developed Pan-U Green and Eco Concrete. As an approved Green Concrete Supplier by Building & Construction Authority (BCA), we supply Green Concrete to Singapore's First Sustainable Construction Building – **Tampines Concourse**.



CONCRETE BATCHING PLANT

Tampines Concourse is the First CarbonNeutral® Development in Singapore and the Asia-Pacific.

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Pan-United Concrete is a division of Pan-United Basic Building Materials, which is part of Pan-United Corporation Ltd.

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