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Content of Presentation

- Introduction to Sustainability
- Four technologies to consider for sustainable construction
  - Strength Enhancement
  - Improving Concrete Rheology
  - Sand Treatment
  - Returned Concrete Technology
- Conclusions

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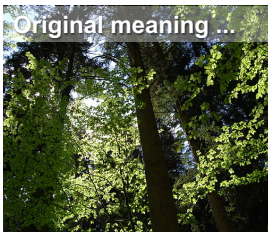
Introduction to sustainability



- Forestry management principle according to which not more trees should be harvested than regrown; first introduced in late 18th century
- A sustainable development meets the needs of the present without compromising the needs of future generations; Bruntland Commission, 1987
- Sustainability of structures is generally evaluated using indexing systems, which account for various technical and non-technical properties
- What about sustainability on infrastructure level?
- **What about sustainability of concrete on the material level?**

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Quantification of Concrete Sustainability Potential

Performance
- concretes with increased strength
- materials with additional functionality
- multiscale modelling of properties

Service life
- increase concrete durability
- adequate service life design
- monitoring and structural inspection

$$\text{sustainability} \sim \frac{\text{performance} \cdot \text{service life}}{\text{environmental impact}}$$

Environmental impact
- use of raw materials with reduced environmental impact, e.g. composite cements
- concretes with reduced binder and/or clinker content
- development of environmentally friendly production and building techniques

Source: Haist, Moffatt, Breiner et al. 2016

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Strength-Enhancing Admixture

- Strength-enhancing admixture.
- New product is based on exclusive MBS's **Crystalline Calcium Silicate Hydrate (CSH)** nanotechnology.
- Improves both early- and late-age strength development without affecting set-time.
- It is classified as an ASTM C494, Type S admixture.
- Patent-pending.

Enhance concrete strength | Permit use of supplementary cement | Reduce Carbon footprint | Improve concrete durability

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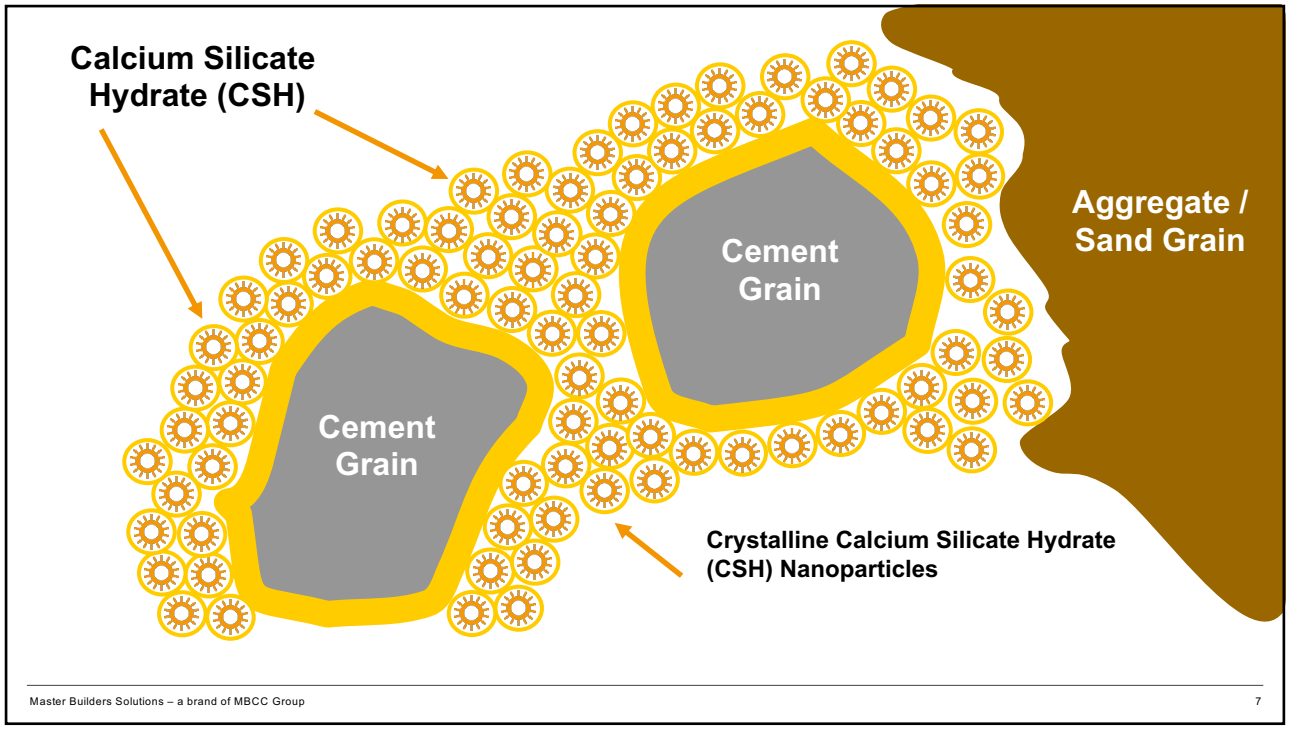

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Crystalline Calcium Silicate Hydrate (CSH) Nanoparticles

Admixture Includes CSH Seeds

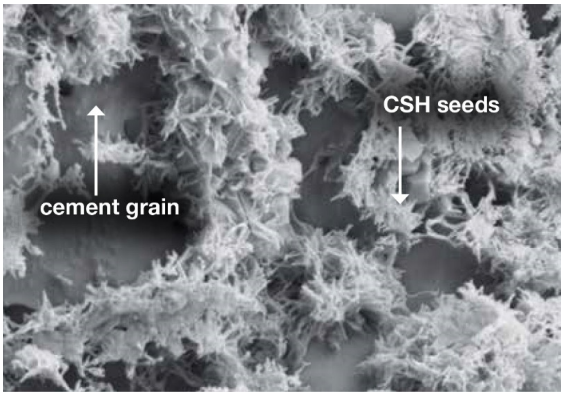
- Nanoparticles improve cement hydration
- Breakthrough technology – creating a new category of admixture performance

Unmatched Strength Enhancement

- Improves early- and late-age strength development
- Ability to increase the use of supplementary cementitious materials

Improving Concrete Performance

- Provides for strength safety factor and expanded performance space
- CSH nanoparticles provide flexibility in concrete design and production



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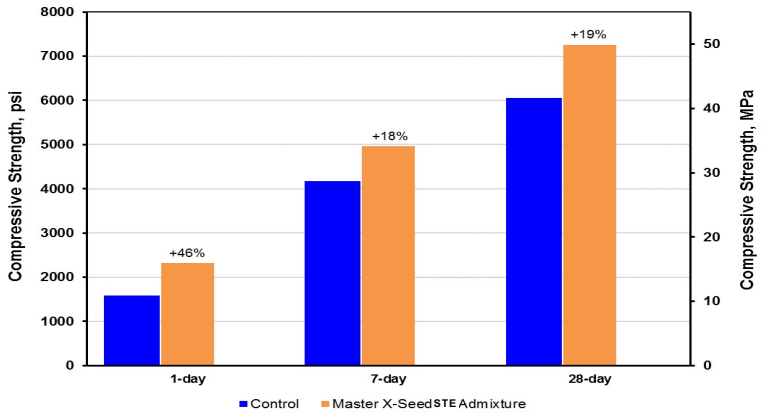
Enhancement of Compressive Strength



Enhancement in Compressive Strength from Addition of Strength Enhancing Admixture

(Nominal cementitious materials content of 611 lb/yd³ [362 kg/m3] with 20 percent fly ash, w/cm of 0.47; STE admixture dosage of 10 fl oz/cwt [650 mL/100 kg])

Applications

Enhanced Strength

1. Upgrade the strength by one grade
2. Expand or increase the safety margin factor of concrete
3. As a stop gap measure for poorer quality cement and/or aggregates

Cost Savings

1. Increase the use of cheaper SCMs
2. Use of poorer quality cement and aggregates
3. Faster turnaround of molds

Increased durability

1. Increased SCMs for better durability
2. Reduce heat of hydration for raft foundation or mass concreting

Reduce Carbon Footprints

1. Higher SCMs

Small addition → Great values

Strength Enhancing Admixture

- Improves concrete strength
- Allows higher incorporation of SCMs
- No negative influence on air content, workability and workability retention

Robustness

- Strength increase observed across varying mix designs and raw materials
- Performs in warmer climate (30ºC)
- Works with PCE and BNS admixtures

Sustainability

- Increase SCM content up to 20% to 40% with comparable 28-day strength
- LEED

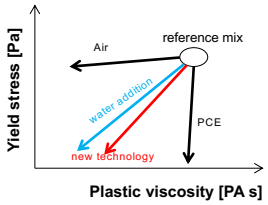
Durability

- Increased durability without loss of strength
- Low heat of hydration for mass concrete casting

Improving Rheology of Concrete - Addressing Needs of Current Trend

High Strength Concrete and High Use of SCMs

Low w/cm



Low viscosity concrete

- New generation of polymers that give fresh concrete exceptional rheological properties.
- Reduces concrete's viscosity by up to 30% and yet maintain stable concrete mixes.
- Enables the use of very low water/cement ratios and high dosages of mineral additives and supplementary cementitious materials, thus resulting in low environmental impact and high durability
- Enables concrete to be easy to pump, place and finish even with very demanding mix designs.
- Optimize €/m³ concrete cost in place through improved rheology

Higher strength | Better rheology | Lower shrinkage | Improves efficiency

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Developing new chemistry

For superior rheology and rheology retention

TRADITIONAL PCE

ADVANTAGES

High Water Reduction
Adjustable Properties
High Early Strength
High Flow Concrete

DISADVANTAGES

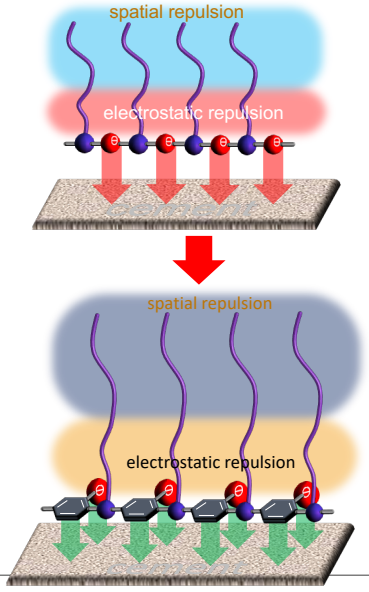
Compatibility
Rheology
Viscosity

NEW CHEMISTRY

A new super plasticizer technology with a unique chemistry to MBS which gives superior Rheology and rheology retention for concrete applications

HOW

By creating a new chemistry that
Has flexible interaction with the cement particle.
Unlike other dispersants which have a rigid backbone structure.



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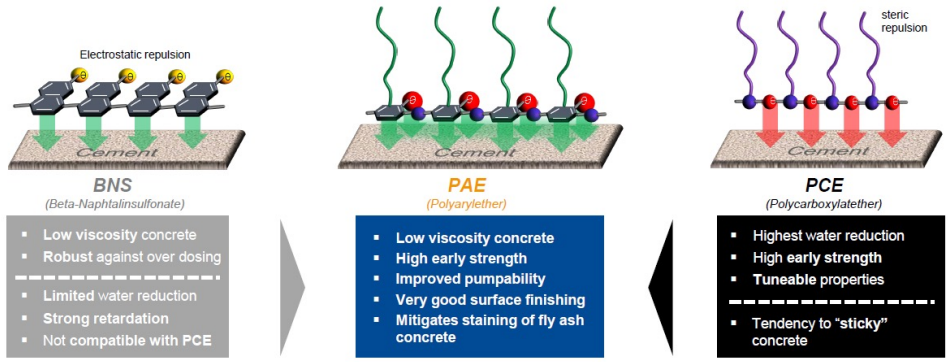
New Polyarylether (PAE) technology

- Maintains all the advantages of PCE technology: water reduction, workability retention, early strength
- Sharply decrease the yield stress and plastic viscosity of concrete



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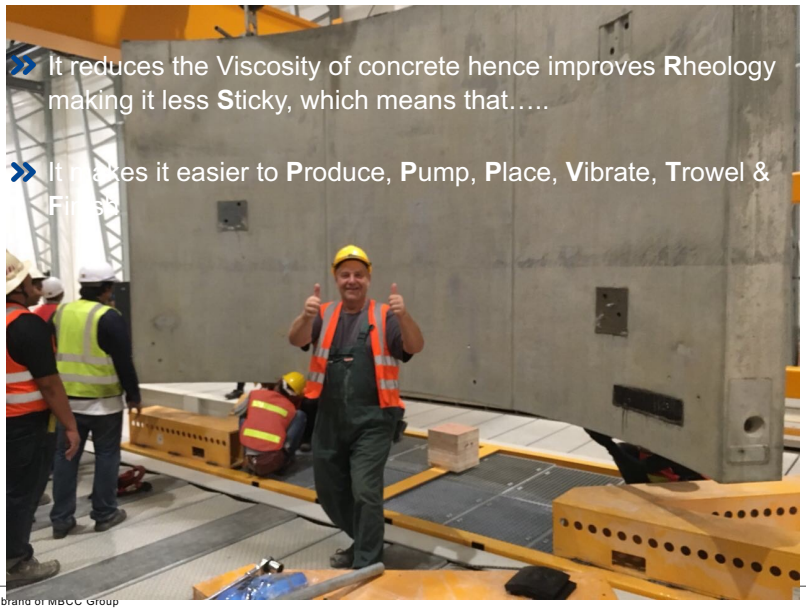
Rheology made easy



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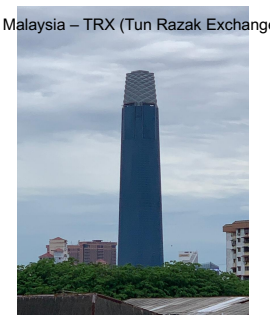
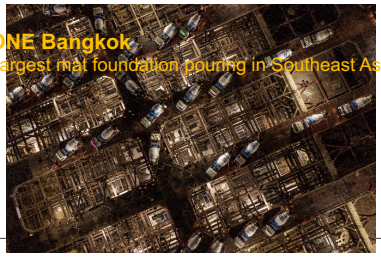
Project References using Rheology Enhancing Admixture

Malaysia – TRX (Tun Razak Exchange)



Vietnam – Landmark 81

Thailand – Four Seasons Private Residences



ONE Bangkok
Largest mat foundation pouring in Southeast Asia history

- Total volume: 23,725 m3
- Peak pour rate: 1,150 m3/hour
- Total duration: 33 hours 15 minutes
- Number of RMC batching plants: 38 plants
- Number of RMC trucks: 547 trucks

Sand Treatment Admixture

Turns clayey aggregates into useful raw materials

- Facilitates the utilization of sand grades which were previously unsuitable to produce everyday concrete.
- Difficult, clay-containing sands under control by simple dosage of MasterSuna as the second component at the same dosage rate of the base super-plasticizer.
- Usage of local / cheaper sands which contain sheet-silicates or clay fines without sacrificing quality and strength class of the concrete – from waste sand to interesting raw material.

Reduce washing and pretreatment of fine aggregates

Increase the economic value of quarry

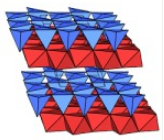
More sustainable

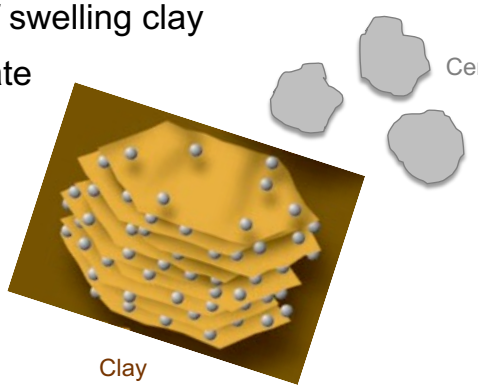
Turning previously classified wastes to useful raw materials

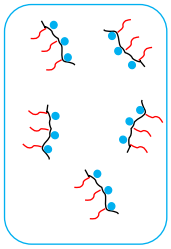
Problem case: Difficult Sand!

Is there a possibility to manage difficult, clay-containing sands in everyday concrete productions?

- Poor water reduction and/or workability retention in presence of swelling clay
- High PCE-adsorption rate







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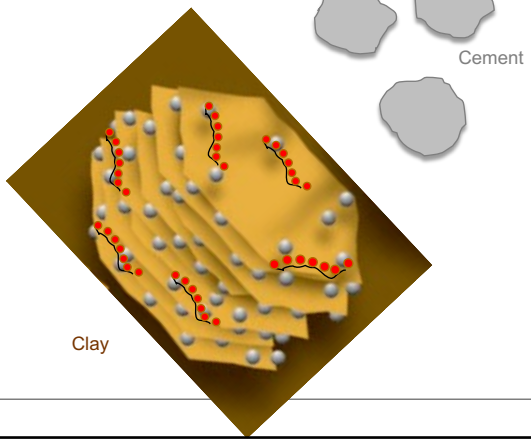
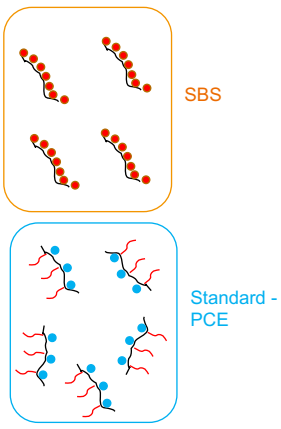
Sand Blocking Solution (SBS)

Difficult sands in the concrete production? – No more problem!

A new, innovative system dedicated to difficult sand:

- Controlled dosage depending on clay content (Mb)
- Two component system





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Sand Blocker Solutions

- SBS saturates the inner and outer surfaces of the fine aggregates contaminated with swelling clay, to prevent adsorption of water reducing admixture molecules.
- Thus enabling water reducing admixtures - to provide optimal control over concrete workability and consistency retention, even when using critical fine aggregates.

Concrete with fine aggregates contaminated with swelling clay, without MasterSuna SBS

Concrete with fine aggregates contaminated with swelling clay, with MasterSuna SBS

Treatment for Returned Concrete
What is this Technology?

Turns a pile of this returned concrete

Into a resale material without crushing

Historical ways to address Returned Concrete

Producing Concrete Block

Pros:

- Positive financials, Environmental benefits

Cons:

- Marketing/Sales Costs, Capital for forms, Labor intensive, Safety concerns

Concrete Crushing

Pros:

- Outsourced option, Resale opportunity,

Cons:

- Negative environmental option (carbon intensive), Safety concerns

Dumping – onsite/quarry/landfill

Pros:

- Easy to implement, low/no labor, low/no cost if dumped onsite

Cons:

- Costly if diverted landfill, high environmental burden, unsightly is dumped onsite, finite land space to implement

Returned Concrete Treatment (RCT)

Concrete returns to batch plant. Determine the volume of the returned concrete

Driver adds of RCT admixture. Mix for about two minutes.

Discharge the treated concrete onto the ground in piles that are about 12 inches (300 mm) in height.

That day: Flatten the treated piles. Next day: Mix and turn the treated concrete piles

Treated material sold and used for road base or other applications

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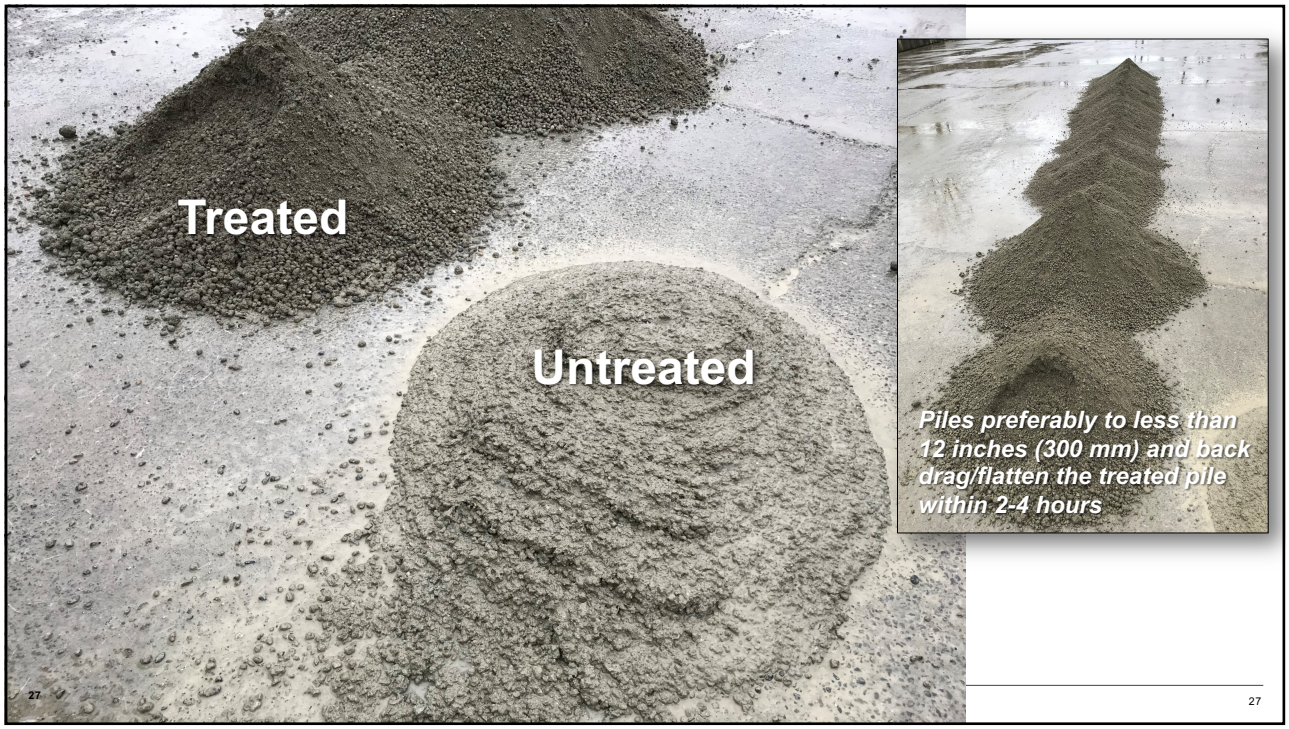
RCT - Packaging

- Product is packaged is 2.0 lb (0.9 kg) water soluble bags in 5-gallon pails (15 bags per pail)



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Conclusions

- Four technologies to consider for sustainable construction
  - Strength Enhancement Admixture
    - Reduction of cementitious content – reducing carbon footprint
    - Increasing use of SCM – increasing concrete durability
  - Improving Concrete Rheology
    - Enable use of very low w/c ratio – reduction of cementitious content for equal strength
    - Increasing use of SCM – increasing concrete durability
    - Reduction of viscosity of concrete for ease of mixing, pumping and finishing – reduction of energy required
  - Returned Concrete Treatment
    - Turning returned (waste) concrete to useful aggregates
  - Sand Treatment
    - Allowing the use of poor-quality aggregates

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