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banahCEM
GEOPOLYMER BINDER SYSTEM

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Geopolymer Camp 2014

7 – 9 July 2014
St. Quentin

Agenda

- Introduction to banah
- The banahCEM system
- Using banahCEM
- Design of banahCEM-based concretes
- The next steps...

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Introduction

banah UK Ltd – The Company

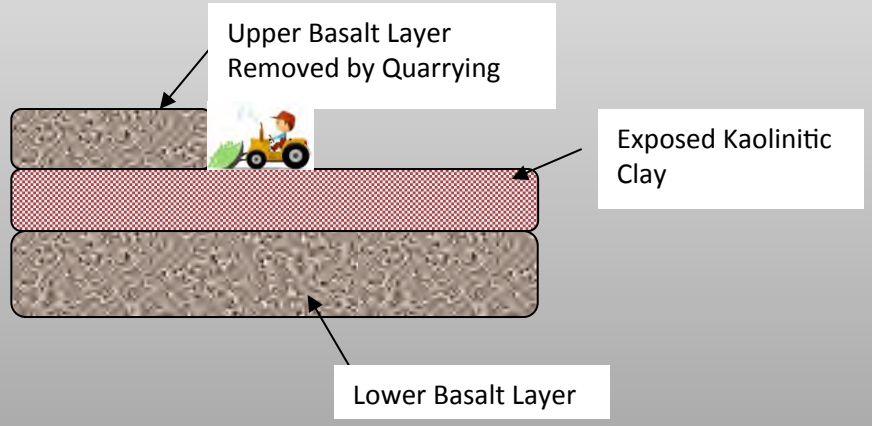
- Formed November 2008
- Research and Development of Geopolymer Technology
- Construction of Production Plant for Geopolymer Cements

- Establishment of a Centre of Excellence for Novel Cements
- Reduction in the Future Environmental Impact of the Construction Industry

The banahCEM system

Powder Component - Precursor

- Calcined Clay-based Geopolymer
- Lower Kaolinite Contents
- Presence of Other Minerals that may Improve Performance
- National and International Availability
- Lower Environmental Impact and Cost



The banahCEM system

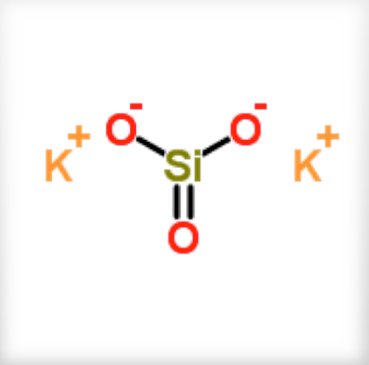
Powder Component - Processing

- Tailings from local quarrying and mining
- Material Ground and Dried
- Low Level Thermal Treatment
- Rapid Cooling
- Blending with Other By-Products

The banahCEM system

Liquid Component - Activator

- Alkali Silicate Solution
- Formulated to be User-Friendly rather than Caustic
- Needs to be Matched to the Precursor Material
- Optimised to Prevent Efflorescence
- Ultimate Aim is to have Solid Activator Component



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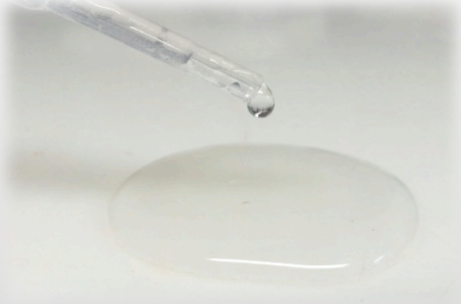
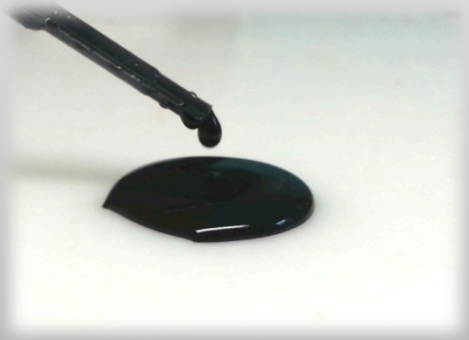
Liquid Component - Production

- Two Options Available
  - Modified Commercially-available Silicate Solutions
  - Alternative Amorphous Silica-based Production of Alkali Silicate Solution



- Alternative Option Enables use of By-products Containing Amorphous Silica Source.



- Option Chosen Depends on End-Use

- Alternative Option has Lower Carbon Footprint

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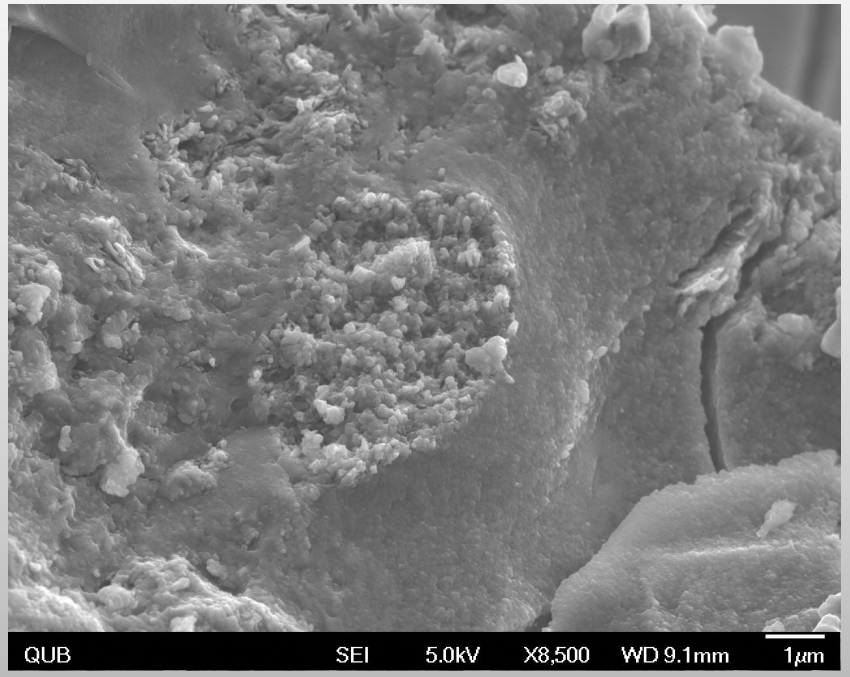
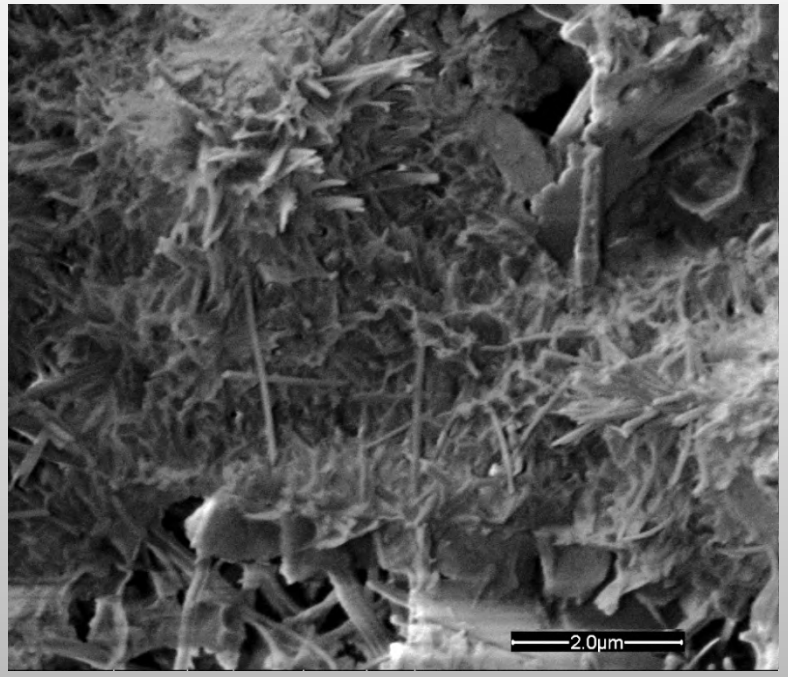
The banahCEM system

Scanning Electron Micrographs

Geopolymer vs Portland Cement



Geopolymer Binder



Portland Cement (32 Hours)

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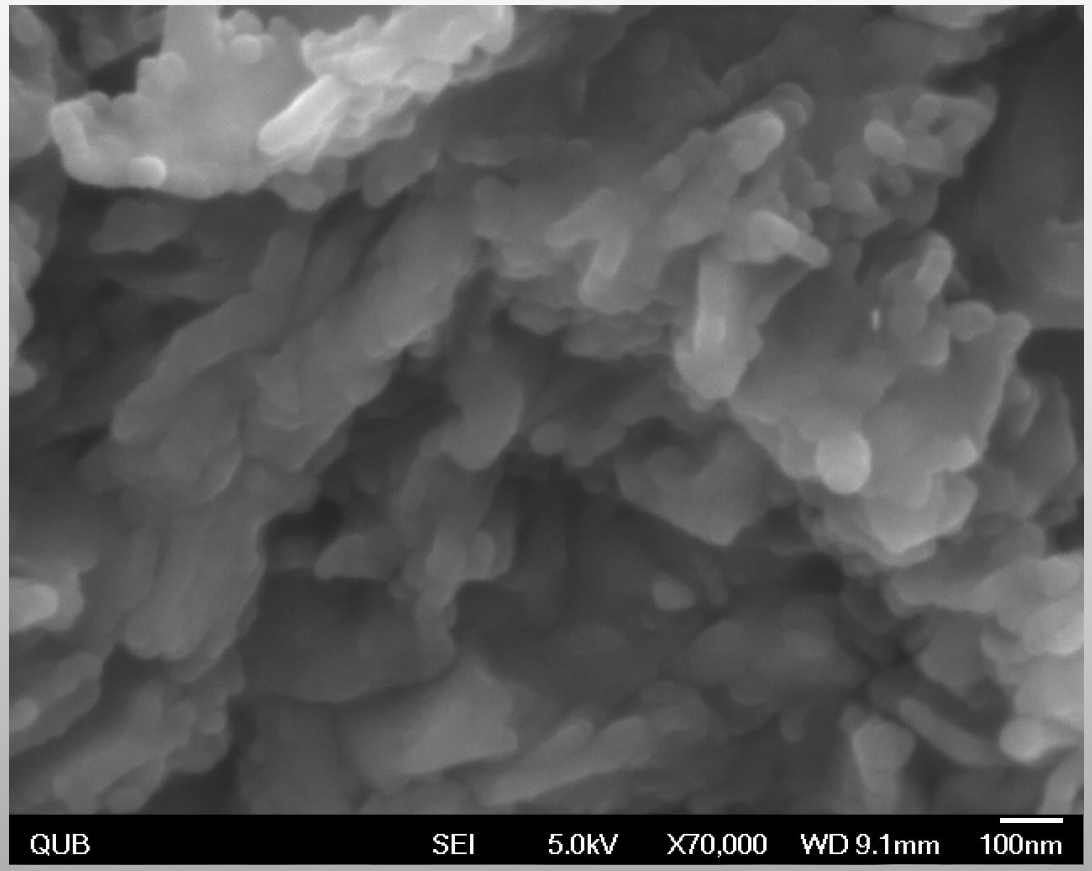
The banahCEM system

Scanning Electron Micrograph of Reacted Geopolymer



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Using banahCEM

Batching and Placing

- Use Existing Concrete Batching Facilities
- Geopolymer Concrete More Viscous with Self-Levelling Properties
- Excellent Bond with Mild Steel and Low Shrinkage Values after Curing
- Strength Gain More Rapid Than Standard Cements
- Compressive Strengths of 130 N/mm^2 Achievable

Design of banahCEM Concrete

Introduction

- Mix Design of Geopolymer concretes for commercial applications
- Selection of a suitable concrete mix for durability testing
- Comparison of banahCEM concrete with OPC
- BRE – Design of Normal Concrete Mixes
- Work carried out with Dr Jacek Kwasy of QUB

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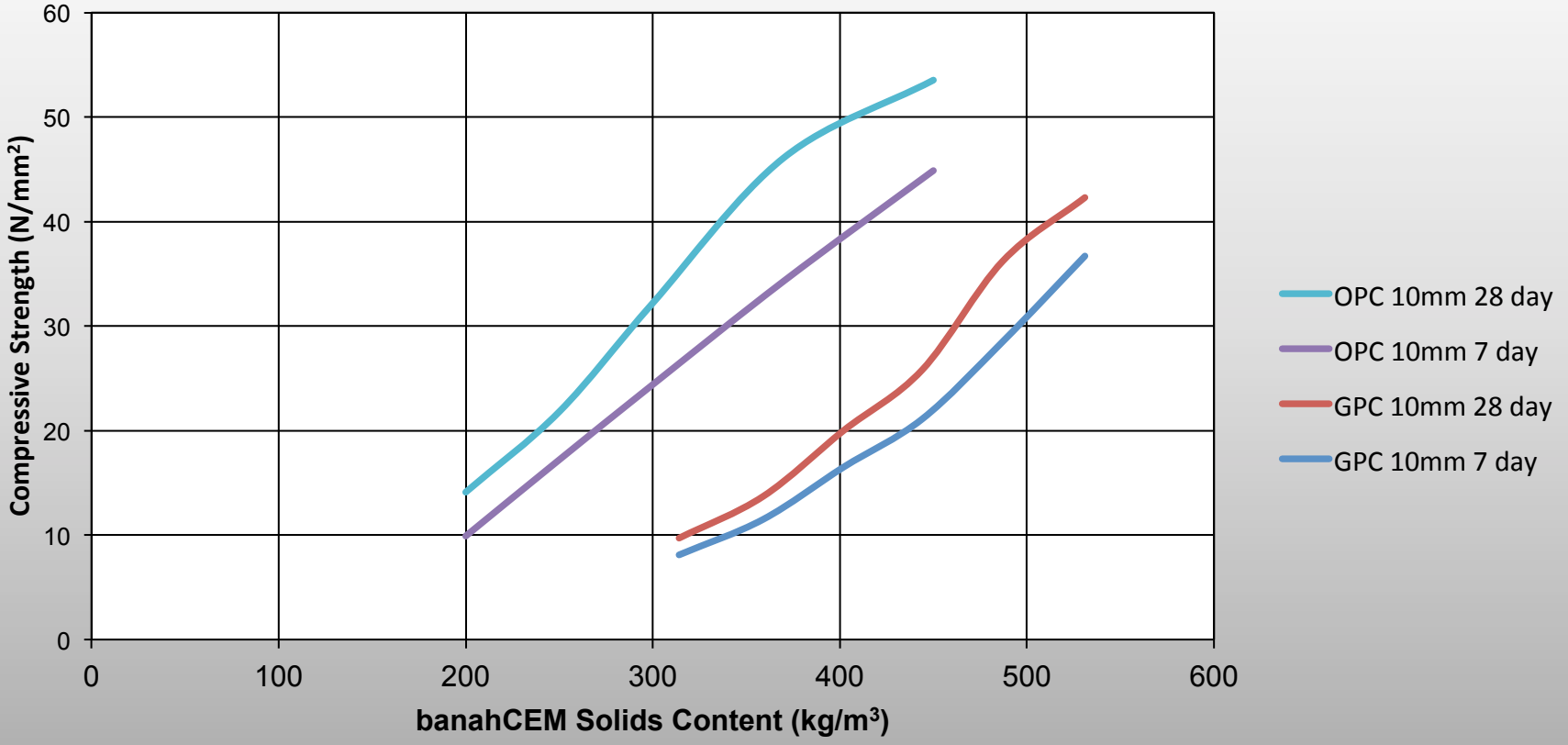
Design of banahCEM Concrete

banahCEM vs OPC



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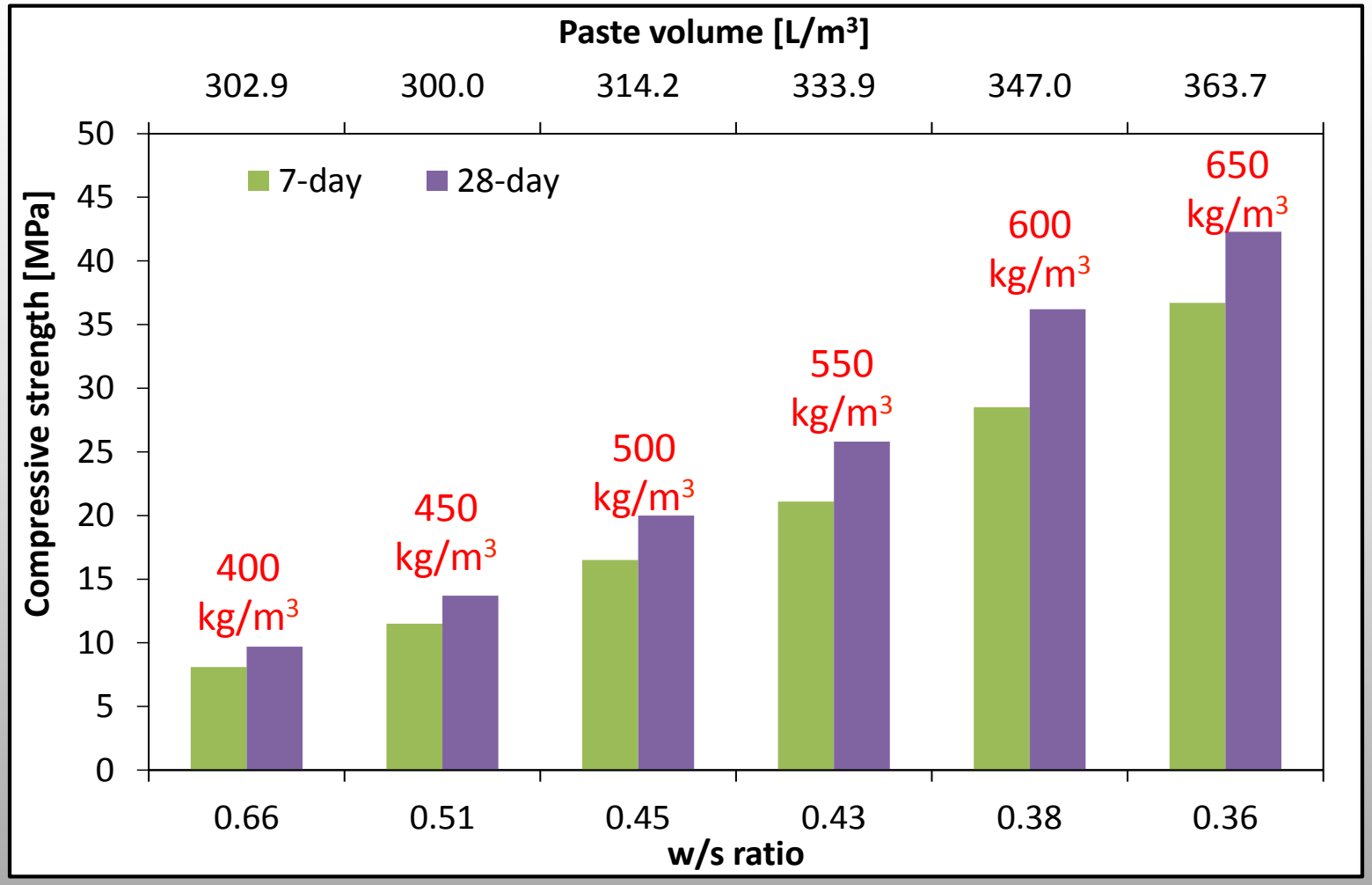

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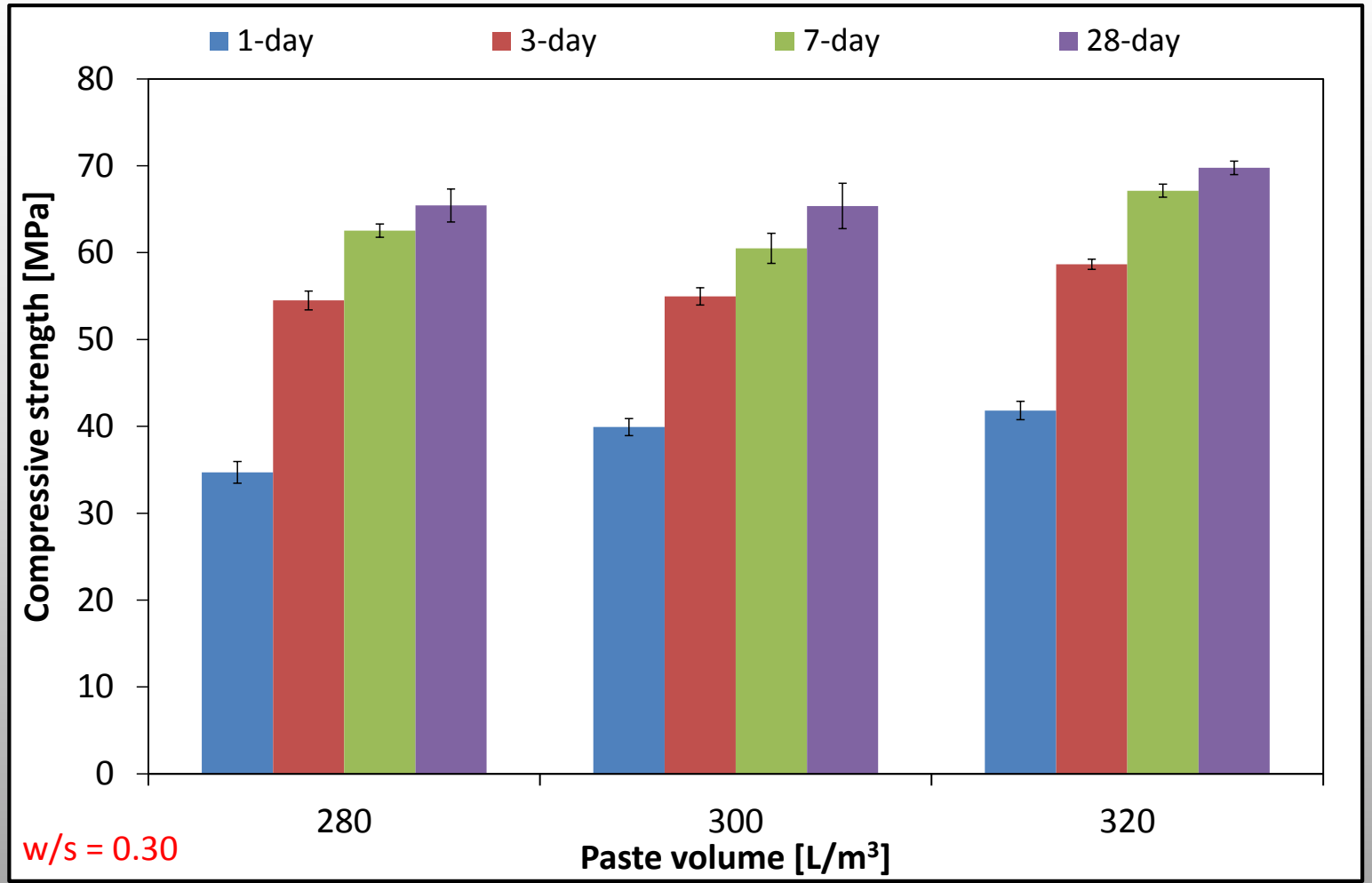
Design of banahCEM Concrete

Variation of Paste Volume at Fixed w/s Ratio



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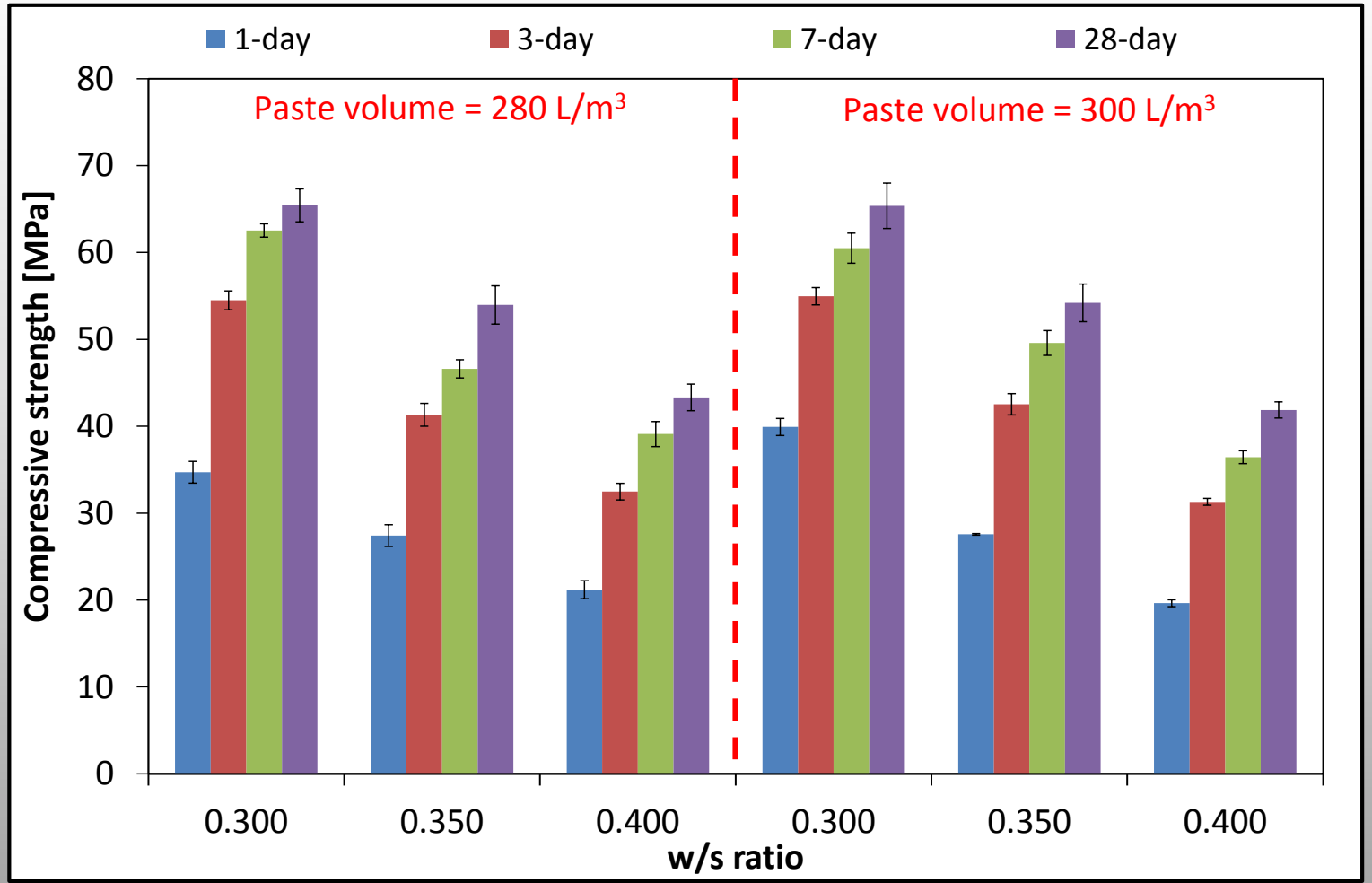
Design of banahCEM Concrete

Variation of Paste Volume and w/s Ratio



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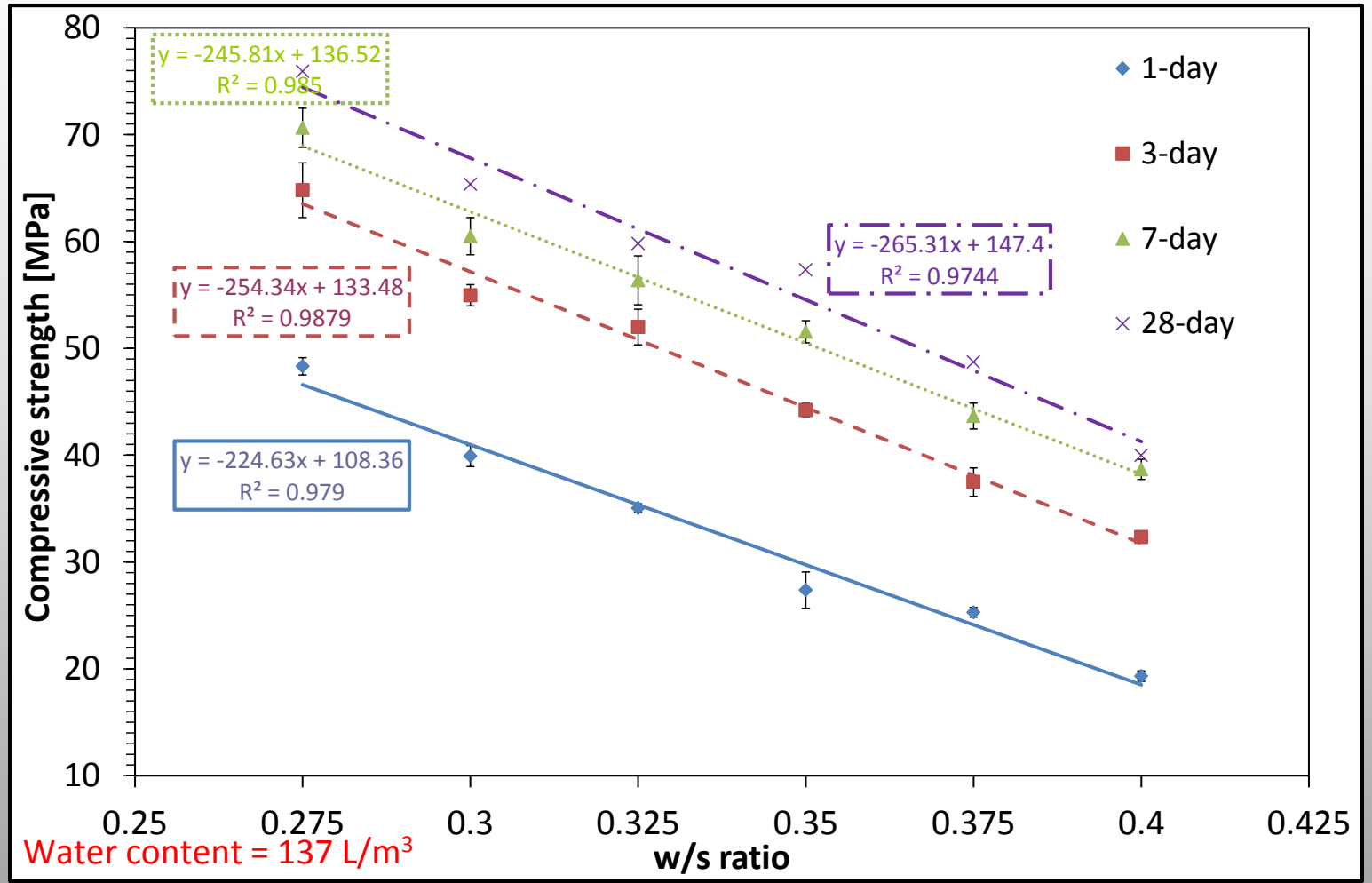
Design of banahCEM Concrete

Water Content Fixed at 137 L/m³



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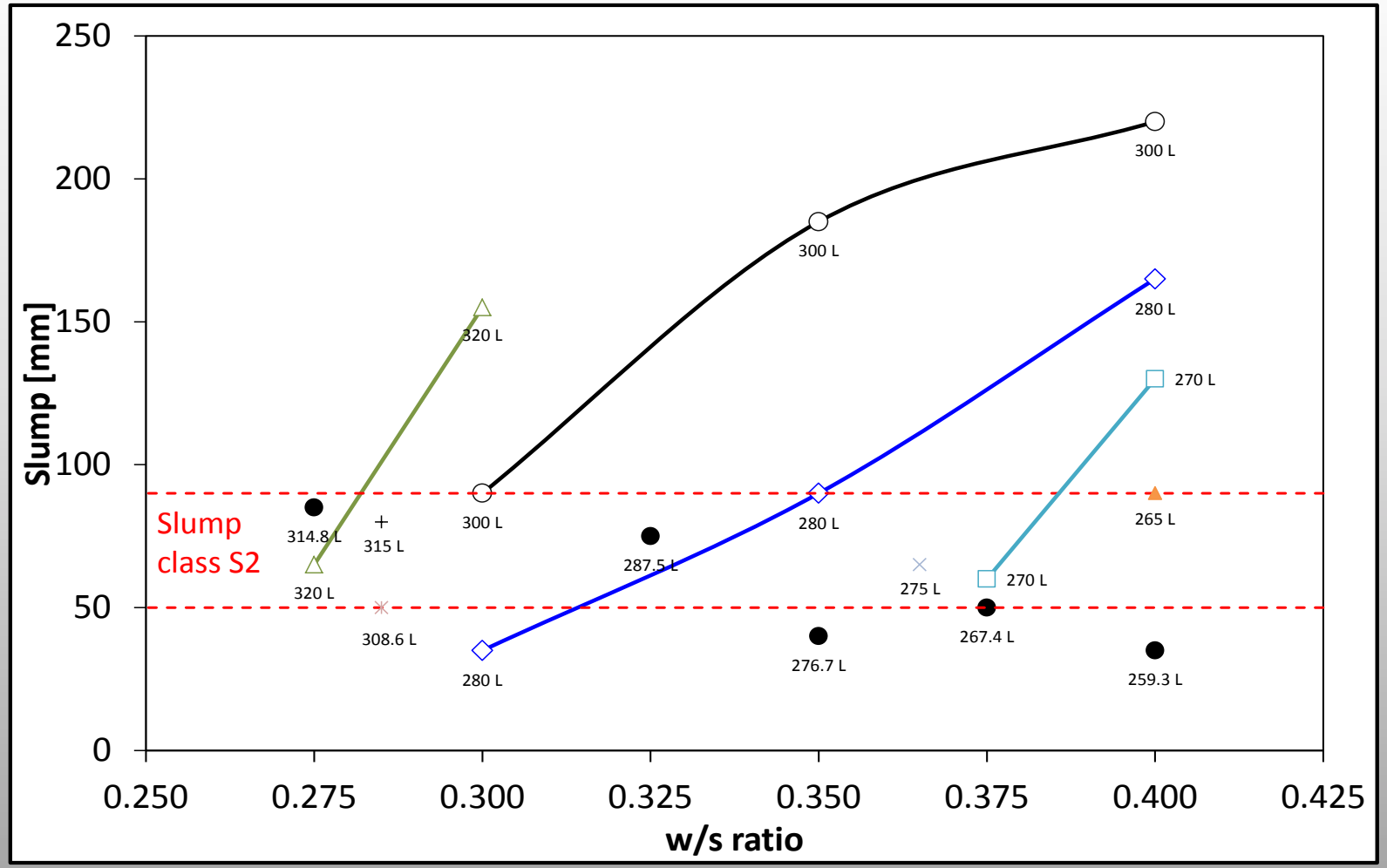
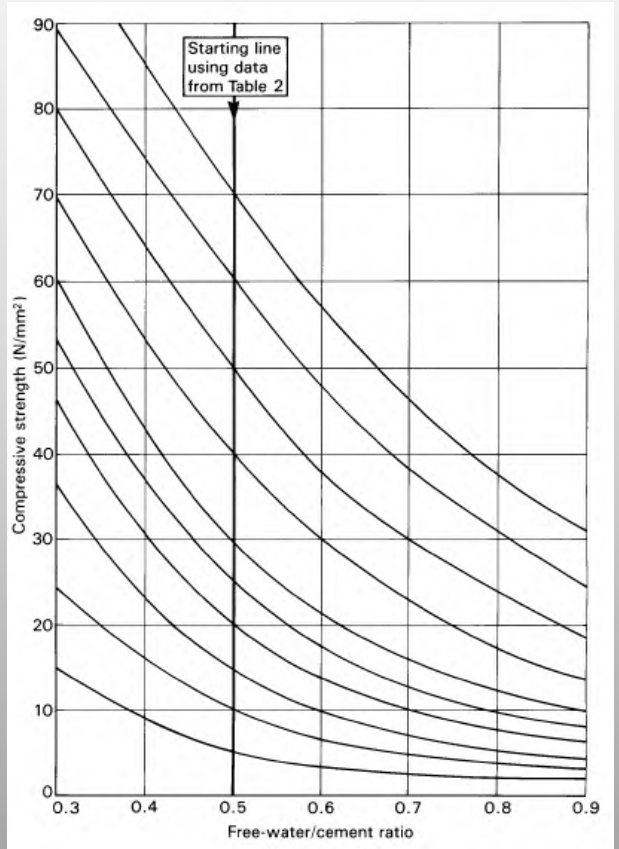
Relationship of Slump, Paste Volume and w/s Ratio



Design of banahCEM Concrete

BRE Design of Normal Concrete Mixes

'… the strength of concrete is better related to the free-water/cement ratio…'



- Initial work has confirmed similar trends based on variation of w/s ratio
- Development of a set of charts to enable design of geopolymer mixes
- Work is being carried out on natural uncrushed aggregates

Figure 4 – from BRE Design of Normal Concrete Mixes

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The next steps...

- Commencement of banahCEM Production
- Development of Standards for Geopolymer Cements
- Development of a 1-Part System
- Increased Use of Waste Alkali Streams for Some Applications

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