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SUSTAINABLE BUILDING PRODUCTS

DEVELOPMENT OF A GEOPOLYMER CEMENT FOR USE IN CONSTRUCTION

Andrew McIntosh

Geopolymer Camp 2011

5 – 6 July 2011
St. Quentin

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Presentation Overview

- Company Background
- Properties of a Geopolymer Cement
- Applications
- Future Opportunities

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Company Background

- formed in November 2008

- aim of company ‘to develop and manufacture new cements and building technologies’

- originally concentrated on ‘building envelope’

- main focus is now the development and manufacture of geopolymer cement

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THE STORY

In N. Ireland there is a readily available precursor which has been:

- Designed by Nature
  - Successive volcanic episodes in Co Antrim provide precursor
- Discovered by Industry
  - Material associated with precursor exploited in 19th and early 20th Century
- Discarded by Quarrying
  - Precursor found in many quarries and is considered a 'nuisance' material
- Developed by banah UK Ltd
  - Over the last two years this precursor has been used in the development of geopolymer cement

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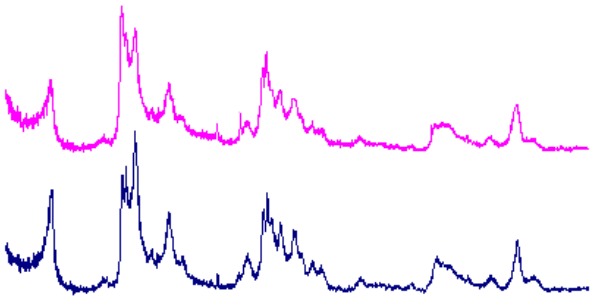
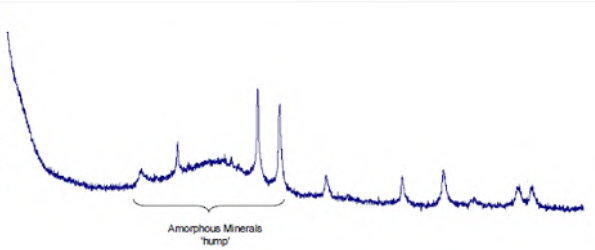
Geopolymer Cement Development

- Search for local sources of aluminosilicate
  - correct mineralogy
  - preferably existing quarry site
  - low environmental impact
- Design of geopolymer cement formulation
  - pre-treatment of raw materials
  - alkali content
  - Si:Al ratios
  - user friendliness
- Increasing sustainability; reducing costs
  - alternative sources of alkali silicate
- Fitness for purpose
  - testing in various applications
  - third party testing





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- Two-part cement system
- May be used as an OPC replacement
- Ambient temperature setting
- Compressive Strength – 115 MPa +
- Has the following benefits:
    - Low carbon
    - Low environmental impact
    - Acid resistance
    - Sulphate resistance
    - Heat resistance
    - Consistent performance due to quality of raw materials

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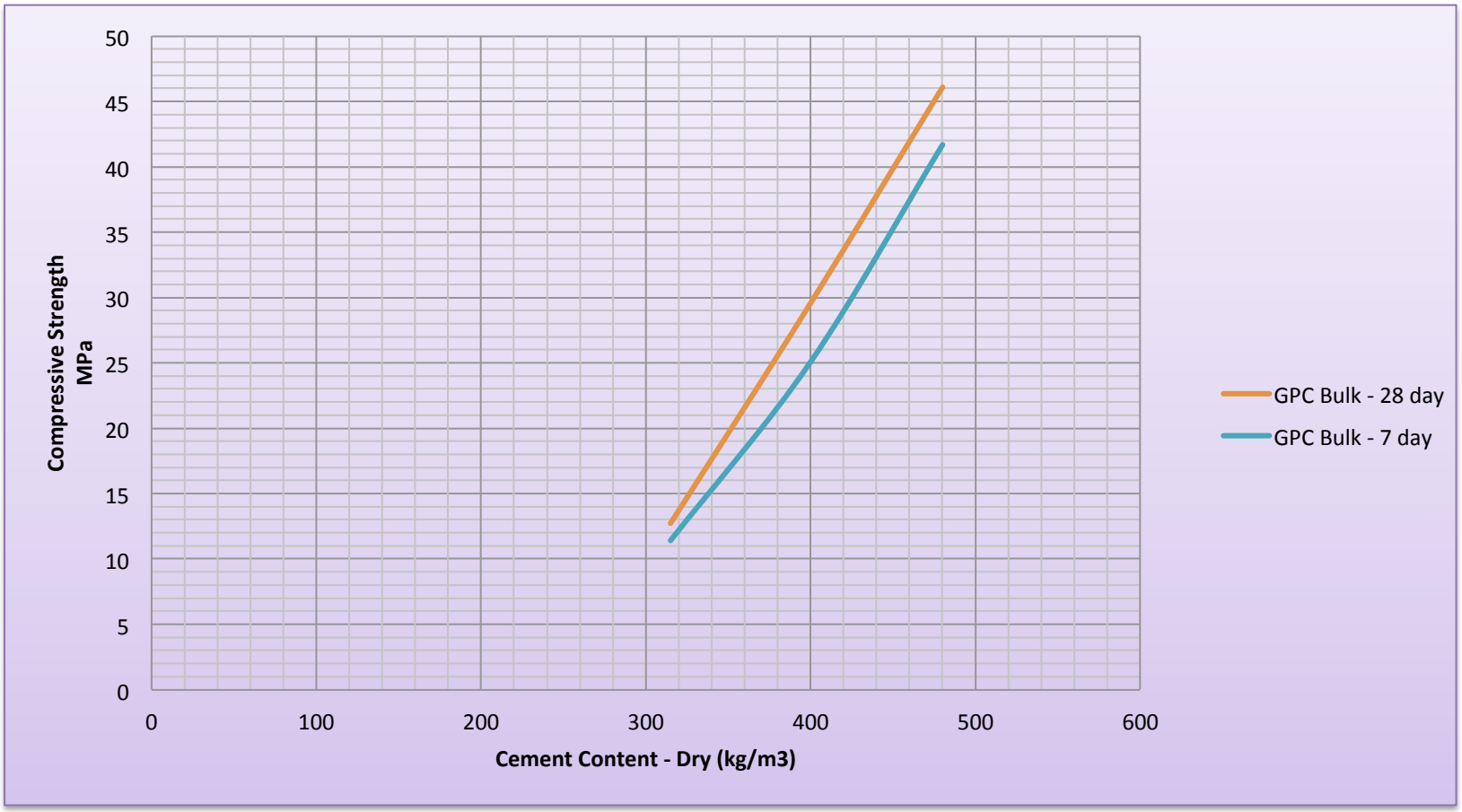
Compressive Strength of Geopolymer Concrete



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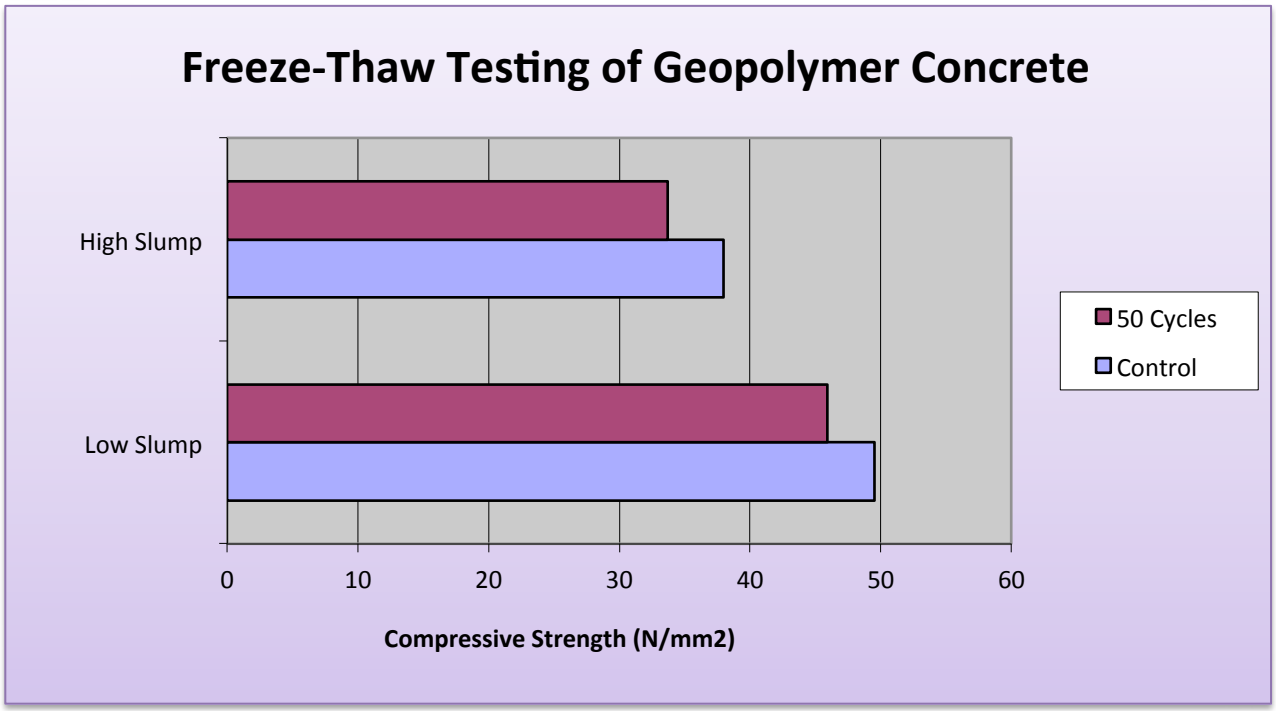
Freeze/Thaw Testing



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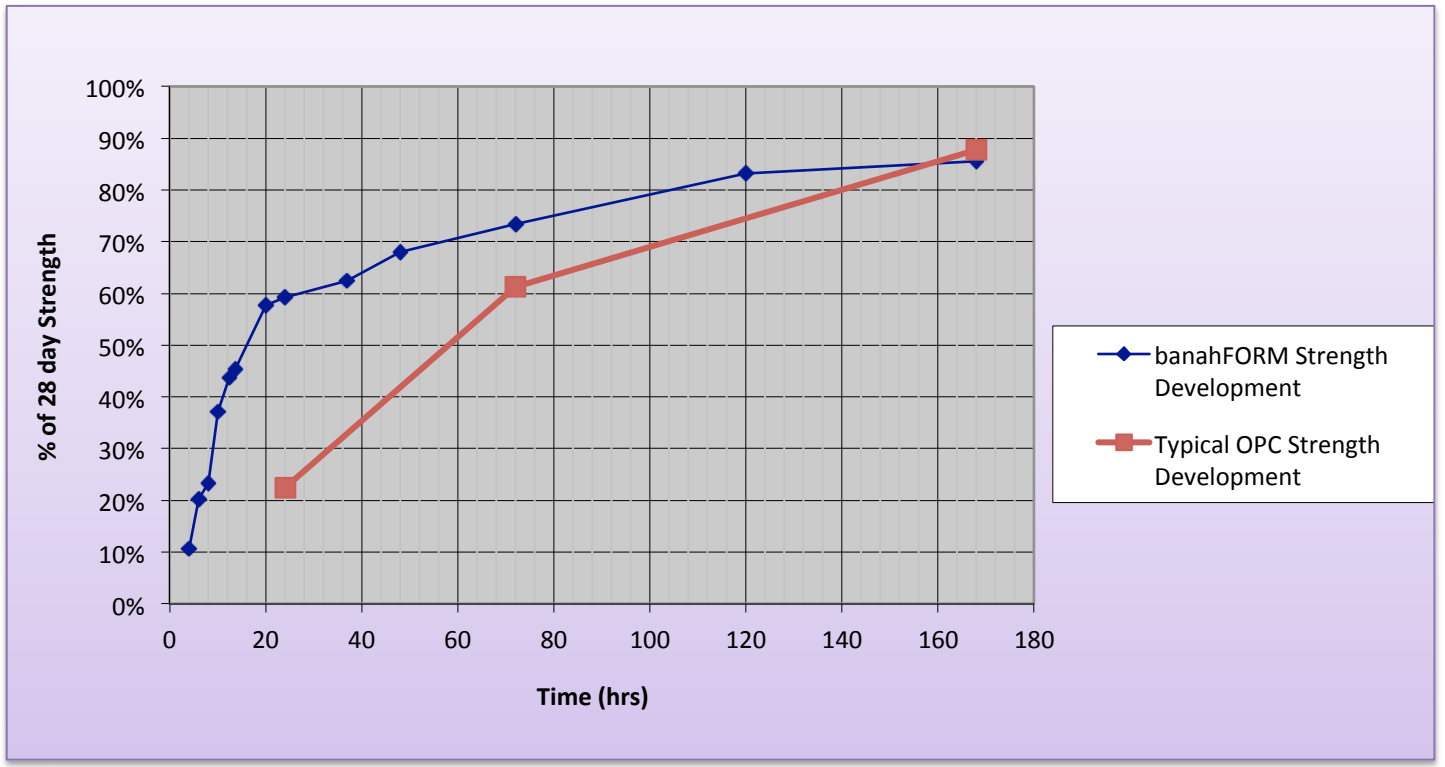
Strength Development



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Environmental Impact

CO_2 Emissions

- OPC – typically 800 kg per tonne of product*

  * **2006 avg figures for global cement production supplied by IEA.org**

- GPC – only 57% of the final binder calcined
  - calcination temperature is 50% that of OPC
  - no CO_2 released from raw material

'Hole-in-the-ground' Factor

- OPC – 2.05 tonnes raw material for 1 tonne product
  - 1.65 tonnes limestone; 0.4 tonnes clay

  British Geological Survey, *Cement Raw Materials,* November 2005

- GPC – 0.97 tonnes raw material for 1 tonne product

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Additional Results

- Water/Cement Ratios
  - Lower than with OPC concretes
  - Addition of water must be done carefully

- Curing Regimes
  - Optimum curing occurs in a high humidity environment
  - Water loss by evaporation must be prevented in early days

- Lightweight Concrete
  - Density – 1000 kg/m^3; 11 MPa

- Third Party Testing
  - Queen's University, Belfast
  - Ceram Research
  - University of Ulster - FireSert

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Applications

- Geopolymer concrete
- Links with local ready mixed concrete company
- High thermal performance building units
- Lightweight foamed geopolymer concrete
- See website for further information

www.banahuk.co.uk

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Opportunities

• Opportunities for companies to use banahFORM to develop their own products

• Potential products may include:
  – foundations for wind turbines
  – general foundations and paths
  – wall panels
  – manholes
  – sills
  – lintels
  – precast units for farms and sewage transport
  – firewalls
  – waste containment systems
  – etc

• banah will work with partners to develop geopolymer cements

• Development of admixtures for geopolymer systems

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In summary, banah UK Ltd

• is committed to the development of a viable geopolymer cement for use in construction

• is finalising plans for a pilot plant capable of 100,000 t/yr

• will be looking to partner with interested parties to further develop geopolymer cements

• will be pressing forward in the design and supply of sustainable, low environmental impact construction

• will continue in the research and development of geopolymer technology in construction

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