RPF

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UFS Green Concrete Research

Dr Hossein Naghizadeh

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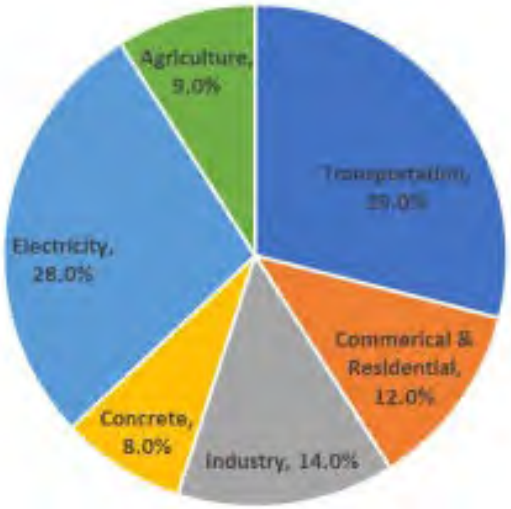
Background

Despite its excellent mechanical and durability properties, Portland cement is increasingly scrutinized from an environmental perspective. Its environmental impact can be categorised into three main aspects:

Significant carbon emissions – Due to lime calcination

Depletion of natural resources – Use non-renewable raw materials

High energy consumption – Need for elevated temperatures



1 ton OPC = 1 ton CO_2

(*Approximately 8% of global carbon emissions*)

(Ramsden, 2020)

Geopolymer binders and alkali – activated cements

Synthesized inorganic material, produced through a reaction between aluminosilicate materials and alkaline solutions,

Highlights

- Reduction in use of natural resources as starting materials
- Use of wastes, beneficial from waste management point of view
- Lower carbon emission and lower energy consumption through elimination of lime calcination,

Concrete Mixtures

Aggregate

+

OPC

+

Water

=

Normal Concrete

Concrete Mixtures

Aggregate

+

Aluminosilicate Raw Material

+

Alkali Solution

=

Geopolymer Concrete

Normal Concrete

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Aggregate

Aluminosilicate Raw Material

Alkali Solution

Geopolymer Concrete

Raw Materials

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Industrial Wastes

- Fly ash
- Slag
- Silica fume
- Bottom ash
- Red mud
- Ceramic waste
- Glass waste

Agricultural Wastes

- Rice husk ash
- Sugar cane bagasse ash
- Corn cob ash
- Palm oil fuel ash
- Wheat straw ash
- Cashew nutshell ash

Natural

- Metakaolin
- Volcanic ash
- Laterite soil
- Termite soil

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Advantages of geopolymer binders

- Lower environmental impacts,
- Superior mechanical properties depending on raw materials and synthesis condition,
- Superior durability performance, including:

  Better resistance under sever conditions,

  Higher resistance to fire attack,

  Lower expansion due to alkali-silica reaction (ASR), Lower carbonation,

- **Recyclability!**

Geopolymer Concrete

Recycling Geopolymer Binder

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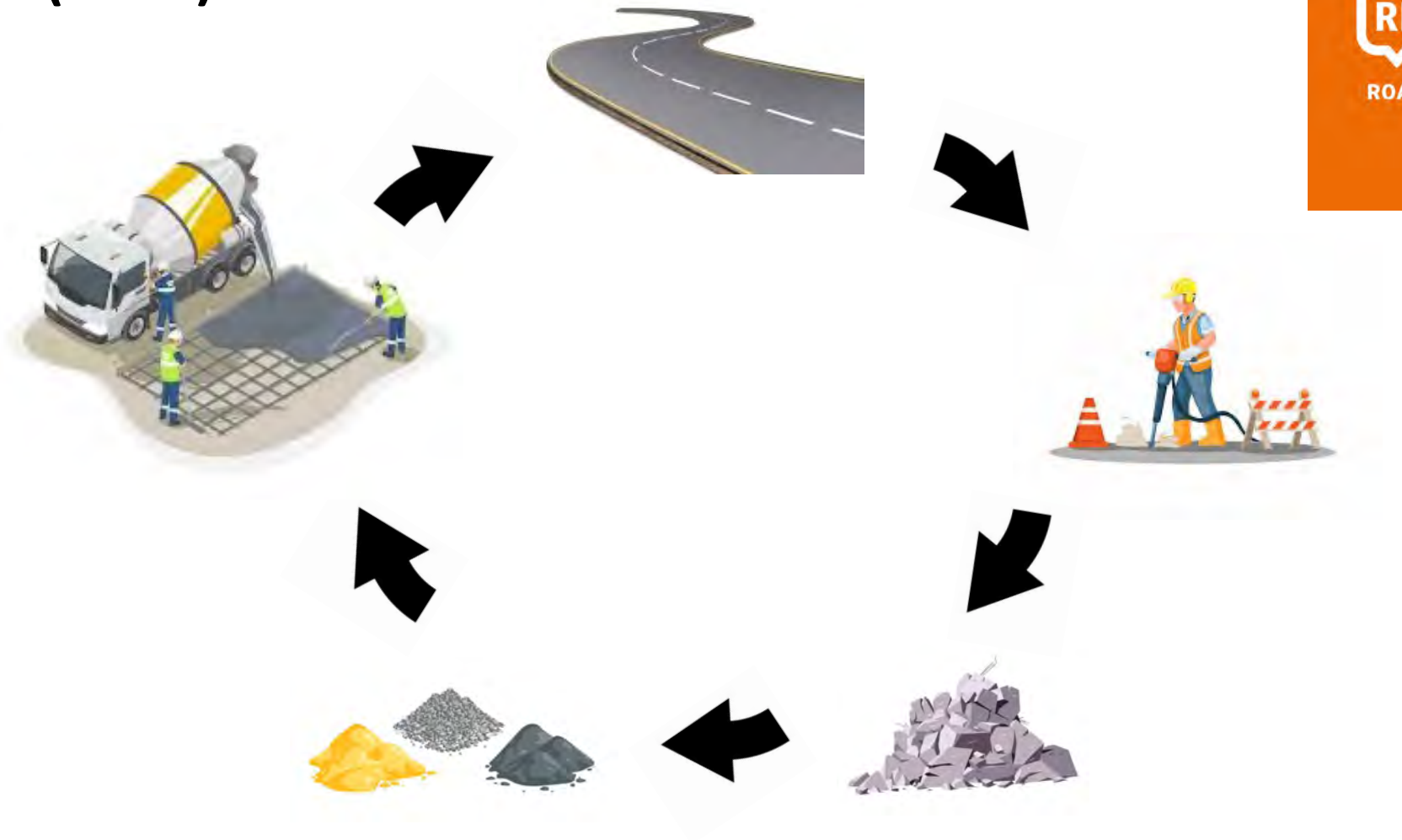
Recyclable Cement (cont.)



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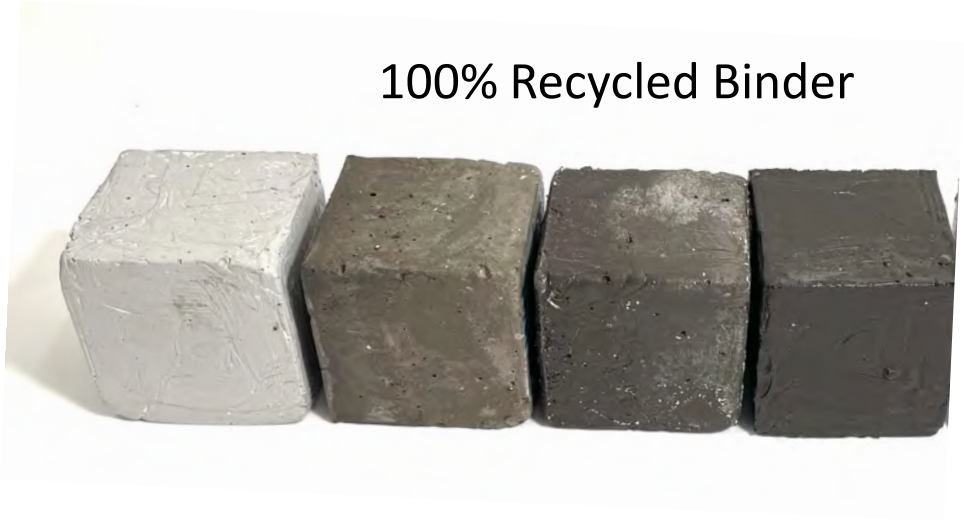
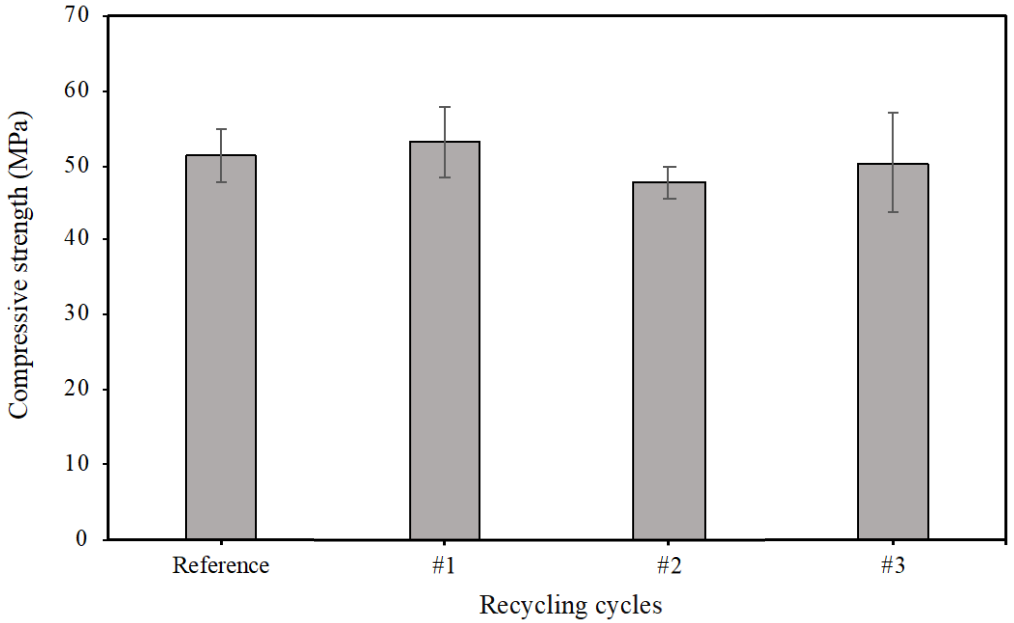
#3 times of recycling concrete
(Net-zero waste Process)

100% Recycled Binder





Geopolymer Concrete Applications

Example of Large-scale Projects

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Project Name: Brisbane West Wellcamp Airport

Year: 2014

Location: Toowoomba, Australia

Geopolymer Concrete Used: ~100,000

435 mm thick payments used for the turning node, apron and taxiway aircraft pavements.

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Geopolymer Concrete Applications

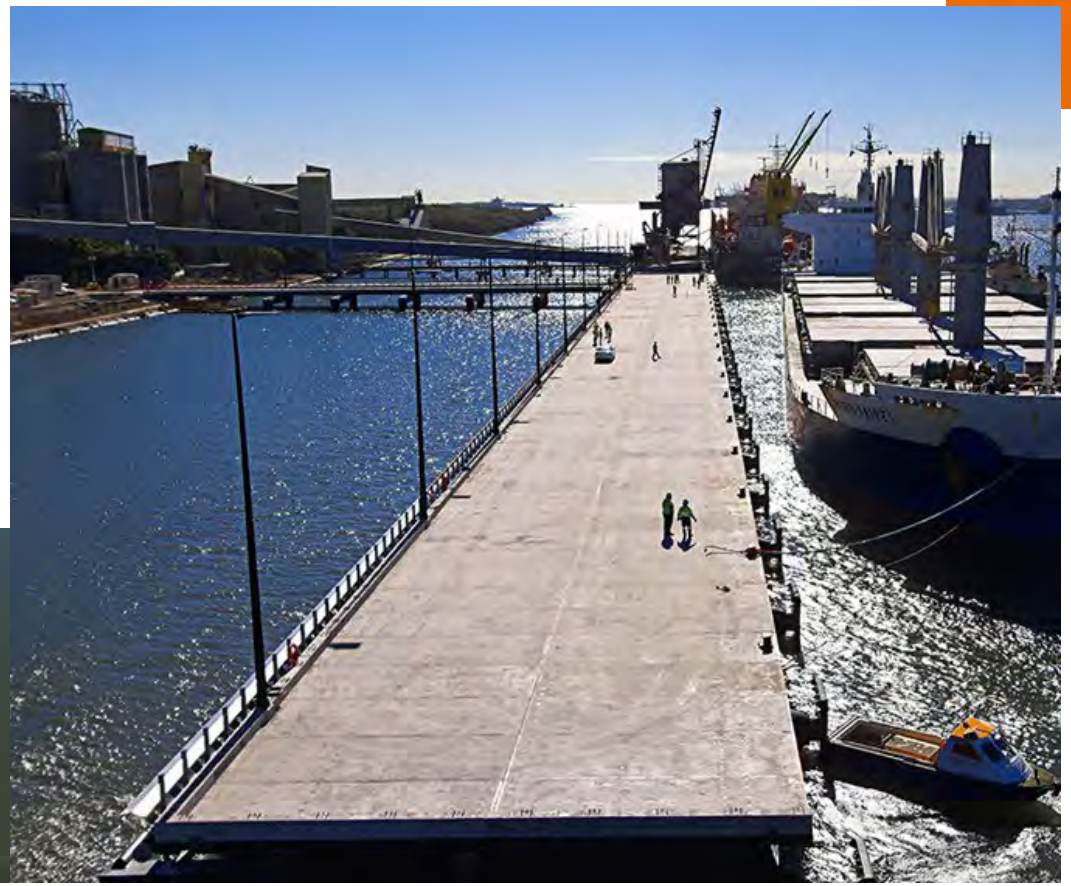
Example of Large-scale Projects

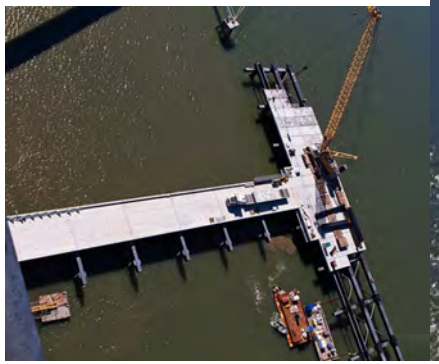
Project Name: Pinkenba Wharf (FRP Deck)

Year: 2018

Location: Brisbane, Australia

Geopolymer Concrete Used: ~3,800 tons





Geopolymer Concrete Applications

Example of Large-scale Projects

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Project Name: NTPC Dadri Power Plant Road

Year: 2018

Location: Dadri, India

Geopolymer Concrete Used: ~3,000 tons

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Geopolymer Concrete Applications

Example of Large-scale Projects

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Project Name: London Power Tunnels (Hurst shaft)

Year: 2023

Location: London, UK

Geopolymer Concrete Used: ~1800 tons

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Potential for Application Green Concrete Pavement in South Africa

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- Outstanding availability of raw materials such as fly ash,
- Excellent properties of South African materials for Geopolymer production,
- Strong knowledge developed by extensive research over a decade.

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Potential for Application Green Concrete Pavement in South Africa

N2/N3 Freeway upgrades (Sanral)

	Required Concrete	Total (ton)
1	Road Base (35 MPa)	789 400
2	Road Interlayers (10 MPa)	146 100
3	Drainage	166 000
4	Bridges and Structures	596 000
5	Walls	439 200
Total		**2 136 700**

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Q & A

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