Geopolymer Camp 2023

Application of Geopolymer Technology in Pavement Engineering- In Indian Perspective

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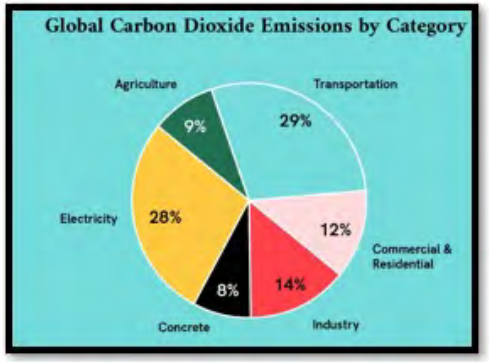
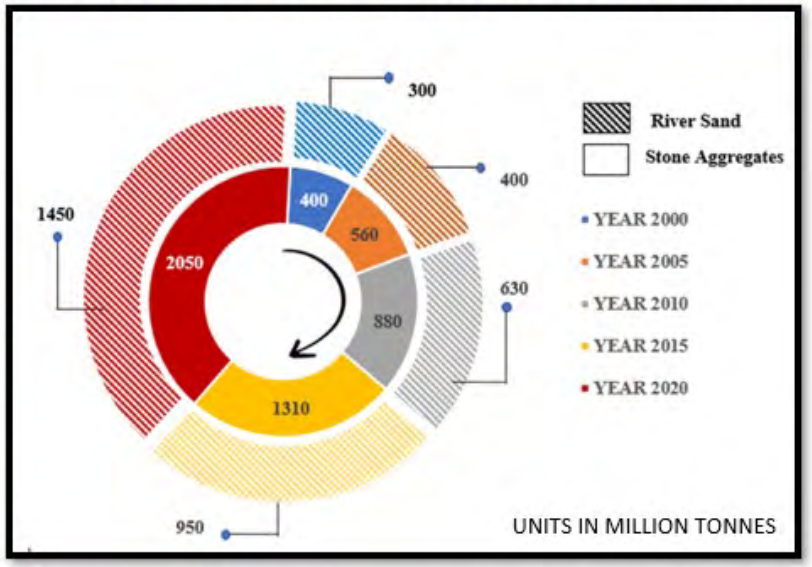
Performance Evaluation of Reclaimed Asphalt Pavement Aggregates (RAP) Incorporated Geopolymer Technology for Rigid Pavement Application

GLOBAL CO_2 EMISSIONS



OVER EXPLOITATION OF NATURAL RESOURCES



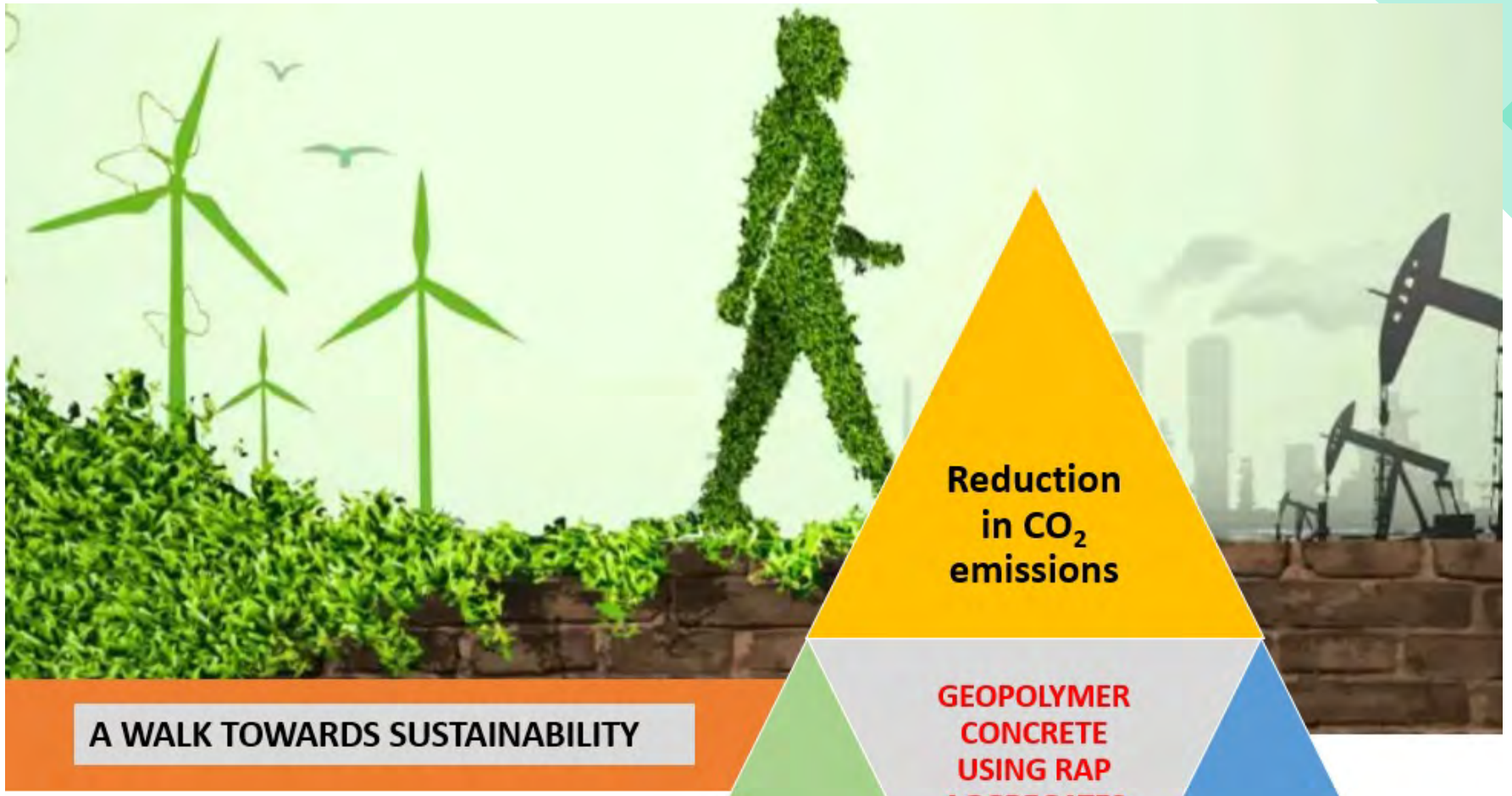
Projected demand for natural aggregates by the transportation sector of India (Data analysed from FRG Report, 2016)

DEPOSITION OF INDUSTRIAL WASTES

ACCUMULATION OF RECLAIMED AGGREGATES

Research Motivation- Current Problems

Source- https://carbonbuilt.com/low-carbon-concrete-czi-investements/



Source- https://www.youthopportunitieshub.com/walking-the-talk-on-sustainability-as-young-people-towards-the-climate-ambition/

Materials Used

Alumino-silicate Source Materials

Sodium Silicate

Sodium Hydroxide

Substantial Findings

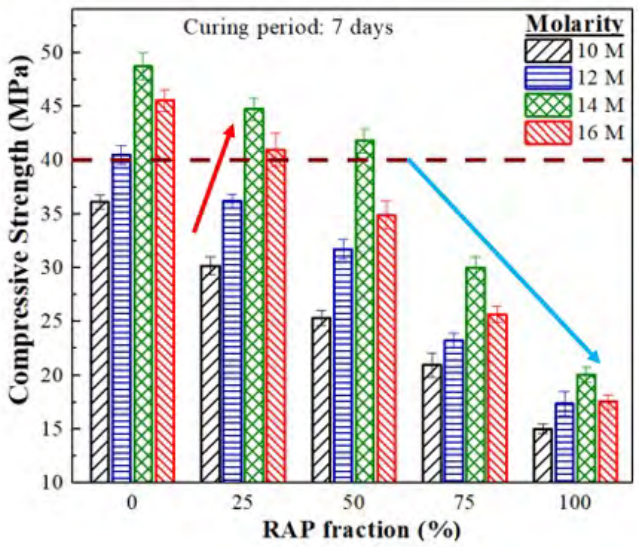
Ambient-cured GPC of desired strength cannot be produced using FA, RM, or GP alone.

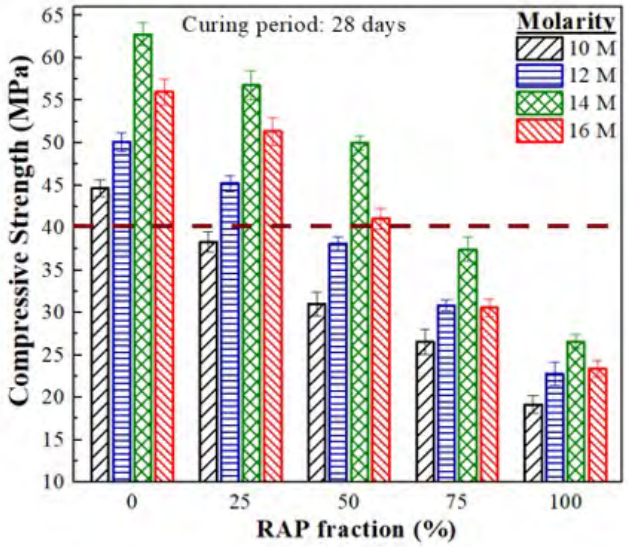
Oven-cured specimens depicted maximum compressive and flexural strength for all the industrial wastes used in this study.

For the construction of structures demanding medium/ high-strength concrete at ambient temperature, the use of red mud and glass powder with fly ash is not recommended.

Incorporation of GGBS resulted in achieving the desired compressive and flexural strength of GPC at ambient temperature, and the best-performing mix was obtained for a 70% FA and 30% GGBS combination.

Compressive strength

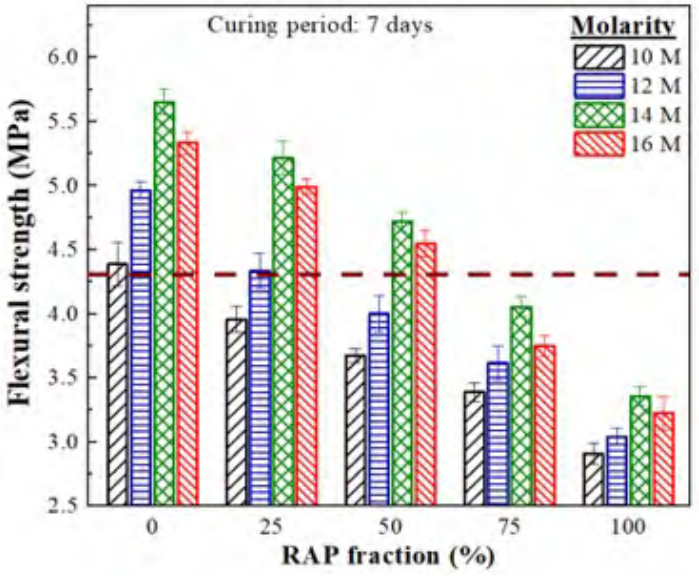


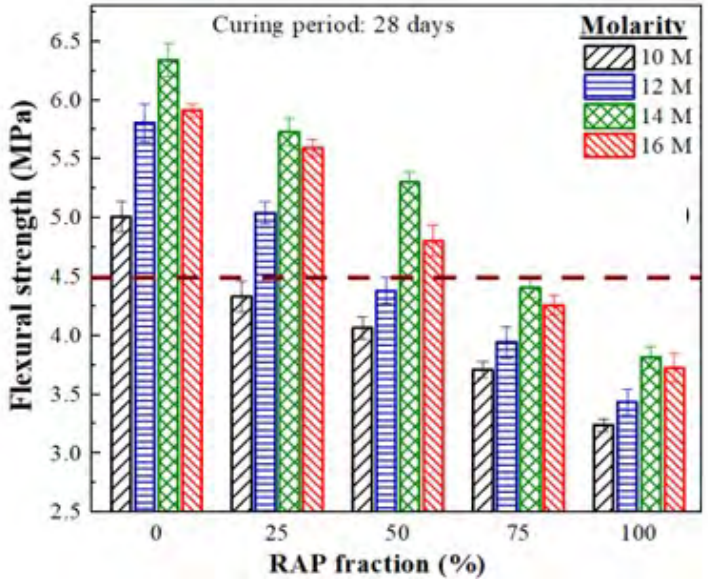


1. Optimum performance obtained for 14 molarity of NaOH
2. Incorporation of RAP beyond 50% not desirable

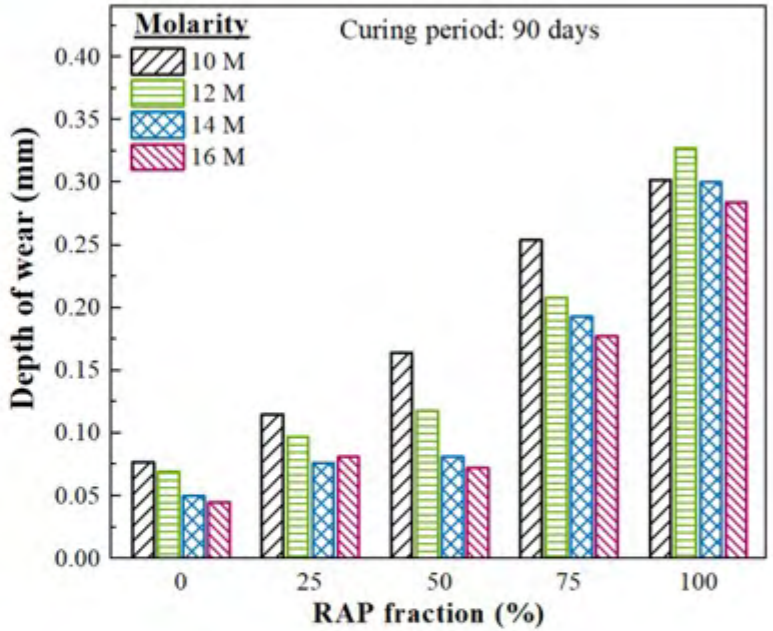
The minimum flexural strength criteria for PQC mixes (4.5 MPa) at 28days of curing for conventional concrete could be attained only at 7days for 50% RAP-GPC specimens subjected to ambient curing (4.71MPa)

Flexural Strength





Durability Analysis- Resistance to surface abrasion



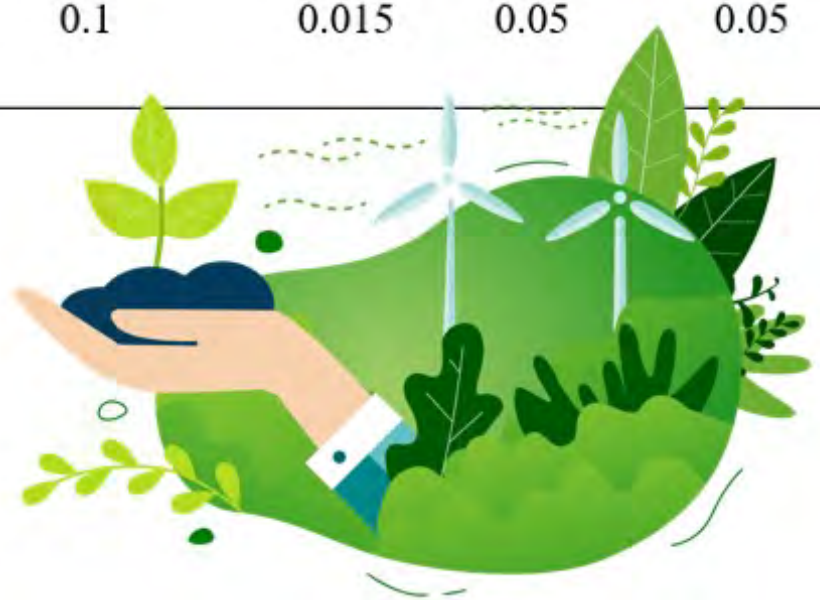
1. All the mixes exhibited high resistance to surface abrasion

2. Resistance decreased with an increase in RAP content in the mix

Environmental Viability

TOXICITY CHARACTERISTICS LEACHING PROCEDURE

Sample	Heavy metals (mg/l)					
	As	Cd	Cr	Pb	Se	Ag
100RAP-GPC	0.018	0.000073	0.000573	0	0.01143	0.000059
USEPA regulatory levels	5	1	5	5	1	5
Drinking water standards (EPA, 1999)	0.05	0.005	0.1	0.015	0.05	0.05



The first RAP-Geopolymer Project in India

- The Ministry of Road Transport and Highways (MoRTH) is currently sponsoring the research
- And the first RAP-Geopolymer Concrete Trial Road is being constructed in Uttarakhand, India in August 2023.

Feasibility study of Geopolymer Treated Base using Full Depth Reclamation Technique

Introduction to FDR

- Full Depth Reclamation (FDR) is a pavement rehabilitation process that involves in-situ recycling of existing distressed pavement. Both the bound asphalt layer and underlying granular layers are admixed with suitable additives to produce a stable base layer.
- The depth of reclamation may range from 100-400 mm.
- The major activities include the following

Cement Spreading

Pulverization &Watering

Compaction & Grading

Surface Layer

Merits of FDR

Full-depth reclamation has numerous benefits, including the following:

- Cost-effectiveness
- Increased structural capacity
- Increased durability
- Opportunity to improve roadway geometry
- Shortened construction schedule
- Early opening to traffic
- Reduced impacts on the community during construction
- Reduced carbon footprint

"Reconstruction without the price tag"

Conventional stabilizers

- Portland Cement
- Lime
- Asphalt Emulsion
- Fly ash
- Fly ash-cement combination

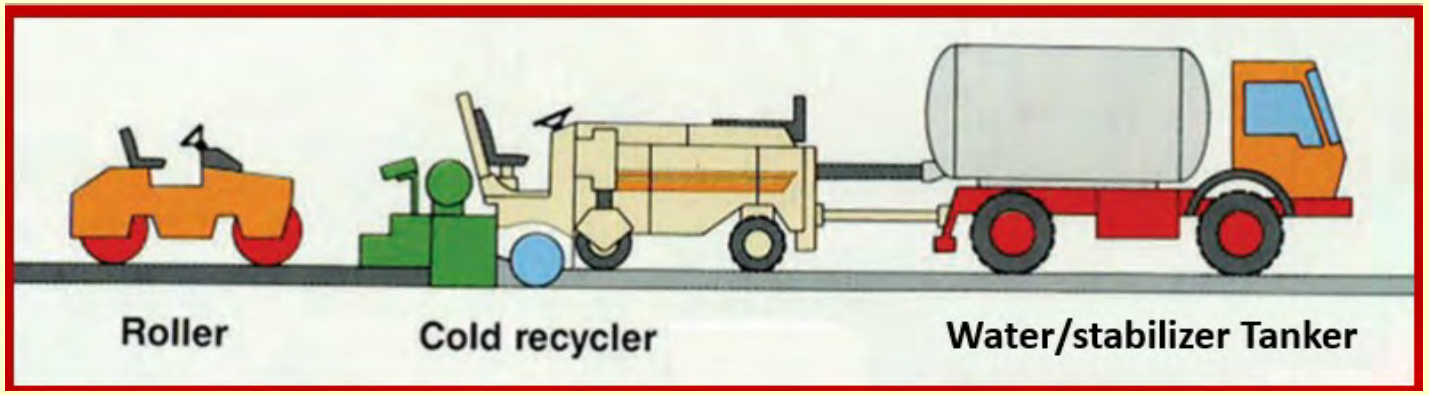
*** Cement is most preferred since it is applicable to wide variety of soils (FDR-PC)-Basic Asphalt Recycling Manual, 2nd Edition, Asphalt Recycling and Reclamation Association (ARRA) 2015

Geopolymer Treated Base-Laboratory Trial

Road Materials

Geopolymer Stabiliser

Treated mix for base layer application

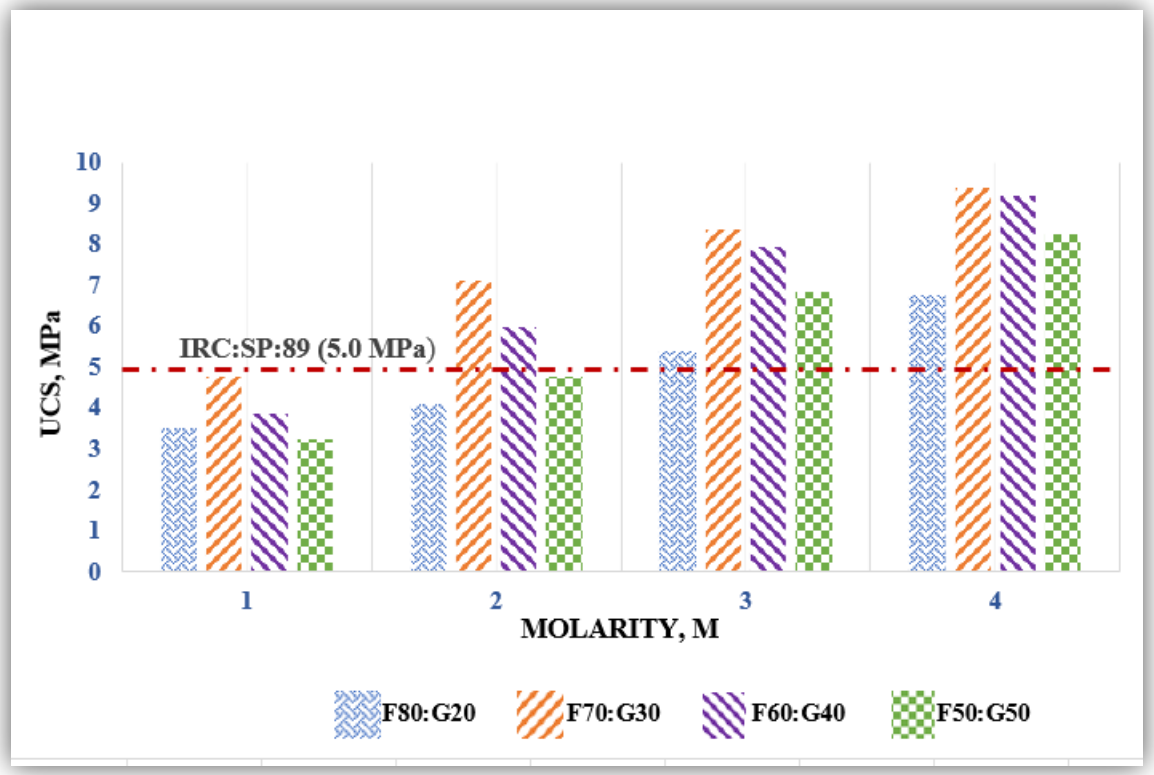


Geopolymer Treated Base-Field Implementation

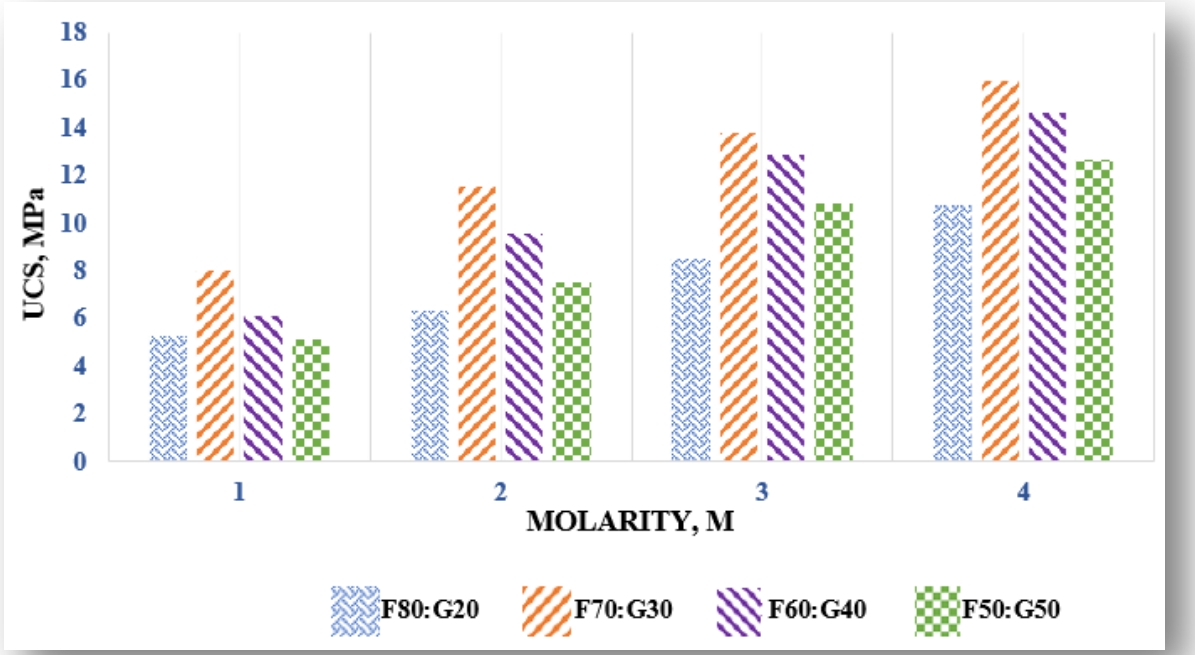
FDR-Geopolymer Interaction

Feasibility study of Geopolymer Treated Base using Full Depth Reclamation Technique

Preliminary Investigations



7 and 28 days Unconfined Compressive Strength with varying molarity

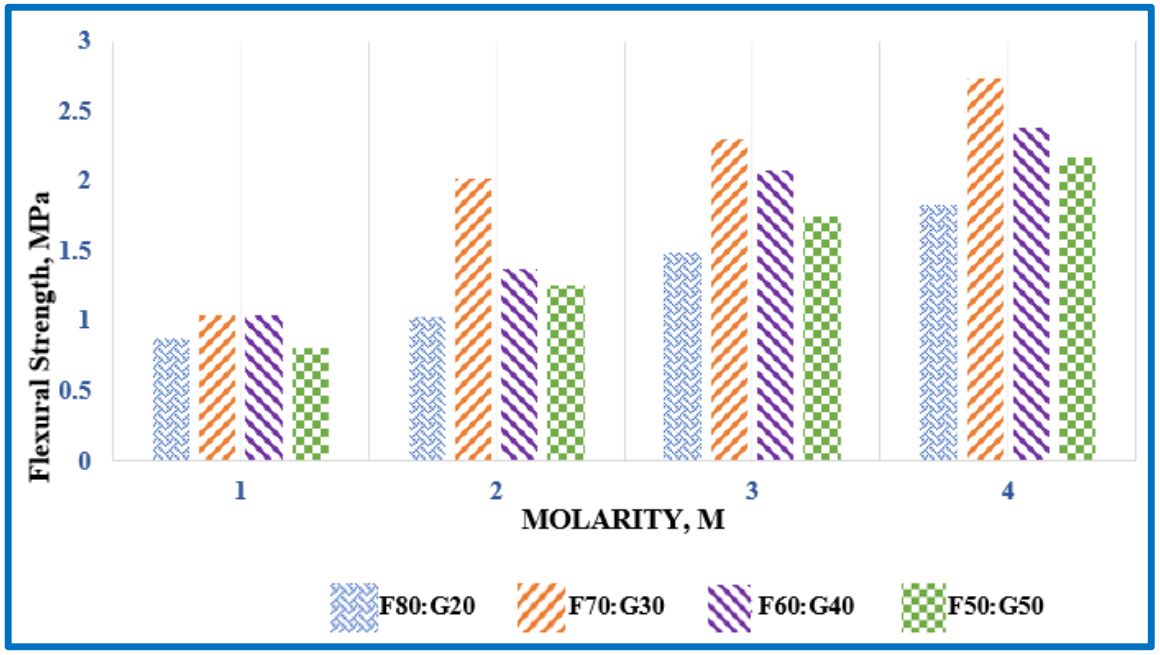


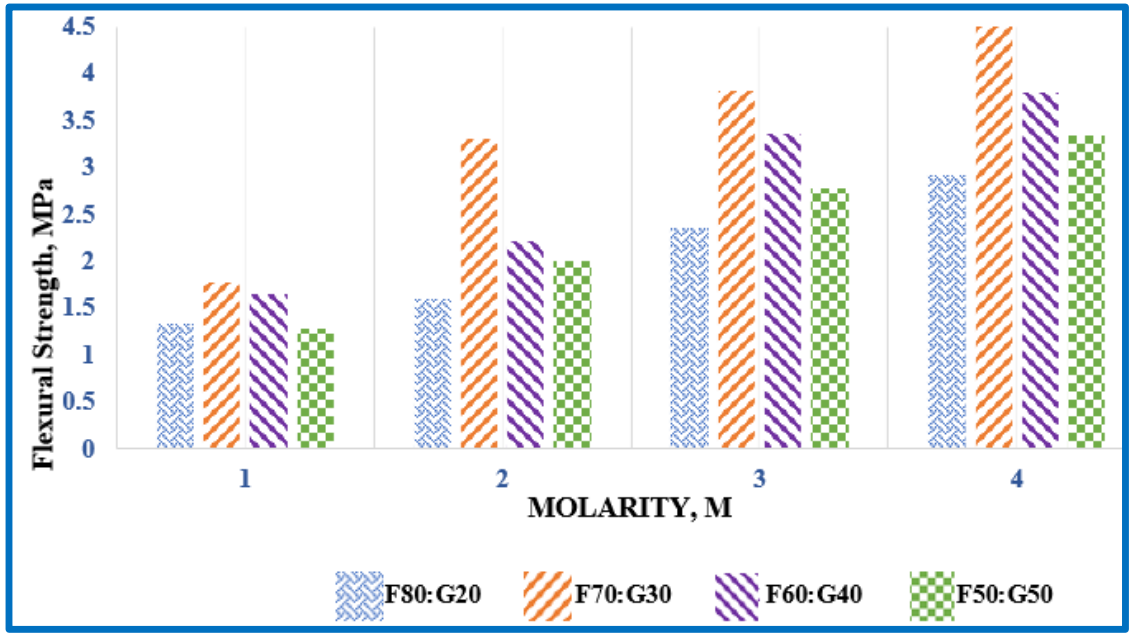
IRC SP 89- 2018 proposes a minimum strength requirement of 5MPa at 7 days for stabilized base layer.

2M F70:G30

Average Strength gain = 70%

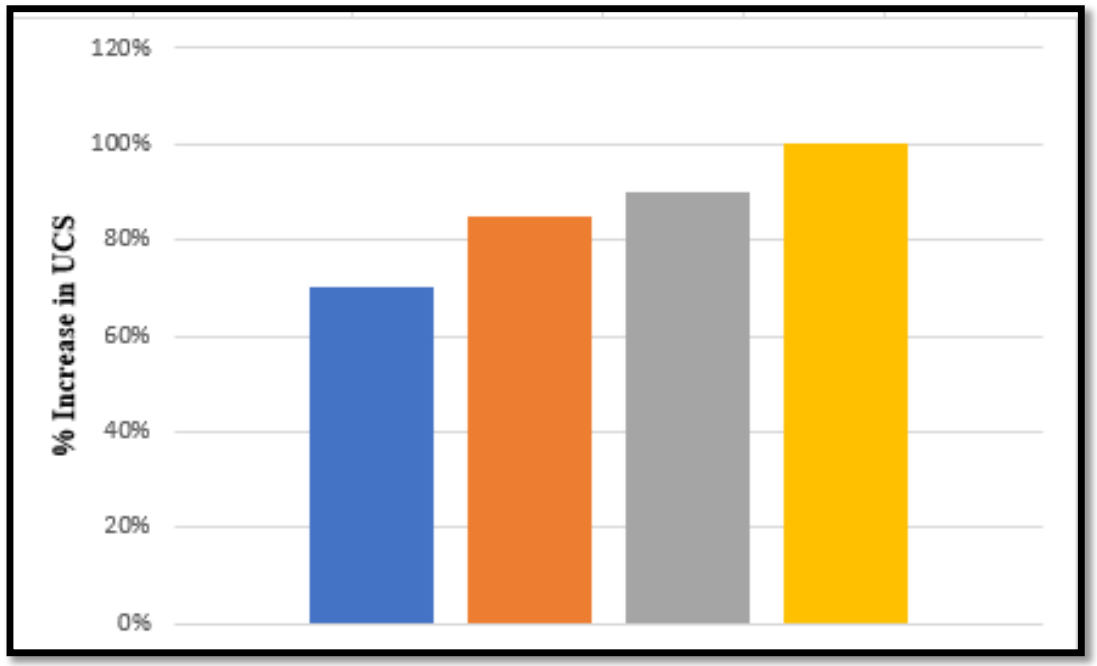
7 and 28 days Flexural Strength with varying molarity



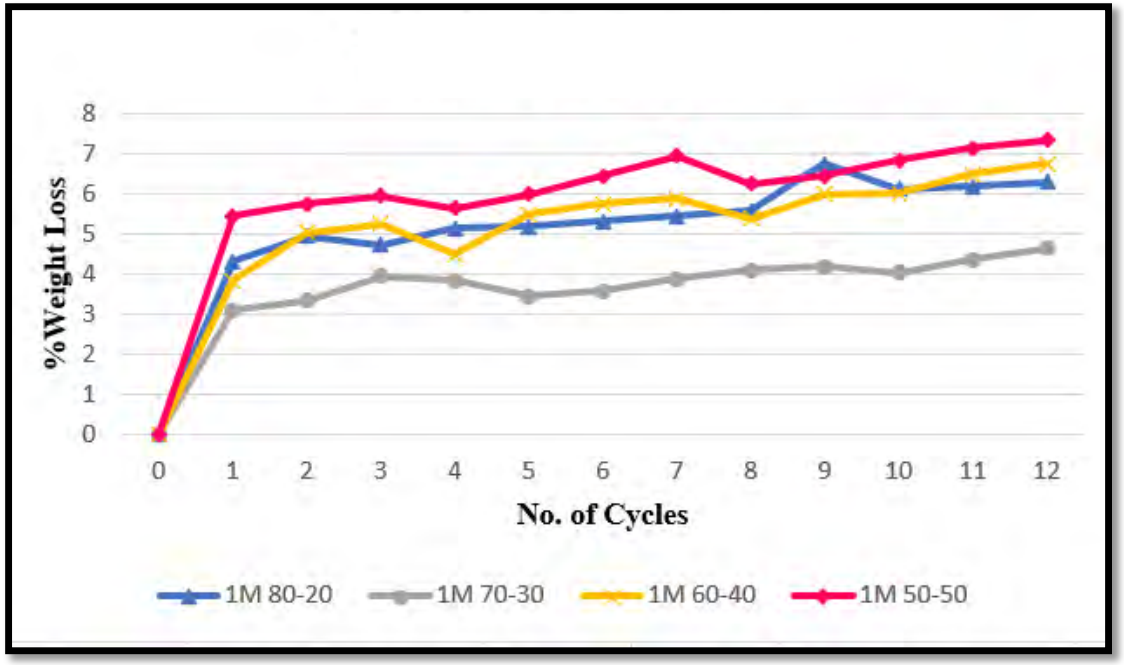


Durability Analysis

Wetting and Drying test



% increment in UCS after 12 Cycles of Wetting and Drying Test



% weight loss after 12 Cycles of Wetting and Drying Test

Challenges in Indian perspective

- Effect of temperature variation on mix performance
- Lack of acceptability and awareness
- Gap in industry-academia interface
- In a developing economy like India that primarily relies on labour intensive construction setup, the use of NaOH solution prepared beyond 4M poses health hazard to the construction workers who aren't trained enough to handle chemicals

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Thank You

Our biggest challenge in this new century is
To take an idea that seems abstract-
"sustainable development"-
and turn it into a reality for all the world's people.

- Kofi Annan