Basalt FRP reinforcement and Novel Macro Basalt Fibres in Low Carbon Concrete

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Aim of Research

Basalt Fibre Reinforced Plastic (BFRP) bars is new type of FRP that can be used as an alternative to steel reinforcing due to excellent corrosion resistance. Novel wave-shaped Macro-basalt fibres has been recently manufactured. Alkali-activated cements are tentatively being used in infrastructure projects, though more scoping for use with BFRP and application testing is required. Both BFRP and Alkali-activated cementitious materials have environmental benefits, compared with conventional materials. The project aims to investigate the integration of two novel technologies and the structural and life-cycle performance of the BFRP materials and Alkali-activated concrete compared with steel and OPC.

Basalt Fibre Reinforced Polymer (BFRP)

Basalt fibre is a type of inorganic fibre which are produced by melting the volcanic rock basalt.
In this project, Basalt FRP reinforcement were used to replace steel while Marco-Basalt fibres (have wave-shaped) will be mixed in concrete.

- High strength
- Higher elasticity than GFRP
- High temperature stability
- Good processibility properties
- Good corrosion resistance
- Less embodied carbon

Fig –Macro-Basalt fibres and Basalt reinforcement

Alkali-Activated Concrete (AAC)

- Concrete that has a cement-less binder made from reacting either a geological material or an industrial by-product (such as slag, fly ash, rice husk ash, etc.) with an alkali solution
- Steel in AAC is proved to have better corrosion resistance than steel in OPC concrete
- No research on integration of BFRP as reinforcement in AAC.

Methodology

Basalt Fibre reinforced concrete samples → BFRP RC slabs testing made from AAC and reinforced with Macro-Basalt fibres → Life-Cycle Analysis

Results and Discussion

Effect of fibers percentage on concrete properties:

- Slight reduction in compressive strength
- Significant improvement in the tensile strength. Adding 2% increases tensile strength by 61.7%.

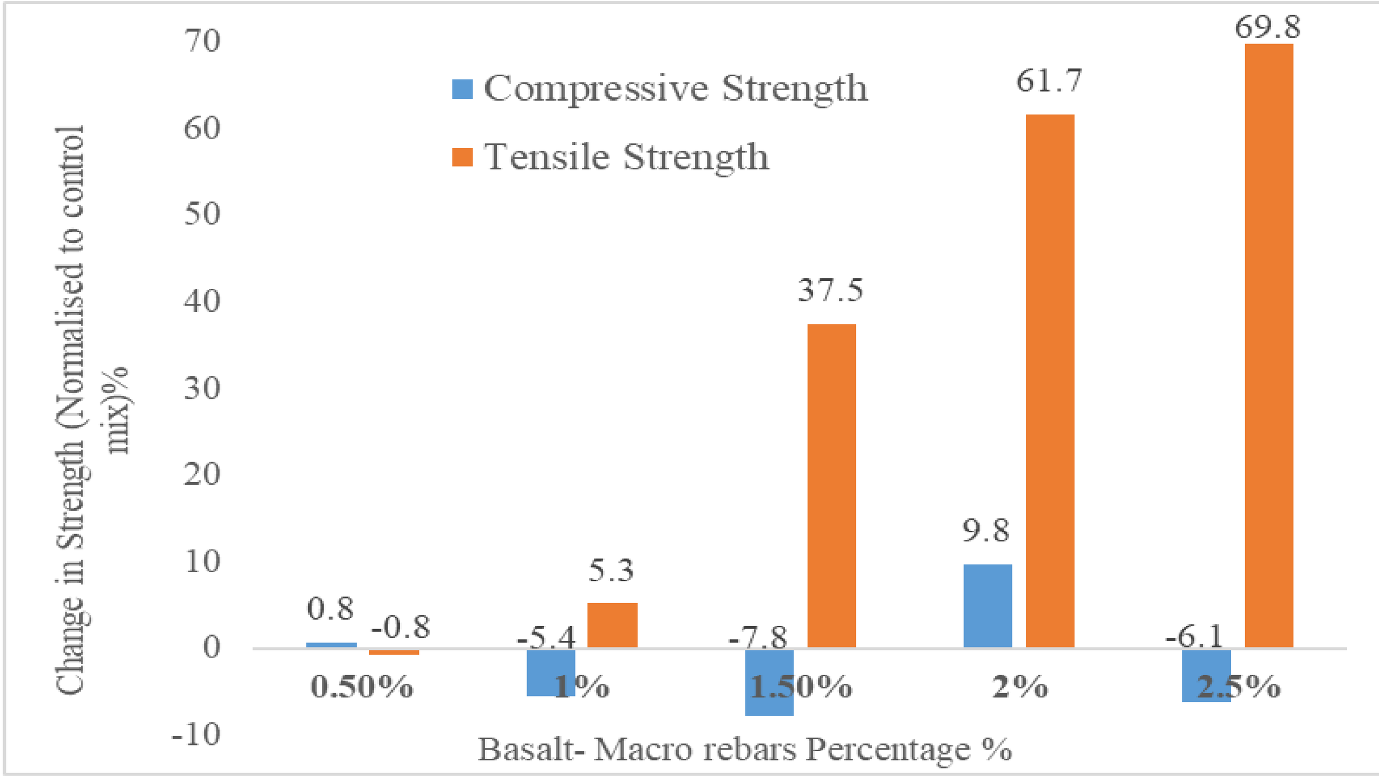


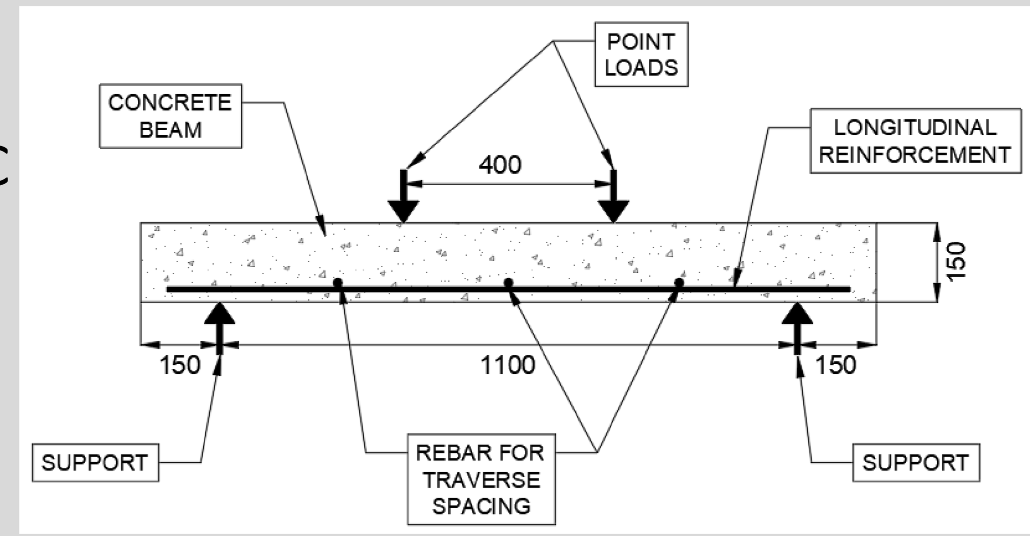
Fig – Effect of Macro-basalt fibres

Slab testing

- BFRP reinforced slabs showed elastic behaviour with brittle failure and steel reinforced slabs showed ductile failure
- Higher BFRP rebar size showed lower deflections
- Higher fiber content showed reduced workability but better crack resistance and shear capacity of BFRP RC AAC slabs

<u>Testing</u>

6x BFRP-reinforced AAC concrete and 1x steel-reinforced OPC were tested until failure



<u>Slab Notation</u>

A-B-C-D(E)
A = Rebar type
B = Rebar size
C = Concrete type (AAC or OPC)
D = % fibre
E=compressive strength of the concrete in Mpa

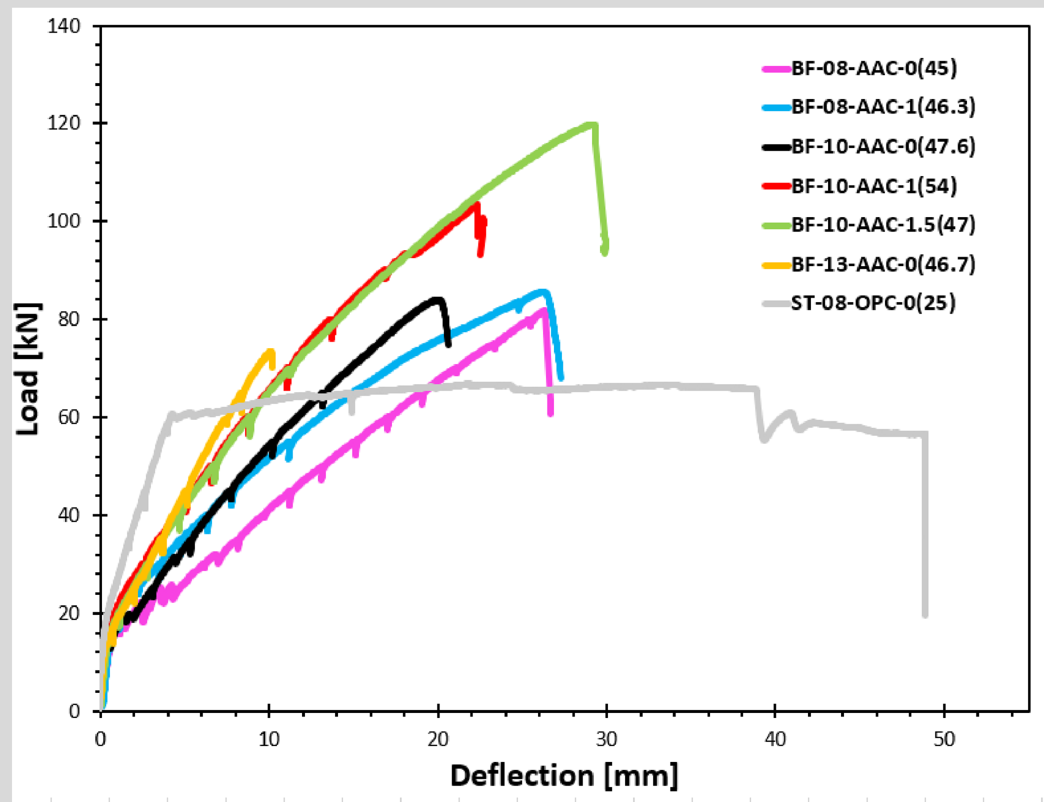


Fig – Load-Deflection Plots

Life-cycle Analysis

- BFRP AAC slabs had 200% lower CO_2 emissions than steel OPC slabs
- A LCA study with slabs of same design strength is recommended
- Further research into effects of fibre content is recommended as previous studies have seen significant improvements in concrete's performance

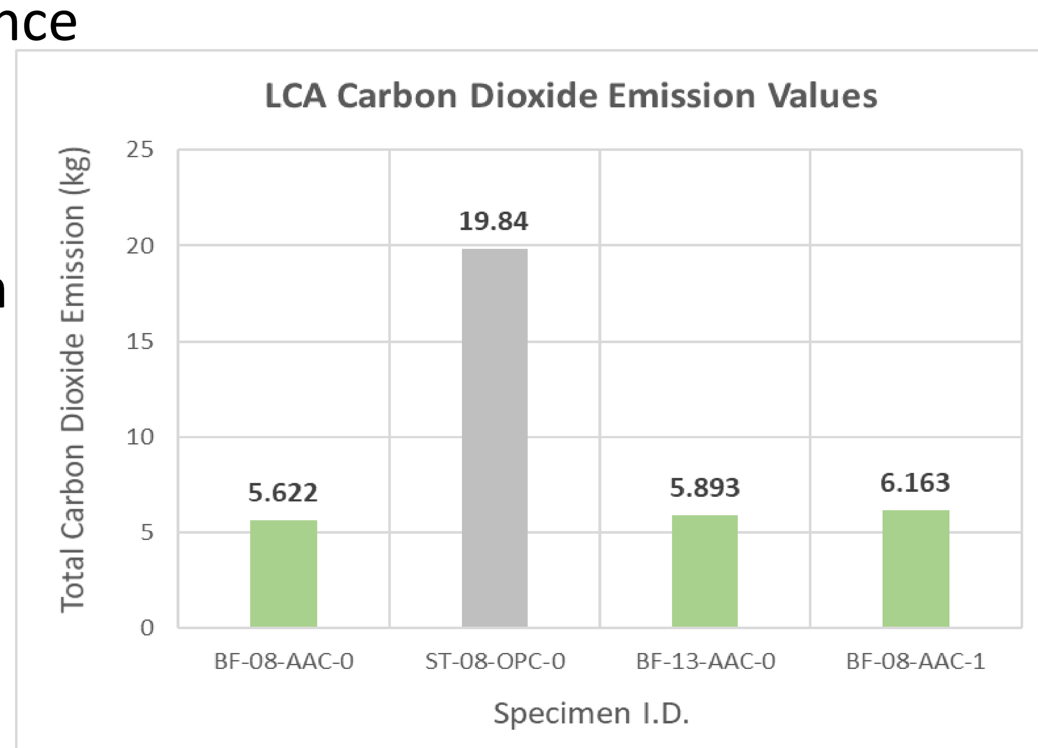


Fig – LCA CO_2 Emission Values for Each Slab