



Beneficial Use of Biochar in Concrete with Natural and Recycled Aggregate

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Introduction and Objectives

Biochar is an organic material produced as a result of the pyrolysis of carbon-based biomass and organic waste. It is a sustainable material obtained by heating biomass i.e., plant materials, agricultural residues, biomass from wood, solid wastes, etc. Objectives of the study:

- Preparation of biochar suitable for inclusion in concrete
- Mechanism of biochar in the basic mechanical and durability properties of concrete with natural and recycled aggregates

Parameters evaluated

- Biochar addition levels on mortar and concrete strength with natural aggregate and recycled aggregate
- Cement replacement with biochar mortar strength
- Biochar mixtures with reduced cement

Biochar Preparation



Suppliers:

- B1: Barcel Mill & Lumber
- B2: Frontline/NPPD
- B3: Barcel Mill & Lumber
- B4: Frontline/NPPD

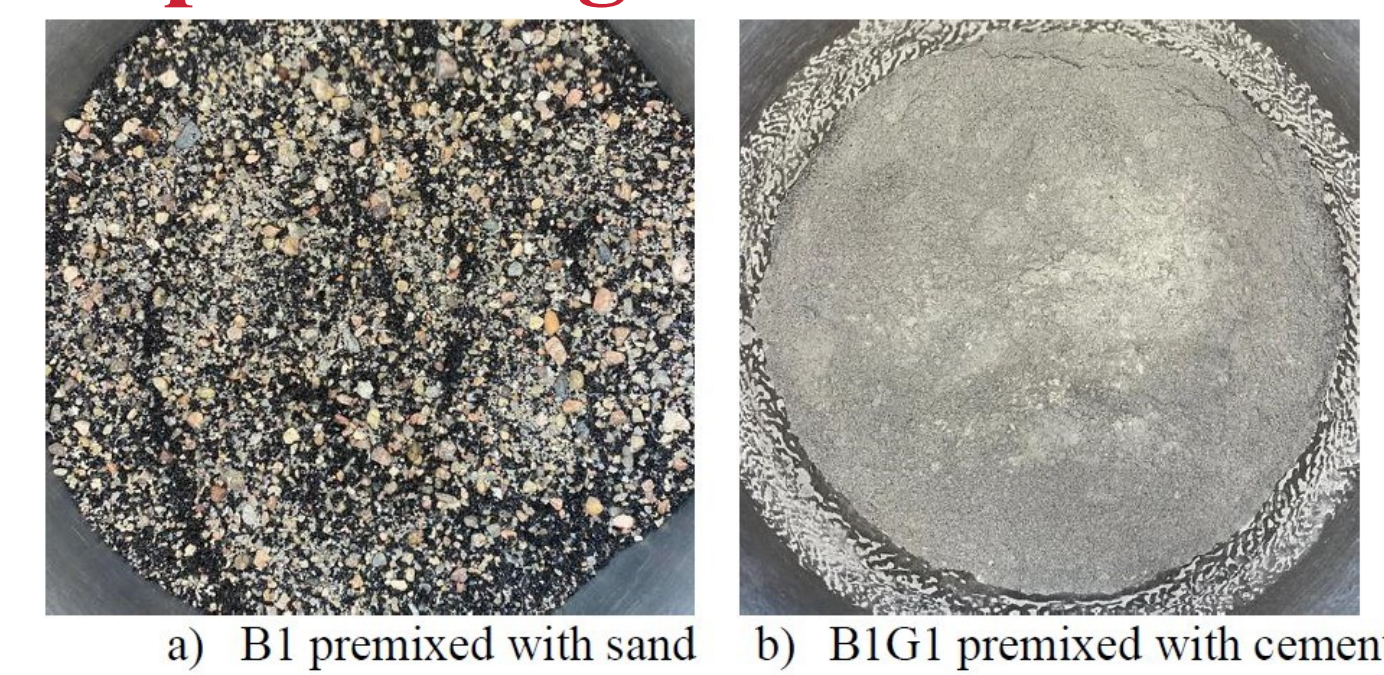
- B'1/2/3/4' indicates the biochar as received
- B1G'Y', 'Y' indicates the fineness of biochar after grinding, with 2 being the finest biochar

Experimental Procedure

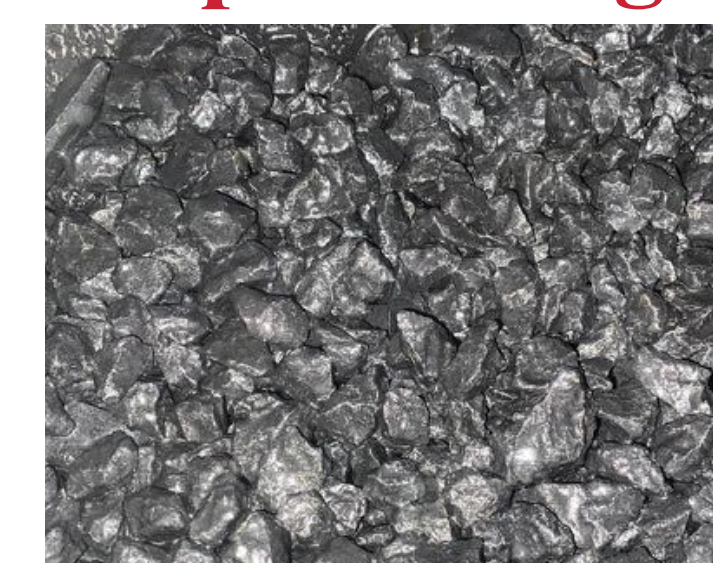
Mortar = Cement+Water+Sand

Concrete = Cement+Water+Sand+Coarse agg

Biochar premixing for mortar



Biochar premixing for concrete



Type A:

1. RCA + 30% water in the mixer – 30 sec
2. Add biochar while the mixer is running – 30 sec
3. Follow ASTM C192



Type B:

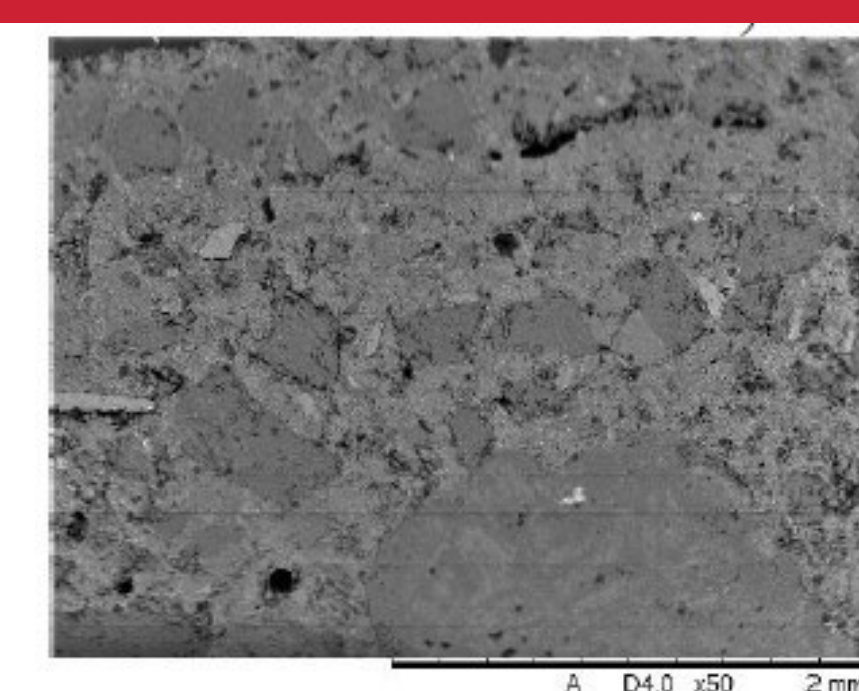
1. Premix biochar with cement.
2. Add prepared biochar in the mixer with RCA and mix for 30 sec
3. Follow ASTM C192

Tests performed



- Flow test (ASTM C1437)
- Compressive strength test (ASTM C39)
- Slump test (ASTM C143)
- Scanning electronic microscope (SEM)

Microstructural Analysis



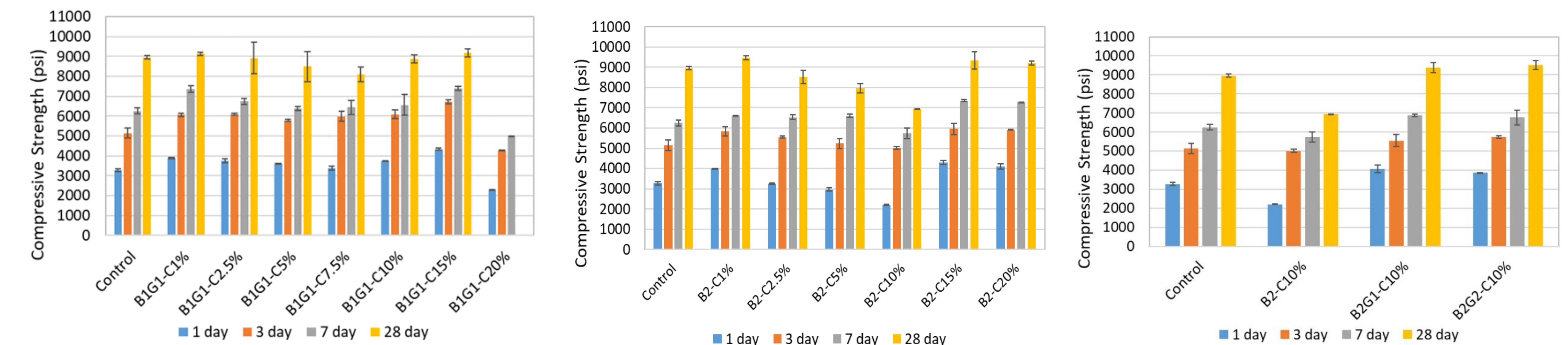
SEM figure of biochar materials inside concrete



SEM figure of 5% addition of Biochar for improved aggregate-cement paste bonding

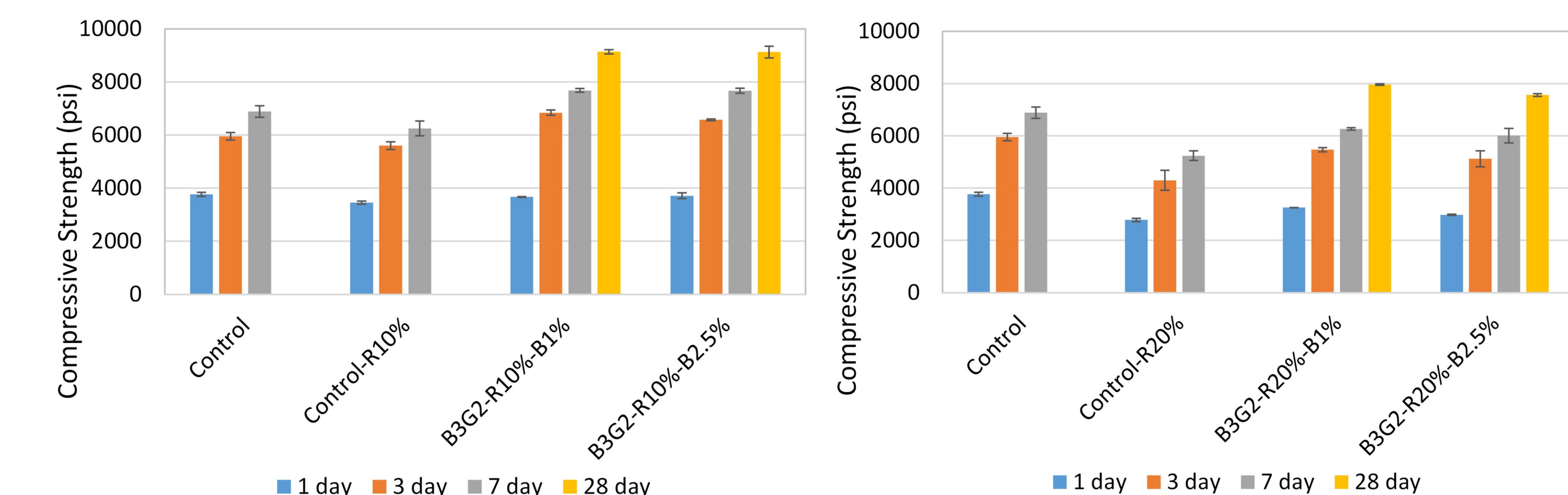
Results and Discussion

Biochar addition levels and fineness on mortar strength



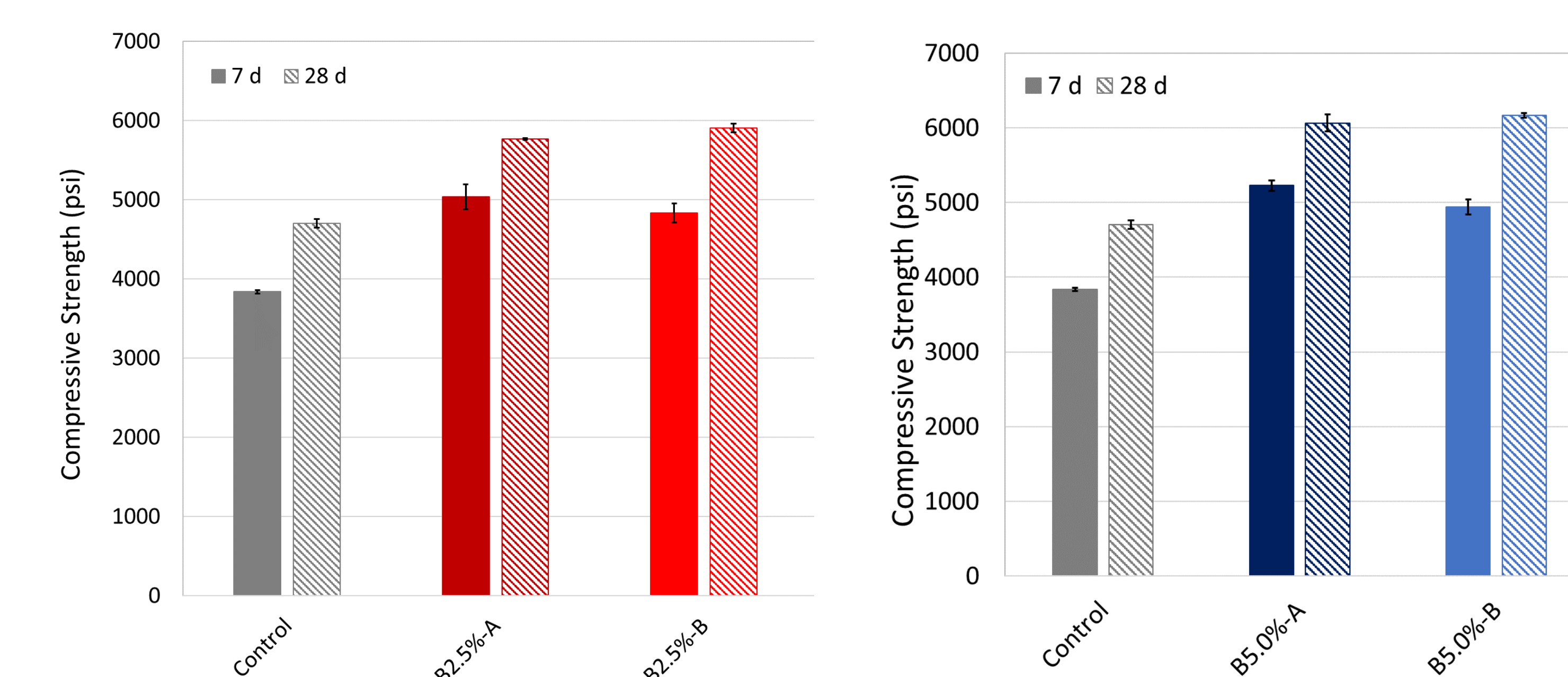
- C1% indicates the addition of 1% biochar by the weight of cement in the mix.
- 1-2.5%, and 15% of biochar addition leads to optimum performance.
- Finer biochar (grounded) increases the compressive strength.

Biochar mixtures with reduced cement



- R10% indicates the reduction of 10% cement by weight (90pcy in this case).
- Up to 20% of cement can be effectively reduced while achieving comparable strength with the addition of Biochar.

Biochar concrete mixtures with recycled aggregate (RCA)



- B5.0%-A indicates 5% addition of Biochar with Type A concrete mixing.
- Type A mixing yields higher compressive strength compared to Type B mixing.
- 5% biochar addition is the optimum biochar content in concrete.
- Biochar can increase strength of concrete with RCA due to the improved aggregate-paste interface.

Summary

- Low dosage of biochar (1.0-2.5% based on weight of cement) increases the mortar strength sufficiently to compensate the reduction of cement content (up to 20%), which can be attributed to nucleation and filler effects.
- Reducing biochar particles size (through grinding) enhance the positive effect of biochar application.
- Biochar improves the Interfacial Transition Zone (ITZ) between RCA and cement-paste to increase the compressive strength.

Ongoing Work

Biochar concrete mixtures with **reduced cement content + natural agg/RCA** for mechanical, durability and microstructural performance evaluation.

Acknowledgement

The project was supported by Nebraska Center for Energy Sciences Research.