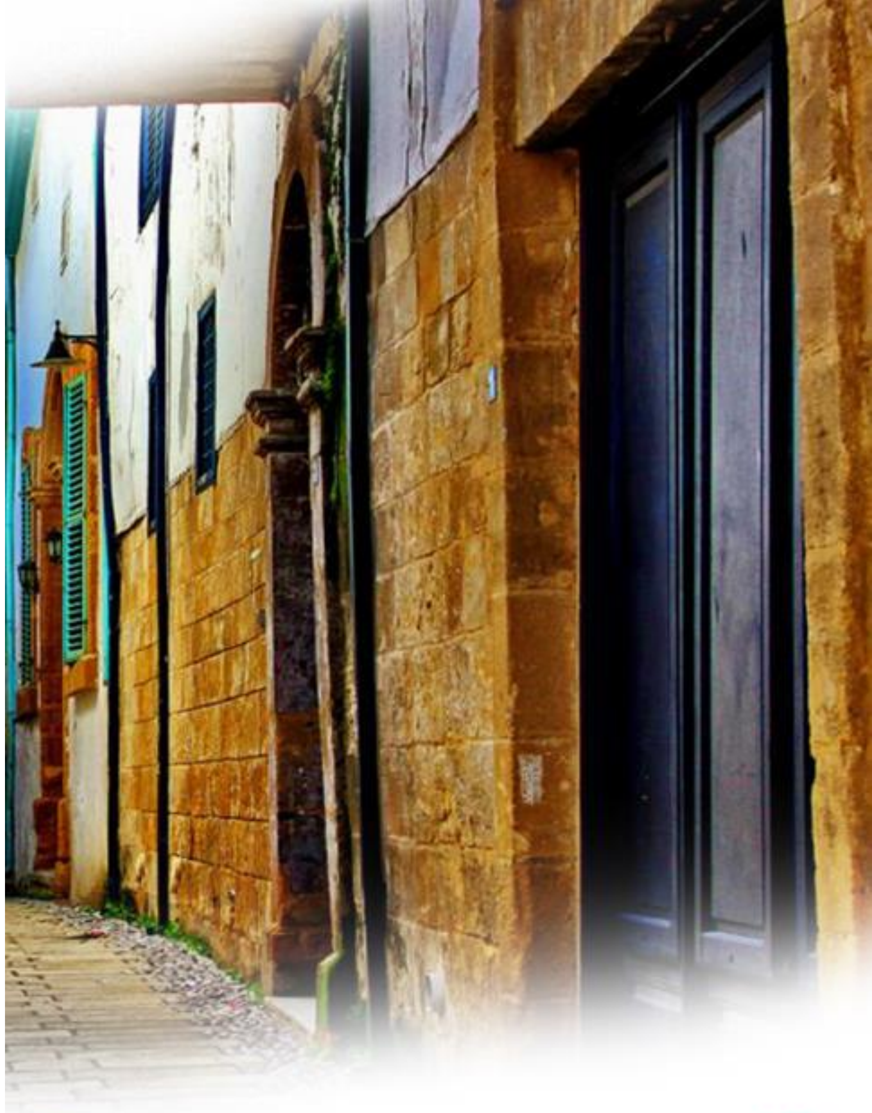
Sustainable Approaches for Improving the Mechanical and Microstructural Properties of Cementitious Composites and Soils



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Introduction

- Since the cement was introduced in the 19th century, it became the major used material in the construction industry.
- Environmental Concerns about the production process.
- The cement is:
  - Relatively expansive.
  - Uses up natural resources (unsustainable)
  - Largely contributes to CO_2 emissions[1].

- With the increased building rates, it became vital to find a more sustainable material.

Introduction

Geomaterials

Clean Production

Bottom Ash	Marble dust
Copper Slag	Wood-Ash

Advantages:

- ❖Reduce the use of cement.
- ❖Reduce the cost of construction projects.
- ❖Reduce the impact the industry having on the environment.
- ❖Provide a cleaner way to dispose of these materials.
- ❖Can improve the engineering properties of the mixture.

Bottom Ash

Materials

- Adversely affects the workability[2].
- Improves the bulk density, thermal conductivity, flexural and compressive strength[3].
- 20% of coal bottom ash showed optimum results at all ages[4].
- Significantly increased the flexural and splitting tensile when replaced with sand in concrete[5].

Geotechnics

- Increased significantly the bearing capacity and reduced the foundation settlement when used with lime[6].
- Increases the optimum water content and decreases the maximum dry density[7].
- Can be used as a backfill material in reinforced soil structures[8].

Marble Dust

Materials

- Improved strength when 10% added to pure cement composites[9].
- Resulted in higher porosity at 15% replacement[10].
- enhanced strength and durability with maximum positive effect at 15 % replacement[11].
- up to 60% replacement can be effectively used in various low to medium strength applications[12].

Geotechnics

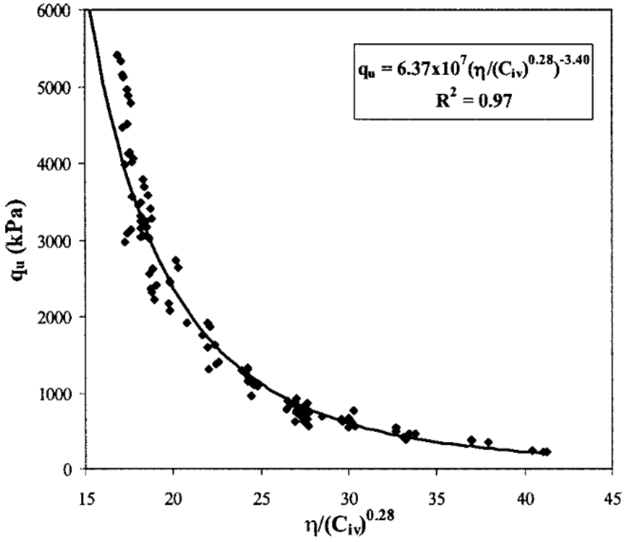
- Improves the compressive strength when added alone to clays[13].
- Limited literature.

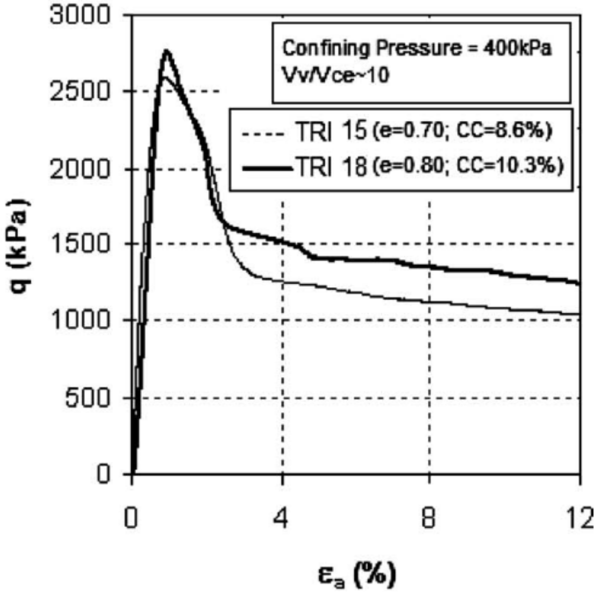
Binders - soil

Breakthrough: Porosity/cement Index

$$\frac{\eta}{C_{iv}} = \frac{\frac{V_v}{V_{total}}}{\frac{V_c}{V_{total}}} = \frac{V_v}{V_c}$$

$$n/Xiv$$





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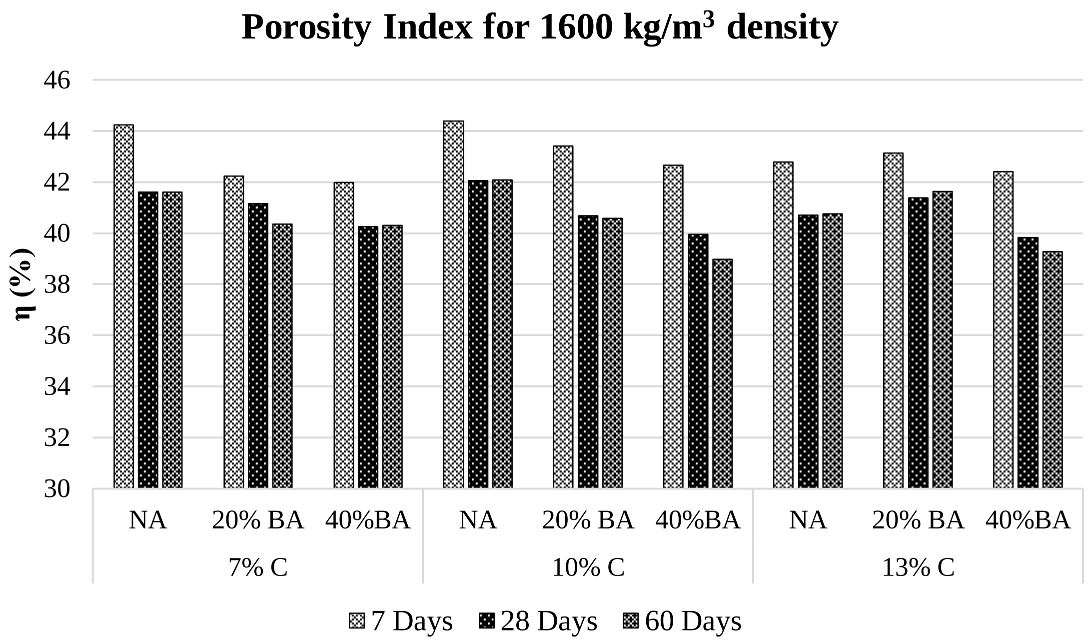
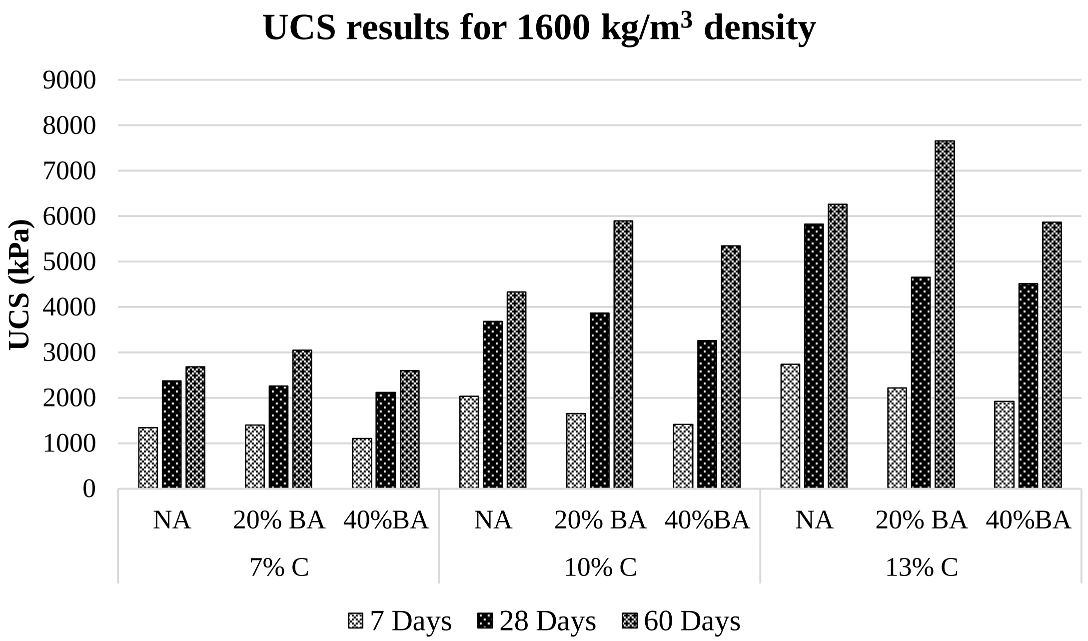
Effect on the porosity and strength





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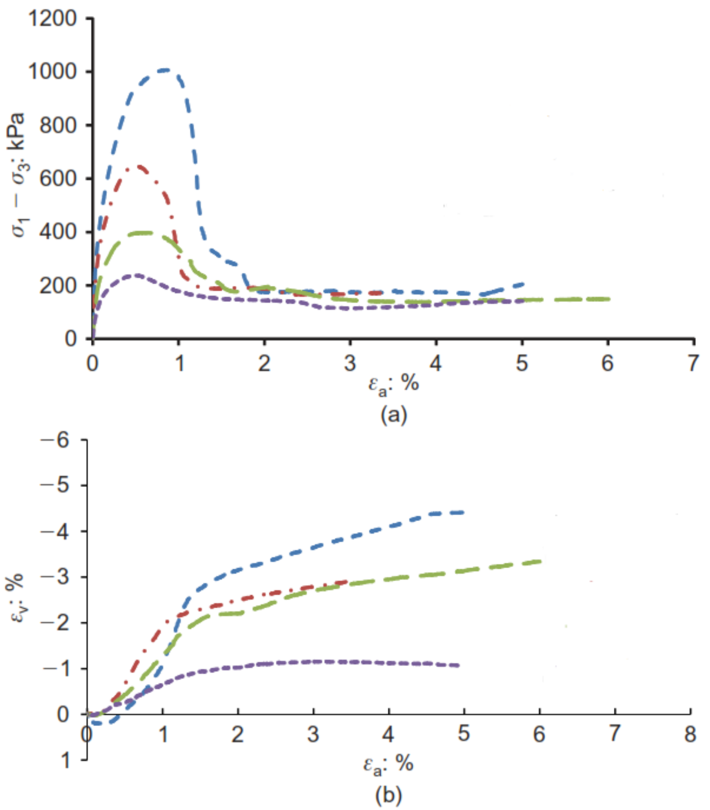
Binders - Soil



As the binder content increase, the strength increases.

However, the brittleness increases.

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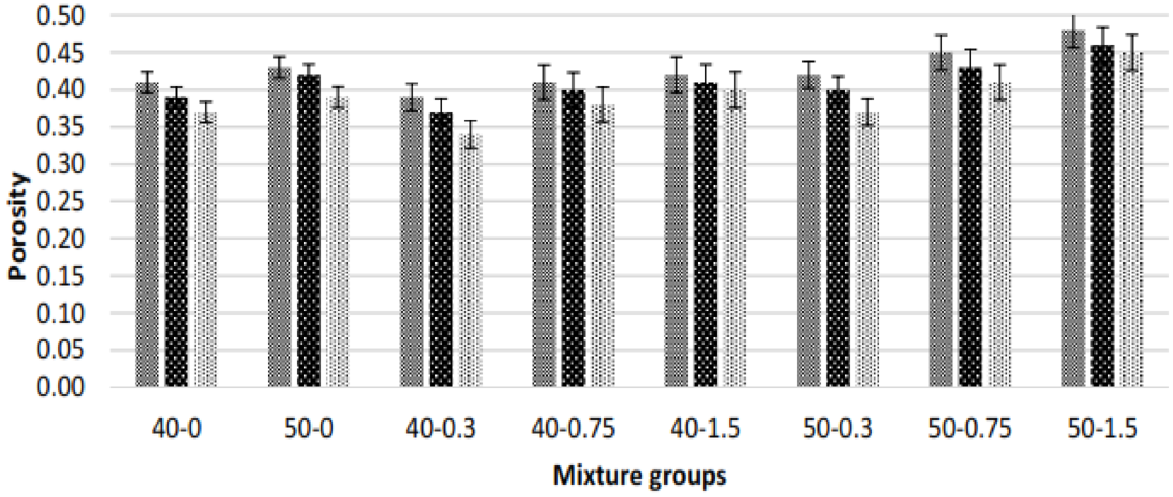
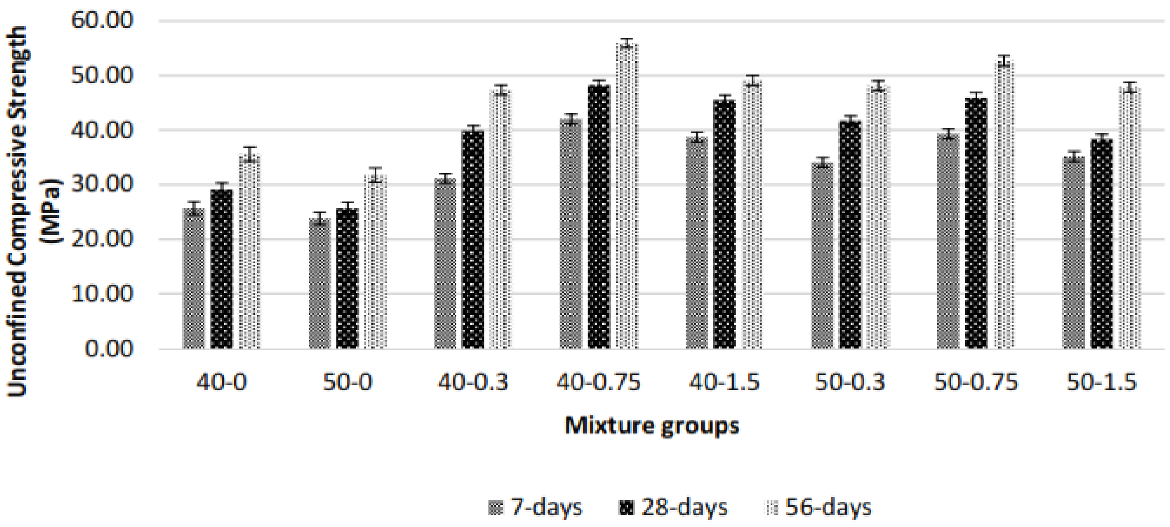
Effect on the porosity and strength - fibers





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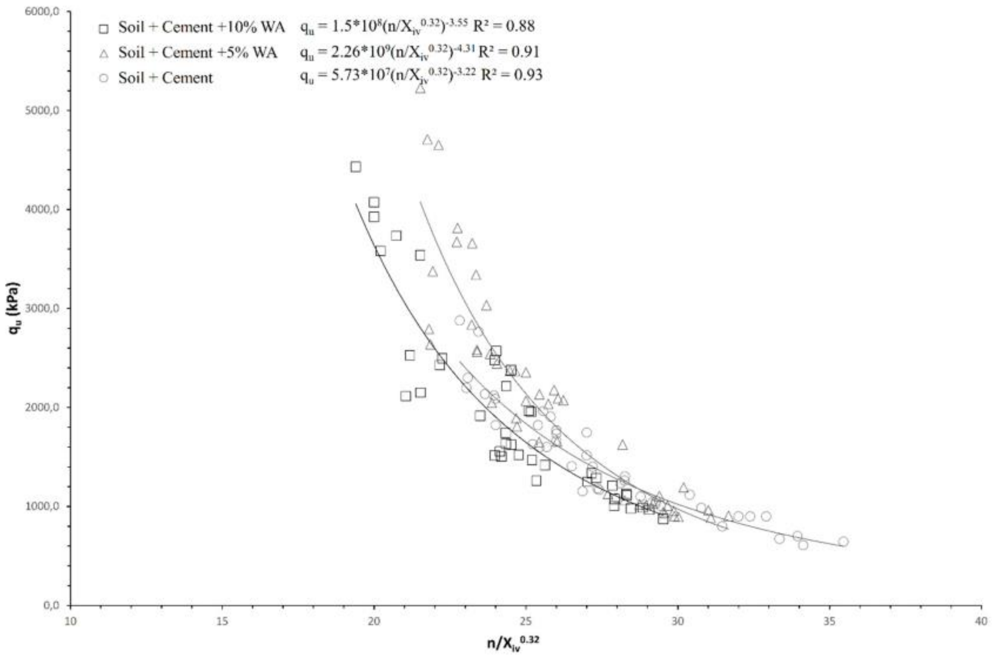
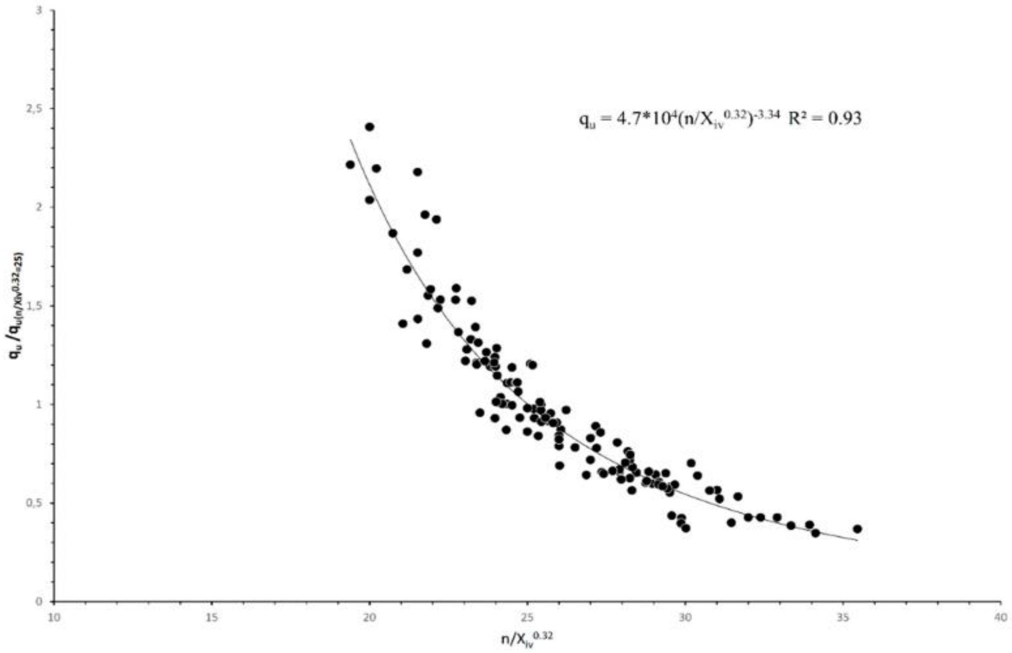
Effect on the Compressive strength





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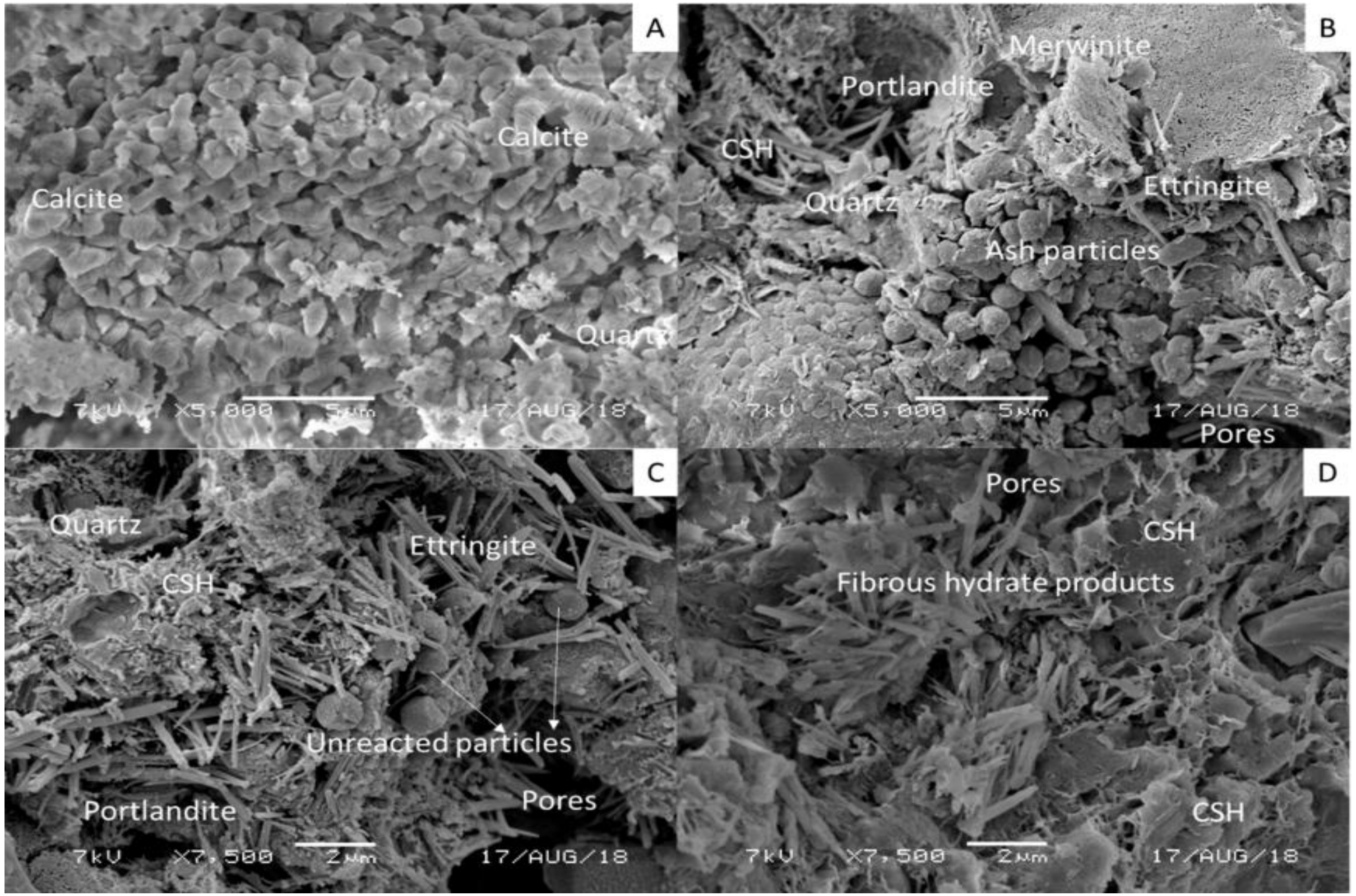
Micro-structure



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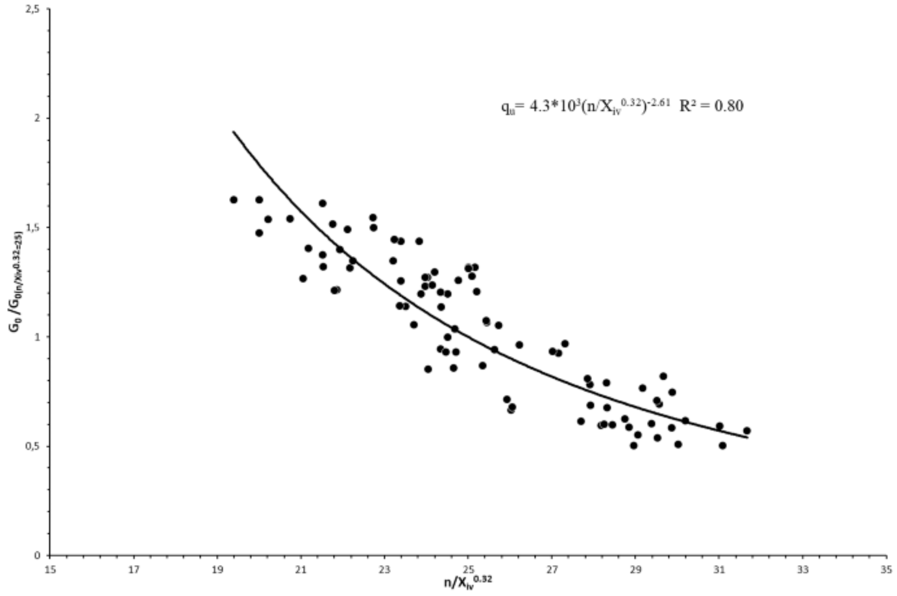
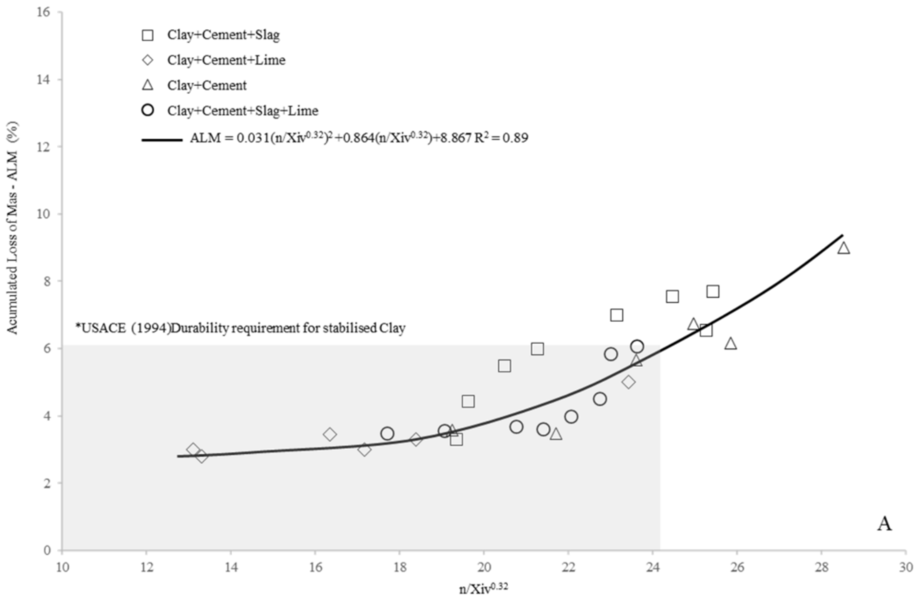
Mechanical Properties





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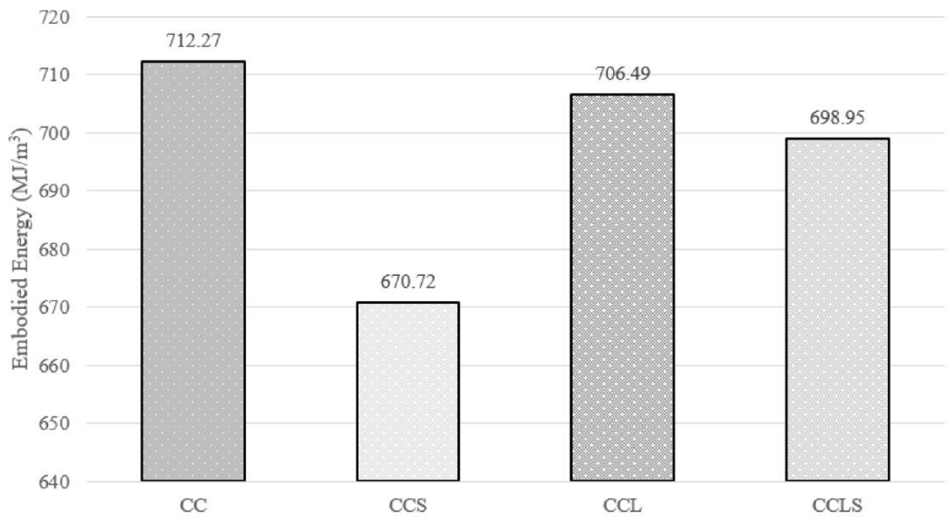
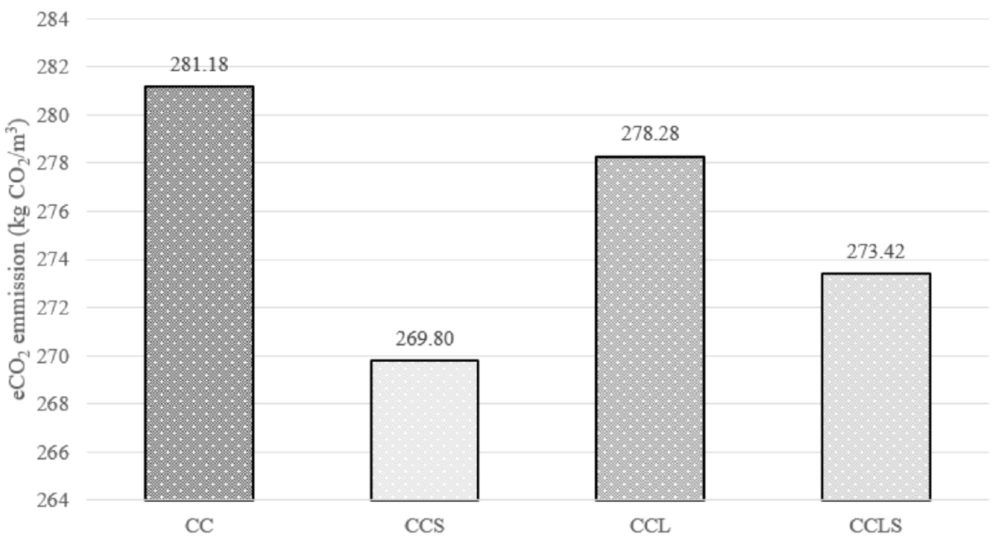
Sustainability Assessment





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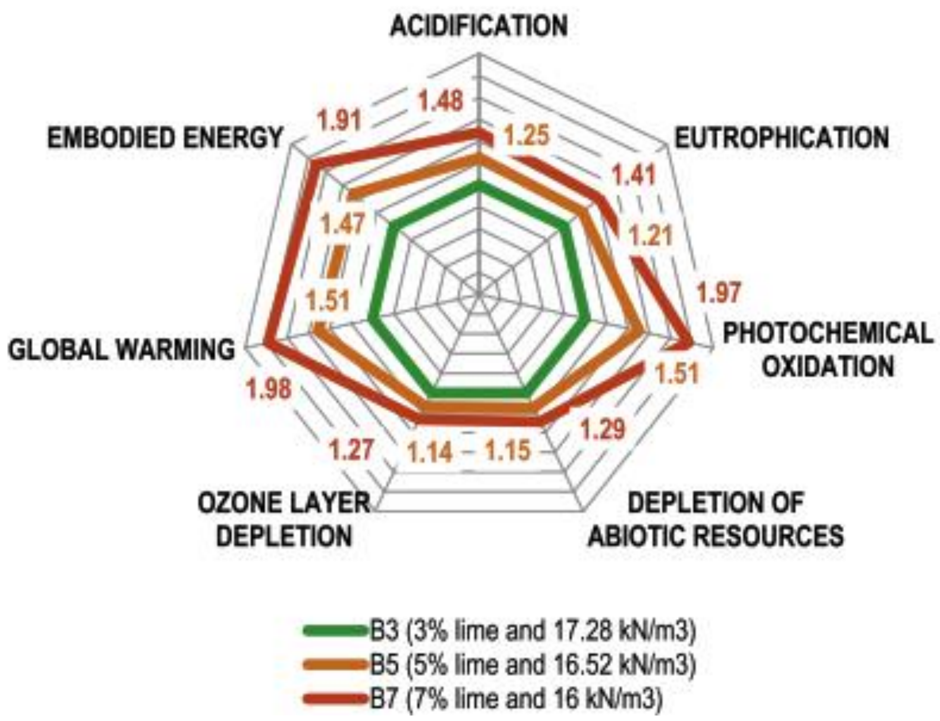
Sustainability Assessment



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Thank you for listening