

EFFECT OF GLASS SAND REPLACEMENT ON MECHANICAL PROPERTIES OF CEMENTITIOUS MIXTURES

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Abstract: This study explores the effects of partial replacement of cement with glass sand on the mechanical properties of cementitious mixtures. For this purpose, cement was replaced with glass sand at different levels including 5%, 10%, 15%, 20%, and 25%, while maintaining a constant water-to-binder ratio of 0.4. The mechanical properties assessed include compressive strength, 3-point bending, and toughness at 28 days of curing. Results reveal varying trends in mechanical properties with increasing levels of glass sand replacement. 3-point bending results show a consistent improvement with increasing glass sand content, with percentage increases of 33%, 34.8%, 21.8%, 25%, and 39.2% observed for 5%, 10%, 15%, 20%, and 25% replacement levels, respectively. On the other hand, compressive strength exhibits varied results, with a 7.35% and 28.93% increase for 5% and 10% replacement, followed by a 39.67% decrease for 15% replacement. However, a subsequent increase of 36.27% for 20% replacement and a decrease of 19.83% for 25% replacement were observed. Furthermore, toughness demonstrates a similar trend to 3-point bending, with a 19.05% increase observed for 5% replacement, followed by a 12.3% decrease for 10% replacement. Notably, replacements of 15%, 20%, and 25% exhibit improvements in toughness, with increases of 9.52%, 44.05%, and 48.81%, respectively. These findings suggest that partial replacement of cement with glass sand can lead to improvements in 3-point bending and toughness, while the effects on compressive strength vary depending on the replacement level. Such insights contribute to the understanding of utilizing glass sand as a sustainable alternative in cementitious mixtures and can be beneficial in structural performance and environmental sustainability.

Keywords: Glass sand, Cementitious mixtures, Mechanical properties

Concrete, which is a fundamental building material is the most widely used man-made material in the world [1]. Cement being the main constituent of concrete is responsible for about 5–8% of the world's CO₂ emissions during the energy-intensive and extremely polluting production process [2]. This significant contribution results from the combustion of fuel and cement raw materials, which releases one ton of carbon dioxide (CO₂) into the atmosphere during cement manufacture [3]. One practical way to lessen the amount of Portland cement used in concrete and, consequently, the energy and environmental effects of its manufacturing is to employ solid waste materials, other substitutes or industrial byproducts in place of some of the cement [4]. Among the available options, glass sand is one of

them. Glass particles' pozzolanic activity can enhance the mechanical properties of concrete. Recycled glass powder that has a particle size of 100 micrometers or less shows interesting reactive behavior that is comparable to the pozzolanic reaction in concrete [5].

This study evaluates the mechanical properties of cement mixtures with partial replacement of cement by glass sand.

This study presented experimental findings on the replacement glass sand to cement mixture as a cementitious material. Based on the results the following points can be drawn.

The sustainability of cement mixture is increased significantly by replacing up to 20-25% of cement.

Regarding the strength activity index and based on 28 days of compressive strength, 3-point bending stress and toughness glass sand can be used as cement replacement until 20% and 25% respectively.

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