Shear behavior of reinforced concrete beams incorporating waste glass powder as partial replacement of cement

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Abstract:

This work aimed to investigate experimentally the effect of incorporating waste glass powder on the shear behaviour of reinforced concrete beams under bending load in terms of load- vertical displacement relation, load-strain relation, cracks pattern/propagation, load –cracks relation, and mode of failure. The replaced cement partially with waste glass powder achieves two main goals; the first is an economic benefit represented by reducing the cost of supplementary materials and the second one is an environmental benefit represented by solving some of the solid waste problems that waste causes and saving energy. The experimental program consists of testing nine simply supported beams of 150 × 150 × 900 mm designed to fail in shear. Three parameters have been studied; glass powder content (0, 10, and 15% as partial replacement of cement), steel reinforcement ratio equal to 0.02267 (2Φ16mm), and 0.013785 (2Φ12mm), and spacing between stirrups (65 and 170 mm). The test results showed that using glass powder improved the strength capacity of the beam and that can be seen through the increase in ultimate load for beams incorporating glass powder compared to the control beam. Recorded load at failure increased by 39% and 23% for 10% and 15% replacement compared with the control beam. For the same waste glass powder content, an increase in the amount of longitudinal steel reinforcement from 2Φ12 mm to 2Φ16 mm led to an increase in ultimate load but decreases in the corresponding vertical displacement, which refers to more brittle behaviour. In addition, reducing the spacing among the stirrups from 170 mm to 65 mm led to a decrease in ultimate load and

increasing in the corresponding vertical displacement. The incorporation of waste glass powder made the behaviour of beams more brittle i.e. for the same load the vertical displacement for beams incorporating waste glass powder (especially for 15%) is lower than for reference beams without waste glass powder, which is not desired. To take advantage of the property of waste glass powder by improving the ultimate strength of the beam, which appeared by increasing the maximum load at failure compared to the reference beam and at the same time preventing the property of brittle failure caused by the addition of this material, it is suggested to use waste glass powder with fibers.