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Effect of Volcanic Ash and Recycled Aggregates in Concrete

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Abstract : The cement industry is responsible for around a 5% of the CO2 emissions worldwide and considering that concrete is one of the most used materials in construction its total effect is important. An alternative to reduce the environmental impact of concrete production is to incorporate certain amount of residuals in the dosing, limiting the replacement percentages to avoid significant losses in the mechanical properties of the final material. This study analyses the variation in the mechanical properties of structural concretes with recycled aggregates and volcanic ash as cement replacement to test the effect of the simultaneous use of different residuals in the same material. Analyzed concretes are dosed for a compressive strength of 30MPa. The recycled aggregates are obtained from prefabricated pipe debris with a compressive strength of 20MPa. The volcanic ash was obtained from the Ensenada (Chile) area after the Calbuco eruption in April 2015. The percentages of natural course aggregates that are replaced by recycled aggregates are of 0% and 30% and the percentages of cement replaced by volcanic ash are of 0%, 5%, 10% and 15%. The combined effect of both residuals in the mechanical properties of the concrete is evaluated through compressive strength tests after, 28 curing days, flexural strength tests after 28 days, and the elasticity modulus after 28 curing days. Results show that increasing the amount of volcanic ash used increases the losses in compressive strength. However, the use of up to a 5% of volcanic ash allows obtaining concretes with similar compressive strength to the control concrete, whether recycled aggregates are used or not. Furthermore, the pozzolanic reaction that occurs between the amorphous silica and the calcium hydroxide (Ca(OH)2) provokes an increase of a 10% in the compressive strength when a 5% of volcanic ash is combined with a 30% of recycled aggregates. Flexural strength does not show significant changes with neither of the residues. On the other hand, decreases between a 14% and a 25% in the elasticity modulus have been found. Concretes with up to a 30% of recycled aggregates and a 5% of volcanic ash as cement replacement can be produced without significant losses in their mechanical properties, reducing considerably the environmental impact of the final material.

Keywords : compressive strength of recycled concrete, mechanical properties of recycled concrete, recycled aggregates, volcanic ash as cement replacement
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