A SOLUTION FOR QUARRY LIMESTONE DUST RECYCLING

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INTRODUCTION

In quarrying activities, rock is extracted and transformed into aggregate of various sizes for civil engineering applications. In this process waste fine aggregates (dust waste) are generated. The disposal of this type of waste is a further cost in the extraction process, but also a possible cause of environmental pollution. A strategy for the effective recycling of quarry dust, not only reduces waste generation and disposal but also addresses protection of the environment. Many researchers have tried to exploit quarry dust for the production of concrete and the quarry dust has been used as partial or full substitute of the sand. Rai et al (1) carried out an experimental investigation based on the substitution of the sand with quarry dust for the production of self-compacting concrete. Prakash et al (2) assessed the use of dust for normal concrete, reporting that a 40% replacement of fine aggregate by quarry dust resulted in the highest compressive strength. In the study reported by Bahoria et al (3) sand was replaced with quarry dust in combination with waste plastic. Other researches have addressed the replacement of sand with quarry dust for the production of concrete (e. g. Jagadeesh et al (4) and Liebermann et al (5)). A literature review of the strategies used in the replacement of aggregate for concrete with waste is presented by Bahoria et al (3). However, some studies on the stress strain characteristics of concrete made using quarry dust waste are reported in literature (Kankam et al (6)). An interesting strategy refers to the use of quarry dust for the production of coarse aggregate through a cold bonding procedure as reported by Thomas et al (7). With regards marble quarries, different strategies have been employed for the use of coarse aggregate in concrete as reported by André et al (8).

The Italian quarrying industry covers a relevant portion of global mineral extraction resulting in a significant production of fine waste are often located close to ecological sensitive and protected areas and to the coast with higher risks for biodiversity (an example is the limestone extraction industry in Trapani, Sicily). In this context, the paper discusses an experimental program intended to assess the mechanical properties of concrete made with the fine limestone waste produced in the area of Trapani, as a partial substitute of fine aggregate (sand).

EXPERIMENTAL

In this study the fine aggregate of a reference control mix has been progressively replaced with a single type of quarry dust sourced from Custonaci, at two different levels of substitution. The experimental study reported forms part of a more extensive research.

The reference concrete was produced using portland limestone cement Type 32.5 as the hydraulic binding agent, together with quarry rock of 2 mm nominal maximum size used as fine aggregate, and 20 mm crushed rock coarse aggregate. The sand (having a specific weight of 2860 kg/m3) was replaced by a marble quarry dust.

The reference mix was composed of 15 kg of cement, 38 kg of course aggregate, 35 kg of sand and a water/cement ratio of 0.5. In total, 11 cubic test samples (15 cm cubic specimen) were produced for each mix. Six mixes were prepared: two reference mixes and further four mixes with different levels of replacement of fine aggregate. The four mixes consisted of the same quantities of cement, water and coarse aggregate as for the reference mixes. The fine aggregate portion was composed of 31 kg of sand and 4 kg of quarry dust for two of the four cases, and 27 kg of sand and 8 kg of quarry dust for the remaining two mixes. The concrete mixes had a similar slump class in the range 30-60 mm, but which was reduced with the increase in the quarry dust content in the concrete.

RESULTS AND DISCUSSION

The results of the compressive strength tests on each cube at 3, 7, 14, 28, 60 days indicates that it is immediately clear that the replacement of 13% of the sand produces an increase of the strength while the replacement of the 26% of the sand produce a decrease of strength variable with the days of curing. The strength of the mix characterized by a sand replacement of 26% is recovered at 60 days. Further, a greater dispersion of the compressive strength results was observed for the mixes with no replacement and replacement of 13 % of the sand.

Fig. 1 presents the average results of the compressive strength tests showing the effect of sand replacement with Custonaci quarry dust. In spite of the replacement of 26% of sand resulting in a decrease of the strength with reference to the control mix, the reduction in strength is less at 14 days than at 7 days and negligible at 60 days.

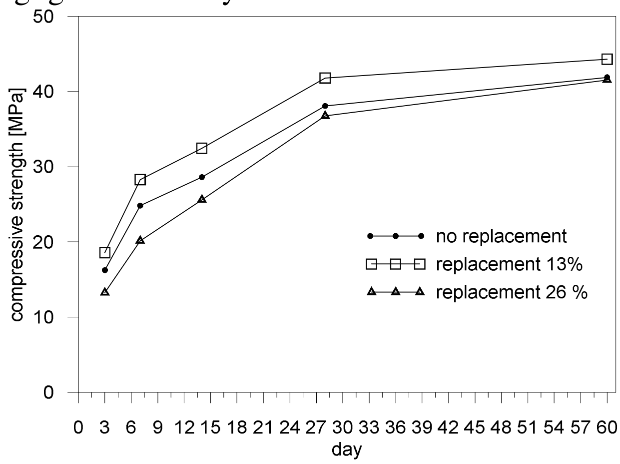

Fig. 1 Fine aggregate and quarry dust: granulometric curves

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