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Feasibility as a Potential Substitute for Natural Sand: A Comparative Study between Granite Cutting Waste and Marble Slurry

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Abstract

One of the most challenging problems of 21st century is solid waste management and stone slurry is a prime shareholder in this waste. The paper aims at assessing the feasibility of utilizing the two different types of stone waste generated globally in huge quantities i.e., Granite cutting waste and marble slurry as a replacement for fine aggregate in concrete manufacturing. The paper reports the similarities and highlights the contrasting behaviour of GCW and MS concrete in terms of durability, compressive and flexure strength, abrasion, permeability and ultra-pulse velocity. The strength and durability of concrete is determined by a number of factors including the physical and chemical composition of constituent ingredients as well as the microstructure of ingredient particles. Explanations for the trends observed have been derived from microstructural studies using SEM and EDS test and also the inter-particle behaviour of the ingredients within concrete matrix .It was found that neglecting minor variations the optimum replacement percentage for GCW and MS concrete were 25% and 15% respectively.

Abbreviation: GCW- Granite cutting waste; MS – Marble Slurry; w/c – water-cement ratio.

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1. Introduction

With more and more economies undergoing massive globalization in the present context the pace of consumption of natural resources and subsequently the rate of scrap generation is on an all-time high in all sectors of manufacturing industries. Construction industry is not an exception to this trend. Over the years the consumption of concrete throughout the world has reached mind boggling scales. A study published by Berkeley University (2015) showedthat the annual global consumption of concrete is about 11.5 billion tons including 1.5billion ton of cement, 1 billion ton of water and 9 billion ton of aggregate. This generates about 1.5 billion ton of CO_2 which accounts for almost 5% of the total CO_2 production in the world. This by any means is a serious threat to the environment and demands immediate attention.

Sustainable Concrete is the need of the hour. Production of concrete with waste material as alternative ingredient reduces the overall carbon footprint of the manufactured concrete by addressing the problem of efficient waste disposal. For the past few years researchers have been struggling hard to ascertain the feasibility of a wide range of industrial byproducts like rubber, fly ash, coal bottom ash, blast furnace slag, and marble waste as a potential substitute for concrete ingredients. Hamza et al. (2011) DemirelBahar et al. (2010) Almeida et al(2007). Alzboon and Mahasneh et al. (2009) concluded that the concrete with marble waste performed satisfactorily on mechanical strength requirements. Rajgor and Pitroda et al. (2013) suggested utilization of waste stone slurry in the manufacture of ceramic and glass tiles, thermoset resins. Granite cutting waste got the attention of researchers quite recently and has invoked research for assessment of its potentiality to replace cement and natural sand in the concrete. The primary work of analysing granite as a substitute for natural sand in concrete was accomplished by Beretka and Taylor(1991).They utilized granite dust for making aerated concrete and ceramic products. Moreira et al.(2005)concluded that the adapted methodology of utilizing granite waste in ceramic bodies for manufacturing structural ceramics was mechanically as well as environmentally efficient. It was also inferred from the experiments of Saboya et al.(2007) , Bekir et al.(2009) ,Binici et al.(2008) Corinaldesi et al.(2010) and Hebhoub et al.(2011) that Granite waste could be substituted for natural sand thanks to the GCW(Granite Cutting Waste) concrete satisfactorily satisfying mechanical strength requirements. Further, work done by Flexikala and Partheeban(2010)concluded that Granite substitution fostered improved behaviour of concrete in terms of mechanical strength and drying plastic shrinkage properties with respect to the control specimen. Recently Telma Ramos et al.(2013) concluded with the fact that the granite sludge waste if finely powdered leads to a significant reduction in expansion due to ASR and simultaneously improves the chloride resistance of concrete.

When a range of byproducts are available at disposal it becomes critical to have a comparative study of the individual features. However any such comparative study bringing out contrasting properties and distinguishing characteristics of the byproducts is still lacking. This paper tries to bring about a comparison between marble slurry and granite cutting waste in terms of feasibility and efficiency as a potential replacement for natural sand aggregate in the concrete production.

2. Material-ingredients:

2.1 Cement

The ordinary Portland cement of grade 43 as per BIS: 8112-1989 was utilized for the experimental studies. The specific gravity of the Portland cement was 3.14 The cement had a compressive strength of 43 N/mm^2.

2.2 Coarse Aggregate:

The coarse aggregates of maximum nominal size 20 mm & with basaltic origin were used. Particle size distribution analysis of aggregates used is presented in Fig. The mean specific gravity of coarse aggregates used was 2.65.