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Research

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Experimental Investigation of Partial Substitution of Cement with Eggshell Ash in M20 Grade Concrete

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ABSTRACT

Commonly used for bonding construction materials, cement has influenced not only construction industry, but also environmental design systems. Mass production of cement from rocks of heavy minerals (plaster of Paris) is known to result in large amounts of mineral waste and requires ball mill processing systems. In this research, partial substitution of cement with eggshell ash in M20 grade concrete at 20, 30, and 40% is considered.

Key words: OPC cement, Eggshell ash powder, Coarse aggregate, Fine aggregate.

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1. INTRODUCTION

This research aims at investigating potentials of waste material for enhancing concrete performance (1). Conventionally, limestone is used as a mineral for producing cement concrete. Direct disposal of waste materials to environment may end up with environmental problems. However, incorporating the waste into concrete technology can reduce the use of natural minerals and waste production while improving nominal strength of the resultant concrete less and lowering the load applied by the waste onto the surrounding environment. Application of eggshell ash has reportedly strengthened concrete (2-4). Waste eggshell ash significantly contributes to workability of the concrete when producing hydrated concrete mixes (3, 5, 6). Presently, the large amounts of calcium content in the eggshell ash produced in different industries result in major problems including atmospheric issues as well as problems for living organisms. Accordingly, it has been suggested to incorporate eggshell ash into concrete manufacturing to substitute cement as a major bonding agent (7-9). In India, igneous rocks and limestone form the majority of sources from which cement is produced; however, these are associated with sandstone and limestone grime generation, thereby affecting human and environmental health. Mechanical properties of raw and hardened concrete have

been reportedly investigated. Partially substitution of constituents of concrete is known to be associated with cost and energy savings, significantly better performance (2, 3), and weaker environmental impacts. In this research, the main aim is to investigate partial substitution of cement in M20 grade concrete by eggshell ash and to evaluate the resultant mix through compressive and tensile tests. Such a substitution adds to the concrete strength. Today, fine particles of marble and marbonite develop a noxious waste. Accordingly, addition of eggshell ash to concrete was proposed to reduce associated environmental impacts while lowering the production cost and preserving natural mineral assets.

2. EXPERIMENTAL MATERIALS

2.1. Cement

OPC 53 grade cement was used in this research, with its properties mentioned in IS 12269 - 1987. Specific gravity, initial setting time, and final setting time of the cement mortar were 3.15, 55 minutes, and finally, 258 minutes, respectively. According to test results, the corresponding value of SCT for the considered cement was 29.5%.

2.2. Fine aggregates