International Journal of Engineering &Technology, 7 (3.12) (2018) 168-170

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Utilization of Cow-dung Ash, Granite Powder and Marble Stone to Enhance Strength of Concrete

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Abstract

The construction industry has been responsible for degrading the environment due to ecological imbalance caused during the extraction and production of building materials. To make this production of construction materials cleaner, the dependency on conventional materials has to be reduced. With this aim, this article presents an experimental study on partial replacement of cement, sand and aggregate by cowdung ash(CDA), granite powder(GP) and marble stone(MS) respectively. For this, four series of mix proportions were prepared to evaluate the compressive strength and the split tensile strength. Replacement ratios of the first, second, third and fourth mixes are (5%CDA, 10%GP, 15%MS), (5%CDA, 15%GP, 30%MS), (10%CDA, 15%GP, 30%MS), (5%CDA, 7.5%GP, 15%MS) respectively. Results revealed that the partial replacement of binders and fillers is effective to enhance compressive and split tensile strength of concrete. This would enable the construction industry to reduce their dependency on river sand and natural coarse aggregate.

Keywords: *Cement, Cowdung ash, Granite powder, Marble stone, Strength.*

1. Introduction

Concrete is the world's most consumed man-made material due to its high strength, durability and availability. However, its production is not environment friendly this requires an attempt to identify industrial byproducts as partial replacement to cement and aggregates. Cement can be replaced with industrial by-products such as Fly ash, GGBS, Cowdung ash etc., as they have good binding properties. Fine aggregate can be replaced by Granite powder due to non-availability of river sand. Moreover granite powder is a by-product of granite stone crushing process that has been a waste material throughout the years. Marble stones have no method of systematic disposal of waste in the quarrying areas. Thus it can be used in replacing coarse aggregate.

According to Roshanlal et.al.[1], marble and granite as coarse aggregates give high strength to concrete at early stages with 20% and 30% replacement ratios. The compressive strength is increased by 8.7% and 5.5% respectively. The tensile strength is increased by 12% and 6% respectively.Ojedokun.O.Y et.al.[2], stated that cowdung ash can be used to produce light weight concrete. The usage of cowdung ash can be restricted to less than 10% and can be used for finishing, flooring and temporary structures.Omoniyi T et.al.[3], investigated that replacement of cement with cowdung ash should not be more than 15%. Increase in cowdung ash increases the setting time, hence it can be used in hot weather.Dr.T.Felix Kala [5], stated that the use of granite powder in concrete has beneficial effects on the mechanical properties such as compressive, tensile and flexural strength of concrete. Early attainment on strength at 7 days is obtained. Hence it can be used in bridge and dam construction.

Pranali K kohad et.al.[6], reported that increase in marble more than 15% increases workability but affects compressive strength. The flexural strength is increased when compared to conventional concrete. The replacement of 30% aggregate by recycled marble stone gives maximum compressive strength of concrete. Manasseh JOEL [8], performed slump, compressive and indirect tensile strength on fresh and hardened concrete by partially replacing river sand with crushed granite powder. Based on economic analysis and results of test river sand replaced with 20% granite powder is recommended for use.

The advantages of using Cowdung ash, granite powder and marble stone have been studied in our literature review. The scope of this investigation is to study the variations of strength characteristics in concrete by replacing materials. The replacement ratios of the first, second, third and fourth mixes are (5%CDA, 10%GP, 15%MS), (5%CDA, 15%GP, 30%MS), (10%CDA, 15%GP, 30%MS), (5%CDA, 7.5%GP, 15%MS) respectively and are compared to the conventional concrete.

2. Experimental Methodology

2.1 Materials Required

Portland Pozzolana Cement having specific gravity of 3.15 was used as binder adhering to IS-8112. River sand having specific gravity of 2.38 and crushed granite powder having specific gravity of 2.58 were used as fine aggregatesthat passed through 4.75mm and retained on 150micron sieve. Natural aggregates having specific gravity and fineness modulus of 2.76 and 7.54 and marble stone having specific gravity and fineness modulus of 2.70 and 7.55 were used as course aggreagtes that passed through 20mm and retained on 10mm sieve. CDA with a specific gravity

of 2.55 was used. Ordinary portable water from the college campus was used to prepare concrete.

The concrete mix was designed for M20 grade as per IS 10262:2009 with mix proportion having w/c ratio as 0.45.

2.2 Mix Design

Table 1: Details of mix proportioning for conventional concrete(C0)

Description	Cement	Water	Fine aggreagte	Course aggregate
Quantity (kg/m³)	380	160	650	1200

2.3 Methods

The control mix of concrete was casted for the following ratios of replacement (as shown in Table 2), in which cement was replaced by cowdung ash, fine aggregate was replaced by granite powder and course aggreagte was replaced by marble stone.

Table 2: Replacement Ratios

Specimen No.	Replacement ratios
C0	-
C1	5% CDA, 10% Granite powder and 15% Marble stone
C2	5% CDA, 15% Granite powder and 30% Marble stone
C3	10%CDA, 15% Granite powder and 30% Marble stone
C4	5% CDA, 7.5% Granite powder and 15% Marble stone

The compressive strength test was performed using 150mm size cube at the age of 7,14 and 28 days of curing. The split tensile strength test was performed using 150mm diameter x 300mm length cylindrical specimens at the age of 14 and 28 days of curing.

3. Test Results and Discussions

3.1 Compressive Strength Test

Figure 1 represents the comparison of compressive strength for 7, 14 and 28 days of curing for conventional cube and the cubes with replaced materials.

From the obtained compression test results, we infer that the increase in percentage of cowdung ash decreases the strength. Thus, 5% is the Optimum Percentage of addition gives better results. Also, the optimum percentage of granite powder is 7.5% beyond which the strength seems to be decreasing. Similarly, optimum percentage of addition of marble stone is 15%. Increasing marble stone beyond this limit doesn't give satisfactory results comparatively.

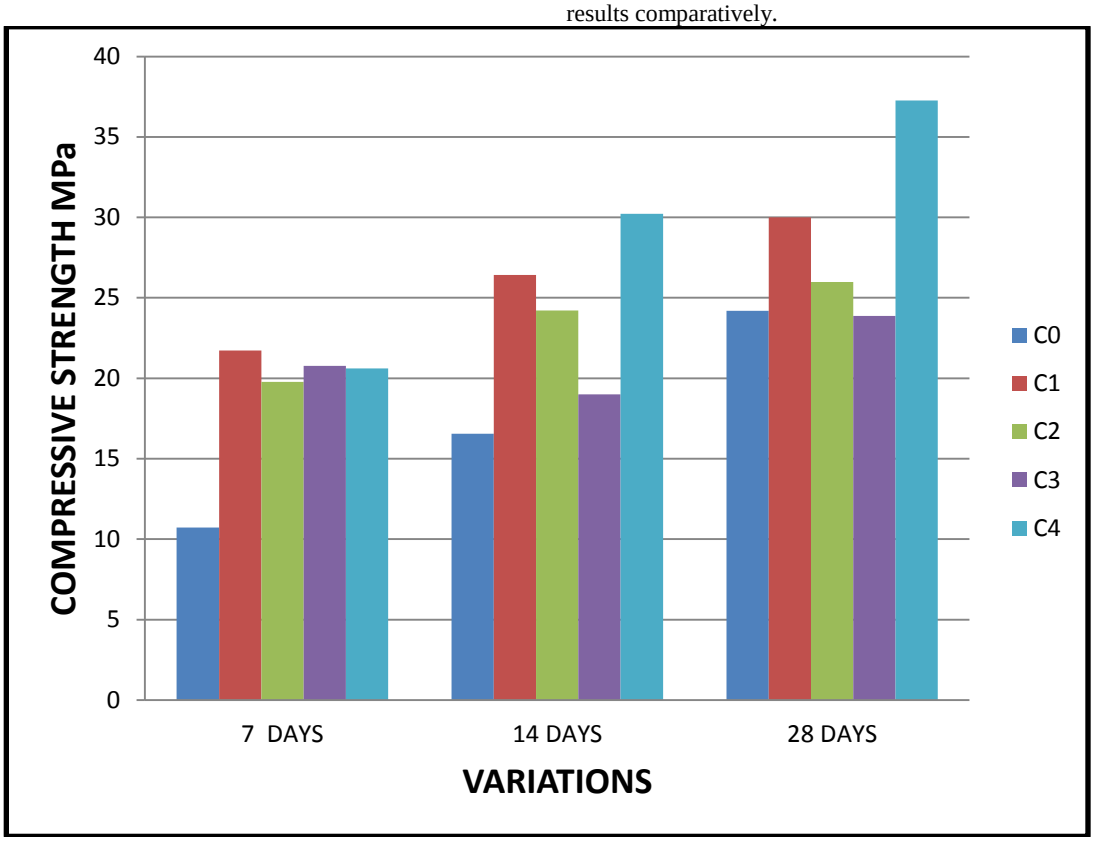

Fig. 1: Compressive Strength Results

3.2 Split Tensile Strength Test

Figure 2 represents the comparison of Split tensile strength for 14 and 28 days of curing for conventional cube and the cubes with replaced materials.

From the split tensile test results, it was found that increase in CDA improves tensile strength. The Split tensile strength was good at 10% CDA, 15% granite powder, 30% marble stone.C3(10%, 15%, 30%) cylinder has better tensile strength at early stages. The tensile strength of replaced concrete is better than conventional concrete.

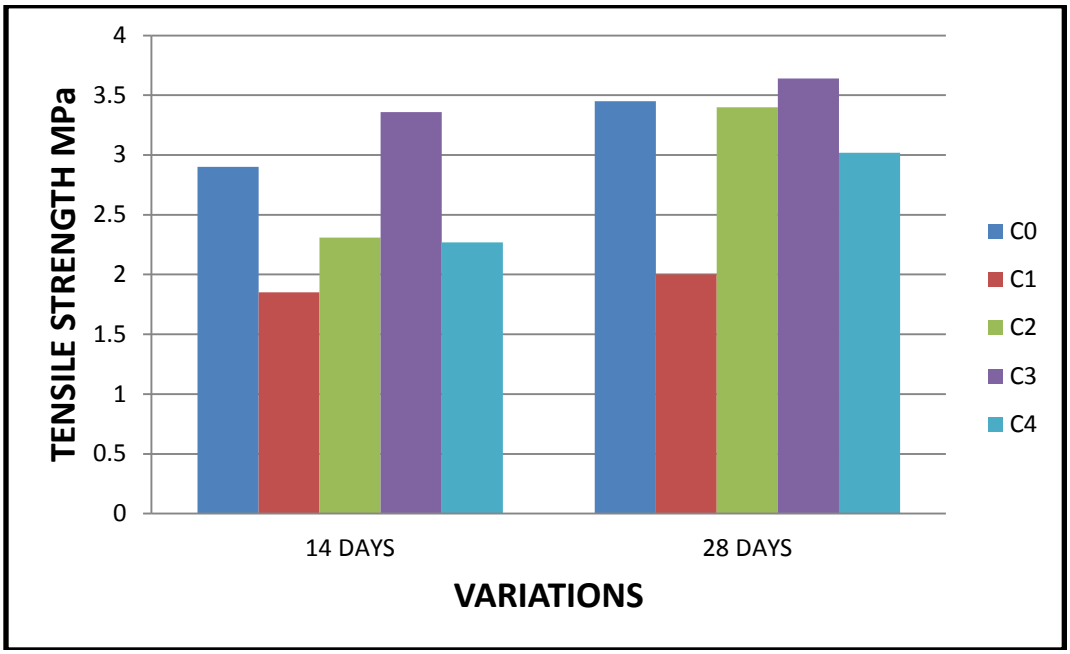

Fig. 2: Split tensile Strength Results

4. Conclusions

- From the experimental study, we conclude that the strength characteristics of replaced material give better results compared to conventional concrete.
- The C4 cube with CDA(5%), Granite Powder (7.5%) and marble stone (15%) has better compressive strength compared to other ratios and conventional concrete.
- Considering the split tensile strength, C3(10%CDA, 15% Granite Powder, 30%Marble stone) gives better result.
- Therefore, recommended mix is C4 (5% CDA, 7.5% Granite powder and 15% Marble stone), which has good compressive strength and tensile strength which lies within the permissible value of 1/8-1/12 to compression strength.
- Use of these replacements in concrete reduces the environmental impact, effect of waste disposal and demand of cement in concrete.

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