

Experimental Study on Strength Characteristics of Concrete Containing Waste Marble and Ceramic Aggregate Along With Granite Slurry Powder

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ABSTRACT: The increase in the growth of industrial production with an important consumption and growing need for aggregates, has led to a decrease of available resources, on the other hand a high volume of marble and granite production has generated a considerable amount of waste material; almost 70% of this mineral gets wasted in the mining, processing and polishing stages which have a serious impact on the environment. And also in the ceramic industry, nearly 15-30% production goes on waste. So it has become necessary to reuse these wastes particularly in the manufacture of concrete for construction purposes. The objective of the present experimental study is to demonstrate the possibility of using marble and ceramic waste as a substitute to natural aggregates along with waste granite slurry powder as substitute to cement. This experimental study was carried out on two series of concrete mixtures; Cement substitution mixture and mixture of cement and gravel substitution. The concrete formulations were produced with constant water/cement ratio. The results obtained show that the strength characteristics of concrete specimens produced using marble, ceramic waste aggregate along with granite waste slurry powder were found to conform with concrete production standards and substitution of natural aggregates by waste marble and ceramic aggregates up to 20% along with substitution of cement by granite waste slurry powder up to 10% of any formulation is beneficial for concrete.

KEYWORDS: Granite slurry powder, Marble waste aggregate, Ceramic waste aggregate, Ordinary Portland Cement, compressive strength

I. INTRODUCTION

Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent in concrete brought a revolution in applications of concrete. Concrete has unlimited opportunities for innovative applications, design and construction techniques. Its great versatility and relative economy in filling wide range of needs has made it very competitive building material. Recycling of industrial wastes has actually environmental, economical and technical benefits. These benefits can be seen from two different angles, one from the point of the waste producer and the other from the user part. For the producer, the benefits of recycling industrial wastes are economical and environmental for the user additional technical benefits may be attained from recycling. For the producer, the environmental benefit can be attained as far as the waste is recycled. It is independent of where it is recycled. But the economical benefit is determined on the demand for the waste by different user. Sustainability in Concrete Production can be achieved by innovations in substitutions of materials used.

In my project I had used the waste materials like Granite slurry powder [3], Waste marble aggregate [1] and Waste ceramic aggregate [7] obtained from Industries. Use of these waste materials is not very usual though it has no

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behavioural problem and there has been little research work done on the waste. Granite waste slurry powder is a solid waste material generated from the granite processing [2], and can be used as a partial replacement of cement while preparing concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its colour and appearance; it is white if the limestone is composed solely of calcite (100% CaCO_3). Marble is used for construction and decoration; marble is durable, has a noble appearance, and is consequently in great demand. The concrete industry is constantly looking for supplementary material with the objective of reducing the solid waste disposal problem. Marble stone industry generates both solid waste and stone slurry. Whereas solid waste results from the rejects at the mine sites or at the processing units. Marble countertop scraps were collected from countertop suppliers and construction sites. Today industry's disposal of stone waste is one of the environmental problems around the world, a large quantity of marble stone is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. The waste is dumped in nearby pits and vacant spaces. This leads to serious environmental pollution an occupation of vast area of land. So it poses a severe threat on the environment, eco-system and the health of the people. This huge unattended mass of marble is too high and is used in concrete as partial replacement of natural coarse aggregate in construction industry. In modern way of construction, the consumption of ceramic materials has building up day by day in the form of tiles, sanitary fittings and other electrical goods like insulators. Crushed Insulator bush scrap was used as a coarse aggregate in the present study. This insulator bush was used in manufacturing of transformers. This type of Ceramic waste [6] from industries is mounting day by day in processing, transporting and fixing due to its brittle nature.

II. EXPERIMENTAL PROGRAM

MATERIAL USED AND THEIR PROPERTIES

Cement: Ordinary Portland cement of 53 grades is available in local market is used in the investigation. The cement used for all tests is from the same batch. The cement used has been tested for various properties as per IS: 4031-1988 and found to be conforming to various specifications of IS: 12269-1987.

Coarse Aggregate: Crushed angular granite from local quarry is used as coarse aggregate. The cleaned coarse aggregate is chosen and tested for various properties such as specific gravity, fineness modulus, bulk modulus etc. The physical characteristics are tested in accordance with IS: 2386 – 1963. The aggregates are free from alkali contents.

Fine Aggregate: The locally available river sand is used as fine aggregate in the present investigation. The cleaned fine aggregate is chosen and tested for various properties such as specific gravity, fineness modulus, bulk modulus etc. in accordance with IS: 2386-1963. The fine aggregate belongs to zone-II. It is free from harm full ingredients.

Water: Water used for mixing and curing is fresh potable water, conforming to IS: 3025-1964 part 22, part 23 and IS: 456-2000. Sometimes an image may contain text embedded on to it. Detecting and recognizing these characters can be very important, and removing these is important in the context of removing indirect advertisements, and for aesthetic reasons.

Granite Slurry Powder: Granite Slurry powder was collected from the deposits of granite factories during processing. It was sieved by IS-90 micron sieve before mixing in concrete.

Marble Waste Aggregate: The marble waste stone was generated during the cutting process. The waste marble stone are crushed into pieces manually. The aggregates passing through IS sieve 20mm and retained on 12.5mm were taken.

Ceramic Waste Aggregate: Ceramic waste was collected from manufactures of electric Transformers, in which ceramic insulator bushes are used. Crushing of these bushes was done manually [4] and passing through IS sieve 20mm and retained on 12.5mm were taken.

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MIX PROPORTION: Based on the ingredient properties of concrete, M25 concrete mix design as per IS 10262-2009 was prepared and its proportion was 0.5: 1: 1.65: 2.84 (W: C: FA: CA) by weight.

PROCEDURE: This experimental study was carried out on two series of concrete mixtures: Cement substitution mixture and mixture of cement and gravel substitution. 6 Standard cubes of 150mm x 150mm x150mm are cast and are cured in water for each mixture. In the first series G1, G2, G3, G4, and G5 mixes are prepared with partial replacement of cement as 5%, 10%, 15%, 20% & 25% respectively. In the second series R1, R2, R3, R4, R5, and R6 mixes are prepared with aggregate is replaced by 5%, 10%, 15%, 20%, 25% and 30% respectively along with 10% replacement of cement with granite slurry powder obtained from first series, which is taken as optimum for second series. In **G1, G2, G3, G4, and G5** mixes cement is replaced by **Granite** slurry powder where as in **R1, R2, R3, R4, R5, and R6** mixes aggregate is replaced by **Waste Marble and Ceramic** aggregate along with cement replacement. In aggregate replacement equal amount of waste marble aggregate and waste ceramic aggregate were taken. After curing of these specimens, these are tested for compressive strength [5].

III. EXPERIMENTAL RESULTS

Table 1: Compressive strength of cubes with only cement replacement

Mix type	% of cement replacement by granite slurry powder	Compressive strength in N/mm ²	
		7days	28days
Control	0	25.674	33.82
G1	5	27.87	35.78
G2	10	30.325	38.459
G3	15	26.415	33.052
G4	20	24.37	29.48
G5	25	20.756	25.08

Table 2: Compressive strength of cubes with aggregate replacement along with cement replacement

Mix type	% of cement replacement by granite slurry powder	% of Aggregate replacement by marble waste and ceramic waste aggregate	Compressive strength in N/mm ²	
			7days	28days
Control	10	0	25.674	33.82
R1	10	5	25.85	34.104
R2	10	10	26.34	34.76
R3	10	15	26.96	35.76
R4	10	20	27.45	37.17
R5	10	25	24.03	31.94
R6	10	30	22.31	29.23

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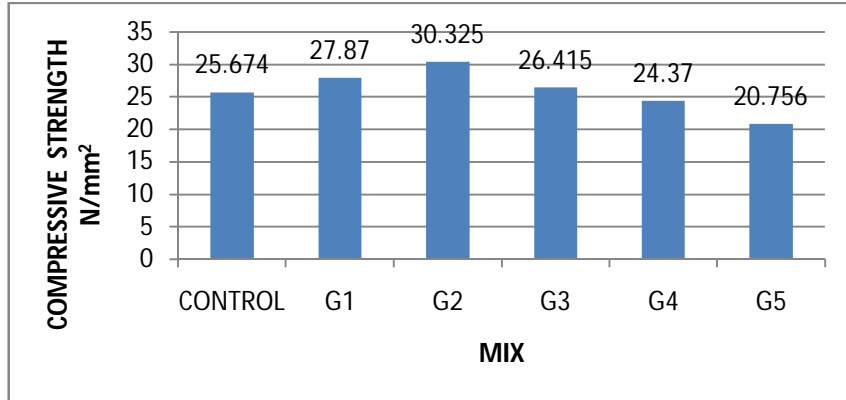


Fig 1: 7 day's Compressive strength in N/mm² of cubes with only cement replacement

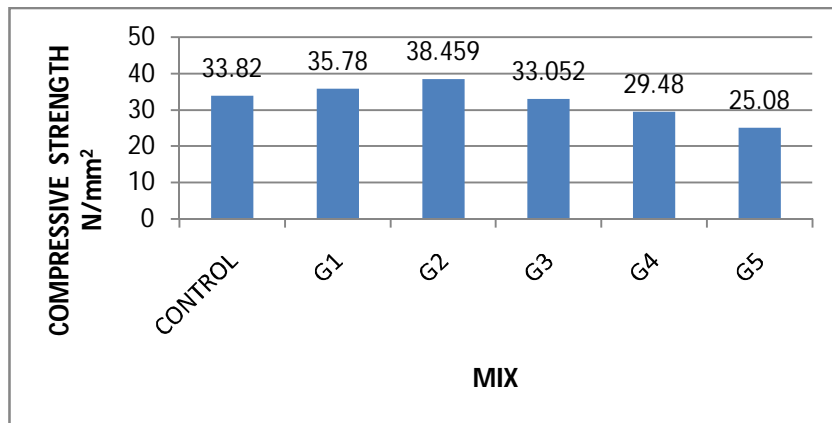


Fig 2: 28 day's Compressive strength with only cement replacement

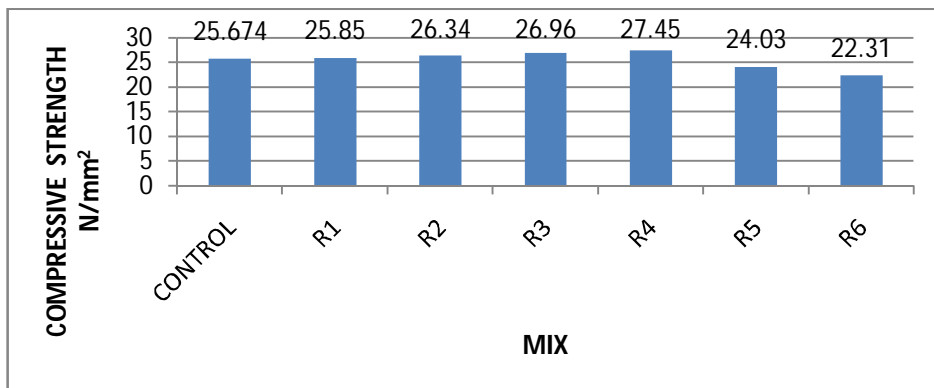


Fig 3: 7 day's Compressive strength with aggregate replacement along with cement replacement

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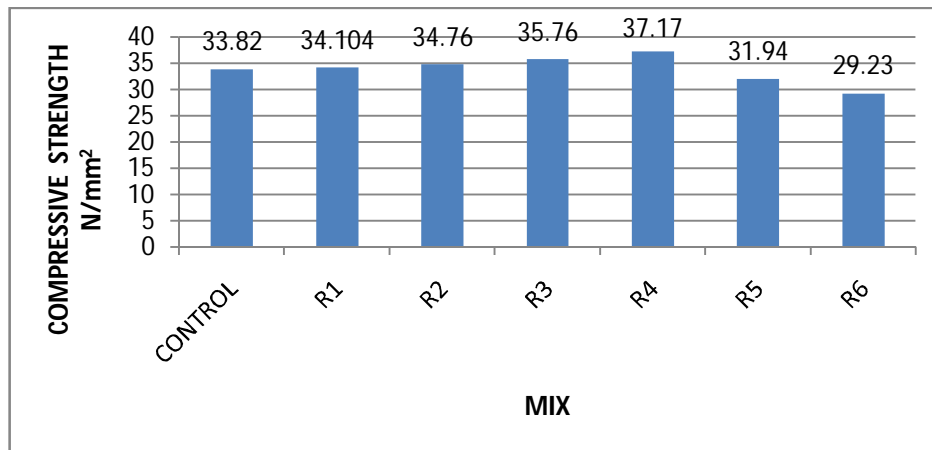


Fig 4: 28 day's Compressive strength with aggregate replacement along with cement replacement

IV. CONCLUSION

Based on the above results of the investigation conducted on recycled concrete with partial replacement of cement and aggregate up to 25% granite slurry powder and up to 30% waste marble and ceramic aggregate respectively, the following conclusions can be drawn:

1. Compressive strength of concrete is increased with the replacement of cement up to 10% granite slurry powder, and the strengths decreased with cement replacement by granite slurry powder more than 10%. Hence 10% Cement replacement by granite slurry powder is taken as optimum.
2. Compressive strength of concrete is increased with aggregate replacement up to 20% combination of waste marble and waste ceramic aggregate along with 10% cement replacement by granite slurry powder and the strengths decreased with aggregate replacement more than 20% along with cement replacement by granite slurry powder. Hence 20% Aggregate replacement is taken as optimum in which 10% of waste marble aggregate and 10% of waste ceramic aggregate were taken.
3. From above results it is noticed that though there is no significant increase in strengths, the above replacements are acceptable and economical, since cost of cement is high.

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