Experimental Study on Workability and Strength Characteristics of Concrete Containing Waste Marble Aggregate Along with Marble Slurry Powder

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Abstract

Concrete is most extensively used and most popular construction material used in the world. The demand for materials in the construction industry has consecutively increased which has resulted in the reduction of sources and an increase in price. On the other hand a high volume of marble production has generated a considerable amount of waste material; almost 40% of marble stone mined and handled usually rejects at the mine sites or at processing units in the range of 250-400 tonnes. Leaving the waste materials to the environment cause environmental problem. 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 aggregates as partial replacement of natural aggregates along with waste marble slurry powder as partial replacement of cement. This experimental study was carried out as a 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 waste aggregate along with marble waste slurry powder were found to confirm with concrete production standards and substitution of natural aggregates by waste marble aggregates up to 10% along with substitution of cement by marble waste slurry powder up to 10% of any formulation is beneficial for concrete.

Keywords: Compressive Strength, Marble Slurry Powder, Marble Waste Aggregate, Ordinary Portland Cement, Split Tensile 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.

Now-a-days, industries are growing rapidly and due to this there will be consequent increase in production and fast declination of natural resources available. Because of this impact great amount of municipal solid waste is generating every day. This solid waste is disposed in two ways, one by land filling and second by burning. These two cause environmental pollution. So, best alternative method to dispose these wastes is waste management technique.

Marble is non–foliated metamorphic rock. It is formed from the Sedimentation of Carbonate rocks (protolith) limestone, dolomite under certain temperature and pressure conditions over a period of time inside earth’s crust. This process is called recrystallization. Marble stone is purely white, if it is composed of purely limestone or calcite (100% CaCO3). Swirls and veins, colour characteristics of marble stone is due to mineral impurities present in limestone layers. Some of the mineral impurities present in limestone are hematite gives reddish colour to marble stone, whereas limonite gives yellow colour and serpentine (formed if water is present during the formation of talc) gives green colour to marble stone. The chemical impurities associated in marble rock are FeS2 (pyrite), Fe3O4, SiO2, manganese.

Since from ancient times, Marble has been commonly used for sculptures. It is also commonly used for decorative purposes, cladding, flooring, as a building material and partial replacement of coarse aggregate.

India is one of the top most exporters of marble stone in the world. Indian Marble industry annual growing rate is around 10% per year i.e. annual output is 68 million tonnes of processed products. Not only solid waste but also stone slurry is generated by marble stone industry. Solid wastes are rejected at the mine sites or at processing units. Whereas stone slurry i.e. semi liquid substance. It is in a semi liquid state consisting of particles originated from sawing and polishing process and water which is used to cool and lubricate polishing machines. Large quantity of marble slurry powder is generated during marble cutting, sawing, shaping, polishing, dressing, processing and grinding in marble industries.
II. EXPERIMENTAL PROGRAM

A. Materials used and their Properties
- Cement: Ordinary Portland cement of 43 grade 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 harmful 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.
- Marble Slurry Powder: Marble Slurry powder was collected from the deposits of marble factories during processing. It was sieved by IS 90 micrometer 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.
- 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: 1.661: 2.851 (W: C: FA: CA) by weight.

B. Procedure
This experimental study was carried out on mixture of cement and coarse aggregate substitution. For each mix 6 cubes of size 150mm×150mm×150mm and 6 cylinders of 150mm diameter and 300mm height are casted and tested. A total of six mixes are prepared as Control, G-1, G-2, G-3, G-4 and G-5 with 0%, 5%, 10%, 15%, 20% and 25% respectively as partial replacement of coarse aggregate keeping optimum percentage of marble slurry i.e. 10% constant by weight of cement (90% cement + 10% marble slurry) in all the six mixes. Then the specimens are casted and kept for curing for 7, 28 days and after compressive strength test are carried out on cubes and split tensile test is carried out on cylinders.

III. EXPERIMENTAL RESULTS

Table - 1
Compressive strength of cubes with coarse aggregate replacement along with cement replacement

<table>
<thead>
<tr>
<th>Mix type</th>
<th>% of cement replacement by marble slurry powder</th>
<th>% of coarse aggregate replacement by waste marble aggregate</th>
<th>Compressive Strength in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 days</td>
</tr>
<tr>
<td>Control</td>
<td>10</td>
<td>0</td>
<td>21.76</td>
</tr>
<tr>
<td>G-1</td>
<td>10</td>
<td>5</td>
<td>23.98</td>
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<tr>
<td>G-2</td>
<td>10</td>
<td>10</td>
<td>24.46</td>
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<tr>
<td>G-3</td>
<td>10</td>
<td>15</td>
<td>21.25</td>
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<tr>
<td>G-4</td>
<td>10</td>
<td>20</td>
<td>19.58</td>
</tr>
<tr>
<td>G-5</td>
<td>10</td>
<td>25</td>
<td>17.80</td>
</tr>
</tbody>
</table>

Table - 2
Split Tensile strength of cylinders with coarse aggregate replacement along with cement replacement

<table>
<thead>
<tr>
<th>Mix type</th>
<th>% of cement replacement by marble slurry powder</th>
<th>% of coarse aggregate replacement by waste marble aggregate</th>
<th>Split Tensile Strength in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 days</td>
</tr>
<tr>
<td>Control</td>
<td>10</td>
<td>0</td>
<td>2.17</td>
</tr>
<tr>
<td>G-1</td>
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<td>5</td>
<td>2.32</td>
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<tr>
<td>G-2</td>
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<tr>
<td>G-3</td>
<td>10</td>
<td>15</td>
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<tr>
<td>G-4</td>
<td>10</td>
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<tr>
<td>G-5</td>
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<td>25</td>
<td>1.83</td>
</tr>
</tbody>
</table>
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Fig. 1: 7 days Compressive Strength of cubes with cement and coarse aggregate replacement

Fig. 2: 28 days Compressive Strength of cubes with cement and coarse aggregate replacement

Fig. 3: 7 days Split Tensile Strength of cylinders with cement and coarse aggregate replacement

Fig. 4: 28 days Split Tensile Strength of cylinders with cement and coarse aggregate replacement
IV. CONCLUSIONS

Based on the above results of the investigation conducted on recycled concrete with partial replacement of cement and coarse aggregate, keeping the optimum content of marble slurry powder i.e. 10% by weight of cement as constant, the coarse aggregate is replaced by waste marble aggregate up to 25%, the following conclusions can be drawn:

1) Compressive strength of concrete is increased up to 10% replacement of coarse aggregate by waste marble aggregate along with 10% of cement replacement by marble slurry powder and the strengths decreased with aggregate replacement more than 10% along with cement replacement by marble slurry powder. Hence 10% Aggregate replacement is taken as optimum.

2) Split tensile strength of concrete is increased with aggregate replacement up to 10% along with 10% of cement replacement by marble slurry powder and the strengths decreased with aggregate replacement more than 10% along with cement replacement by marble slurry powder. Hence 10% Aggregate replacement is taken as optimum.

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.

REFERENCES