EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE USING GRANITE POWDER

CH SWATHI 1*, CH DURGA RAO 2*


ABSTRACT

Concrete plays a major role in the construction industry and a large quantum of concrete is being utilized. River sand, which is one of the constituent used in the production of conventional concrete, has become expensive and also a scarce material. In view of this, there is a need to identify suitable alternative material from industrial waste in place of river sand. The utilization of quarry dust which is a waste material has been accepted as building material in many countries for the past three decades.

At present time, gypsum is used only for interior applications as plasterboards, blocks for bathroom walls or as fire safeguards. Only few research workers deal with utilization of materials on gypsum basis for exterior applications.

In the present work an attempt is made to study the effect of concrete when cement is replaced by glass powder at 20% by weight of cement, and sand by granite powder at 10%, 20%, 30%, 40% and 50% by weight of sand for M25 mix. The experimental studies are made to obtain the properties of concrete like the compression strength at the curing age of 7, 14, and 28 days and compressive strength of cylinders, split tensile strength, modulus of elasticity of concrete at 28 days of curing period. Concrete mixtures were produced, tested and compared with the conventional concrete.

1. INTRODUCTION

1.1 GENERAL

Concrete is a composite construction material composed primarily of aggregate, cement and water. Generally Concrete is strong in compression and weak in tension. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason is usually reinforced with materials that are strong in tension (often steel). Concrete can be damaged by many processes, such as the freezing of trapped water. Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is only approximately one tenth of its compressive strength. As a result for these characteristics, concrete member could not support such loads and stresses that usually take place, majority on concrete beams and slabs. The introduction of waste glass in cement will increase the alkali content in the cement. It also helps in bricks and ceramic manufacture and it preserves raw materials, decreases energy consumption and volume of waste sent to landfill. Their recycling ratio is close to 100%, and it is also used in concrete without adverse effects in concrete durability. The main objective of this project is to investigate the development of Concrete Strength using glass powder as a partial replacement for cement and granite powder for fine aggregate. In trial mixes fine aggregate is replaced 10%, 20%, 30%, 40% and 50% of its weight by Granite powder and cement is replaced 20% of its weight by Glass powder in all mixes. The investigation is also aimed at finding out the optimum grade of concrete for superior strength while using Glass powder and Granite powder.

1.1 OBJECTIVES OF THE PROJECT

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The main objective of the project is to determine the optimum utilization of Glass Powder and Granite Powder. The effect of these admixtures on the mechanical properties of concrete at different replacement levels.

- To study the compressive strength, split tensile strength and flexural strength properties of concrete with Glass Powder and Granite Powder in certain proportions.
- To utilize of glass powder and Granite powder in concrete up to 20%and 10%, 20%, 30%, 40% and 50% respectively.
- To compare the strength of concrete between partially replaced glass powder concrete and the concrete with addition of Granite powder.

2. REVIEW OF LITERATURE

The literature survey was carried out and it was found that almost all the researchers have concentrated utilization of glass powder as a partial replacement of cement in ordinary Portland cement concrete. A detailed overview of the Granite powder carried for the various test compressive strength, split tensile strength, deflection etc, are discussed the specific conclusion drawn from the various experimental studies are summarized in the following studied.

Pooja J.Chavhan Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. Granite stone industry generates both solid waste and stone slurry. The concrete industry is constantly looking for supplementary material with the objective of reducing the solid waste disposal problem. In that paper Granite powder is replace by sand the research is carried out by using M25 grade concrete with replacement of 0%, 5%,10%,15%,20%,25%,30%,35%,40%,45%,50% Granite powder by sand and is carried out to determine the optimum percentage of replacement at which maximum compressive strength and also split tensile strength is achieved. There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. The physical, chemical and mechanical properties of the waste are analyzed.

Soman. K Granite quarry sludge is the waste from rock processing in quarries and crusher units. The fines are at present disposed by filling in barren land causing serious environmental issues. If this material is possible to be used for partial cement replacement it is of benefit both economically and environmentally. The effect on strength properties of concrete in replacing some portion of cement by quarry sludge obtained from a local crusher unit is analyzed. The research work carried out included an experimental investigation on strength properties of concrete made with 2.5% to 20% replacement of cement by Granite Powder of less than 75 micron particle size. The tests were carried out to find the compressive strength, splitting tensile strength and flexural strength on specimens. Results showed that up to 7.5 % replacement of cement by Granite Powder there was no reduction in compressive strength, splitting tensile strength and flexural strength. The experimental work was carried out with M sand confirming to zone II as fine aggregate in concrete. Test is also carried out using another fine aggregate, namely bottom ash obtained from the furnace of an industry combined with manufactured sand. The study showed that the trend is same whatever be the fine aggregate used.

Pranali K. Kohad The use of recycled aggregate in concrete has great potential to positively affect the properties of concrete in a wide spectrum. Leaving the waste materials to the environment directly can cause environmental problem. Thus use of waste material has been emphasized. New products can be produced by using recycled aggregate & Granite sludge powder so that natural resources are used more efficiently and the environment is protected from waste deposits. The main goal of this study is to check the properties of concrete when the recycled aggregate & Granite sludge powder is used as a partial replacement of aggregate. It ultimately helps to evaluate recovery and reuse of by-products coming...
from destroyed buildings & Granite processing industries. So that it helps to conserves the use of natural aggregate and it preserves the use of landfill for materials which cannot be recycled.

T. Shafana The construction industry is the largest consumer of natural resources which led to depletion of good quality natural sand (fine aggregate). This situation compels us to explore alternative materials and sugarcane bagasse ash, a waste industrial byproduct is one such material identified for use as a replacement of natural sand. Sugarcane bagasse ash (SCBA) generated from sugar mills is fibrous waste-product usually delivered to landfills for disposal. Using of sugarcane bagasse ash in concrete is an interesting possibility for economy and conservation of natural resources. This research work examines the possibility of using sugarcane bagasse ash as replacement of fine aggregate in concrete. We partially replaced 10%, 15%, 20%, 25% and 30% of natural sand with SCBA. We compared compressive strength, tensile strength and flexural strength with those of concrete made with natural fine aggregate. We also studied chemical properties of SCBA. The test results indicate that it is possible to manufacture concrete containing sugarcane bagasse ash with characteristics similar to those of natural river sand aggregate concrete, provided that the percentage of sugarcane bagasse ash as fine aggregate is limited to 10 percent.

Abdullah Anwar et al. studied the Compressive Strength of Concrete by Partial Replacement of Cement with High Volume Fly Ash and presented a brief review with mixtures containing 10%, 20%, 30% and 40% Fly Ash by the bulk of the cementitious material (OPC) for M30 and M40 grade of concrete. The test result indicates that the compressive strength of mix with 10%, 20% and 30% replaced with fly ash were more as compared with conventional concrete thus enhancing the durability of structures. When the percentage of replacement is increased the water/binder ratio gets reduced, thereby, increasing the compressive strength. Also, it is observed that the compressive strength of concrete having more than 40% replacement of cement by fly ash suffers adverse effects though water/binder ratio is gradually lost weight. The compressive strength of the concrete mix with 40% replacement with fly ash was lesser than the conventional concrete at 28 days. The result obtained for 28-day compressive strength confirms that the optimal percentage for replacement of cement with fly ash is about 30%. Yet, in reality approximately 50% of the Fly Ash produced throughout the world is stockpiled/land filled as a wasteland.

Balamurugan and Perumal studied the behaviour of concrete by replacing sand by Granite Powder. They reported that the variation in the strength of concrete when replacing sand by Granite Powder from 0% to 100% in steps of 10%. M20 and M25 grades of concrete are taken for their study keeping a constant slump of 60mm. From their test results it is found that the maximum compressive strength, split tensile strength and flexural strength are obtained only at 50% replacement. So, they concluded that Granite Powder can be utilized in concrete mixtures as a good substitute for natural river sand at 50% replacement with additional strength than control concrete.

Chandana Sukesh et al. carried out a work on partial replacement of sand with Granite Powder in concrete. The work mainly focus on the properties of concrete and to investigate some properties of Granite Powder, the suitability of those properties to enable them to be used as partial replacement materials for sand in concrete. They concluded that the replacement of sand with Granite Powder shows an improved in the compressive strength of the concrete and the ideal percentage of the replacement of sand with Granite Powder is 55% to 75% in case of compressive strength. The further increasing the percentage of replacement can be made useful by adding the fly ash along with the Granite Powder so that 100% replacement of sand can be achieved.

3. MATERIAL AND METHODOLOGY

3.1 Ordinary Portland Cement
Cement used in the experimental work is Ordinary Portland Cement (OPC) of 53grade (ZUARI brand) conforming to IS: 12269-1987.

3.2 Glass Powder:
The issue of recycled glass is quite complicated from a chemistry point of view. Years ago, the reinforcement fiberglass manufacturers saw a large market potential in using glass reinforcements as reinforcing fiber in concrete. Early tests soon
indicated that normal chemistry reinforcement fiberglass almost totally dissolved in the concrete environment, as the extremely low alkali content of the fiber glass, about 1%, caused it to be highly susceptible to alkalis in concrete environments. The fiberglass manufacturers were able to address the problem by adding 16% zirconia to the glass chemistry to make it alkali resistant (so called AR glass).

3.3 Coarse aggregate

The coarse aggregate is obtained from a local quarry. The coarse aggregate with size less than 20mm and greater than 12.5 mm having a specific gravity 2.76 and fineness modulus of 7.36 is used in the present study. The rodded and loose bulk density values obtained are 1605 kg/m3 and 1477 kg/m3 respectively and the water absorption is 0.41%.

3.4 Granite Powder

Granite powder can be used as filler as it helps to reduce the total voids content in concrete. Granite powder and quarry rock dust improve pozzolanic reaction. The quarry rock dust and granite powder can be used as 100% substitutes for natural sand in concrete. The compressive, split tensile and durability studies of concrete made of quarry rock dust nearly more than the conventional concrete. The concrete resistance to sulphate attack will enhance greatly. The combination of pozzolanic and filler action leads to increase in compressive and split tensile strengths, reduction in bleeding and segregation of fresh concrete, reduction in permeability, reduction in alkali silica reaction, reduction in sulphate attack, chemical attack and corrosion attack, leading to increased durability and reduction in heat of hydration.

3.5 METHODOLOGY

The Mix Design is done according to (BIS Method)

- Grade Designation: M20
- Type of Cement: OPC 53 grade confirming to IS 8112
- Maximum nominal size of aggregate: 20mm
- Minimum cement content: 300 kg/m3
- Maximum water cement ratio: 0.45
- Workability: 100 mm slump
- Exposure condition: Mild
- Method of concrete placing: Manual placement
- Degree of supervision: Good
- Type of aggregate: Crushed angular
- Maximum cement (OPC) content: 450 kg/m3

Test data for materials:

- Cement used: OPC 53 grade confirming to IS 8112
- Specific gravity of cement: 3.15
- Specific gravity of coarse aggregate: 2.74
- Fine aggregate: 2.74
- Water absorption: Course aggregate: 0.5%
- Fine aggregate: 1%
- Free surface moisture: Coarse aggregate: NIL
- Fine aggregate: NIL

Fig-1: Glass Powder

Fig-2: Granite Powder
Table 1. Details of Mix Proportions

<table>
<thead>
<tr>
<th>Mix Design</th>
<th>Cement (Kg/m³)</th>
<th>Glass Powder (Kg/m³)</th>
<th>Fine Aggregate (Kg/m³)</th>
<th>Granite Powder (Kg/m³)</th>
<th>Course Aggregate (Kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M0</td>
<td>400</td>
<td>-</td>
<td>600</td>
<td>-</td>
<td>1200</td>
</tr>
<tr>
<td>M1</td>
<td>320</td>
<td>80</td>
<td>600</td>
<td>-</td>
<td>1200</td>
</tr>
<tr>
<td>M2</td>
<td>320</td>
<td>80</td>
<td>540</td>
<td>60</td>
<td>1200</td>
</tr>
<tr>
<td>M3</td>
<td>320</td>
<td>80</td>
<td>480</td>
<td>120</td>
<td>1200</td>
</tr>
<tr>
<td>M4</td>
<td>320</td>
<td>80</td>
<td>420</td>
<td>180</td>
<td>1200</td>
</tr>
<tr>
<td>M5</td>
<td>320</td>
<td>80</td>
<td>360</td>
<td>240</td>
<td>1200</td>
</tr>
<tr>
<td>M6</td>
<td>320</td>
<td>80</td>
<td>300</td>
<td>300</td>
<td>1200</td>
</tr>
</tbody>
</table>

3.6 CASTING, CURING AND TESTING

The study is conducted to analyse the properties of concrete when the base materials i.e., when cement is replaced with gypsum and fine aggregate is replaced by stone dust, respectively. The cement is replaced at 0%, 10%, 20% and 30% by gypsum and fine aggregate is replaced at 20%, 30% and 40% by stone dust.

As the aggregate of size less than 20mm and greater than 12.5mm is used, cube moulds of size 150mmx150mmx150mm are used for compressive strength test and ultrasonic pulse velocity test. Cylindrical moulds of size 150mm diameter and 300mm height are used for casting specimens for compressive strength test of cylinders, split tensile test and modulus of elasticity test. Moulds are removed after 24 hours of casting and cured in water up to the date of testing. The cubes and cylinders are analysed after their curing periods. The each test result is the average test results of three specimens. The results of the replacements proportions of concrete are compared with that of the controlled concrete.

4. RESULTS AND DISCUSSION

4.1 Compressive Strength

Compressive strength test is the most common test conducted on hardened concrete as it is easy to perform and also most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The tests are performed in a compression testing machine using cube and cylindrical samples. The compressive strength of concrete cubes are tested at 7, 14, and 28 days of curing period and compressive strength of concrete cylinders are tested at 28 days of curing period. The mean compressive strength is calculated and tabulated in Table 2.

Table 2. Compressive Strength of Concrete Cubes

<table>
<thead>
<tr>
<th>Concrete Mix Design</th>
<th>Compressive Strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 Days</td>
</tr>
<tr>
<td>M0</td>
<td>18.54</td>
</tr>
<tr>
<td>M1</td>
<td>17.53</td>
</tr>
<tr>
<td>M2</td>
<td>22.57</td>
</tr>
<tr>
<td>M3</td>
<td>25.33</td>
</tr>
<tr>
<td>M4</td>
<td>21.36</td>
</tr>
<tr>
<td>M5</td>
<td>19.42</td>
</tr>
<tr>
<td>M6</td>
<td>24.6</td>
</tr>
</tbody>
</table>

From the Fig 3, it is observed that the maximum strength occurs at 20% glass powder in case of 20% granite powder (M3) and 30% granite powder. The mix comprising 20% glass powder and 30% granite powder (M3) attains higher strength irrespective of curing period among all the mixes considered. When compared to controlled concrete, for M6 mix the amount of improvement in strength of cubes is about 33%, 15%, and 32% at 7, 14 and 28 days of curing period.
4.2 Split Tensile Strength:

Split tensile test is done by placing the cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied till the cylinder failed along the vertical diameter. Split tensile strength of concrete mixes is determined at the age of 28 days. The mean tensile strength is calculated and tabulated in Table 3.

Split tensile strength = LOAD / AREA = 2P / LDπ

Table 3: Split Tensile Strength of Concrete

<table>
<thead>
<tr>
<th>Concrete Mix Design</th>
<th>7 Days</th>
<th>14 Days</th>
<th>28 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>M0</td>
<td>1.79</td>
<td>2.242</td>
<td>2.69</td>
</tr>
<tr>
<td>M1</td>
<td>1.73</td>
<td>2.158</td>
<td>2.59</td>
</tr>
<tr>
<td>M2</td>
<td>1.89</td>
<td>2.358</td>
<td>2.83</td>
</tr>
<tr>
<td>M3</td>
<td>2.01</td>
<td>2.517</td>
<td>3.02</td>
</tr>
<tr>
<td>M4</td>
<td>1.89</td>
<td>2.358</td>
<td>2.83</td>
</tr>
<tr>
<td>M5</td>
<td>1.85</td>
<td>2.317</td>
<td>2.78</td>
</tr>
<tr>
<td>M6</td>
<td>1.95</td>
<td>2.433</td>
<td>2.92</td>
</tr>
</tbody>
</table>

From the Fig-4, it is observed that in case of 20% granite powder and 30% granite powder, the split tensile strength attains a maximum value. The improvement in split tensile strength with respect to the controlled concrete is about 12%, 12% and 9% at mixes 20% glass powder and 20% granite powder, 20% glass powder and 30% granite powder, 20% glass powder and 50% granite powder, respectively. The mix comprising 20% glass powder and 30% granite powder (M3) attains higher strength among all the mixes considered.

4.3 Flexural Strength

After curing of Beam specimens they are placed in testing machine having a maximum capacity of 40 tonne. The load is applied on the beam specimens. The specimen is failed at ultimate load which is noted from dial gauge reading. From the result flexural strength is increased with respect to the grade of concrete when adding 20% of Glass powder and 25% of granite powder when compared to the conventional concrete.

Table-4: Flexural Strength of Beams

<table>
<thead>
<tr>
<th>Concrete Mix Design</th>
<th>Avg. Flexural Strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28 Days</td>
</tr>
<tr>
<td>M0</td>
<td>5.23</td>
</tr>
<tr>
<td>M1</td>
<td>6.78</td>
</tr>
<tr>
<td>M2</td>
<td>8.34</td>
</tr>
<tr>
<td>M3</td>
<td>8.21</td>
</tr>
<tr>
<td>M4</td>
<td>7.92</td>
</tr>
<tr>
<td>M5</td>
<td>6.63</td>
</tr>
<tr>
<td>M6</td>
<td>5.64</td>
</tr>
</tbody>
</table>

CONCLUSION

- Glass Powder consumes more water for consistency and workability.
- Addition of Glass Powder to cement enhances the initial setting time whereas reduces the final setting time.
- In general, all the mixes attain more than the target strength when compared to the controlled concrete irrespective of curing period.
- All the mixes gain strength irrespective of curing period.
- The compressive strength of different mixes of cylindrical specimens is slightly less than that of the cube specimens.
- The concrete comprising 20% Glass Powder and 30% granite powder is considered to be the optimum mix from compressive strength, tensile
strength and modulus of elasticity of concrete point of view as well as from quality point of view.

- The partial replacement of cement by Glass Powder and sand by granite powder in concrete not only enhances the strength of concrete, but also reduces the cost of production of concrete and at the same time, it also eliminates the environmental pollution and hazards caused due to the disposal of these waste by-products on land.

- There’s a rise of 74 % throughout the 28 day flexural strength of glass powder concrete when put next to standard concrete.

REFERENCE


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[7]. IS 13311 (part 1):1992 Non-Destructive Testing of Concrete-Method of Test; Part 1- Ultrasonic Pulse Velocity, Bureau of Indian Standards, New Delhi, India.

