EXPERIMENTAL INVESTIGATION ON REINFORCED CONCRETE BEAM USING QUARRY ROCK DUST AND MARBLE SLUDGE POWDER

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Abstract— In this study, investigations were carried out on strength properties such as compressive strength, split tensile strength of M25 grade concrete mixes with different replacement levels. Those mixes were the complete replacement of sand with quarry rock dust and marble sludge powder separately. Then the other mixes having sand as 40% constantly. Remaining 60% have replaced with varying the percentages of both Quarry rock dust and Marble sludge powder for each mix such as 20percent, 30percent, and 40percent with water cement ratio as 0.4, normal curing condition is adopted for 3, 7, and 28 days. The results of these investigations demonstrate the strength characteristics of various mix proportions adopted. Based on the result obtained, Mix-4 has higher compressive strength and Mix-2 has higher split tensile strength. Here Flexural behavior and shear behavior of reinforced concrete beam are evaluated for both control mix and design mix. The details of the investigations along with the result are presented in this report.

Keywords— Quarry rock dust, Marble sludge powder, superplastizer, concrete, strength characteristics

I. INTRODUCTION

Concrete is the most widely used construction material which is plastic and malleable when it is freshly prepared. Concrete can be moulded into any shape and size. When hardened it becomes hard and durable. Coarse aggregate, fine aggregate, cement, admixture and water are the ingredients of normal concrete. The small stone and gravel (aggregate) is the reinforcement and the cement is the matrix that binds it together. Concrete is good in resisting compression but is very weak in resisting tension. Hence reinforcement is provided in the concrete wherever tensile stress is expected. Concrete is widely used in domestic, commercial, recreational, rural and educational construction. Communities around the world rely on concrete as a safe, strong and simple building material. It is used in all types of construction; from domestic work to multi-storey office blocks and shopping complexes. Despite the common usage of concrete, few people are aware of the considerations involved in designing strong, durable, high quality concrete.

Shahul Hameed and Sekar [1] Conducted a study on Green concrete which is capable for sustainable development is characterized by application of industrial wastes and reduce consumption of natural resources energy and pollution of the environment. Natural sand in many parts of the country is not graded properly and has excessive silt on other hand quarry rock dust does not contain silt or organic impurities and can be produced to meet desired gradation and fineness as per requirement. Marble sludge powder and quarry rock dust improved pozzolanic reaction, micro-aggregate filling and concrete durability.

An experimental investigation carried out by Monica and Dhoka [2] about the challenge of the present century is to make a transition to the new form that can sustain the natural system. There is a necessity of making a concrete movement for developing innovative and alternative novel material for construction. This type of concrete is cable for sustainable development and characterized by application of industrial waste such as marble sludge powder and quarry rock dust to reduce consumption of natural resources and pollution of the environment.

In this investigation Chandana Sukesh [3] studied on reduction in the source of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute material to sand as fine aggregate in the production of concrete. It led to
study the properties of concrete and to investigate some properties for quarry rock dust for suitability of those properties to be used as partial replacement of fine aggregate in concrete.

Animesh Mishra [4] conducted a study on usage of marble sludge powder hundred percent substitutes for natural sand in concrete. The compressive strength and microstructure of blended cement was investigated in this study. It was observed that the blended cements developed higher strength, at 28 days compared to 7 days. The strength increased where, the higher the marble dust content. The concrete prepared by marble dust which helpful to reduce consumption of natural resources and energy and pollution of the environment.

Valeria Corinaldesi [5] carried out study on usage of the marble powder which is obtained from chemical and physical point of view in order to use addition for mortars and concretes. The marble sludge powders are used as filler material in the concrete. In order to evaluate the effect of marble sludge powder on mechanical behavior of concrete many different mortar mixes were tested. The mixture was evaluated based upon the cement or sand substitution by the marble sludge powder.

Md Mahboob Ali [6] The present work is directed towards developing a better understanding on strengths characteristics of concrete using marble dust powder as a partial replacement of cement. The Dissertation work is carried out with M30 grade concrete for which the marble powder is replaced by 0%, 5%, 10%, 15%, 20% by weight of cement. Waste marble powder is generated as a by-product during cutting of marble.

Er. Lakhan Nagpal [7] The purpose of this study was to investigate the possibility of using crushed stone dust as fine aggregate partially or fully with different grades of concrete composites. The suitability of crushed stone dust waste as fine aggregate for concrete has been assessed by comparing its basic properties with that of conventional concrete. In the experimental study of strength characteristics of concrete using crushed stone dust as fine aggregate it is found that there is increase in compressive strength, flexural strength and tensile strength of concrete.

G.Balamurugan [8] this experimental study presents the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. This result gives clear picture that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand at 50% replacement with additional strength than control concrete. Maximum flexural strength is also at 50% replacement.

K. Subramanian [9] Quarry Dust which is a residue tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. The Quarry rock dust can be an economic alternative to the river sand since river sand is expensive due to excessive cost of transportation from natural sources and also large scale depletion of these sources creates environmental problems.

Anitha selva sofia [10] Major initiatives are taken by developing countries like India in developing the infrastructure such as express highways, power projects, industrial structures, ports and harbors to meet the requirements of globalization in construction of buildings and other structures. 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.

II. EXPERIMENTAL INVESTIGATION

A. Materials used

Quarry rock dust

The quarry rock dust was obtained from local crusher.

Marble sludge powder

Marble sludge powder was collected from deposits of marble factories.

Cement

Portland Pozzolona Cement (PPC) of 53 grade (IS 1489-1-1991) and with the specific gravity 3.15 was used for casting all the specimens.

Fine aggregate
Locally available clean and dry river sand was used (IS 383-1970). Sand passing through IS 4.75 mm sieve was used for casting all the specimens

Coarse aggregate

Crushed aggregate with specific gravity of 2.62 and passing through 20 mm sieve and retained on 12.5 mm are per (IS 383-1970) was used as course aggregate for casting all the specimens

Water

Casting and curing of specimens were done with the potable water.

Admixture

CONPLAST-SP430 was used for the experimental investigation.

B. Methodology

The various stages of involves for this study are shown in flow chart in Fig.1.

<table>
<thead>
<tr>
<th>Mix</th>
<th>Name of mix</th>
<th>Type of mix</th>
<th>Normal river sand in %</th>
<th>Quarry rock dust in %</th>
<th>Marble sludge powder in %</th>
<th>Mix proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix-1</td>
<td>Control mix</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>1:2:1:3.45</td>
<td></td>
</tr>
<tr>
<td>Mix-2</td>
<td>Design mix</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>1:2:1:3.45</td>
<td></td>
</tr>
<tr>
<td>Mix-3</td>
<td>Design mix</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>1:2:1:3.45</td>
<td></td>
</tr>
<tr>
<td>Mix-4</td>
<td>Design mix</td>
<td>40</td>
<td>40</td>
<td>20</td>
<td>1:2:1:3.45</td>
<td></td>
</tr>
<tr>
<td>Mix-5</td>
<td>Design mix</td>
<td>40</td>
<td>20</td>
<td>40</td>
<td>1:2:1:3.45</td>
<td></td>
</tr>
<tr>
<td>Mix-6</td>
<td>Design mix</td>
<td>40</td>
<td>30</td>
<td>30</td>
<td>1:2:1:3.45</td>
<td></td>
</tr>
</tbody>
</table>

TABLE II. Mix Proportion of Various Mixes

Concrete cube size 150mm x 150mm x 150mm and size of cylinder is 150mm diameter and 300mm height were casted for the above mixes to test the compressive strength and split tensile strength.

III. RESULTS AND DISCUSSIONS

A. Slump test

The slump for controlled mix and design mix with various percentages for replacement of sand with quarry rock dust and marble sludge powder (20%, 30%, and 40%) and remaining 60% fine aggregate for M25 mix. The slump for controlled mix is 128mm. The minimum slump value was obtained for mix-5. The slump values of various mixes are given in Table-3 and its bar chart is shown in Fig.2.
C. Compressive strength

The cube compressive strength for controlled mix and design mix with various percentages for replacement of sand with quarry rock dust and marble sludge powder (20%, 30%, and 40%) and remaining 60% fine aggregate for M25 mix. The compressive strength for controlled mix is 26.96 N/mm². The cube compressive strength for design mixes are varying between 27.70 and 32.88 N/mm². The compressive strength values are presented in Table V and Fig.4.

<table>
<thead>
<tr>
<th>Mix</th>
<th>Compressive strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 Days</td>
</tr>
<tr>
<td>Mix-1</td>
<td>16.88</td>
</tr>
<tr>
<td>Mix-2</td>
<td>15.7</td>
</tr>
<tr>
<td>Mix-3</td>
<td>15.55</td>
</tr>
<tr>
<td>Mix-4</td>
<td>15.11</td>
</tr>
<tr>
<td>Mix-5</td>
<td>17.77</td>
</tr>
<tr>
<td>Mix-6</td>
<td>15.11</td>
</tr>
</tbody>
</table>

D. Split tensile strength

The split tensile strength for controlled mix and design mix are obtained with various percentage replacements of fine aggregate with quarry rock dust and marble sludge powder (20%, 30%, and 40%) and remaining 60% fine aggregate as constant for M25 mix. The split tensile strength for controlled mix is 3.01 N/mm². The split tensile strength for design mixes ranging between 2.37 and 3.11 N/mm². Split tensile strength for various mixes are given in Table VI and Fig.5.
TABLE VI. Split Tensile Strength Value

<table>
<thead>
<tr>
<th>Mix</th>
<th>Split tensile strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 Days</td>
</tr>
<tr>
<td>Mix-1</td>
<td>2.45</td>
</tr>
<tr>
<td>Mix-2</td>
<td>2.40</td>
</tr>
<tr>
<td>Mix-3</td>
<td>2.35</td>
</tr>
<tr>
<td>Mix-4</td>
<td>2.02</td>
</tr>
<tr>
<td>Mix-5</td>
<td>2.31</td>
</tr>
<tr>
<td>Mix-6</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Fig.5. Split tensile strength graph

E. Beam

The flexural strength and shear strength for controlled mix and design mix with various percentages for replacement of sand with quarry rock dust and marble sludge powder for M25.

Flexural beam.

The Flexural strength for Control mix is obtained is shown in fig.6.

Fig.6. Deflection curve for Nominal Mix

The Flexural strength for Design mix are obtained for mix-4 is shown in fig.7.

Fig.7. Deflection curve for Design Mix

Shear Beam.

The minimum Shear Strength for Control mix is obtained is shown in fig.8.

Fig.8. Deflection curve for Nominal Mix

The Shear strength for Design mix are obtained for mix-4 is shown in fig.9.

Fig.9. Deflection curve for Design Mix

F. Discussions

The test results of test for mechanical properties of Green concrete were analysed. The results shown that the compressive strength is maximum at the percentage of Mix-4 and split
tensile strength is maximum at Mix-2 compared to other mix combinations. Here flexural and shear strength of reinforced concrete beam are obtained for control mix and design mix (mix-4).

IV. CONCLUSION

In this study, concrete mix M25 has been designed. The concrete with various percentages of quarry rock dust and marble sludge powder are used and the test results have been evaluated. The following conclusions are arrived based on the experimental results of the study.

• Workability test shown that the Mix-3 has the higher slump value.
• Mix-4 has high compressive strength. While Mix-1 have the least value. With addition of quarry rock dust and marble sludge powder there is notable increase in compressive strength between 3, 7 and 28 days.
• Mix-2 has high split tensile strength. The quarry rock dust and marble sludge powder influence high split tensile strength. There is almost 28 % increase in strength between 7and 28 days for Mix-2.
• Flexural and shear strength behavior Reinforced concrete beam are evaluated for both control mix as well design mix. For design mix Mix-4 is evaluated for flexural and shear strength.

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References
