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EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF SAND BY QUARRY DUST IN CONCRETE

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Abstract - *This paper was investigates the effect of partial replacement of the cement with waste material quarry dust. Quarry Rock Dust 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 main objective is to evaluate the possibilities of using quarry dust as a replacement to fine aggregate with an aim not to lose the strength far from original concrete mix. . During the present study, 10%, 20%, 30%, 40%, 50% and 100% traditional fine aggregate is replaced with quarry dust. Compressive strength of quarry dust fine aggregate is decreased due to deficient grading and excessive flakiness. The slump value and water cement ratio is increased with the replacement of sand. But voids present in quarry dust mortar were lesser as compared to that of sand hence higher compressive strength. When sand is replaced partially or fully with or without concrete admixtures, it is expected to have comparatively good strength. Use of quarry rock dust as a fine aggregate in concrete draws serious attention of researchers.*

***Key Words*: Concrete, Quarry rock dust, workability, Compressive strength, split tensile strength**

1. INTRODUCTION

The most widely used fine aggregate for making of concrete is the natural sand mined from the riverbeds. The demand for natural sand is quite high in developing countries owing to rapid infrastructural growth which results supply scarcity(1). Quarry dust as a byproduct from crushing process during quarrying activities is one of those materials that have recently gained attention to be used as concreting aggregates. Various rock types produce different types or different qualities of quarry dusts due to the inclusion of their fresh minerals. Also, it has no uniformity and similarity to river sand. In concrete production it could be used as a partial or full replacement of natural sand. Besides, the utilization of quarry waste, which itself is a waste material, will reduce the cost of concrete production. The successful utilization of quarry dust as fine aggregate would turn this waste material that causes disposal problem into a valuable resource(2). The utilization will also reduce the strain on supply of natural fine aggregate, which will also reduce the cost of concrete. Therefore it is obvious that the noticeable effects on environment and the eco system caused by sand mining, together with the growing demand of aggregates to fulfill the construction requirements of the urban world has made it imperative to look for alternate solutions to the concern.

2. METHODOLOGY

The experimental investigation consisted of making M20 concrete with various proportions of quarry dust as a replacement to fine aggregate and determining the mechanical properties of concrete. Initially tests were conducted on the materials used for conducting the tests as per the specifications of Indian standards. These materials were used for casting the required specimens. Cubical mould of size 150 mm x 150mm x150mm is used. Ordinary Portland cement of 53 grade, locally available coarse aggregate, natural sand and quarry dust collected from a local quarry were used for this experimental investigation

2.1 Test on Materials

Specific gravity test, particle size analysis, bulking etc. are carried out to find the basic properties of natural sand and quarry dust. It was found that, specific gravity of aggregate lies in range 2.6 to 2.8.Since we have got values in this range, the materials confirm to IS specification. From the particle size analysis, the zone of natural sand and quarry dust is found to be of zone II. Bulking increases gradually with moisture content up to a certain limit and then decreases with increase in water content due to the merging of films. The optimum value of bulking is obtained as 31.8 for natural sand when 6% water is added and 30.4 for quarry dust when 8% water is added. All the properties of quarry dust is comparable with that of natural sand. So it can be used as a replacement material for natural sand.

2.2 Test on Fresh concrete

M20 grade concrete were prepared by replacing sand by quarry dust by 0%,10%,20%,30%,40%,50%,&100%.For each mix prepared workability was measured by using slump test & compaction factor test. The slump value obtained for the different mixes proportioned are tabulated and the values are compared with the standard values as per IS specifications As per the data obtained, concrete does not give adequate workability with the increase of quarry dust as fine aggregate. Water requirement will be more for angular stone dust, results in decrease workability than natural sand.

3. SPECIMEN DETAIL

Steel mould of size 150mm X150mmX150mm and cylinder mould of 150 mm diam. and 300 mm size was used for casting the cube and cylinder specimens respectively. The required materials were weighed using an electronic balance. Initially dry mixing was dine with cement, fine aggregate and coarse aggregate. After attaining a uniform colour the required quantity of water was added. It was mixed to obtain

a uniform mix. Specimens were kept in the mould itself for 24 hours after casting. Then it was kept in water for curing for 3, 7 and 28 days. After the curing period was over the specimens were kept ready for testing.

4. RESULTS AND DISCUSSION

4.1 Compressive strength test

Compressive strength test is the most common test conducted on hardened concrete. It was carried out on the cube specimen at 3, 7 & 28 days of curing. The tests for concrete cubes with 10%, 20%, 30%, 40%, 50% and 100% replacement were carried out.

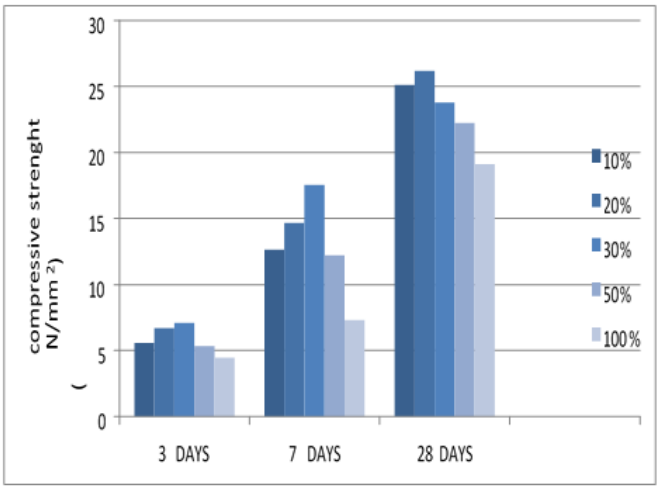

Chart -1 : Compressive strength of specimens at 3, 7 and 28 days

4.2 Split tensile strength test

The splitting test is well-known indirect tests used for determining the tensile strength of concrete, sometimes referred as the splitting tensile strength of concrete. The test consists of applying compressive line loads along the opposite generators of a concrete cylinder placed with its axis horizontal between the platens. The split tensile strength of concrete decreases with increase in percentage of replacement. Even though it is decreasing it lies around the range of IS specifications, i.e. 0.7(fck) 0.5.

Table -1: Split tensile strength of specimens at 28 days of curing

% Replacement	Split Tensile Strength (N/mm²)
Control mix	2.64
10%	2.36
20%	2.29
30%	2.122
40%	2.05
50%	1.92
100%	1.64

4.3 Modulus of elasticity

The modulus of elasticity of concrete would be a property for the case when the material is treated as elastic. It is determined by subjecting a cylinder specimen to uniaxial compression in compression testing machine using compressometer and measuring the deformations by means of dial gauges fixed between certain gauge lengths. Dial gauge r eading divided by gauge length will give the strain and load applied divide by area of cross-section will give the stress. A series of readings are taken and stress-strain relationship is established.

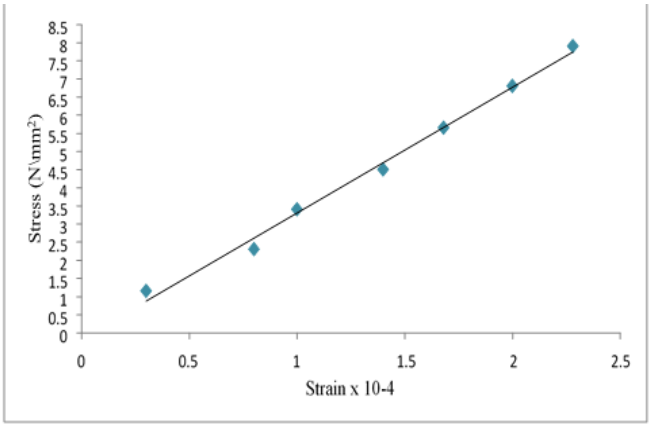

Chart-2: Modulus of elasticity for control mix.

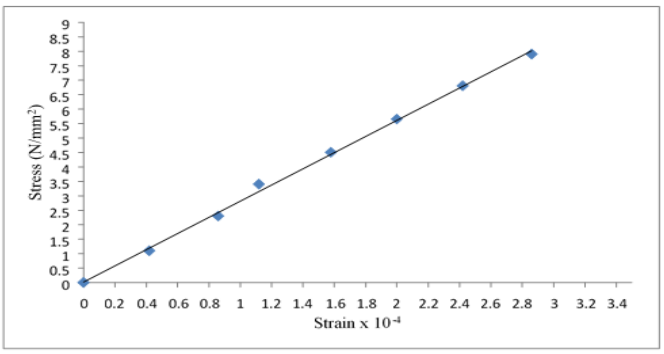

Chart-3: Modulus of elasticity for 10% replacement by quarry dust

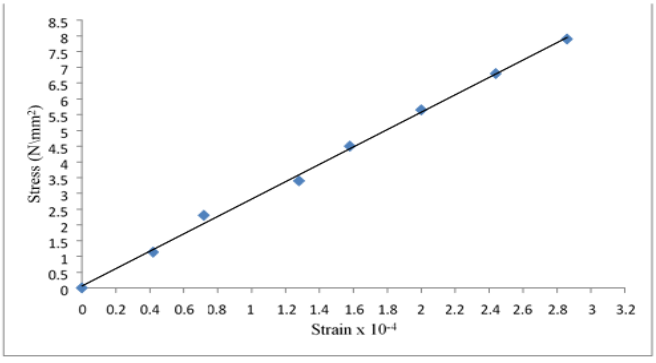

Chart-4: Modulus of elasticity for 20% replacement by quarry dust

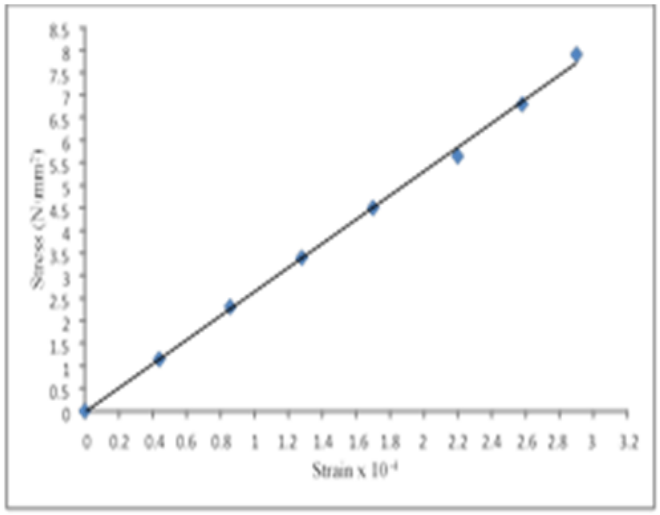

Chart-5: Modulus of elasticity for 30% replacement by quarry dust

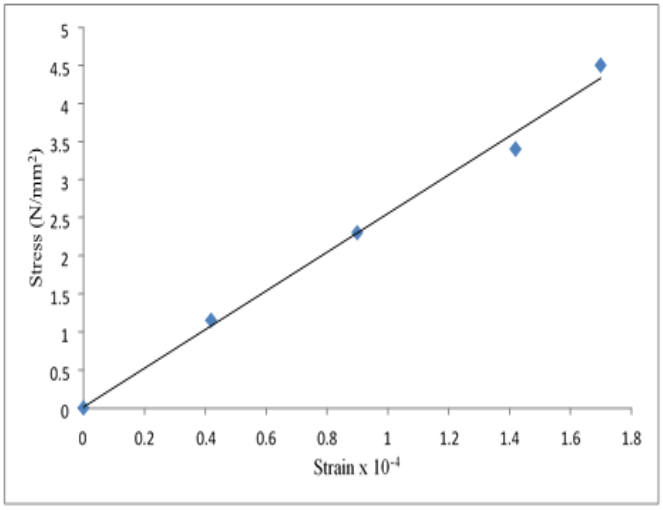

Chart-6: Modulus of elasticity for 40% replacement by quarry dust

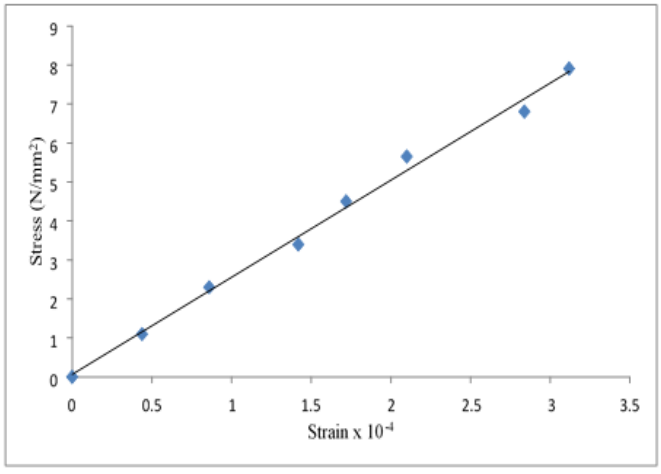

Chart-7: Modulus of elasticity for 50% replacement by quarry dust

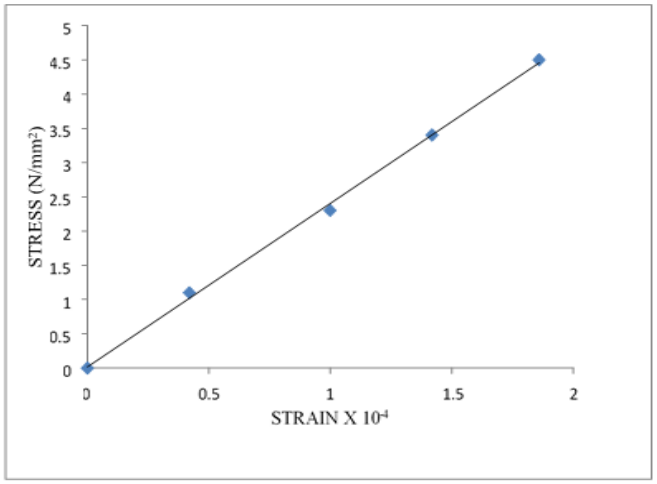

Chart-8: Modulus of elasticity for 100% replacement by quarry dust

5. CONCLUSIONS

Based on the experimental investigation, it is found that quarry dust can be used as an alternative material to the natural river sand. Usage of quarry dust will also reduce the cost of concrete because it is a waste material from quarries. Use of quarry dust in concrete will also reduce the disposal problem. The following conclusions can be made from the experimental investigations.

1. For casting specimens water cement ratio is kept constant as 0.6. The results of particle size analysis shows that silt content in the quarry dust is high. So the water absorption is high when compared to natural sand. This accounts for the increased water cement ratio for M20 grade concrete.
2. Compressive strength of concrete increase up to 20% replacement of quarry dust with natural sand and then decreases. On 10% replacement increase of 7.629% and on 20% replacement increase of 12.4% is observed for 28 days of curing. Further compressive strength values show a decrease with increase in quarry dust amount. Hence 20% of replacement can be suggested as optimum.
3. Modulus of elasticity of concrete decreases with increase in the amount of quarry dust. On 100% replacement by quarry dust a decrease of about 27.63% is observed. Even though value decreases it lies within IS specifications which makes it suitable for construction.
4. Split tensile strength decreases with increase in percentage replacement. But it conforms to the IS specifications. We know that concrete is weak in tension. The addition of quarry dust in concrete again reduces the tensile strength which is not significant as much as tensile strength of concrete is less.

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