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Study on Strength Properties of Concrete by Replacing Fine Aggregate as Quarry Dust

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ABSTRACT- Today, concrete is the building material that is most frequently used. Water, coarse aggregate, fine aggregate limiting material, and cement are its main ingredients. Rapid growth in development activities results in a severe lack of common development materials. Sand has long been used as the fine aggregate in concrete. Since a few years ago, even in locations where nearby river sand is accessible, the cost of sand has increased due to administrative restrictions in India, requiring a comparatively more significant charge that is roughly several times the cost of quarry dust. It is suggested to concentrate on using smasher powder, a quarry waste product, as an alternative resource to replace sand in order to achieve economy. With 15% of the sand replaced with generated sand, the compressive quality of the cement increased significantly. Possible substitution levels are 35% and 45%, respectively. Due to insufficient reviewing and excessive flakiness, quarry dust fine significantly decreased its compressive quality. With the removal of sand, the w/c proportion and droop value increased. The quarry dust mortar's compressive quality also increased since the amount of voids was lower. When solid admixtures are used to replace sand partially, entirely, or both with or without, a similarly respectable quality is typical.

keywords
flakiness, compressive, Concrete, etc.

1. I.INTRODUCTION

It is suggested that research be done into the viability of making concrete without sand while using locally accessible quarry dust. An essential component of R.C.C. work for all sorts of structures is coarse aggregate. This is made by using stone crushers to break chunks of stone measuring 100 to 150 mm. Quarry dust is the term for the sieved aggregate that is employed in building construction projects and has a size smaller than 4.75mm. This dust is piled up next to the stone crushers like a mountain. The amount of waste dust produced is growing every day. It is challenging for the proprietors of the crushers to remove the dust from the crusher machines. The highways department uses quarry dust as a binding agent between the bitumen and coarse aggregate on freshly constructed bituminous roads. When making grout, cement and fine quarry dust powder are combined. Making hollow blocks requires the use of quarry dust. Some mosaic businesses partially substitute quarry dust for sand.

1.1 General Applications

The necessity to find substitute construction materials for sand as fine aggregates in the construction projects has increased due to the reduction in sand supply sources and the desire to lower the cost of construction projects.

Construction projects can benefit from using quarry dust, a by-product of the crushing process used in quarrying activities. Quarry dust is used as a sand alternative to create concrete that is thought to be stronger and more durable than typical concrete ingredients. It can be used as a whole or partial replacement for sand. In comparison to sand, both with and without concrete admixtures, it delivers a comparably good strength.

2. LITERATURE REVIEW

Quarry dust's potential as a sand substitute material demonstrates that its mechanical and elastic properties have both improved.

Quarry dust's potential as a sand substitute material demonstrates that its mechanical and elastic properties have both improved. By replacing fine aggregate with quarry dust in a ratio of 60:40, as done by Hmaid Mir, the compressive strength was maximized.

According to Felekoglu et al., adding quarry waste at the same cement content typically results in a reduction in the need for super plasticizer and an increase in the 28-day compressive strength of SCC. High amounts of quarry waste can be used to successfully construct SCC mixtures of normal strength that contain 300–310 Kg of cement per cubic meter.

According to Sukuma et al., relationships between the increase in compressive strength at early curing ages (12 h to 28 days) for various classes of SCC mixes have been created and are compared with the IS Code formula for straight concrete as per IS: SP 23-1982.

he usage of the granite fines in the manufacturing of SCC was discussed by Ho et al. However, it's crucial to note that because stone fines are a waste product, their characteristics are likely to change with time. Then, following that, durability issues like silica-alkli reactions could be resolved thanks to the fineness of granite particles. If the information is to be used confidently, these two difficulties must be resolved.

According to Muhit et al., retaining from a 100 mm sieve is used to replace sand while going through a 200 mm sieve is utilised to replace cement. Stone dust was used in place of cement in amounts of 3, 5, and 7%. Similar to this, stone dust was used in place of sand at a ratio of 15 to 50 with a 5 percent increase. According to test results, the compressive strength of the mould grows to 21.33% and 22.76% in that order when compared to the standard mortar mould at 7 and 28 days, while the tensile strength climbs to 13.47%.

In comparison to those for regular concrete, Ukpata and Ephraim identified the flexural and tensile strength parameters. So long as the lateritic sand component of the combination is kept below 50%, concrete made of lateritic sand and quarry dust can be used for construction. Increased lateritic content results in greater

flexural and tensile strength.
The physical features of recycled destruction aggregates may adversely affect the qualities of the blocks, claim Soutsos et al. The compressive strength will not be significantly harmed by degrees of replacement of quarried stone aggregates with recycled aggregates, it has been determined.
When using high-quality components, the right amount of superplasticizer, the right mixing techniques, and the right curing procedures, it is possible to use quarry dust as fine aggregate in concrete in the construction sector successfully and prevent environmental damage (Devi and Kannan).
The study by Ilangovana et al. focuses on the physical and chemical characteristics of quarry dust in relation to the codal requirements that are met. When sand is completely replaced with quarry dust, compressive strength tests produce better results.

3. MATERIALS AND METHODOLOGY

3.1 Materials used

3.1.1 Cement

As it is generally known, cement is a complex material created by combining clay and limestone at extremely high temperatures (1400 to 1600 c). Despite the fact that there are various cements for specific applications, this project will only concentrate on Portland cement and its characteristics.

3.1.2 Water

The main component, water, when combined with cement creates a paste that holds the aggregates together. Concrete hardens as a result of hydration, which is a process caused by the water. The primary chemical constituents of cement undergo a chemical reaction known as hydration, which results in the formation of hydrates, also known as hydration products. In order to avoid side reactions that could weaken the concrete or otherwise obstruct the hydration process, the water must be pure. Water plays a significant role in the creation of "ideal" concrete since the water to cement ratio is the most crucial component. Concrete loses strength when it has too much or too little water. Unworkable.
In order to consolidate and shape concrete into various shapes, it must be workable (I.e. walls, domes, etc.). Making concrete requires careful balancing of the cement to water ratio since concrete must be both strong and workable. For mixing concrete, portable water is deemed adequate. The water has to be smell- and color-free. Chlorides and sulphates can cause reinforcing bars to corrode, which is harmful.

3.1.3 Aggregates

The cement holds together the chemically inert solid substances known as aggregates. Aggregates are made of a variety of components, including small sand particles and huge, angular boulders. It is preferable to use as little cement as possible because it is the most expensive component of concrete. Aggregate makes up 70 to 80 percent of the concrete's volume, keeping the price of the material inexpensive. The intended properties of the concrete influence how the aggregate is chosen. The density of concrete, for instance, depends on the density of the aggregate. Using firm aggregates can provide strong concrete with a high resistance to abrasion, but using soft, porous particles can produce weak concrete with low wear resistance.
The ideal aggregates are clear, robust, and hard. In order to prevent dust, silt, clay, organic matter, or other contaminants from preventing the cement paste and aggregate from bonding, the aggregate is typically washed. The materials are then sent through a succession of screens with varying size apertures to divide them into different sizes. concrete can be made to be sturdy and have a high resistance to abrasion by employing hard particles.

3.1.4 Fine Aggregates

This experiment employed locally sourced fine aggregate. Through an IS sieve, the aggregate was screened. Sand or fine aggregate could be crushed or natural. It might be found in a quarry or a riverbank. Sand particles range in size from a maximum of 4.75 mm down to 150 microns, or 0.150 mm. All of the particles in the aforementioned range must be present in good sand, and the sand should be graded. The following Indian standards sieves can be used to separate the sand: 4.75 mm, 2.36 mm, 1.18 mm, 600 microns, 300 microns, and 150 microns. Depending on the distribution of grain sizes, the sand can be categorised as VERY COURSE (ZONE 1), MEDIUM COURSE (ZONE 2), COURSE (ZONE 3), and FINE (ZONE 4).

3.1.5 Coarse Aggregate

Natural or crushed gravel may be used as the coarse aggregate. It should be graded and can range in size from 4.75 mm to a maximum of 20 mm. Dust and other contaminants should be absent, and it should be spotless. It should be kept on a hard surface, away from sand, lime, etc. The aggregate can be washed and allowed to dry for 72 hours if necessary before use. Construction projects should employ moist or wet aggregate. More than 75% of the aggregate is made of concrete mix. So, to save cement, choose clean, graded aggregate that has the right form and size.

3.1.6 Quarry Dust

Quarry dust, a waste product of the crushing process, is a concentrated material that can be used as aggregates for concreting, particularly as fine aggregates. The rock is crushed into different sizes during quarrying activities; the dust produced during the process is referred to as quarry dust and it is created as trash. As a result, it is rendered unusable and contributes to air pollution. Consequently, quarry dust should be employed in construction projects to lower construction costs and conserve building materials. The usage of the natural resources is appropriate. The majority of developing nations are under pressure to partially or completely replace fine aggregate in concrete with an alternative material without sacrificing the quality of the concrete. Quarry dust has been utilised in the construction industry for a variety of purposes, including bricks, tiles, aggregates for roads, and building materials.

3.1.7 Admixture

Conplast SP420 is a chloride free, superplastic sing admixture based on selected sulphonated naphthalene polymers. It is supplied as a brown solution which instantly disperses in water.
Uses

- To considerably reduce the amount of water required in a concrete mix, which results in exceptional acceleration of strength improvement at young ages and considerable gains in strength at all ages.
- Especially appropriate for high early strength needs and precast concrete.
- To considerably increase site-mixed and precast concrete's usability without raising water usage.
- To increase concrete's ultimate strengths and decrease its permeability in order to give enhanced durability.

4. EXPERIMENTAL TEST

Slump Cone Test: The concrete stoop test is an empirical analysis that assesses how well clean concrete can be poured. The hunch cone test illustrates how a compacted concrete cone responds to gravitational force displacement. The test is conducted using a tool called a "hunch cone" mould. The stoop cone is filled with three layers of new concrete, each of which has been tamped 25 times with a standard tamping rod. It is situated on a horizontal, non-absorbent floor. Examine is only suitable for concretes with a medium to high degree of workability.

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The container is filled with three layers of bacterial concrete whose workability is to be examined, and the metallic plate, or Base, is set on a spotless surface. A well-known steel rod with a diameter of 16 mm (five/eight inches) and a rounded end is used to temperature each layer 25 times. The pinnacle floor is struck off (levelled with the moulds pinnacle establishing) using screening and rolling motions of the temping rod once the mould is fully packed with microbiological concrete. The Moulds were firmly clamped to its base throughout the entire process, preventing concrete from spilling through due to the use of handles or foot rests. When the cone is gently and precisely raised vertically after the filling is complete and the concrete has been levelled, an unsupported bacterial concrete will now sag. One measures the droop. Scales are used to compare the height of concrete to that of moulds; the difference is found to be 50mm for bacterial concrete and 110mm for traditional concrete. Figure depicts the results of the stoop cone test overall.

4.1.1 Compaction factor test

Apply grease to the interior surfaces of the hoppers and cylinders while keeping the compaction factor device on level ground. Glue the flap doors shut. Accurately weigh the empty cylinder and record the weight in kilograms (W1 Kg_). By using fly nuts and bolts, secure the cylinder to the base so that the center points of the hoppers and the cylinder are on the same vertical line. With water cement ratios of 0.5, 0.6, 0.7, and 0.8, four mixtures are created. Using a hand scoop, carefully and slowly fill the higher hopper with the freshly mixed concrete without compacting.

Release the trap door after two minutes so that the concrete can fall into the bottom hopper and be compacted as normal. Open the bottom hopper's trap door as soon as the concrete has settled, allowing it to fall into the cylinder and achieve standard compaction. Remove the extra concrete that is above the cylinder's top. Once the cylinder has been thoroughly cleaned, determine the mass of the partially compacted concrete that has been added to it.

Place 50mm layers of the same concrete sample in the cylinder to refill it. Before weighing the concrete, level it and strike it off. The mass should be W3 kg.

4.1.2 Compression Test

Casting of Cube Specimens for Compression Test

On their interior surfaces, the steel moulds were oil-coated before being set on the platform. Weights were used to determine how much cement, steel fibers, sand, and coarse aggregate were needed for 30 cubes. To create a uniform mixture, the components were first properly dry-mixed. After being put into the moulds, the concrete cubes were removed from the moulds after 24 hours and examples were stored for curing.

Testing apparatus: The apparatus may be of any dependable kind, have the necessary capacity for the tests, and be able to apply the load at the prescribed rate.

Age at test: Tests must be performed on test subjects at known ages, with 28 and 56 days being the most common. If examinations at older ages are necessary, the ages of weeks and one year are advised. At the ages of 24 hours+ 1/2 hour and 72 hours+ 1 hours, testing may be conducted if it is required to get the early strengths. However, for this inquiry, ages of 28, and 56 days are taken into account.

Number of specimens: For testing at each chosen age, at least three specimens must be made, preferably from distinct batches. Procedure After being removed from the water and while they are still wet, specimens stored in water must be analyzed right away. The specimens must be cleaned of any surface water and debris, and any protruding fins must be cut off. Dry specimens must be maintained in water for 24 hours before being used for testing. Before testing, the items' weight and measurements, to the nearest 0.2 mm, must be recorded.

Placing the specimens in the testing specimen: Any loose sand or other material removed from the surfaces of the specimen that will be in contact with the compression platens. The bearing surfaces of the testing machine. When using cubes, the specimen must be positioned in the machine so that the load is applied to the opposing sides of the cubes rather than the top and bottom. The load must be applied gradually and steadily at a rate of about 140 kg per square meter per minute until the specimen loses its ability to resist the rising strain and no further load can be supported. Prior testing, noted.

The maximum load applied to the specimen must then be noted, together with the concrete's appearance and any typical characteristics of the type of failure.

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5. EXPERIMENTAL RESULT

5.1 Compressive strength test results

For each concrete mix, the compressive strength is determined on three 150×150×150 mm cubes at 7 and 28 days of curing. Compressive strength of RHA concrete for 7 days.

Table 1: Compressive strength test results

[1] Mix Designation	[2] COMPRESSIVE STRENGTH (N/MM2)			
	[3] 7 Days	[4] 14 Days	[5] 28 Days	[6] 56 Days
[7] M0	[8] 26.15	[9] 27.75	[10] 28.85	[11] 28.95
[12] M1	[13] 27.11	[14] 28.55	[15] 29.65	[16] 29.85
[17] M2	[18] 31.48	[19] 32.88	[20] 33.92	[21] 33.98
[22] M3	[23] 35.70	[24] 36.95	[25] 37.85	[26] 37.95
[27] M4	[28] 27.78	[29] 29.20	[30] 30.10	[31] 30.15

5.2 28th day Compressive strength result

Table gives the 7th and 28th day of compressive strength test results conducted for control mix and replacement of fine aggregate with different percentage of quarry dust The bar chart indicates that the better result obtained with an optimum percentage of 30% and 15% by quarry dust respectively.

5.3 Split Tensile Strength Results

From the above graph indicates the results it was observed that the split tensile strength is obtained for mix 30% quarry dust replacement at the water cement ratio 0.45. The above result clearly indicates that the split tensile strength decreases up to 20% by quarry dust but it increases by replacement of 30% by quarry dust.

Table 2: Split tensile strength test results

[32] Mix Designation	[33] SPLIT TENSILE STRENGTH RESULTS (N/mm2)			
	[34] 7 Days	[35] 14 Days	[36] 28 Days	[37] 56 Days
[38] M0	[39] 3.47	[40] 4.36	[41] 4.58	[42] 4.62
[43] M1	[44] 3.38	[45] 4.24	[46] 4.54	[47] 4.58
[48] M2	[49] 3.10	[50] 3.80	[51] 3.95	[52] 3.98
[53] M3	[54] 3.35	[55] 4.01	[56] 4.10	[57] 4.20
[58] M4	[59] 2.87	[60] 3.72	[61] 3.92	[62] 3.92

5.4 Flexural strength test

Flexural strength testing procedure from IS516-1959
Placing the specimen in testing machine.

Table 3: Flexural strength test results

[63] Mix Designation	[64] FLEXURE STRENGTH (N/MM2)			
	[65] 7 Days	[66] 14 Days	[67] 28 Days	[68] 56 Days
[69] M0	[70] 2.37	[71] 3.26	[72] 3.42	[73] 3.58
[74] M1	[75] 2.27	[76] 3.14	[77] 3.56	[78] 3.56
[79] M2	[80] 2.05	[81] 2.70	[82] 2.58	[83] 2.78
[84] M3	[85] 2.25	[86] 3.05	[87] 3.15	[88] 3.05
[89] M4	[90] 1.17	[91] 2.56	[92] 2.78	[93] 2.25

6. CONCLUSION

- Table gives the 7th and 28th day of compressive strength test results conducted for control mix and replacement of fine aggregate with different percentage of quarry dust The bar chart indicates that the better result obtained with an optimum percentage of 30% and quarry dust respectively
- From the above graph indicates the results it was observed that the split tensile strength is obtained for mix 30% quarry dust replacement at the water cement ratio 0.45. The above result clearly indicates that the split tensile strength decreases up to 20% by quarry dust but it increases by replacement of 30% by quarry dust
- The weight can be reduced up to 20%.

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