Investigating the effect of Replacing Fine aggregate with Quarry Dust for Concrete Strength

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***Abstract*—Globally, infrastructure is being developed with significant help from concrete. Fine aggregate is the key component of concrete. The goal of research is to substitute the fine aggregate (River Sand) with quarry dust given the rising cost of river sand. The replacement of river sand in concrete with quarry dust at intervals of 10%, 20%, 30%, 40%, and 50% for M30 grade concrete cubes of size 150mm x 150mm x 150mm for compressive strength test and for concrete cylinders specimen of size 150mm x 300mm for split tensile strength test at 7, 14 and 28 days are prepared and tested in this investigation. This study shows that quarry dust could partially replace natural sand in concrete.**

***Index Terms*—Fine aggregate, Quarry dust, Compressive strength, split-tensile strength.**

I. INTRODUCTION

Cement, fine aggregate, coarse aggregate, and water are the ingredients of concrete, a widely used building material. The fine aggregate is typically natural sand. Because of the quick expansion of infrastructure projects, there is a significant demand for natural sand. River sand extraction is prohibited by a number of laws. A new substitute for sand in concrete was discovered as a result of the unavailability of river sand and the desire to cut costs. Quarry dust is a very affordable alternative material that can partially replace sand.

In the construction, quarry dust is used for various tasks including road construction and building construction manufacture materials like tiles and bricks etc. Quarry dust is used in place of natural sand gathered from close by quarry.

Easily accessible quarry dust is useful as a partial substitute for a natural river sand, hence lowering the need for natural sand, their extraction and environmental pollution. Therefore, it is essential to look for some substitute for natural sand. The findings of research done on quarry dust and specifications of concrete created using quarry dust are presented in this paper.

SCOPE OF THE PRESENT STUDY

Partial replacement of fine aggregate with quarry dust prepared and modified M30 grade concrete in this work.This project performs and investigates several tests on materials; then, by preparing concrete cubes and cylinders, the strength of concrete was assessed in terms of compressive and split tensile strengths. This work shows that the quarry dust is use as a partial replacement of natural sand.

II. LITERATURE REVIEW

Multiple research investigations on the partial substitution of quarry dust for fine aggregate that are related to my areas of expertise fall under:

- Ilangovan et al. (2008) conducted research and found that the strength of concrete mixed with quarry rock dust is roughly 10% to 12% higher than that of a comparable mix of conventional concrete. When compared to regular concrete, Quarry Rock Dust concrete has a lower permeability, in Relation to conventional concrete, quarry rock dust concrete absorbs water a little more.
- Sivakumar et al. (2010) The purpose of this paper is to investigate whether the 28-day compressive strength of a mortar cube that contains 100% quarry dust in place of sand (CM 1:1) is greater than that of a cement mortar cube that is under control. When 100% of the sand was replaced with 400 kg/m3 of quarry dust at F/C=0.6, the concrete's maximum compressive strength, split tensile strength, and modulus of

elasticity were all greater than those of the reference concrete after 56 days.

- Lohani T.K, Padhi M, Dash K.P., Jena S. (2012) best use of quarry dust in concrete as a partial substitute for sand. The design mix of M20 grade concrete was investigated using 0%, 20%, 30%, 40%, and 50% of quarry dust replacement, arranged as M1, M2, M3, M4, and M5, respectively. Laboratory analysis, including slump test, compaction factor test, compressive strength (cube, cylindrical sample), split tensile strength, flexural strength, modulus of elasticity, and water absorption of hardened concrete, was taken into consideration. Mechanical characteristics of quarry dust-containing concrete. They stated that natural river sand could be effectively substituted with quarry dust, increasing the material's strength.
- Preethi A V, Dr. S Rajendra, Navneeth, Pawan Kumar L P (2017) The goal of this experimental study is to replace the fine aggregates in concrete with quarry dust. One finer material that can be used to lessen the voids in concrete is quarry dust. Results are satisfactory when up to 20% of fine aggregates are replaced with quarry dust; 15% replacement of quarry dust results in high compressive and flexural strength. This leads to the conclusion that building with quarry waste is environmentally friendly since it uses waste and lessens pollution of the air, land, and water. It is economical as well as energy efficient.
- Sravya Nallamothu, P. Mittu Sai Kalyan, G. Vinay, S. K. Sameer Baba, S. Sai Charan (2021) This paper's work focuses on assessing the potential for using waste materials, specifically quarry dust, as a substitute for fine aggregate.Quarry dust was used to partially replace sand in M40 grade concrete at percentages of 0%, 10%, 20%, 30%, and 40%. Concrete's mechanical and fresh properties tests were conducted at 3, 7, and 28 days, respectively. According to this study, adding mineral admixtures to concrete mixes improves their workability when compared to using a conventional mix. When 20% of the fine aggregate in the concrete mix is quarry dust, a notable increase in strength is seen.

III. EXPERIMENTAL STUDY

1. CEMENT

OPC (53 grade) ultra tech brand cement was used for the project. which should be greenish blue in color and free of lumps of sand. In cement concrete, cement serves as a binding agent. It is employed in a variety of engineering projects where durability and strength are crucial (According to IS 12269-1987).

Figure 1: Cement

Table-1: Test Results of Cement

SR.NO	PROPERTIES	RESULT
1	Standard Consistency	32%
2	Initial Setting Time & Final Setting Time	110 minutes & 180 minutes
3	fineness	6%
4	Specific Gravity	3.15

2. COARSE AGGREGATE

In this experiment, 20 mm aggregates are used, and coarse aggregate particle sizes are greater than 4.75 mm. Coarse and fine aggregates make up the majority of the concrete mixture. Aggregates such as natural gravel are used in concrete mixes. crushed stone and sand. Additionally, coarse aggregate was gathered from nearby sources. (According to IS 2386-1963)

Figure 2: Coarse Aggregate

Table-2: Test Results of Coarse Aggregate

SR.NO	PROPERTIES	RESULT
1	Fineness modulus	7.4
2	Specific gravity	2.78
3	Flakiness& Elongation Index	11.75% & 13.80%

3. FINE AGGREGATE

Anything that can pass through a 4.75mm sieve is considered as a fine aggregate. In order to improve workability and save money by using less cement, the fine aggregate brought to be rounded. The fine aggregate serves as a workability agent and fills in the spaces left by the coarse aggregate. In This Experimental Work, We Use fine aggregate as a natural river sand. (According to IS 2386-1963)

Figure 3: Fine aggregate

4. QUARRY DUST

The nearby stone crusher provides the quarry dust needed for the project. Quarry dust, a concentrated material used as aggregates for concreting, particularly as fine aggregates, is a by-product of the crushing process. This quarry dust works well as a partial substitute for natural river sand in the construction sector.

Figure 4: Quarry Dust

Table-3: Test Results of Fine Aggregate & Quarry Dust

SR.NO.	PROPERTIES	NATURAL SAND	QUARRY DUST
1	Fineness Modulus	2.70	1.80
2	Specific Gravity	2.60	2.50
3	Zone	II	II

IV. RESULTS AND DISCUSSIONS

COMPRESSIVE STRENGTH TEST: -

In the mix design, we make M30 grade concrete with cement, sand, coarse aggregate, water, and a small amount of quarry dust to replace the natural sand. Concrete cubes measuring 150 mm x 150mm x 150 mm were cast. Cubes cast in this experimental study had 10%, 20%, 30%, 40%, and 50% quarry dust substituted for natural sand and allow for cured in curing tank and tested after 7,14 and 28 days. IS Code 10262:2009 is used in the design of M30 grade concrete. The concrete cubes compressive strength is determined. Results from the test data were plotted in a graph and displayed in a table.

Figure 5: - sample of cubes

Figure 6: - Cube under compressive testing machine

Table 4: - Compressive Strength of Cubes After 7,14 and 28 Days

Sr.No.	% Replacement	Compressive Strength(N/mm^2) After 7 Days	Compressive Strength(N/mm^2) After 14 Days	Compressive Strength(N/mm^2) After 28 Days
1	10	15.20	27.33	33.12
2	20	21.01	32.77	38.63
3	30	23.99	36.10	46.76
4	40	23.18	32.90	45.89
5	50	17.79	29.48	41.00

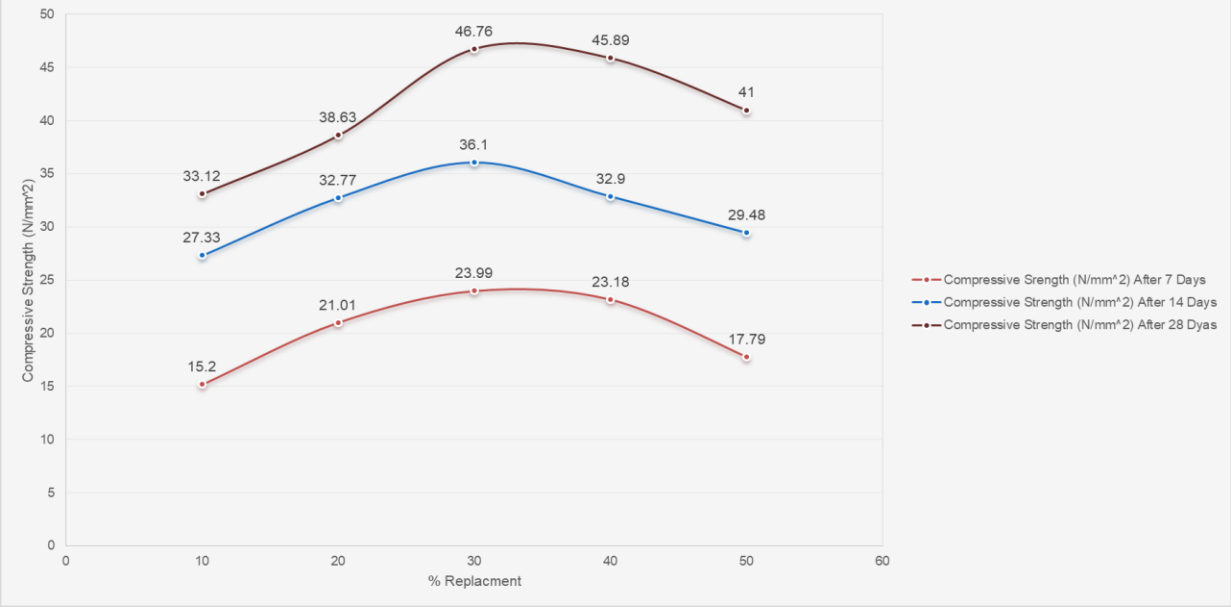

Figure 7: - Graph Of Compressive Strength VS % Replacement Of sand with Quarry Dust

V. SPLIT TENSILE STRENGTH TEST

The split tensile test is also known as a "Brazilian Test."A cylindrical specimen is positioned horizontally Between a compression-testing machine's loading surfaces and the load is applied along the vertical diameter until the cylinder fails. In the mix design, we make M30 grade concrete with cement, sand, coarse aggregate, water, and a small amount of quarry dust to replace the natural sand. Concrete Cylinders measuring Of 150 mm x 300mm were cast. Cylinders cast in this experimental study had 10%, 20%, 30%, 40%, and 50% quarry dust substituted for natural sand and allow for cured in

curing tank and tested after 7,14 and 28 days. IS Code 10262:2009 is used in the design of M30 grade concrete. The concrete Cylinders Split –Tensile Strength are determined. Results from the test data were plotted in a graph and displayed in a table.

Figure 8: - Sample Of Concrete Cubes & Cylinders

Figure 9: - Cylinder under Testing Machine

Table 5:- Split Tensile Strength Of Cylinders After 7,14 and 28 Days

Sr.No.	% Replacement	Split Tensile Strength(N/mm^2) After 7 Days	Split Tensile Strength(N/mm^2) After 14 Days	Split Tensile Strength(N/mm^2) After 28 Days
1	10	2.55	3.70	3.56
2	20	3.11	3.90	4.59
3	30	3.22	4.30	5.37
4	40	3.34	4.0	4.95
5	50	3.89	3.60	3.54

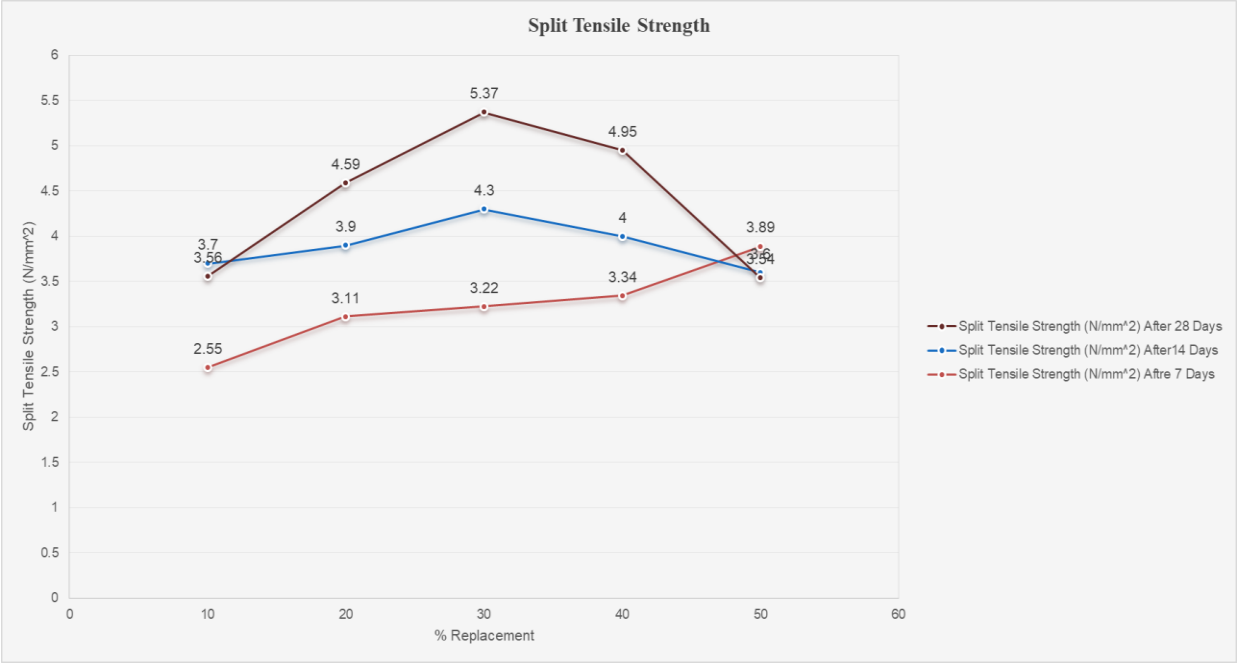

Figure 10 :- Graph Of Split-Tensile Strength VS % Replacement Of sand with Quarry Dust

VI. CONCLUSIONS

The goal of this experimental study is to replace the fine aggregate (natural sand) in concrete with quarry dust. Some of the conclusions derived from this investigation's findings are as follows:

1. Concrete voids can be reduced by using quarry dust, which is a finer material.
2. By substituting quarry dust wastes for traditional materials, it would be possible to solve the waste disposal issue, which has grown to be a significant issue, in addition to protecting the natural resources.
3. From the above results, it should be conclude that 30% replacement of quarry dust gives high compressive and split-tensile strength
4. After 30% replacement of fine aggregate with quarry dust, decreases the value of compressive & Split-tensile strength result.
5. The issue of natural sand scarcity can be resolved by employing quarry dust.
6. Due to quarry dust is a waste product from quarries, using it will also reduce the cost of concrete.

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