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Experimental Analysis of Concrete with Quarry Dust and Demolished Concrete Waste

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ABSTRACT
The use of Recycle product is increasing with innovation in present scenario. The utilization of waste product in the manufacturing of new product is a challenging job. The Natural Resource decreases in a short period and therefore the use of waste product is necessary. In the construction field of the world, use of Demolished Concrete Waste as alternative of coarse aggregate plays a vital role to save natural resources and economically good for us. Natural sand is a prime material used for the preparation of concrete and also plays an important role in Mix Design. One such material is Quarry stone dust: a by-product obtained during quarrying process. Attempts have been made to study the suitability of Quarry Dust as sand replacing material and it has been found that Quarry Dust improves the mechanical properties of concrete as well as elastic modulus. This present work is an attempt to use Quarry Dust as partial replacement for fine aggregate in concrete and Demolished Concrete Waste as partial replacement for coarse aggregate in concrete. The main object of this project is to determine the Compressive strength, Split tensile strength, Flexural strength. Various mixes were prepared for carrying out the research by varying the proportions of cement, sand and aggregates. All mixes were designed for characteristic strength (f_{ck}) of M20. The Compressive strength, Split tensile strength, Flexural strength of concrete was tested in laboratory after 7, 14 and 28 days.
***Keywords*:** Concrete, Natural Sand, Quarry Dust, Natural Coarse Aggregate Demolished Concrete Waste.

I. INTRODUCTION

Concrete is the premier construction material across the world and the most widely used in all types of civil engineering works, including infrastructure, low and high-rise buildings, defense installations, environment protection and local/domestic developments. Concrete is a manufactured product, essentially consisting of cement, aggregates, water and admixture(s).

Among these, aggregates, i.e. inert granular materials such as sand, crushed stone or gravel form the major part. Traditionally aggregates have been readily available at economic price. However, in recent years the wisdom of our continuedwholesale extraction and use of aggregates from natural resources has been questioned at an international level. This is mainly because of the depletion of quality primary aggregates and greater awareness of environmental protection. In light of this, the availability of natural resources to future generations has also been realized. Given this background, the concept of sustainable development put forward almost a decade ago, at the 1992 Earth Summit in Rio de Janeiro, and it has now become a guiding principle for the construction industry worldwide.

Quarry dust, a byproduct from the crushing process of stones (Blue metal) which is available abundantly from rock quarries at low cost in many areas can be an economical alternative to the river sand. Quarry dust can be defined as residue, tailing material after the extraction and processing of rocks to form fine particles less than 4.75mm. Quarry dust, which is generally considered as a waste material, causes an environmental load due to disposal problem. Quarry dust being by and large, a waste product, will also reduce environmental impact, if consumed by construction industry in large quantities. Hence, the use of quarry dust as fine aggregate in concrete will reduce not only the demand for natural sand but also reduces the environmental problems. Moreover, the incorporation of quarry dust will offset the production cost of concrete and hence, the successful utilization of quarry dust as fine aggregate will turn this waste material into valuable resource.

Construction waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, fly over, subway, remodeling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. A part of this waste comes to the municipal stream. These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or communal waste bin/container. It is not uncommon to see huge piles of such waste, which is heavy as well, stacked on roads especially in large projects, resulting in traffic congestion and disruption.

II. EXPERIMENTAL INVESTIGATIONS

2.1 MATERIALS

2.1.1 Cement: In this experimental investigation Ordinary Portland cement of 53 grade is used The properties of Cement are as follows in table 2.1:

TABLE 2.1. PROPERTIES OF CEMENT

S.No	Property	Value
1.	Specific Gravity	3.15
2.	Initial Setting Time	87minutes
3.	Standard Consistency	33%
4.	Fineness	1.75

2.1.2 Fine Aggregate: Natural river sand with fraction passing through 4.75mm sieve and on 150µm sieve was used and tested as per IS: 2386-1983. The important properties tested for the aggregate are given below in the table 2.2

TABLE 2.2 PROPERTIES OF FINE AGGREGATE

S.No	Property	Value
1.	Specific Gravity	2.64
2.	Fineness modulus	2.73
3.	Water absorption	1.24

2.1.3 Coarse Aggregate: crushed granite coarse aggregate of size 15.5mm was used and tested as per IS:2386-1983.The important properties tested for coarse aggregates are given below in the table 2.3

TABLE2.3 Properties Of Coarse Aggregate

S.No	Property	Value
1.	Specific Gravity	2.76
2.	Water absorption	0.54

2.1.4 quarry dust : Quarry dust, a byproduct from the crushing process of stones (Blue metal) which is available abundantly from rock quarries at low cost in many areas can be an economical alternative to the river sand. Quarry dust can be defined as residue, tailing material after the extraction and processing of rocks to form fine particles less than 4.75mm. The properties of silica fume shown in the table 2.4

Figure 2.1 quarry dust

TABLE 2.4. Properties Of Quarry Dust

S.No	Properties and composition	Value
1.	Specific gravity	2.54 -2.60
2.	Bulk density (kg/m3)	1720- 1810
3.	Absorption (%)	1.20- 1.50
4.	Moisture Content (%)	Nil
5.	Fine particles less than 0.075 mm (%)	12-15
6.	Sieve analysis	Zone-II
7.	SiO2	62.48
8.	Al2O3	18.72
9.	Fe2O3	6.54
10.	MgO	2.56
11.	Na2O	Nil
12.	K2O	3.18
13.	TiO2	1.21
14.	Loss of ignition	0.48

2.1.5 Demolished Concrete Waste

When structures made of concrete are demolished or renovated, **concrete recycling** is an increasingly common method of utilizing the rubble. Concrete was once routinely trucked to landfills for disposal, but recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws, and the desire to keep construction costs down. The properties of rice husk ash is shown in the table 2.5

Figure 2.2 demolished concrete waste.

TABLE 2.4. PROPERTIES OF Demolishe Concrete Waste

S.No	Properties and composition	Value
1.	Specific Gravity	2.72
2.	Bulk Density(kg/m3)	1741
3.	Water absorption	1.73
4.	Aggregate Impact Value (%)	8.55

III. MIX PROPORTIONS

Mix design is carried out as per EFNARC Specifications which satisfied the workability test methods on concrete. The MIX PROPORTIONS of SCC as shown in the table 2.5.

TABLE 2.5. MIX PROPORTIONS

Cement	394 kg/m^3
Fine aggregate	644.37 kg/m^3
Coarse aggregate	1197.61 kg/m^3
water	197 kg/m^3

IV. WORKABILITY TEST METHODS

4.1.1 Slump Flow Test: The slump flow is used to assess the horizontal free flow of Self Compacting Concrete in the absence of obstruction. This method is based on the test method for determining the slump.

V. SPECIMEN PREPARATION

Concrete cubes specimens (150 mm x 150 mm x150mm) for 45cubes were casted for computing compressive strength. The cylindrical specimens (diameter- 150 mm and length- 300 mm) for 30cylinders were casted to determine spilt tensile strength of concrete. The prism specimens (150 mm x 150 mm x150mm) for 30prisms were casted for computing flexural strength. All the specimens were cured for a period of 28 days before test.

VI. RESULTS AND DISCUSSIONS

After a detailed study we have obtained the following results for compression, split tensile strength and flexural strength.

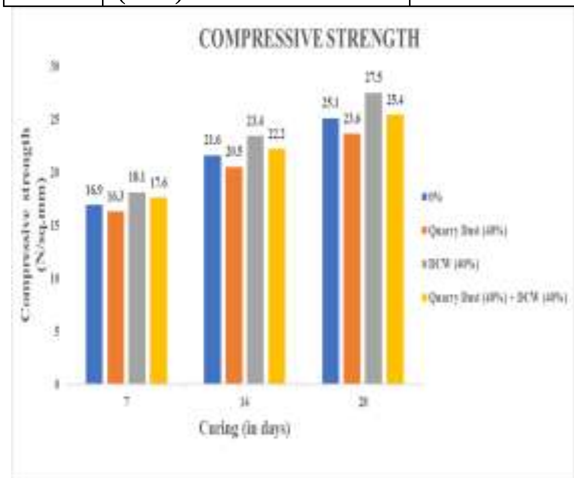
6.1COMPRESSIVE STRENGTH

The specimen is tested by compression test machine after 7 days, 14 days and 28 days curing. Load should be applied gradually at the rate of 140kg/cm^2 per minute till specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Figure 6.2 compressive strength for various proport

TABLE 6.1 RESULTS FOR COMPRESSIVE STRENGTH

Sl.No.	Replacement details	Compressive strength N/mm^2
1.	Nominal Mix	**16.9**
2.	Nominal Mix River sand (60%) + Quarry Dust (40%)	**16.3**
3.	C.A (60%) + DCW 40%)	**18.6**
4.	River sand (60%) + Quarry Dust (40%) & C.A (60%) + DCW (40%)	**17.1**



6.2 SPLIT TENSILE STRENGTH

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tensile due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may cracks.

Figure 6.3 split tensile testing machine

TABLE 6.2 RESULTS FOR SPLIT TENSILE STRENGTH

Replacement Details	**14 days (N/mm^2)**	**28 days (N/mm^2)**
Nominal Mix	**2.27**	**2.57**
\River sand (60%) + Quarry Dust (40%)	**1.94**	**2.12**
C.A (60%) +DCW (40%)	**2.63**	**2.89**
River sand (60%) + Quarry dust (40%) & C.A (60%) + DCW (40%)	**2.40**	**2.65**

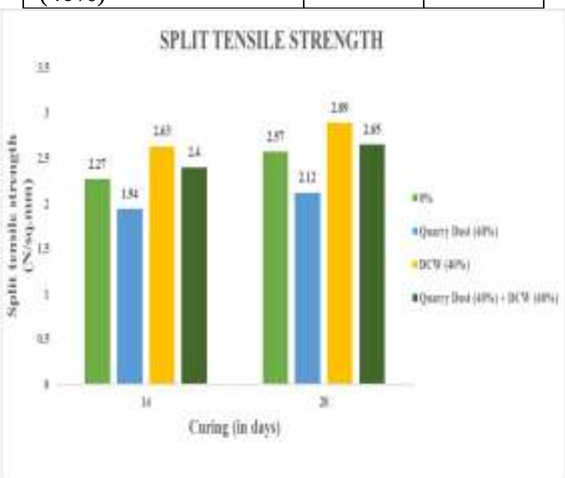


Figure 6.4 split tensile strength for various proportions of SF and RHA

6.1 FLEXURAL STRENGTH

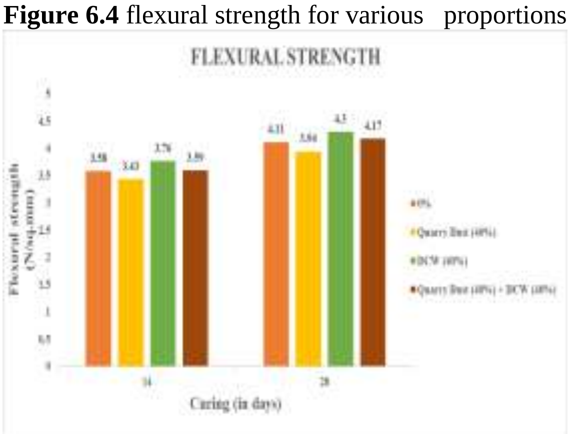
"Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm x 100mm x 500mm concrete beam".

Figure 6.4 flexural testing machine

TABLE 6.3 TEST RESULTS FOR FLEXURAL STRENGTH

Replacement Details	**14 days (N/mm^2)**	**28 days (N/mm^2)**
Nominal Mix	**3.58**	**4.11**
River sand (60%) + Quarry Dust (40%)	**3.43**	**3.94**
C.A (60%) +DCW (40%)	**3.76**	**4.30**
River sand (60%) + Quarry Dust (40%) & C.A (60%) + DCW (40%)	**3.59**	**4.17**

Figure 6.4 flexural strength for various proportions



VII. CONCLUSIONS

COMPRESSIVE STRENGTH

- For River sand (60%) + Quarry dust (40%), the compressive strength has decreased to about

23.6 N/mm^2 from 25.1 N/mm^2 when compared to conventional concrete.

- For C.A (60%) +Demolished concrete waste (40%), the compressive strength has increased to about 27.5 N/mm^2 from 25.1 N/mm^2 when compared to conventional concrete.
- For River sand (60%) + Quarry dust (40%) & C.A (60%) + Demolished concrete waste (40%), the compressive strength has increased to about 25.4 N/mm^2 from 25.1 N/mm^2 when compared to conventional concrete.

SPLIT TENSILE STRENGTH

- For River sand (60%) + Quarry dust (40%), the split tensile strength has decreased to about 2.12 N/mm^2 from 2.57 N/mm^2 when compared to conventional concrete.
- For C.A (60%) +Demolished concrete waste (40%), the split tensile strength has increased to about 2.89 N/mm^2 from 2.57 N/mm^2 when compared to conventional concrete.
- For River sand (60%) + Quarry dust (40%) & C.A (60%) + Demolished waste (40%), the split tensile strength has increased to about 2.65 N/mm^2 from 2.57 N/mm^2 when compared to conventional concrete.

FLEXURAL STRENGTH

- For River sand (60%) + Quarry dust (40%), the flexural strength has decreased to about 3.94 N/mm^2 from 4.11 N/mm^2 when compared to conventional concrete.
- For C.A (60%) +Demolished concrete waste (40%), the flexural strength has increased to about 4.30 N/mm^2 from 4.11N/mm^2 when compared to conventional concrete.
- For River sand (60%) + Quarry dust (40%) & C.A (60%) + Demolished concrete waste (40%), the flexural strength has increased to about 4.17 N/mm^2 from 4.11 N/mm^2 when compared to conventional concrete.

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