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An Investigation on Strength and Durability Properties of Concrete of Cement Partially Replaced With Granite Slurry

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ABSTRACT

Granite quarry slurry is the waste from rock preparing in quarries and crusher units. The fines are at introduced arranged by filling in infertile land causing genuine natural issues. On the off chance that this material is conceivable to be utilized for partial concrete replacement it is of benefit both economically and naturally. The impact on strength properties of concrete in replacing some bit of cement by quarry dust acquired from a nearby crusher unit is investigated. The examination work did incorporated a test examination on strength properties of concrete made with 5% to 20% substitution of concrete by quarry dust of under 75 micron molecule estimate. The tests were done to locate the compressive strength and flexural strength. Results demonstrated that up to 10 % substitution of concrete by quarry dust there was no decrease in compressive strength, flexural strength, Split tensile strength. The durability properties are sorptivity and RCPT values are shown moderate values.

INTRODUCTION:

Rapid industrial development causes serious problems all over the world. Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization, in the construction of buildings and other structures.

Concrete plays the key role and a large quantum of concrete is being utilized in every construction practices [1]. River sand, which is one of the constituents used in the production of conventional concrete, has become very expensive and also becoming scarce due to depletion of river bed. In the present study, the hardened and durable properties of concrete using granite slurry were investigated. Also, the use of granite slurry as replacement of cement decreases the cost of concrete production [2]. This paper reports the experimental study which investigated the influence of 100% replacement of cement with granite slurry. Design mix of M25 grade concrete with replacement of 0%, 25%, 50%, 75%, and 100% of quarry dust organized as M1, M2, M3, M4 and M5 respectively have been considered for laboratory analysis viz. slump test, compaction factor test, compressive strength ,split tensile strength and flexural strength of hardened concrete. In the present paper, the hardened properties of concrete using quarry dust were investigated and durable properties sorptivity, water absorption, were determined

In the construction industry river sand is used as an important building material and the world consumption of sand in concrete generation alone is around 1000 million tons per year making it scarce and limited [3]. The excessive and non scientific methods of mining sand from the river beds has led to lowering of water table and sinking of bridge piers.

GRANITE CUTTING SLLURY:

Granite cutting slurry can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of granite rocks to form fine particles

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less than 4.75mm. Granite cutting slurry, is a by-product from the crushing process during quarrying activities is one of materials that have recently gained attention to be used as concreting aggregates, especially as fine aggregates. Granite cutting slurry basically has the same physical characteristics to sand as the size and its properties are approximately very close to sand. Physically, granite cutting slurry has smooth, long, angles, sharp at corner and grey in color. The surface of granite cutting slurry is smoother than sand. Theoretically, the rough surface will lead to high bind compared to smooth surface. The fineness of granite cutting slurry is defined as particles that retained using 4.75mm, 2.36mm, 1.18 mm, 0.6mm, 0.3mm and 0.15mm sieves.

- Granite cutting slurry can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of granite rocks to form fine particles less than 4.75mm.
- Granite cutting slurry, a by-product from the crushing process during quarrying activities is one of materials that have recently gained attention to be used as concreting aggregates, especially as fine aggregates.

Advantages of Granite Cutting Slurry:

- Granite cutting slurry can reduce cost of construction.
- it was proved that using granite cutting slurry is cheaper than sand.
- Granite cutting slurry is known to increase the strength of concrete over concrete made with equal quantities of river sand.
- Granite cutting slurry has partially rough, sharp and angular particles, and as such causes a gain in strength due to better interlocking.

Disadvantages of Granite Cutting Slurry:

- Granite cutting slurry causes reduction in the workability of concrete.
- It causes increase the bleeding effect due to excess maintain workability.

MATERIALS

In this present investigation the following materials were used.

- Puzzlona Portland cement (43 grade).
- Fine Aggregate (sand).
- Coarse Aggregate (20mm gravel).
- Granite cutting slurry
- Water.

CEMENT:

Cement is a fine, grey, and dry powder. It is mixed with water and aggregate materials such as sand, gravel, and crushed stone to make concrete. The cement and water form a paste that binds the other materials together as the concrete hardens. The ordinary portland cement [4] contains two basic ingredients namely argillaceous and calcareous. In argillaceous materials clay predominates and in calcareous materials calcium carbonate predominates.

Ordinary Portland [5] cement was used for casting cubes and cylinders for all concrete mixes. The cement was of uniform colour i.e. grey with a light greenish shade and it was free from any moisture and hard lumps.

Cement is a well-known building material and it has occupied an indispensable place in construction works. There is a variety of cements available in the market and each type is used under certain conditions due to its special properties. The cement commonly used is Ordinary Portland Cement, and the fine and coarse aggregates used are those that are usually obtainable, from nearby sand, gravel or rock deposits. In order to obtain a strong, durable and economical concrete mix, it is necessary to understand the characteristics and behavior of the ingredients [6]. Although all materials that go into a concrete mixture are essential, cement is the most important constituent in concrete because it is usually the delicate link in the chain. The function of cement is first to bind the sand and coarse aggregates together, and second, to fill the voids in between sand and coarse aggregate particles to form a compact mass. Although cement constitutes only about 10 per cent of the volume of the concrete mix, it is the active portion of the binding medium and the only scientifically controlled in gradient of concrete.

FINE AGGREGATE:

The sand used for the experimental programmed was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. The aggregates were sieved through a set of sieves of 4.75,2.36,1.18, 600µ, 300µ, 150µ,75µ, and pan to obtain sieve analysis [7].

COARSE AGGREGATE:

The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate [8]. Locally available coarse aggregate having the maximum size of 20 mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested per Indian Standard Specifications IS: 383-1970. The aggregates were sieved through a set of sieves of 80mm, 40mm, 20mm, 12.5mm, 10mm, 4.75mm and pan to obtain sieve analysis.

GRANITE CUTTING SLURRY:

The granite cutting slurry is the by product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes [9]. The physical and chemical properties of granite cutting slurry obtained by testing the sample as per the Indian Standards are listed in the table

Table3.1.3 PHYSICAL PROPERTIES OF GRANITE CUTTING SLURRY

Property	Granite cutting slurry	Test method
Specific gravity	2.54 – 2.6	IS 2386 (part-III) – 1963
Bulk density(kg/m3)	1720 – 1810	IS 2386 (part-III) – 1963
Absorption	1.2 – 1.5	IS 2386 (part-III) – 1963
Moisture content (%)	--------	IS 2386 (part-III) – 1963
Fine particles less than 0.075 mm (%)	12 – 15	IS 2386 (part-III) – 1963
Sieve analysis	Zone – II	IS 383 -1970

TEST METHODS

TESTS ON MECHANICAL PROPERTIES OF CONCRETE

This section describes the procedure to determine the mechanical properties of concrete and these include compressive strength, splitting tensile strength (STS) [10].

COMPRESSIVE STERNGTH TEST

Compressive strength test was conduct on the cubical specimens for all the mixes at dissimilar curing periods of 7, 28 and 56 and 90days as per IS 516 (1991). Three cubical specimens of size 150 mm x 150 mm were cast and tested for every age and every mix. The compressive strength (f'c) of the specimen was calculated by dividing the maximum load applied to the specimen by the cross-sectional area of the specimen.

Fig.3.1 COMPRESSION TESTING MACHINE

SPLITTING TENSILE TEST

Splitting tensile strength (STS) test was conduct on the specimens for all the mixes at dissimilar curing periods of 28 and 56 and 90days as per IS 5816 (1999). Three cylindrical specimens of size 150 mm x 300 mm were cast and tested for every age and every mix. The load was applied slowly till the breakdown of the specimen occurs [11]. The maximum load applied was then noted. Length and cross-section of the specimen was measured. The splitting tensile strength (f_{ct}) was calculated as follows:

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$$f_{ct} = 2P / (\Pi\, l\, d)$$

Where, f_{ct} = Splitting tensile strength of concrete (N/mm^2)

P = Maximum load applied to the specimen (in Newton)

l = Length of the specimen (in mm)

d = cross-sectional diameter of the specimen (in mm)

Fig.3.2 SPILITTING TENSILE TEST

FLEXURAL STRENGTH TEST

Flexural tests were conducted on concrete beams of size 100 x 100 x 500 mm casted for concrete of each series.

These tests were conducted on 100 kN MTS make Close Loop Actuator System. Figure 3.8 shows controller and pc automation and Figure 3.9 shows hydraulic power unit. The supports and other parts of the supporting and loading unit were cleaned and the test specimen was placed on the supports such that the load was applied to the faces other than the cast faces of the specimen. The third-point loading method was used to carry out the test [12]. The effective span of 450 mm is maintained between the supports. The complete load-deflection curve was recorded for each specimen using the data acquisition system of the machine. Two specimens were tested for each RHA percentage mix for each volume fraction of fibres. Figure 3.7 show flexural strength test

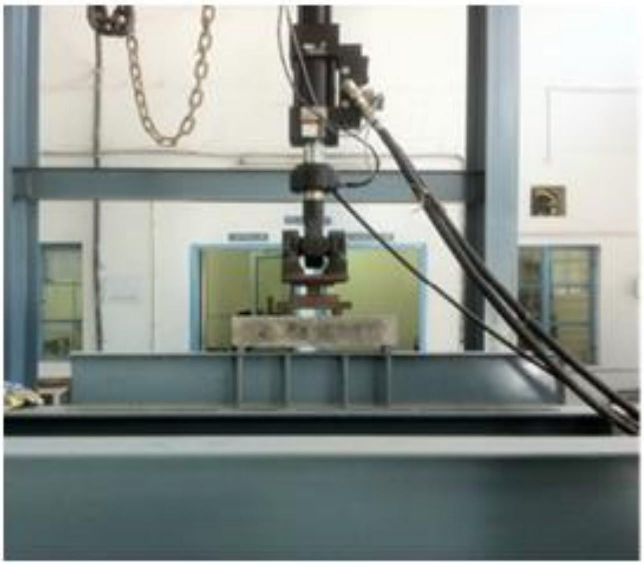

Fig.3.2 FLEXURAL TEST

RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH TEST RESULTS

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section.

The compressive strength test was conducted at curing ages of 28, 56 and 90 days. The compressive strength test results of all the mixes at different curing ages are shown in Table.Variation of compressive strength [13] of all the mixes cured at 28,56 and 90 days is also shown in Fig.- shows the variation of compressive strength of concrete mixes w.r.t control mix (100%OPC),28,56 and 90 days respectively.

Table 4.1 Compressive strength of mortar at 28 days

Sl. No.	1	2	3	4	5
GCS%	0	5	10	15	20
Avg. Compressive strength at 28	33.92	33.36	32.72	29.16	26.7

It is clear from table that Compressive strength of mortar decreases with increase in percentage of GCS.

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Result on concrete

Table 4.2 Characteristic strength of concrete at 56 days

Sl. No.	1	2	3	4	5
GCS %	0	5	10	15	20
Avg. Compressive strength at 56 days in N/mm^2	35.76	34.56	34.10	30.79	27.55

The compressive strength result at 56 days is shows about the increase the values of the strength when compared with the 28 days strength result the increase in strength at 0% is about 10 % of its strength and as at replacement of 5% the strength of cement is increase about 12% and at the replacement value 10% there is increase in the strength of 11% and at the replacement level of 15% there is increase in strength of 9% only and final replacement of the concrete by granite slurry is the values are decreased.

Table 4.3 Characteristic strength of concrete at w/c 0.44 after 90 days

Sl. No.	1	2	3	4	5
GCS %	0	5	10	15	20
Avg. Compressive strength at 90 days in N/mm^2	36.60	35.96	34.84	31.93	26.98

The compressive strength result at 90 days is shows about the increase the values of the strength when compared with the 56 days strength result the decrease in strength at 0% is about 8 % of its strength and as at replacement of 5% the strength of cement is decrease about 11% and at the replacement value 10% there is decrease in the strength of 9% and at the replacement level of 15% there is increase in strength of 11% only and final replacement of the concrete by granite slurry is the values are decreased.

Table 4.4Compressive strength of concrete in N/mm2at different curing periods

GCS	Compressive strength		
	28days	56days	90days
0	33.92	35.76	36.60
5	33.36	34.56	35.96
10	32.72	34.10	34.84
15	29.16	30.69	31.93
20	26.7	27.55	26.98

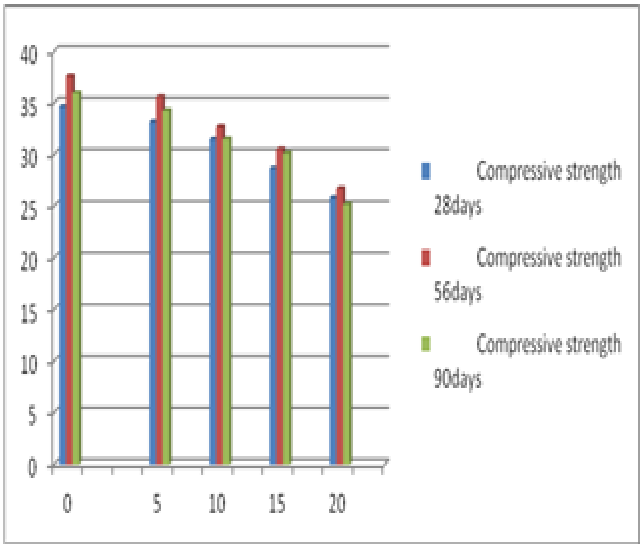

Fig.4.1Compressive strength of concrete in N/mm2at different curing periods

SPLITTING TENSILE STRENGTH TEST RESULTS

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 28, 56 and 90 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table-4.2.Variation of splitting tensile strength of all the mixes cured at 28,56 and 90 days. Figure shows the variation of splitting tensile strength of concrete mixes w.r.t control mix (100%OPC) after 28,56 and 90 days respectively.

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Table 4.11 Split tensile strength of concrete at w/c 0.44

SBA	Split tensile strength		
	28days	56days	90days
0	3.36	3.59	3.61
5	3.04	3.12	3.27
10	2.96	3.10	3.14
15	2.54	2.71	2.79
20	2.21	2.35	2.37

The average split tensile strength of concrete is decreases with increase in percentage of sugar cane bagasse ash. At the replacement level of 5% the value of split tensile strength decrease by 4% and at the replacement level 10% the value reduced to 11% and the replacement level the value of strength at 15% decreases to a13% when compared with nominal concrete mix . The average split tensile strength of concrete is decreases with increase in percentage of granite slurry. At the replacement level of 5% the value of split tensile strength decrease by 4% and at the replacement level 10% the value reduced to 10% and the replacement level the value of strength at 15% decreases to a12% when compared with nominal concrete mix.

The average split tensile strength of concrete is decreases with increase in percentage of granite slurry. At the replacement level of 5% the value of split tensile strength decrease by 5% and at the replacement level 10% the value reduced to 11% and the replacement level the value of strength at 15% decreases to a12% when compared with nominal concrete mix.

FLEXURAL STRENGTH RESULT

Table4.16 Flexurl strength at different curing periods with w/c ratio is 0.44

SBA	flexural strength		
	28days	56days	90days
0	7.15	7.45	7.52
5	7.01	7.17	7.20
10	6.57	6.71	6.75
15	6.35	6.42	6.55
20	6.14	6.21	6.23

The average flexural strength of concrete is decreases with increase in percentage of granite slurry. At the replacement level of 5% the value of split tensile strength decrease by 4% and at the replacement level 10% the value reduced to 11% and the replacement level the value of strength at 15% decreases to a13% when compared with nominal concrete mix . The average flexural strength of concrete is decreases with increase in percentage of granite slurry. At the replacement level of 5% the value of split tensile strength decrease by 4% and at the replacement level 10% the value reduced to 10% and the replacement level the value of strength at 15% decreases to a12% when compared with nominal concrete mix. The average flexural strength of concrete is decreases with increase in percentage of granite slurry. At the replacement level of 5% the value of split tensile strength decrease by 4% and at the replacement level 10% the value reduced to 10% and the replacement level the value of strength at 15% decreases to a12% when compared with nominal concrete mix.

CONCLUSIONS

The use of Granite cutting slurry as replacement of cement at different water cement ratio was studied and after research work is done, the following conclusions were done.

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1. From the results of the compressive strength the 5 % replacement level gives the more approximate values for the concrete with w/c ratio 0.44 and 0.45 when compared with the nominal (0%) mix concrete. from this we can conclude that the replacement level is safe.
2. The compressive strength of mortar prepared with Granite cutting slurry as partial replacement of cement decreases with increase in percentage of Granite cutting slurry .
3. The results of concrete work revealed that, the compressive strength, split tensile strength, flexural strength and density of concrete containing Granite cutting slurry have shown reduction. As the water cement ratio increases, they decreases slightly.
4. Since Granite cutting slurry is a by-product material, its use as a cement replacing material reduces the levels of CO2 emission by the cement industry and also saves a great deal of virgin materials. In addition its use resolves the disposal problems associated with it in the sugar industries.
5. Concrete with partial replacement of cement by Granite cutting slurry were economical and have slightly less density thus can be used at the place at which strength is of less importance and economy and low density concrete density is required.
6. Water absorption values are low at 5 % replacement and more at 20% replacement .
7. RCPT values are shown as the moderate at every replacement values.

SCOPE FOR FUTURE RESEARCH

Based on the present trend of using different percentage of binders in concrete, the possibility of research in the following areas can be explored.
1. Durability properties such as sulphate resistance, chloride penetration, carbonation and permeability can be studied.
2. Microstructure properties of concrete containing RHA in different proportion as partial replacement of cement with different types of fibres can be studied.
3. Non-destructive tests like Drying shrinkage and UPV, And Destructive tests can be studied

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