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EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH SABBATH (CUDDAPAH STONE) STONE

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Abstract: River sand is most commonly used fine aggregate in concrete but due to acute shortage in many areas, availability cost and environmental impact on the major concern. In developing countries like India Sabbath stone has been rampantly used in different construction purpose. The replacement technology has emerged as an innovative development of civil engineering material design mix of M30 grade of concrete with replacement of 0%,10%,20% and 30% of Sabbath stone. For laboratory analysis of Slump test, Compressive strength test, Flexural strength and Water absorption of hardened concrete.

A comparison was made between specimen of partially replaced fine aggregate and the same set of specimen admixed with Silica fume. The results indicated that the replacement of fine aggregate by 20% had attained a good strength in the two mentioned above.

Keywords: Sabbath stone, Silica fume, slump test, Compressive strength, Flexural strength.

1. INTRODUCTION

Concrete is a mixture of cement, aggregate and water. The most commonly used fine aggregate is sand derived from river banks. The high consumption of raw materials by the construction sector, results in chronic shortage of building materials and the associated environmental damage. In the last decade, construction industry has been conducted various researches on the utilization of waste products in concrete in order to reduce the utilization of natural resources. In this content, fine aggregate has been replaced by Sabbath(a variety of cuddapah) stone. Crushed Sabbath stone aggregate are more suitable for production of high strength concrete compared to natural gravel and sand.

It should be passed through I. S. Sieve 2.36 mm. It should have the fineness modulus 2.50 to 3.50 and silt contents should not be more than 4%. And the admixture of silica fume is a byproduct of producing silica metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolanic. Concrete containing silica fume can have very high strength and can be very durable.

It is the reliable replacement for river sand in Sabbath stone, Impact environment impact and also its availability of sand properties. By using Sabbath stone and mixing with different type's ratio and percentage of Sabbath stone, the comparison of it results and analysis can be made whether it is suitable for construction material. It is great practice significance to developing new product for civil engineering works.

River sand is one of the principal components of concrete. The cost of river sand is increasing due to the high demand on the construction industry. The selection of ratio must be alone properly by considering the result of the quality of concrete. The source of material added and proportion of the material according to IS 10262-1984

The primary objective of this investigation is to make use of waste Sabbath stone as fine aggregate in concrete. Compression test were performed on waste Sabbath stone concretes by replacing 10%, 20%, & 30% of fine aggregate of waste Sabbath stone and test results were compared.

In project work ratio concrete is 1:1.67:2.60 both conventional and replaced concrete of 3 different proportions considered. The testing of this study is based on the sources of material added and proportion of the material according to Indian standard 10262-1984. Test method for compressive strength of brick is based on IS 516.

2. LITERATURE REVIEW

The literature review presents the current state of knowledge and examples of successful uses of alternative materials in concrete technology, particularly in use of Sabbath stone as a replacement of fine aggregate.

1.“ EXPERMENTAL INVESTICATION OF CONCRETE WITH PARTIAL REPLACEMET OF COARSE AGGREGATE ” The maximum compressive strength of concrete with and without chemical admixture can be achieved by 30% replacement of Sabbath stone was found to be 56% and 26% higher than the conventional concrete. compare to the conventional concrete the tensile strength of 30% replacement of coarse aggregate concrete was gradually increased up to 21.70% and 28.30% with and without chemical admixture respectively. similarly the flexural strength of concrete was gradually increased up to 11.76% and 15.29% with partial replacement of 30% coarse aggregate, with and without chemical admixture respectively. from the above 3 cases the strength had decreased when the 40% of coarse aggregate was replaced. hence replacement of coarse aggregate with 30% Sabbath stone was achieved good strength.

2.**PROF.CHANDRASUKESH,KATAKAMBALA, S.KANAKAMBARA “ PARTIAL REPLACEMENT OF SAND WITH QUARRY DUST IN CONCRETE”** The cement can be replaced with quarry dust up to 25% without much loss in compressive strength, water to powder ratios of 0.5,0.4,0.35 for M20,M30,M40 were maintained for all the percentage replacements for workability. from the result a marginal decrease in compressive strength is observed up to 25% cement replaced with quarry dust. considered decrease in compressive strength was observed from 25%cement replaced with quarry dust. from 20% to 25% cement replaced with quarry dust 7days compressive strength is slightly increased .

3. EXPERIMENTAL INVESTIGATION

3.1.1 Cement

The word “cement” was introduced by the Romans defined by the term “opuscaementicium”. The cement used for this experimental investigation is used cement (OPC-43 grade). And it is confirmed to the quality provisions of Indian Standard specification. The specific gravity of cement is 3.11. It is found out by using Le-Chatelier’s flask.

3.1.2 Accelerating admixtures

silica fume:

- Concrete mixes containing calcium chloride will always have a faster cure rate than plain concrete. Calcium chloride can accelerate cement hydration reducing its setting time. That means high initial strength, Reduced final setting time and Bleeding ,Improved workability, Greater cost effectiveness, Fast form work turnaround.

3.1.3 Coarse Aggregate

Graded coarse aggregate of size 20mm was used. Test result of coarse aggregate determined as per Indian standards (BIS).

3.1.4 Fine aggregate

Locally available sand is used for the project work .sand is generally considered to have a lower size limit of about 0,007 mm or little less. The process of dividing a sample of aggregate into fraction of same particle size is knows as sieve analysis and its purpose is to determine the grading or size distribution .The sand used having the following properties The specific gravity of sand is2.24.The size distribution of sand used corresponds to zone 2

3.1.5 Alternative material for fine aggregate is Sabbath stone

Sabbath stone as replacement of coarse aggregate have been used in the past. Out of these Sabbath concrete is successful, although its exposure is detrimental to the health of human beings. Sabbath stones improve ductility, flexural strength and toughness. lack of availability and increased density are the drawbacks of Sabbath stones.

Fig.1. Sabbath stone

Table 3.1 Details of Fine Aggregate

S. No	Sieve Size	Percentage retained
1	4.75mm	99.96%
2	2.36mm	99.84%
3	1.18 mm	89.36%
4	600μ_m	55.00%
5	300 μ_m	13.00%
6	150 μ_m	4.44%
7	75 μ_m	0.68%

Table 3.2 Experimental Results (Consolidated Results)

S.NO	MATERIALS	PROPERTIES	RESULTS
1	Cement	Specific gravity Fineness Consistency Initial setting time	3.11 3% 32.5% 42min
2	Fine aggregate	Specific gravity Water absorption	2.60 3.1 %
3	Coarse aggregate	Specific gravity Water Absorption	2.59 0.50 %
4	Sabbath stone	Specific gravity Fineness	2.84 1 %

3.2 Methodology

3.2.1 Methods

1. Grade of concrete - M_{30}
2. Mix proportion - 1:1.67:2.60
3. Mode of mixing - machine mixing
4. Type of cement - ordinary Portland cement

3.2.3 CASTING SIZES

Cube :150 x150 x 150 mm

Prism :100 x150x500 mm

Cylinder :150mm diameter and height

3.2.3 Concrete mix design

The details of M30 concrete mix design details as per IS 10262 are given in the table given below.

Table 3.3Details of M_{30} Concrete mix design

M-30 CONCRETE MIX DESIGN		
As per IS 10262-2009		
Stipulations for Proportioning		
1	**Grade Designation**	**M30**
2	Type of Cement	OPC 43 grade confirming to IS-8112
3	maximum nominal size	20 mm
4	Minimum Cement Content	320 kg/m^3
5	Maximum Water Cement Ratio	0. 45
6	Workability	25 mm (Slump)
7	Exposure Condition	Severe
8	Degree of Supervision	Good
9	Type of Aggregate	Crushed Angular Aggregate
10	Maximum Cement Content	450 kg/m^3
11	Chemical Admixture Type	Nil
Target Strength for Mix Proportioning		
1	Target Mean Strength	38.2N/mm^2
2	Characteristic Strength @ 28 days	

Table 3.4 Selection of Water Cement Ratio

selection of Water Cement Ratio		
1	Maximum Water Cement Ratio	0.45
2	Adopted Water cement Ratio	0.45
Selection of Water Content		
1	Maximum Water content(10262-table-2)	186 Lit.
Calculation of Cement Content		
1	Water Cement Ratio	0.45
2	Cement Content (186/0.50)	413 kg/m^3 Which is greater than 320 kg/m^3
Proportion of Volume of Coarse Aggregate & Fine Aggregate Content		
1	Vol. of C.A. as per table 3 of IS 10262	61.00%
2	Adopted Vol. of Coarse Aggregate	61.00%
3	Adopted Vol. of Fine Aggregate (1-0.62)	39.00%

TABLE 3.5 Details of Mix Calculations

Mix Calculations		
1	Volume of Concrete in m^3	1.00
2	Volume of Cement in m^3 (Mass of Cement) / (Sp. Gravity of Cement)x1000	0.132
3	Volume of Water in m^3 (Mass of Water) / (Sp. Gravity of Water)x1000	0.186
4	Volume of All in Aggregate in m^3 Sr. no. 1 – (Sr. no. 2+3)	0.682

TABLE 3.6 Mix Proportions for One Cum of Concrete

1	Mass of Cement in kg/m^3	413
2	Mass of Water in kg/m^3	186
3	Mass of Fine Aggregate in kg/m^3 [((A-8)-4) x vol. fine aggregate x specific gravity of fine aggregate x 1000]	691.54
4	Mass of Coarse Aggregate in kg/m^3 [((A-8)-4) x vol. coarse aggregate x specific gravity of coarse aggregate x 1000]	1077
5	Water Cement Ratio	0.45

3.3 DETAILS OF TEST SPECIMENS

The quantity of material for the control cube as per worked out ratio (M30 Concrete mix) is shown in the table given below.

Material	Normal concrete (0%Sabbath stone)	10% Sabbath stone +1% silica fume	20% Sabbath stone +1.5% silica fume	30%Sabbath stone +2% silica fume
Mix Ratio	1:1.67:2.60	1:1.67:2.60	1:1.67:2.60	1:1.67:2.60
Cement	45kg	44.55kg	44.32kg	44.1kg
Fine Aggregate	75kg	67.5kg	60kg	54kg
Coarse Aggregate	120kg	120kg	120kg	120kg
Water Cement Ratio	0.45%	0.45%	0.45%	0.45%
Stone Sabbath	-	7.5 kg	15 kg	22.5 kg
Accelerating Admixture	-	0.45kg	0.67kg	1.5 kg

3.3.1 TEST FOR CONCRETE

There are the two types of test in concrete

a) Fresh concrete b)) Hardened concrete

a) Fresh concrete test

The concrete which is done the test after the concrete mix is called as fresh concrete. There are the different type of test in their but in that project done Slump cone test only.

b) Hardened concrete test

The concrete which is done the test after the day of the concrete mix is called as hardened concrete. Compression test and Flexural test had be done in the project.

3.3.2 Compressive Strength Test

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M30 grade of concrete. The moulds were filled with 0%, 10% 20% and 30% Sabbath stones. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were remolded and were transferred to curing tank where in they were allowed to cure for 28 days. After 7th,14th,28th days curing, these cubes were tested on digital compression testing machine a. The failure load was noted. In each category three cubes were tested and their average value is reported. The compressive strength was calculated as follows.

Compressive strength (MPa) = Failure load / cross sectional area.

3.3.3 Flexural strength

The flexural strength was calculated as follows

Flexural strength (MPa) = $(P \times L) / (b \times d^2)$,

Where, P = Failure load, L = Centre to centre distance between the support= 500 mm
b = width of specimen=100 mm, d = depth of specimen= 100 mm

4. RESULTS AND DISCUSSION

4.1 OVERVIEW OF TESTS

Tests were conducted on concrete cubes using varying percentage of Sabbath stone to check the variations in compressive strength. Tests were conducted on concrete beam using varying percentage of Sabbath to check for variations of flexural strength, three sets of nine cubes of M30 mix cast without Sabbath. Later , different sets of cubes were cast with Sabbath content ratio as 10%, 20%, 30%. The results of compressive strength and flexural strength of M30 grade concrete cubes with varying percentage of steel fibers on 7th, 14th, and 28th day.

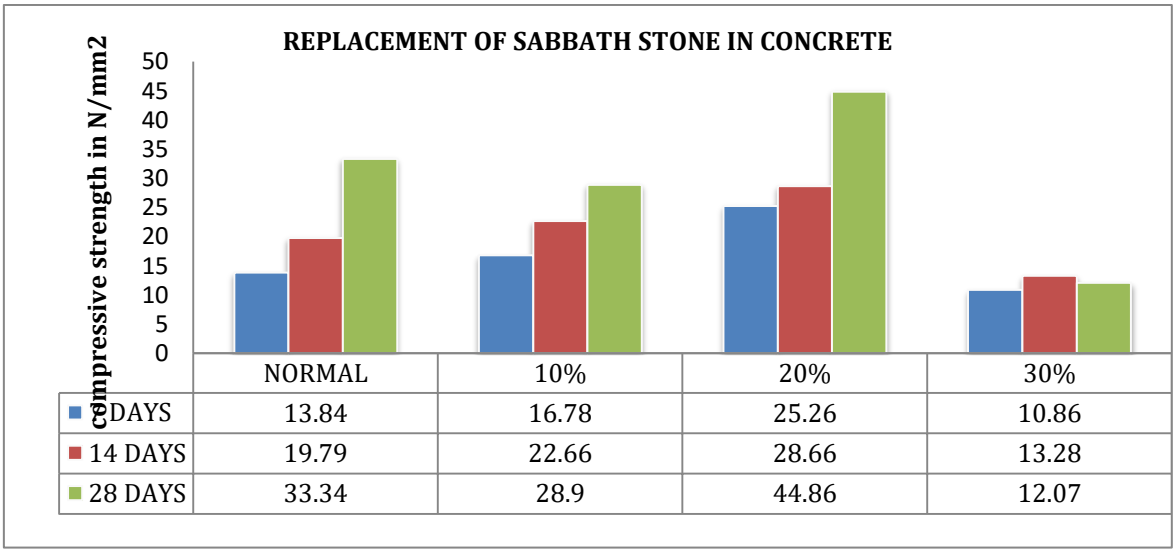
4.2 Compressive Strength

Table 4.1 Comparative analysis for compressive strength

Sabbath content	7th day	14th day	28th day
0%	13.84N/mm²	19.79 N/mm²	33.34 N/mm²
10%	16.78 N/mm²	22.26 N/mm²	28.90 N/mm²
20%	25.6 N/mm²	28.77 N/mm²	44.85 N/mm²
30%	10.6 N/mm²	11.28 N/mm²	12.07 N/mm²

- ✓ The below figure shows the representation of variation in compressive strength with the different mix proportions at the age of 7 days,14 days and 28 days.
- ✓ With respect to the initial compressive strength, the final strength at the age of 28 days gains more strength in 20%.
- ✓ The variation in compressive strength will be more in 20% of 28 days and also be the strength will be less in 0%,10% and 30%.
- ✓ Finally the mix proportions is consider as 20% will be more compressive strength.

Case 1) Comparative analysis for compressive strength



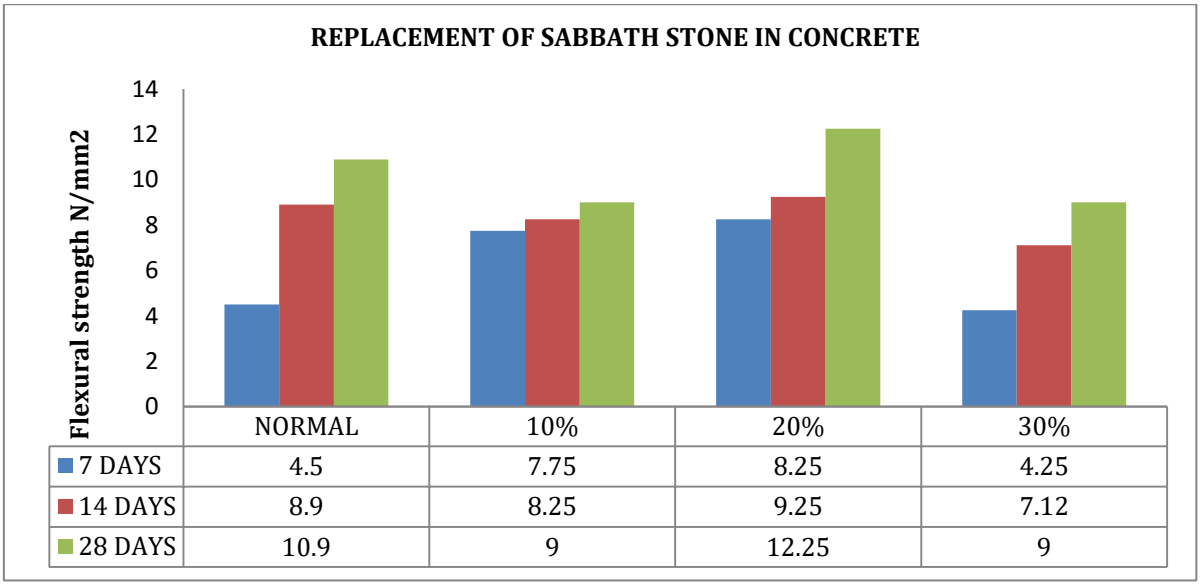
4.3 Flexural Strength

Table 4.2 comparative analysis for flexural strength

Sabbath content	7th day	14th day	28th day
0%	4.5 N/mm²	8.9 N/mm²	10.90 N/mm²
10%	7.75N/mm²	9.0 N/mm²	10.90 N/mm²
20%	8.25 N/mm²	9.25 N/mm²	12.25 N/mm²
30%	4.25 N/mm²	7.12 N/mm²	9.0 N/mm²

- ✓ The representation of flexural strength or bending stress to the various mix proportions are shown in figure below.
- ✓ It gains flexural strength almost increase of normal concrete.
- ✓ It can be seen that, flexural strength when compared with IS 456: 2000; there is 35-40% increase in flexural strength.
- ✓ Flexural strength obtained are almost higher than the flexural strength according to IS 456 : 2000
- ✓ Finally the mix proportions is consider as 20% will be more flexural strength

Case 2)comparative analysis for flexural strength



	NORMAL	10%	20%	30%
7 DAYS	4.5	7.75	8.25	4.25
14 DAYS	8.9	8.25	9.25	7.12
28 DAYS	10.9	9	12.25	9

Results

Compressive strength is calculated by using load/ area

1)compressive strength for normal concrete = **22.32 N/mm²**

2)compressive strength for 10% of Sabbath stone & 1% of silica fume with concrete = **22.78 N/mm²**

3) compressive strength for 20% of Sabbath stone & 1.5% of silica fume with concrete = **33.06 N/mm²**

4) compressive strength for 30% of Sabbath stone & 2% of silica fume with concrete = **11.40N/mm²**

Flexural strength by using PL/BD^2

5) Flexural strength for normal concrete = **8.01N/mm²**

6) Flexural strength for 10% of Sabbath stone & 1% of silica fume with concrete = **8.33N/mm²**

7) Flexural strength for 20% of Sabbath stone & 1.5% of silica fume with concrete =**9.91N/mm²**

8) Flexural strength for 30% of Sabbath stone & 2% of silica fume with concrete = **6.79N/mm²**

5. Conclusion

This experimental study indicates to find out the waste material are used in concrete with adequate strength, Analysis the result concrete containing the replacement of cement & aggregate with sludge & slag respectively gives the following results.

1. It is identified the Sabbath stone & Silica fume are used in construction materials.
2. The replacement of the sand with Sabbath stone shows an improved in compressive strength of concrete.
3. As the replacement of sand with Sabbath stone increase the workability of the concrete is decreasing due to the absorption of the water by the Sabbath stone.

4. The ideal percentage of the replacement of sand with Sabbath stone is 55% to 75% in case of compressive strength.
5. The results from the table show the decrease in the workability of concrete when the percentage of replacement is increasing. The workability is very less at the standard water cement ratio and the water that is require for making the concrete to form a zero slump with a partial replacement requires more water.
6. From the replacement of fine aggregate with 20% of Sabbath stone was achieved good strength.

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