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.

Key words: Sabbath Stone, Slump Test, Compressive Strength Test, Flexural Strength Test

I. 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. On the other hand, the advantages of utilization of by products or aggregate obtained as waste materials are pronounced in the aspects of reduction in environmental load & waste management cost, reduction of production cost as well as augmenting the quality of concrete. In this content, fine aggregate has been replaced by Shabbath (a variety of cudappah) stone. Crushed Shabbath 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 silican metal or ferrosilican 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.

II. Experimental Investigation

The aim and scope of the present investigation and results of experiment done in this field were discussed. Detailed descriptions about the material investigation are also cited. Hence they are described in detail in the following sections.

S. NO	TYPE OF CONCRETE	SPECIMEN CODE	NO. OF SPECIMENS		
			CUBES	BEAMS	CYLINDERS
1	Conventional concrete	CCC	9	6	6
2	Various % replacement of fine aggregate with Sabbath stone	CSSC-1 CSSC-2 CSSC-3	9 9 9	6 6 6	6 6 6
TOTAL			36	24	24

Table 1: Details of the Specimens

S. No	Name of the Material	Specific Gravity
1.	Cement	3.11
2.	Coarse Aggregate	2.59
3.	Fine Aggregate	2.60
4.	Sabbath stone	2.84

Table 2: Proprieties of Materials

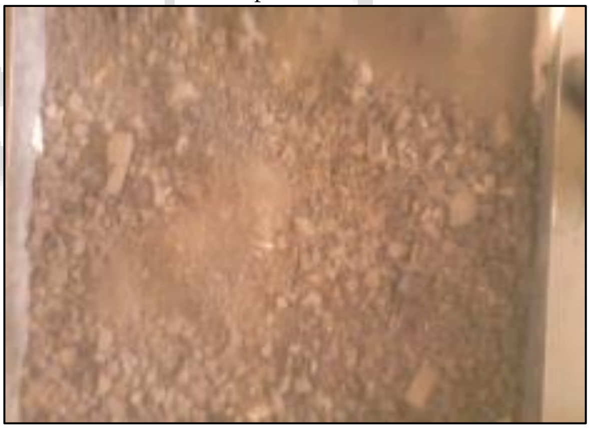

Fig. 1: Sabbath Stone

III. Concrete Mix Design

The details of M_{30} concrete mix design details as per IS 10262 are given in the table given below.

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

Table 3: Details of M_{30} Concrete Mix Design

1	Cement Used	OPC 43 grade
2	Sp. Gravity of Cement	3.11
3	Sp. Gravity of Water	1.00
4	Chemical Admixture	Nil
5	Sp. Gravity of 20 mm coarse Aggregate	2.59
6	Sp. Gravity of fine aggregate	2.60
7	Water Absorption of 20 mm Aggregate	0.5%
8	Water Absorption of fine aggregate	3.1%
9	Free (Surface) Moisture of 20 mm Aggregate	Nil
10	Free (Surface) Moisture of Sand	Nil
11	Sieve Analysis of Coarse Aggregates	Separate Analysis Done
12	Sieve Analysis of Fine Aggregate	Separate Analysis Done
Target Strength for Mix Proportioning		
1	Target Mean Strength	38.2N/mm^2

Table 4: Test Data for Materials

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 4: Calculations of Material Content

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 5: Details of mix calculations

IV. RESULTS

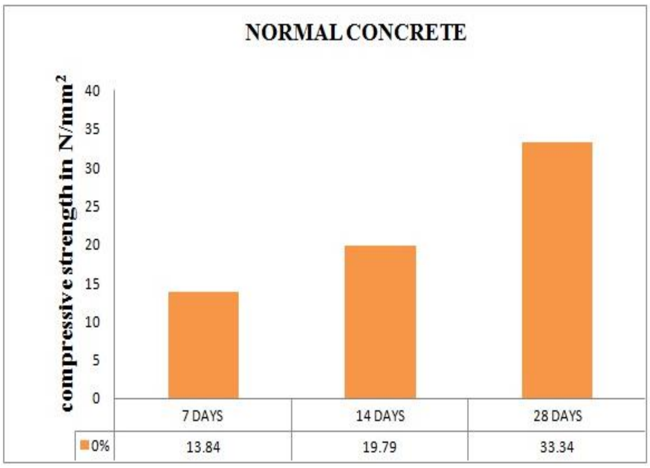

Fig. 2: Compressive Strength for Normal Concrete

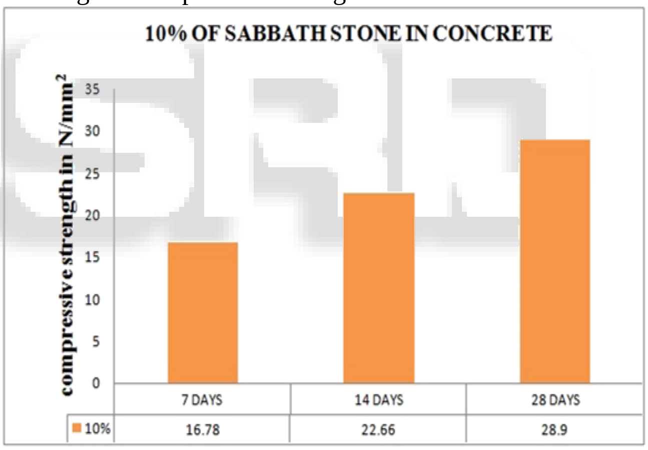

Fig. 3: Compressive Strength For 10% Replacement of Concrete

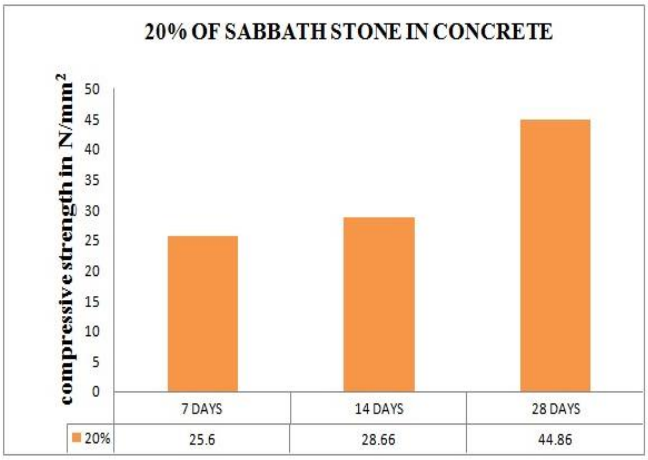

Fig. 4: Compressive Strength For 20% Replacement of Concrete

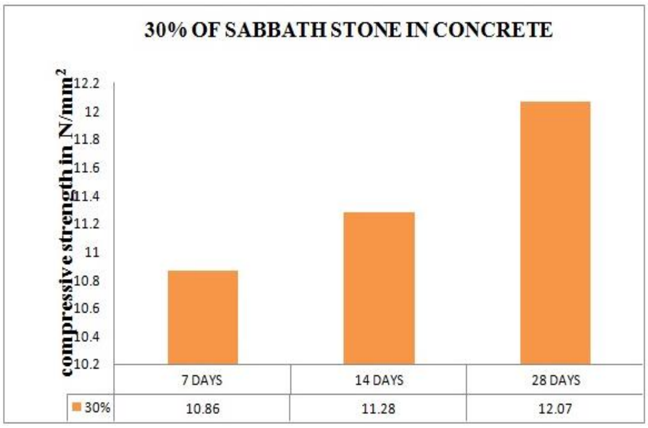

Fig. 5: Compressive Strength For 30% Replacement of Concrete

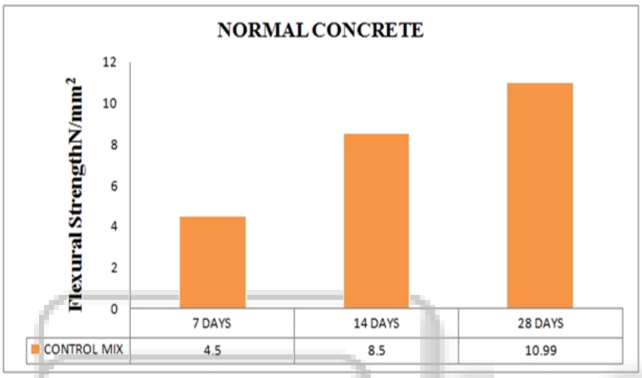

Fig. 6: Flexural Strength for Normal Concrete

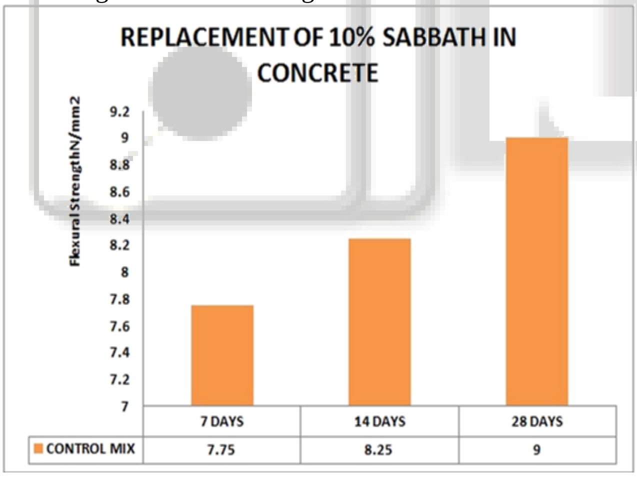

Fig. 7: Flexural Strength For 10% Replacement of Concrete

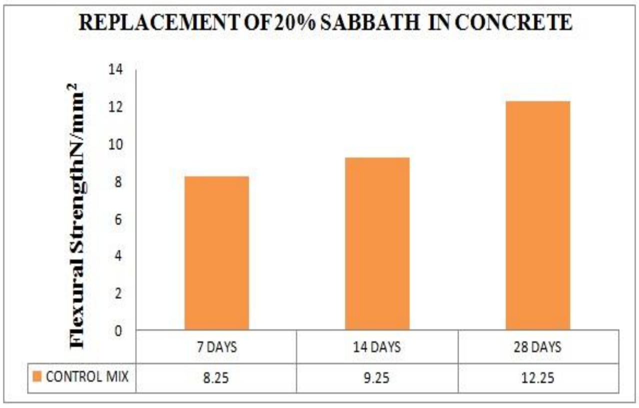

Fig. 8: Flexural Strength For 20% Replacement of Concrete

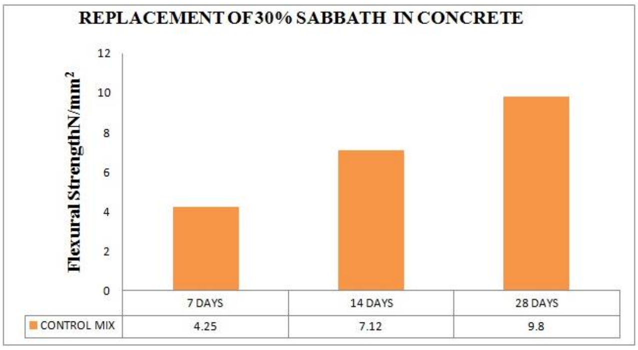

Fig. 9: Flexural Strength For 30% Replacement of Concrete

V. CONCLUSIONS

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 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.
5) The ideal percentage of the replacement of sand with Sabbath stone is 55% to 75% in case of compressive strength.
6) From the replacement of fine aggregate with 20% of Sabbath stone was achieved good strength.

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