Experimental Investigation on Partial Replacement of Fine Aggregate with Sabbath (Cudappah 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. Attempts have been made to study the properties of concrete and to investigate some properties of Sabbath stone the suitability of those properties to enable them to be used as partial replacement materials for fine aggregate in concrete. The results indicated that the replacement of fine aggregate by 20% had attained a good strength in the two mentioned above.
Key words: Sabbath Stone, Silica Fume, Compressive Strength, Flexural Strength

I. INTRODUCTION

The effects of SiO_2 nano particles on both physical properties (water permeability, workability and setting time) and mechanical properties (compressive, split tensile and flexural strength) of binary blended concrete have been investigated. It was concluded that the SiO_2nano particles can improve the filler effect and its ultra-high pozzolanic activity causes more C–S–H gel formation when cured in lime solution, and the lime solution can reduce the strength of control concrete.[1]. The influence of nano silica in concrete. In this project the study confirms the compressive strength of mortar with the addition of nano silica were higher than the normal mortar for 7 days and 28 days results. The strength mainly depends upon the nano silica addition [2]. To investigate the important parameter water cement ratio on abrasive strength and porosity of nano-silica concrete. The water cement ratio is one of the key factors effecting on concrete properties [3]. The Synthesis and characterization of nano-silica from rice husk ash by Precipitation method. The size of the particle is determined from the number averaged particle radius by LPS that show nano-silica particles which obtained from the rice husk ash. [4]. the nano silicate act excellently as corrosion inhibitor for carbon steel in distilled water medium. The surface morphology of carbon steel with and without inhibitor was investigated by SEM-EDX [5]. to determining the performance of the OPC replacements on the properties of the mortar, resulting in the most effective use with simultaneous decrease in porosity and increased compressive strength and corrosion respectively. The use of ashes to improve the properties of mortar has also been studied, and the study of synergy in the simultaneous use of NP and ashes is scarce, research has focused on improving the mechanic properties and chemical properties of mortar.[6]. Nanotechnology finds application in various fields of science and technology and this article presents a critical review of the literature on the influence of nano silica in concrete and its application for the pore filling effect and its pozzolanic activity with cement towards improvement of mechanical properties and durability aspects.[7]. Compressive strength, split tensile strength and flexural strength of M40 and M50 grades of concrete with the use of micro silica (5%, 7.5%, 10%, 15%) and nano silica (1%, 1.5%, 2%, 2.5%) as partial replacement of cement were studied. It was found from the experimental study that concrete composites with superior properties can be produced using micro silica, nano silica and combination of micro silica and nano silica. The main aim is to study of strength properties of concrete by using micro silica and nano silica.[8]. The preparation of rice husk ash by burning at 700^0 C silica content obtained after heat treatment is 90.3%. in this project the SEM analysis shows the 2.5 N NaOH for 3h provided agglomerate particles with dimension 5-10nm.When compared to with the normal silica the addition of nano silica in rice husk ash shows the higher strength. [9]. the models which are analyzed has shown the same structural response and failure modes as found in the experimental investigation [10]. The modelling of RC beams with and without openings by using Ansys and were investigated on beam strength, stiffness, deformed shape, and cracked patterns by the experimental and theoretical results were concluded that the both results were showed satisfactory [11]. A theoretical and experimental study on mechanical properties and flexural strength of fly ash-geo polymer concrete using young's modulus, Poisson's ratio stress-strain relation and indirect tensile strength with four-point loading and as FEM and concluded after the results there were approximate values by comparing both the theoretical and experimental study [12].

II. EXPERIMENTAL STUDY

The experimental procedure is also described. The materials used in casting of specimens for the various tests consists of ordinary Portland cement, locally available rivers sand passing through IS sieve 2.36mm in size, coarse aggregate passing through IS sieve 20mm in size.

The Sabbath stone is partial replacement for the concrete which is alternate for the sand, the fine aggregate will be less than 2.36 mm on the fresh concrete test.

The constituent materials were mixed in a small capacity laboratory mixer machine, the mould specimen which is cube, beam and cylinder. A cube mould of size 150mm×150mm×150mm.A beam mould of size

500mm×100mm×100mm, a cylinder mould of size is 500mm height, 150mm diameter.

A. Materials

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 as shown in figure 1.

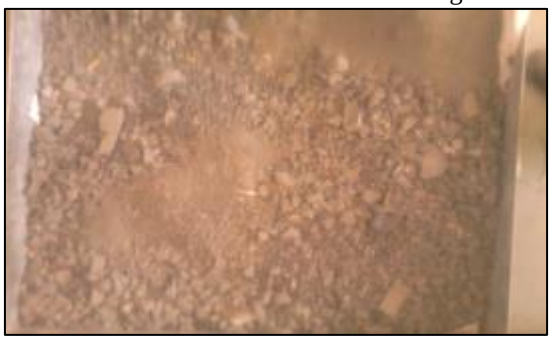

Fig. 1: Sabbath Stone

B. Cement

The cement used in the study is 53 grade ordinary Portland cement ,the raw materials used for manufacturing of Portland cement consist mainly of lime, silica, alumina and iron oxide .four compounds are fegarded as major constituents of cement they are tricalcium silicate (C3S), dicalcium silicate (C2S) tricalcium aluminate (C3A) and tera calcium ferrate (C4AF) are the most important compounds which are responsible for the strength of hydrated cement paste the presence of C3A is undesirable when water is added, the silicates and aluminates of Portland cement form products of hydrates ,which in time produce firm and hard mass . The amount of C3A in most cement is comparatively small. The reaction of pure C3A with water is very rapid and would lead to flash set which is prevented by the addition of two gypsum to the cement clinker, C2S influences the late gain strength.

C. 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:

1) The specific gravity of sand is 2.54
2) The size distribution of sand used corresponds to zone 2

D. Coarse Aggregate

Approximately three quarter of the volume of concrete is made with aggregate particles covering a range of size up to a maximum size, which usually lies between 10mmto 50 mm, but the aggregate size 20 mm is used for this work. The coarse aggregate used in this project is having a specific gravity of 2.34 and its adsorption form the air dried state is 0.25% by weight.

E. Water

Water should be free from acids, oils, alkalies, vegetables or other organic impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mx. Firstly, it reacts chemically with the cement to form the cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a lubricant in the mixture of fine aggregates and cement.

1) Properties

The properties of the materials which are used are shown in below table 1.

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 1: Properties

F. Details of Fine Aggregate

Good quality of river sand, free from silt and other impurities, was used in the study. The percentage of particle of coarse aggregate is evaluated by the test as given below table 2.

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 2: % of Retained Fine Aggregates

G. Accelerating Admixtures-Silica Fume

Concrete mixes containing calcium chloride will always have a faster cure rate than plain concrete. The beneficial effects of calcium chloride will be even more pronounced at lower temperatures. Calcium chloride can accelerate cement hydration reducing its set time.

That means:

- High initial strength
- Reduced final set time
- Reduced bleeding
- Improved workability
- Fast form work turnaround
- Greater cost effectiveness

III. Analysis

A. Testing

1) Details of Control Concrete

The quantity of material for the control cube as per worked out ratio (M30 Concrete mix) is shown in the table3 given below

Mix Ratio	1:1.67:2.60
Cement	45kg
Fine Aggregate	75kg
Coarse Aggregate	120kg
Water Cement Ratio	0.45%

Table 3:

The quantity of materials for 10% replacement of fine aggregate by Sabbath stone as per worked out ratio (M_{30} Concrete mix) is shown in the table 4 given below.

Mix Ratio	1:1.67:2.60

Cement	44.55kg
Fine Aggregate Coarse Aggregate Sabbath stone	67.5kg 120kg 7.5 kg
Accelerating admixture	0.45kg

Table 4: Details of 10% Replacement

The quantity of materials for 20% replacement of fine aggregate by Sabbath stone as per worked out ratio (M_{30} Concrete mix) is shown in the table 5 given below.

Mix Ratio Cement Fine Aggregate	1:1.67:2.60 44.32kg 60kg
Coarse Aggregate stone Sabbath	120kg 15 kg
Accelerating admixture	0.67kg

Table 5: Details of 20% Replacement

The quantity of materials for 30% replacement of fine aggregate by Sabbath stone as per worked out ratio (M_{30} Concrete mix) is shown in the table 6 given below.

Mix Ratio	1:1.67:2.60
Cement	44.1kg
Fine Aggregate	54kg
Coarse Aggregate	120kg
Stone sabbath	22.5 kg
Accelerating admixture	1.5 kg

Table 6: Details of 30% Replacement

IV. RESULTS & DISCUSSION

Tests were conducted on concrete cubes using varying percentage of Sabbath stone to check the varations in compressive strength. Tests were conducted on concrete beam using varying percentage of sabbath to check for varations 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 fibres on 7th, 14th, and 28th day.

A. Compressive Strength of Normal Concrete

The compressive test strength of concrete with 0% of Sabbath stone for 7 and 14 days are shown in below tables and represented graphically as shown in figure 2

S NO	Weight of specimen(kg)	Area of specimen(m m²)	Ultimate load (KN)	Compressive strength(N/m m²)
1)	8.41	22500	310	13.77
2)	8.41	22500	340	14.06
3)	8.42	22500	305	13.33

Table 7: Compressive Strength of Normal Concrete for 7 Days

S NO	Weight of specimen(kg)	Area of specimen(m m²)	Ultimate load (KN)	compressive strength(N/m m²)
1)	8.42	22500	400	18.45
2)	8.42	22500	442	20.23
3)	8.40	22500	427	19.67

Table 8: Compressive Strength of Normal Concrete for 14 Days

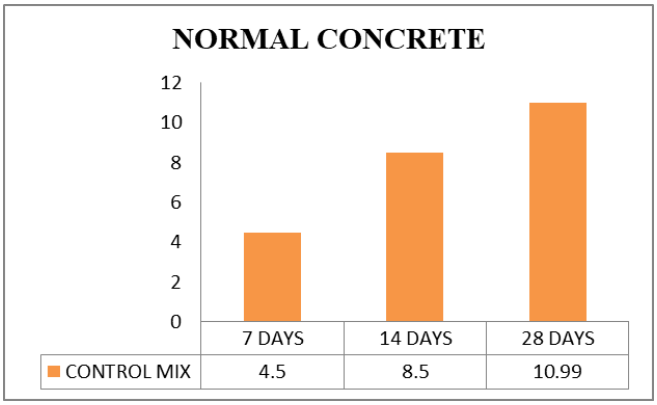

Fig. 2: Graphically Represented of 7, 14, and 28 Days

B. Flexural Strength for 20% Sabbath Stone & 1.5% Silica Fume

The Flexural strength of normal concrete for 7,14 and 28 days are shown in table below and represented graphically as shown in figure

S.NO	Weight (kg)	Length (mm)	Breadth (mm)	Depth (mm)	Load (KN)	Flexural strength (N/mm²)
1)	12.30	500	100	100	18	9.0
2)	12.35	500	100	100	15	7.5

Table 9: Flexural Strength for 7 Days

S.NO	Weight (kg)	Length (mm)	Breadth (mm)	Depth (mm)	Load KN)	Flexural strength (N/mm²)
1)	12.84	500	100	100	19	9.5
2)	12.74	500	100	100	18	9.0

Table 10: Flexural Strength for 14 Days

S.NO	Weight (kg)	Length (mm)	Breadth (mm)	Depth (mm)	Load KN)	Flexural strength (N/mm²)
1)	12.68	500	100	100	20.5	10.25
2)	12.92	500	100	100	24.5	12.25

Table 11: Flexural Strength for 28 Days

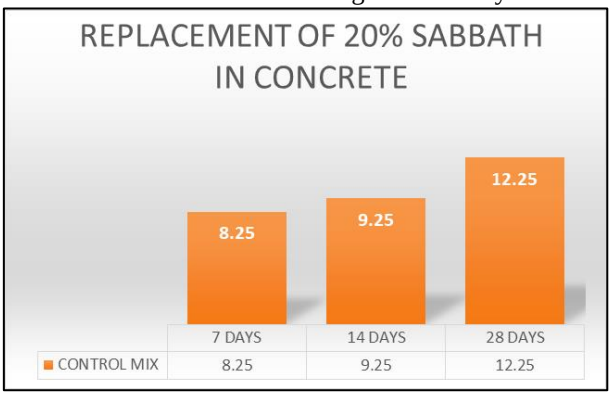

Fig. 3:

V. 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 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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