

# **Experimental Investigation on M40 Grade Concrete with Partial Replacement of Coarse Aggregate with Shabath Crushed Stone and Cement with Fly Ash**

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**ABSTRACT:** In the recent years, the consumption of concrete has been increasing, as a result there is a scarcity and rising in the cost of raw materials. This led to hunt for some alternative materials to manufacture the concrete. Secondly the waste generated from industries is causing severe environmental problems. So an emphasis has been made in this project to study mechanical properties of concrete to increase the properties of fresh and hardened concrete, cement is partially replaced with fly ash and coarse aggregate is partially replaced with shabath crushed stones. The replacement of cement & coarse aggregate with substituting material fly ash and shabath crushed stone in the following replacement percentages, cement is replaced with fly ash at 10% along with coarse aggregate replacement of 10%, 20%, 30% with shabath crushed stones. Similarly for 20% & 30% replacement of cement with fly ash along with 10%, 20%, 30%, replacement of coarse aggregates with shabath crushed stones. The results of hardened concrete such as compressive strength, split tensile are compared with conventional concrete in this project after 7, 28 days.

**KEYWORDS:** Cement, Fly Ash, Shabath Stone, Coarse Aggregate, Fine Aggregate.

## **I. INTRODUCTION**

Concrete is a mixture of cement, fine aggregates, coarse aggregates and water. Cement is the main binding material in concrete. In production of cement industries, CO<sub>2</sub> is the major emission into atmosphere. Due to scarcity of natural resources coarse aggregate and fine aggregate are also not available properly. In such conditions the production of concrete is done by replacement of concrete ingredients with artificial resource. Fly ash is major constituent replaced in the place of cement.

Use of fly ash in concrete imparts several environmental benefits and thus it is eco-friendly. Fly ash is pozzolanic material & it improves the mechanical properties of concrete. Fly ash considered as a waste material from thermal power plant industry, and this by product have been successfully utilized as partial replacement in concrete as a form of binder to improve the construction process.

Secondly, shabath crushed stone obtained from the industry is used to replace coarse aggregate. Shabath crushed stone aggregates are suitable for production of high strength concrete compared to natural coarse aggregate. It is available both in rough and polished finishes, hard and durable nature the stone. It is non-porous and a homogeneous material which can be widely used in different area

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This paper presents the experimental study undertaken to investigate the influences of partial replacement of cement (OPC) with fly ash and partial replacement of coarse aggregate with waste shabbath crushed stone and method to improve the mechanical properties of conventional concrete.

## II. LITERATURE REVIEW

**G.MURALI and V.R.RAM KUMAR "PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF COARSE AGGREGATE"** international journal of emerging trends in engineering and development, issue 2 vol.4 may (2012) pg. no 585-589. An experimental study had been conducted to study the effects of using waste Shabbath stone in the place of coarse aggregate by partial replacement in various percentages such as 10, 20, 30 and 40 over the M20 grade concrete. It was found that the replacement of coarse aggregate by waste Shabbath stone over the concrete had attained the good strength when compared to that of the conventional concrete. Also this had been proved to be eco-friendly since the waste stones were disposed in an economic way. The maximum Compressive strength, split tensile strength and flexural strength of concrete can be achieved by 30% replacement of shabbath stone. The maximum Compressive strength, split tensile strength and flexural strength of concrete can be achieved by 30% replacement of shabbath stone which was found to be 21.09, 2.63, 3.26 N/mm<sup>2</sup>. This project is proved to be economical since the cost of the aggregate has been reduced up to 30 to 40% during construction.

**Rajendra D H Gokulram "Effect of Strength Properties on Concrete by Partial Replacement of Coarse Aggregate with Waste Cuddapah Stones"** International Journal of Engineering Trends and Technology (IJETT) – Volume-44 Number-5 – February 2017 pg. no 221-225. Aim of this paper is to study the strength properties of concrete by partially replacing the coarse aggregate by waste shabbath crushed stone and cement (OPC) with fly ash. In this waste cuddapah crushed stone were partially replaced as coarse aggregate in 20%, 30% and 60% respectively and fly ash was partially replaced with cement by 20% respectively are casted and tested for 7 and 28 days. Fresh and hardened concrete properties are evaluated by workability test, compressive strength and split tensile test with a fixed water cement ratio 0.4. This paper concluded compared to conventional concrete, the compressive strength of Cuddapah stone replaced coarse aggregate concrete was gradually increased up to 4.45%, 9% and 17.03% in 20%, 40% and 60% of coarse aggregate by CWS and 20% cement by fly ash was replaced and this paper Effect on compression with 60% replacement of aggregate has been found to be achieving higher compressive strength.

**A R Nihith Chowdary, E Prema Latha**, in this paper an attempt has been made to save the environment and utilize the waste material as partial replacement of coarse and fine aggregate and to assess the suitability of shabbath waste in concrete making. An experiment has been carried out for M<sub>30</sub> concrete using Shabbath waste as partial replacement of coarse aggregate and fine aggregate. Shabbath waste cutting stones were partially replaced as coarse aggregates in 20%, 30% and 40% respectively and the waste dust was partially replaced as fine aggregate by 25%, 50%, 75% and 100% respectively. Compared to conventional concrete strength is higher when coarse aggregate is replaced by 30% and shabbath waste dust is replaced by 25%. The ultimate compressive strength for partial replacement of coarse aggregate with shabbath waste stone is achieved by 30% is found to be 7.46% greater than the conventional concrete value whereas the maximum compressive strength for partial replacement of fine aggregate with shabbath waste dust is achieved by 25% is found to be 5.97% greater than the conventional concrete value. The maximum split tensile strength for partial replacement of coarse aggregate with shabbath waste stone is achieved by 30% is found to be 6.45% greater than the conventional concrete value whereas the maximum split tensile strength for partial replacement of fine aggregate with shabbath waste dust is achieved by 25% is found to be 5.1% greater than concrete value.

## III. MATERIALS USED

The material properties used in the concrete are given below:

### **Cement**

Ordinary Portland cement of ultra tech brand of 53 grade conforming to IS 4031-1988 was used throughout the study. The specific gravity of cement is taken as 3.12.

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**Fine Aggregate**

The Natural River sand locally available conforming to IS 383-1987 was used of grading zone II. The specific gravity, fineness modulus and water absorption of fine aggregate is 2.62, 2.81 and 1.8%.

**Coarse Aggregate**

Locally available coarse aggregate passing through 20 mm sieve and retained on 10 mm sieve is used throughout the project. The specific gravity, fineness modulus and water absorption of coarse aggregate is 2.87, 7.45 and 1.58%.

**Shabath Crushed stone**

Shabath (Cuddapah stone) Black stone are quite impervious and hard. These Natural Cuddapah Black stone are used for cladding and flooring purposes as the stone is more resistant than most other sedimentary rocks which are used in place of natural coarse aggregate.

**Table 1: Physical properties of Shabath rock**

Density	2.65 kg/cm <sup>3</sup>
Modulus of rupture	22 to 34 N/mm <sup>2</sup>
Compressive strength	28 to 36 N/mm <sup>2</sup>
Specific gravity	2.7 to 2.8
Porosity	Low to very low
Water absorption	1.1%
Weather impact	Resistance
Corrodibility	0.4 to 0.7%
Hardness	4 on Mohr's scale

**Table 2: Chemical properties of Shabath rock**

Sio <sub>2</sub>	55%-65%
Iron	4-8%
Alumina	15-20%
Soda	2-4%
Lime	0.5-1%
Magnesia	0.5-3%
Tio <sub>2</sub>	0.4-0.5%
Loss on ignition	3-4%

**FLY ASH:**

Fly ash is an industrial by-product, generated from the combustion of coal in the thermal power plants. The increasing scarcity of raw materials and the urgent need to protect the environment against pollution has accentuated the significance of developing new building material based on industrial waste generated from coal fired thermal power stations creating unmanageable disposal problems due to their potential to pollute the environment. Fly ash, when used as a mineral admixture in concrete improves its strength and durability characteristics. Fly ash can be used either as an admixture or as a partial replacement of cement. It can also be used as a partial replacement of fine aggregate, as a total replacement of fine aggregates and as supplementary addition to achieve different properties of concrete.

**Water:-**

For curing purpose portable water is used during the project. Which having a p<sup>H</sup> =7

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**Fig: 1** Shabath rock waste source manual cutting and preparation of aggregates



**Fig: 2** Fly Ash

## IV. EXPERIMENTAL INVESTIGATION

In this experimental investigation the properties of shabath crushed stone concrete for different partially replacement percentages of fly ash and various replacements.

### Mix proportions

By using recommended guidelines of concrete mix design using Indian standard code (IS: 10262-2009) the mix proportions of concrete were prepared for M40 grade concrete is **1:1.61:2.89** with a water-cement ratio of **0.38**.

**Table: 3** Mix Proportion

Cement (Kg/m <sup>3</sup> )	Fine Aggregate (Kg/m <sup>3</sup> )	Coarse Aggregate (Kg/m <sup>3</sup> )	W/C (lit)
430	692	1245.56	163.2
1	1.61	2.89	0.38

### Mechanical properties of concrete:-

In order to calculate the Compressive strength tests were conducted at 7, 28 days on cubes (150x 150 x150 mm) specimens. For each set, three cubes are tested.

In order to calculate the Split tensile strength tests were conducted at 7, 28 days on cylinders (150x 300 mm) specimens. For each set, three cylinders are tested.

## V. EXPERIMENTAL RESULTS

### Compressive strength:

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression, whereas tensile strength resists tension.

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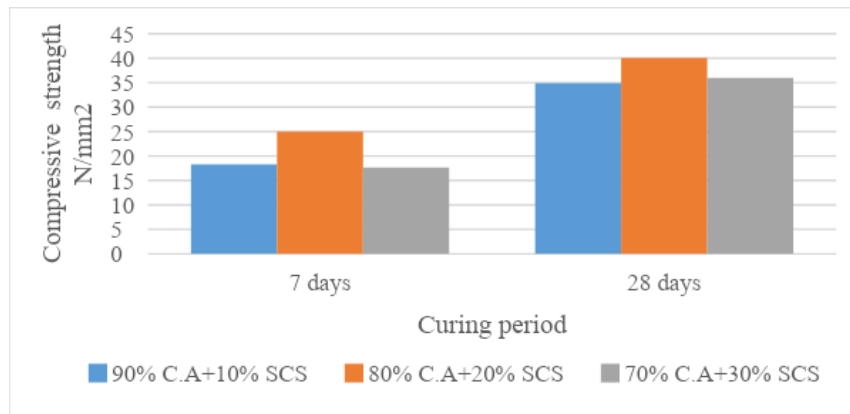
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**Table : 4 Compressive strength at 7 days, 28 days for nominal mix and partial replacement of 90% of Cement (C) with 10% fly ash (F.A) and partial replacement of C.A with Shabath crushed stones (SCS)**

Mix	Percentage replacement of cement	Percentage replacement of C.A	Compressive strength in N/mm <sup>2</sup>	
	% of Cement + % of Fly Ash	% of C.A + % SCS	7 days	28 days
M1	100% C+ 0% F.A	100% C.A+ 0% SCS	30.82	49.43
M2	90% C + 10% F.A	90% C.A+10% SCS	18.32	34.90
M3	90% C + 10% F.A	80% C.A+20% SCS	24.96	40.05
M4	90% C + 10% F.A	70% C.A+30% SCS	17.67	36.01



**Fig: 3 Compressive strength at replacement of 90% of cement with 10% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

**Table: 5 Compressive strength at 7 days, 28 days for partial replacement of 80% of cement with 20% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

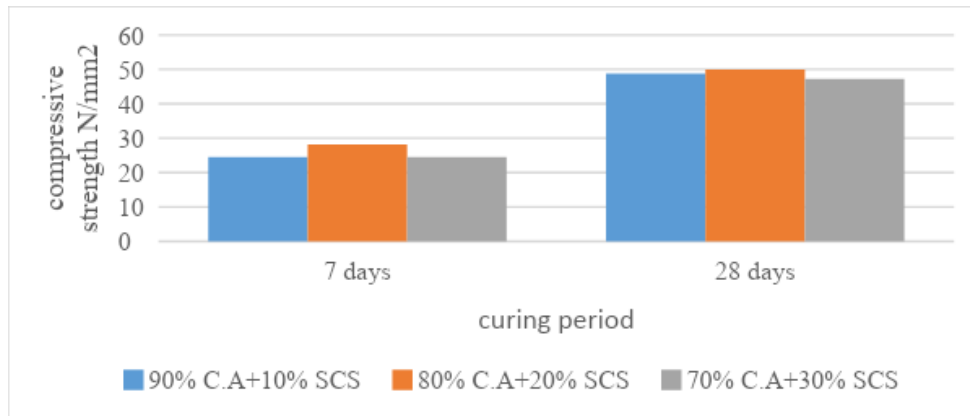
MIX	Percentage replacement of cement	Percentage replacement of C.A	Compressive strength in N/mm <sup>2</sup>	
	% of Cement + % of Fly ash	% of C.A+% (SCS)	7 days	28 days
M5	80% C+20% F.A	90% C.A+10% SCS	24.48	48.74
M6	80% C+20% F.A	80% C.A+20% SCS	28.22	49.91
M7	80% C+20% F.A	70% C.A+30% SCS	24.45	47.23

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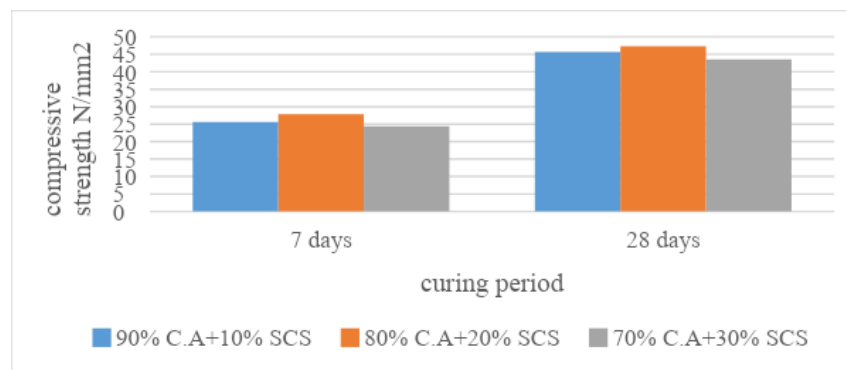
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**Fig: 4 Compressive strength at replacement of 80% of cement with 20% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

**Table: 6 Compressive strength at 7 days, 28 days and 90 days for partial replacement of 70% of cement with 30% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

MIX	Percentage replacement of cement	Percentage replacement of C.A	Compressive strength in N/mm <sup>2</sup>	
	% of Cement+ % of Fly Ash	% C.A +% (SCS)	7 days	28 days
M8	70% C+30% F.A	90% C.A+10% SCS	25.63	45.65
M9	70% C+30% F.A	80% C.A+20% SCS	27.85	47.30
M10	70% C+30% F.A	70% C.A+30% SCS	24.35	43.57



**Fig: 5 Compressive strength at replacement of 70% of cement with 30% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

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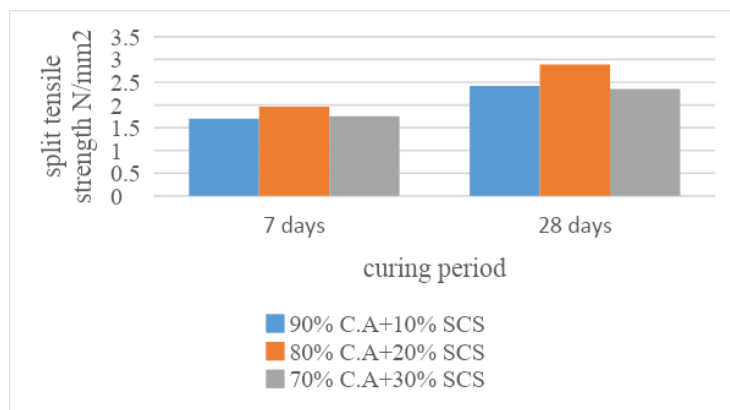
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Split tensile strength:

**Table: 7 Split tensile strength at 7 days, 28 days for nominal mix and partial replacement of 90% of Cement(C) with 10% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

MIX	Percentage replacement of cement	Percentage replacement of C.A	Split tensile strength in N/mm <sup>2</sup>	
	% of Cement +% of Fly ash	% of C.A+% (SCS)	7 days	28 days
M1	100% C+0% F.A	100% C.A +0% SCS	2.56	4.75
M2	90% C+10% F.A	90% C.A+10% SCS	1.70	2.42
M3	90% C+ 10% F.A	80% C.A+20% SCS	1.96	2.89
M4	90% C+10% F.A	70% C.A+30% SCS	1.75	2.35



**Fig: 6 Split tensile strength at replacement of 90% of cement with 10% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

**Table: 8 Split tensile strength at 7 days, 28 days for partial replacement of 80% of cement with 20% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)**

MIX	Percentage replacement of cement	Percentage replacement of C.A	Split tensile strength in N/mm <sup>2</sup>	
	% of Cement +% of Fly ash	% of C.A +% (SCS)	7 days	28 days
M5	80% C+20% F.A	90% C.A+10% SCS	2.23	3.75
M6	80% C+20% F.A	80% C.A+20% SCS	3.15	4.80
M7	80% C+20% F.A	70% C.A+30% SCS	2.89	3.93

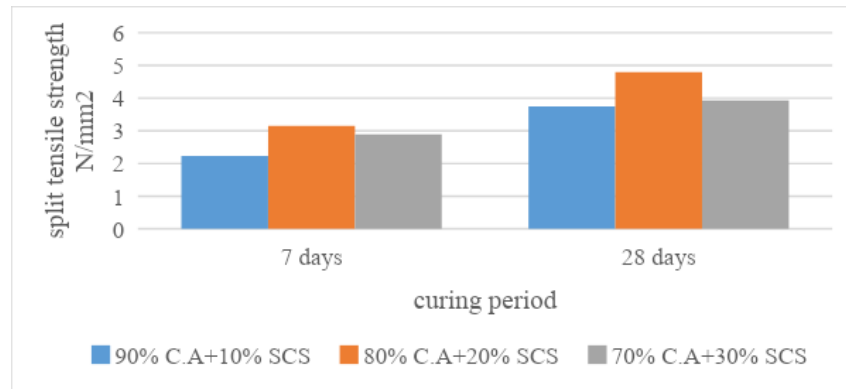


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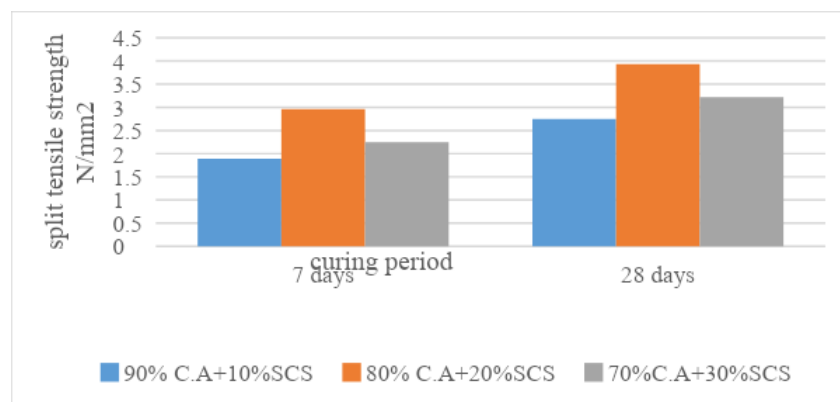
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**Fig: 7** Split tensile strength at replacement of 80% of cement with 20% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)

**Table: 9** Split tensile strength at 7 days, 28 days for partial replacement of 70% of cement with 30% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)

MIX	Percentage replacement of cement	Percentage replacement of C.A	Split tensile strength in N/mm <sup>2</sup>	
	% of Cement+% of Fly ash	% of C.A+% (SCS)	7 days	28 days
M8	70% C+30% F.A	90% C.A+10%SCS	1.89	2.75
M9	70% C+30% F.A	80% C.A+20%SCS	2.96	3.93
M10	70% C+30% F.A	70% C.A+30%SCS	2.25	3.22



**Fig: 8** Split tensile strength at replacement of 70% of cement with 30% fly ash and partial replacement of C.A with Shabath crushed stones (SCS)



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## VI. CONCLUSION

Based on the test results the following conclusions were drawn

- The replacement of cement with fly ash and coarse aggregates with shabath crushed stones increased the compressive strength by 1% compared to conventional concrete.
- The split tensile strength is also slightly increased compared to conventional concrete.
- The 20% replacement of fly ash to cement and 20% replacement of shabath crushed stones to coarse aggregates are effective and increased both compressive strength & split tensile strength.
- Therefore, 20% replacement of shabath crushed stones as coarse aggregates & 20% replacement of fly ash as cement achieves good strength.
- The Mix is Eco-friendly, since it consumes large amount of solid waste and reduces the risk of disposal of harmful industrial wastes onto the ground and avoids dumping problems.

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