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Experimental Investigation on Mechanical Properties of Concrete with Sludge Waste and Silica Fume

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Abstract:

The present investigation aims to evaluate and compare the mechanical and durability properties of binary composite of cement concretes made from Ordinary Portland cement (OPC) blended with sludge waste and silica fume. Compressive strength test, tensile strength test, flexural test and coefficient of water absorption, is conducted on 28 and 90 days. The salient features of the findings are binary composite of cement concrete showed better compressive strength and same reduced the tensile strength. Samples of concrete (eg.cubes) are made in M20 grade. It is found that 0.55 water/cement ratio produced higher compressive strengths, tensile strength and better workability for M20 mix, proportion. Specifically compressive strength ranged from 18.81 -45 N/mm^2 for the mixes considered. These results compare favourably with those of conventional concrete. The concrete was found to be suitable for use as structural members for buildings and related structures, where sludge waste content did not exceed 50%.

Key words: composite cements, compressive strength, tensile strength flexural strength, coefficient of water absorption.

I. INTRODUCTION

In construction field civil engineering's facing lot problem in world due to available of materials contractor, labour, skill person, etc.. Now a day's widely facing materials problem such as river sand. The recently developed M – Sand, eco sand, silica sand, bottom ash partially or fully replaced by river sand. Sewage sludge is the residual, semi-solid material that is produced as a by-product during sewage treatment of industrial or municipal wastewater. The term "septage"

also refers to sludge from simple wastewater treatment but is connected to simple on-site sanitation systems, such as septic tanks. In this paper reported that the addition of dry sludge using in concrete the compressive strength, tensile strength and flexural strength increasing value up to 15% of sludge waste. The dry sludge waste increased above 15% reduces the compressive strength, tensile strength and flexural strength and also increased water absorption of concrete specimen [1]. In this paper reported that the mechanical strength is decreased in reinforced concrete structures with the addition of 10% sludge waste. The sludge waste gradually increased in concrete materials, the workability performance, mechanical performance decreased and durability performance also increased [2]. The sludge waste partially replaced by fine aggregate. The various percentages using in concrete such as 5% , 10% 15% and 20%. The increased sludge waste up to 20%, the strength will be increased .above 20% the strength also decreased [3]. Rice husk ash (RHA) is an agro-waste material abundantly available in all rice producing countries. Today, more than 70 countries, mainly China, India, Indonesia and Bangladesh, produce rice worldwide. Rice husk ash is approximately 20% of the RH. ie. The total worldwide production of RHA was found to be 20 million metric tons. RHA is one of the byproducts of rice, a major food material of most of the developing countries, which is amenable for converting it as an value added product. It is reported that for every ton of rice produces, ~0.23 tons of RH, which on combustion produces about 0.04 tons of ash [4,5]. Nowadays, the rice-producing countries are challenged by the problem of disposing off the rice husk, and have been trying to use it in an economical manner [4].The chemical composition of RHA is found to vary from sample to sample. A number studies have reported [5, 6] the chemical composition of RHA obtained in different parts of the world. It is interesting to note that most of them report that the organic content in RH is 72% of the husk by weight, but with the wide variation of the constituents such as cellulose, moisture content and ash as expected with any natural material.

AIM OF THE STUDY

Partially replacement of cement by sludge waste and silica fume. The study is mainly done to find the compression strength and tensile strength and economy in practice.

II .EXPERIMENTAL INVESTIGATION

2.1 Materials

2.1.1 Cement: Portland pozzolanic cement 53 grade conforming to IS 8112 – 1989, and specific gravity of cement is found to be 3.15. The properties of sludge waste is given in table .1

2.1.2 Sludge waste: sludge waste is partially replacement of cement .it is collected from BIT Coimbatore, The properties of sludge waste is given in table .1

2.1.3 Silica Fume: The cement is partially replaced with silica fume. Steel Authority of India has provided necessary facilities to produce annually about 4000 tons of silica fumes at their Bhadravathi Complex. In India, however, the silica fume of International quality is marketed by Elkem Metallury (P) Ltd. The properties of sludge waste is given in table .1

Table 1: Chemical composition OPC, Silica fume and Sludge Waste

Compound	OPC	Silica fume	Sludge waste
Silicon-di-oxide (SiO_2)%	20–21	85 -97	36.1
Aluminium oxide (Al_2O_3)%	5.2–5.6		14.2
Ferric oxide (Fe_2O_3)%	4.4–4.8		9.2
Calcium oxide (CaO)%	62–63	< 1	14.8
Magnesium oxide (MgO)%	0.5–0.7		2.4
Sulphur-tri-oxide (SO_3)%	2.4–2.8		--
Sodium oxide (Na_2O)%			0.9
Potassium oxide (K_2O)			1.3
Loss on ignition (LOI)%	1.5–2.5		6.1

2.1.4 Fine aggregate: Locally available river sand having bulk density 1762 kg /m^3 is used and the specific gravity 2.73 and fineness modulus of river sand is 3.01. The Sieve analysis of River sand is given in table .2

Table 2 .Sieve analysis of River sand

IS sieve designation	River sand% Passing
4.75 mm	98.23
2.36mm	96.85
1.18mm	67.28
600nm	45.26
300um	32.20
150um	9.67

2.1.5 Course aggregate: Considering all the above aspects, blue granite crushed stone aggregate of 12 mm as maximum size and of typical particle shape "average and cubic" are used as the course aggregate for the present investigation. The aggregates are tested as per the procedure given in BIS: 2386- The bulk density of coarse aggregate 1690 kg/m2 and the specific gravity 2.78 and fineness modulus of coarse aggregate 6.43 . The properties of coarse aggregate is given in table .1

III. EXPERIMENTAL PROCEDURE

The mix ratio is prepared for 1:1.5:3 , for all mixes such as conventional concrete , OPC + SAND + sludge waste , OPC + SAND + silica fume and binary combination .The cement portion of the mix is achieved by combining sludge waste and silica fume in ratio with 10 % , 15 %, 20% , 25% & 30 % and 2 % 4 % ,6 % 8 % & 10 % . The materials are then mixed thoroughly before adding the prescribed quantity of water and then mixed further to produced fresh concrete. Water cements ratios of 0.55 were adopted. The specimen is prepared for compressive and tensile strength for cube size (150 x 150 x 150 mm and cylinder 150mm diameter, 300mm depth. Totally 144 cubes and 144 cylinders are made. The specimens are tested for 7 days, 14 days and 28 days with each proportion of conventional and binary combination of sludge waste and silica fume.

4. RESULTS AND DISCUSSION

4.1 Compressive Strength:

The test is carried out conforming to IS 516 -1959 to obtain compressive strength of concrete at the 7days, 14 days and 28 days. The cubes are tested using 400 tonne capacity HELICO compressive testing machine (CTM) .The results are presented in Fig.1, 2, and 3

Table 3: 7,14 ,28 days Compressive Strength of concrete

Systems	Compressive Strength (N/mm^2)		
	7 - days	14 days	28 days
OPC	14.5	19.8	22
OPC+10% sludge waste	18.2	22.5	25
OPC+15% sludge waste	19.1	22.5	25

OPC+20% sludge waste	17.1	19.8	22
OPC+25% sludge waste	16	18	20
OPC+30% sludge waste	14.2	16.2	18
OPC+2 % silica fume	17.1	18.9	21
OPC+4 % silica fume	19	20.7	23
OPC+6 % silica fume	17.5	18	20
OPC+8 % silica fume	15	15.3	17
OPC+10 % silica fume	12	11.7	13
OPC+10% sludge waste+ 2 % SF	18	21.6	24
OPC+15% sludge waste+ 4 % SF	16.5	19	22
OPC+20% sludge waste+ 6 % SF	18.2	17.9	21
OPC+25% sludge waste+ 8 % SF	15.2	16.7	17
OPC+30% sludge waste+ 10 % SF	14.1	13.6	14

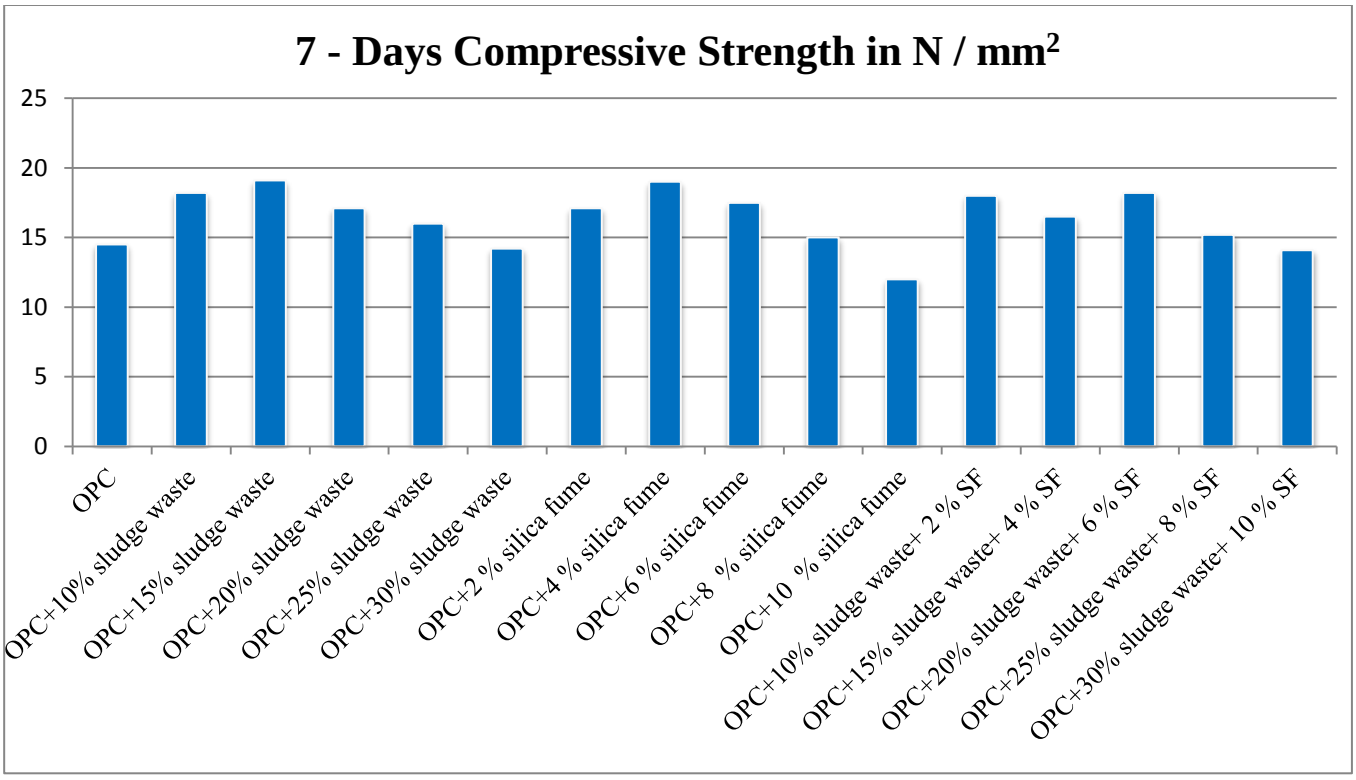

Figure: 1 7 – Days compressive strength of concrete.

The 7- days Compressive strength data obtained for sludge waste (10% to 25%) , silica fume (4 to 6 %) and binary combination 20 % of sludge waste and 2 % of silica fume replaced concretes are reported in Table 2. The 7 days compressive strength obtained for OPC+10 % sludge waste and OPC+15% sludge waste is 18.2 N/mm2 and 19.1 N/mm^2 respectively and binary combination OPC+20% sludge waste+ 6 % SF is 18.1 N/mm^2. The replacement of cement by OPC+15% sludge waste and OPC+4 % silica fume showed higher Compressive strength values compare with other mixes. OPC+10% sludge waste, OPC+20% sludge waste+ 6 % SF and OPC+10% sludge waste+ 2 % SF mixes also shows the compressive strength value is more or less. The OPC+10 % silica fume 20 % of compressive strength is reduced compare with control concrete specimen. The 7 –Day's compressive results are shown in Figure .1 and Table .3

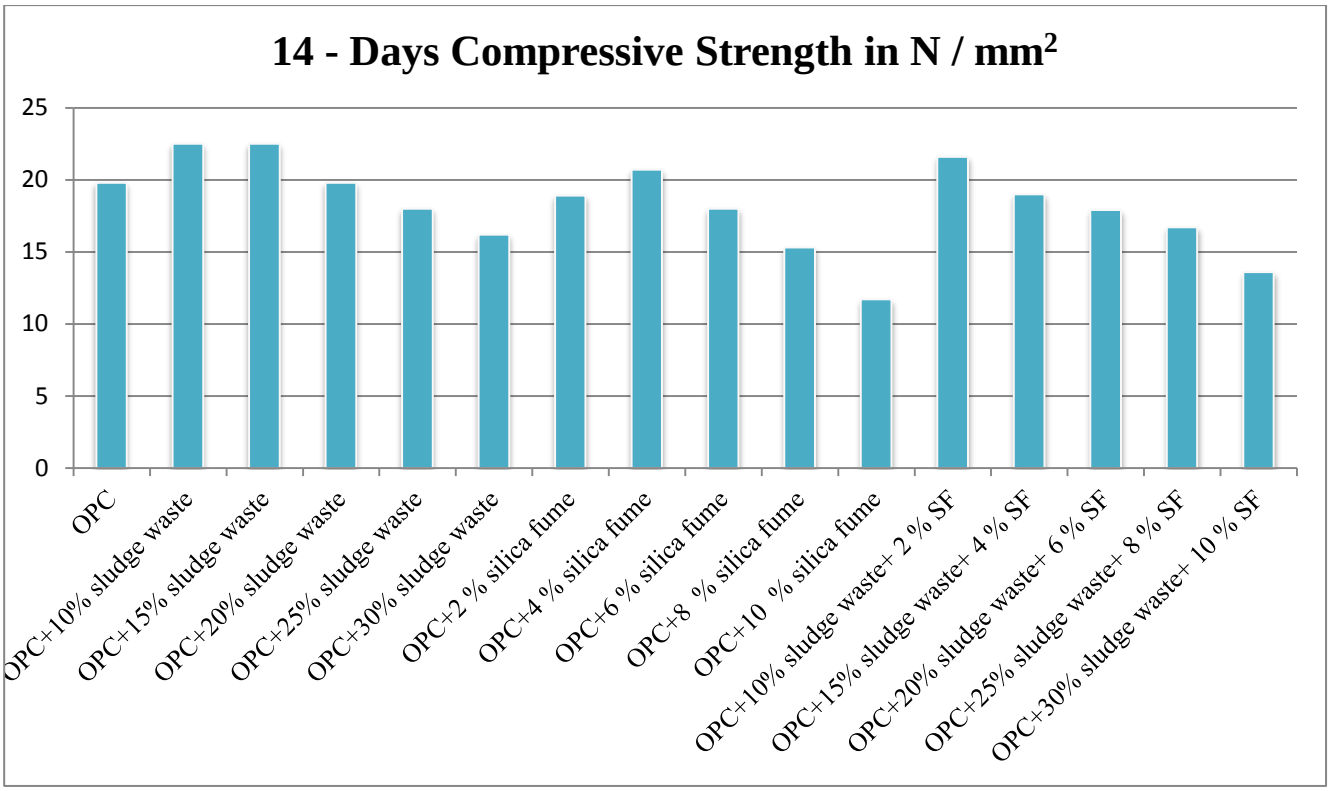

Figure: 2 1 4 – Days compressive strength of concrete

The 14 days compressive strength obtained for OPC+10 % sludge waste and OPC+15% sludge waste is 22.5 N/mm2 respectively and binary combination OPC+15% sludge waste+4 % SF is 21 N/mm^2. The replacement of cement by OPC+10% sludge waste, OPC+15% sludge waste, OPC+4 % silica fume and OPC+10% sludge waste + 2 % of silica fume shows higher Compressive strength values compare with other mixes. OPC+20% sludge waste, OPC+25% sludge waste+ 6 % SF and OPC+15% sludge waste+4 % SF mixes also shows the compressive strength value is more or less.

The OPC+10 % silica fume 22 % of compressive strength is reduced compare with control concrete specimen. The 14 –Day's compressive results are shown in Figure .2 and Table .3

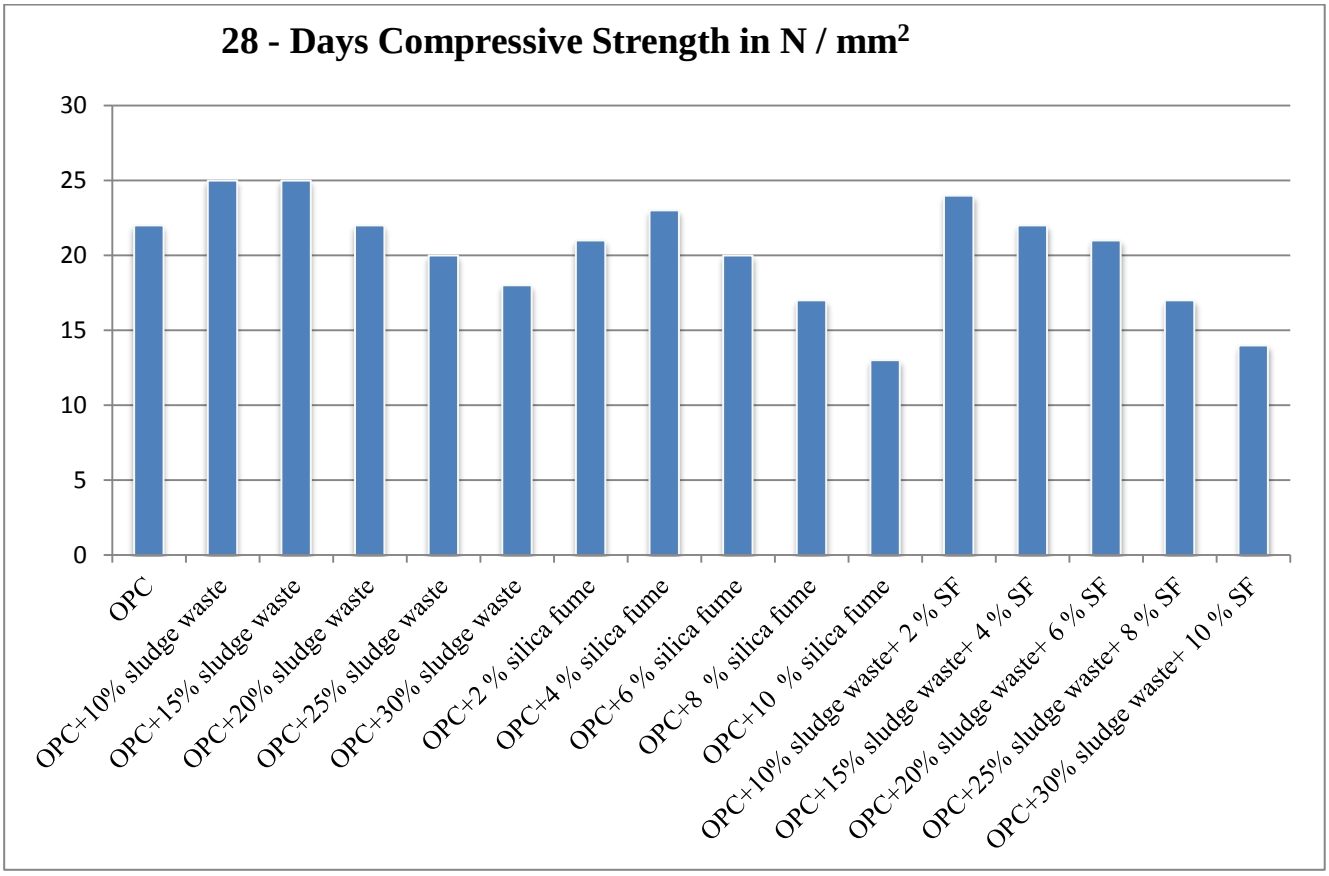

Figure: 3 28 – Days compressive strength of concrete

The 28 days compressive strength obtained for OPC+10 % sludge waste and OPC+15% sludge waste is 25 N/mm2 respectively and binary combination OPC+10% sludge waste+2 % SF is 24 N/mm^2. The replacement of cement by OPC+10% sludge waste, OPC+15% sludge waste, OPC+4 % silica fume and OPC+10% sludge waste + 2 % of silica fume shows higher Compressive strength values compare with other mixes. OPC+20% sludge waste, OPC+25% sludge waste+ 6 % SF and OPC+15% sludge waste+4 % SF mixes also shows the compressive strength value is more or less. The OPC+10 % silica fume19.2 % of compressive strength is reduced compare with control concrete specimen. The 14 –days compressive results are shown in Figure .3 and Table .3

4.2 Tensile Strength

The test is carried out conforming to IS 516 -1959 to obtain tensile strength of concrete at the 7 days, 14 days and 28 days. The cylinders are tested using 400 tonne capacity HELICO compressive testing machine (CTM) .The results are presented in Fig.3

Table 4 : 7 , 14 ,28 days Tensile Strength of concrete

Systems	Tensile Strength (N/mm^2)		
	7 - days	14 days	28 days
OPC	1.65	2.02	2.14
OPC+10% sludge waste	1.89	2.85	3.10
OPC+15% sludge waste	1.95	2.14	2.73
OPC+20% sludge waste	1.84	2.19	2.70
OPC+25% sludge waste	1.69	2.12	2.53
OPC+30% sludge waste	1.87	1.70	1.90
OPC+2 % silica fume	1.69	1.69	1.54
OPC+4 % silica fume	1.89	1.98	2.07
OPC+6 % silica fume	2.10	2.02	2.26
OPC+8 % silica fume	1.85	2.23	2.22
OPC+10 % silica fume	1.79	2.03	1.92
OPC+10% sludge waste+ 2 % SF	1.89	1.86	1.82
OPC+15% sludge waste+ 4 % SF	1.72	1.87	1.92
OPC+20% sludge waste+ 6 % SF	1.81	2.03	1.87
OPC+25% sludge waste+ 8 % SF	1.92	1.94	2.01
OPC+30% sludge waste+ 10 % SF	1.69	1.74	2.03

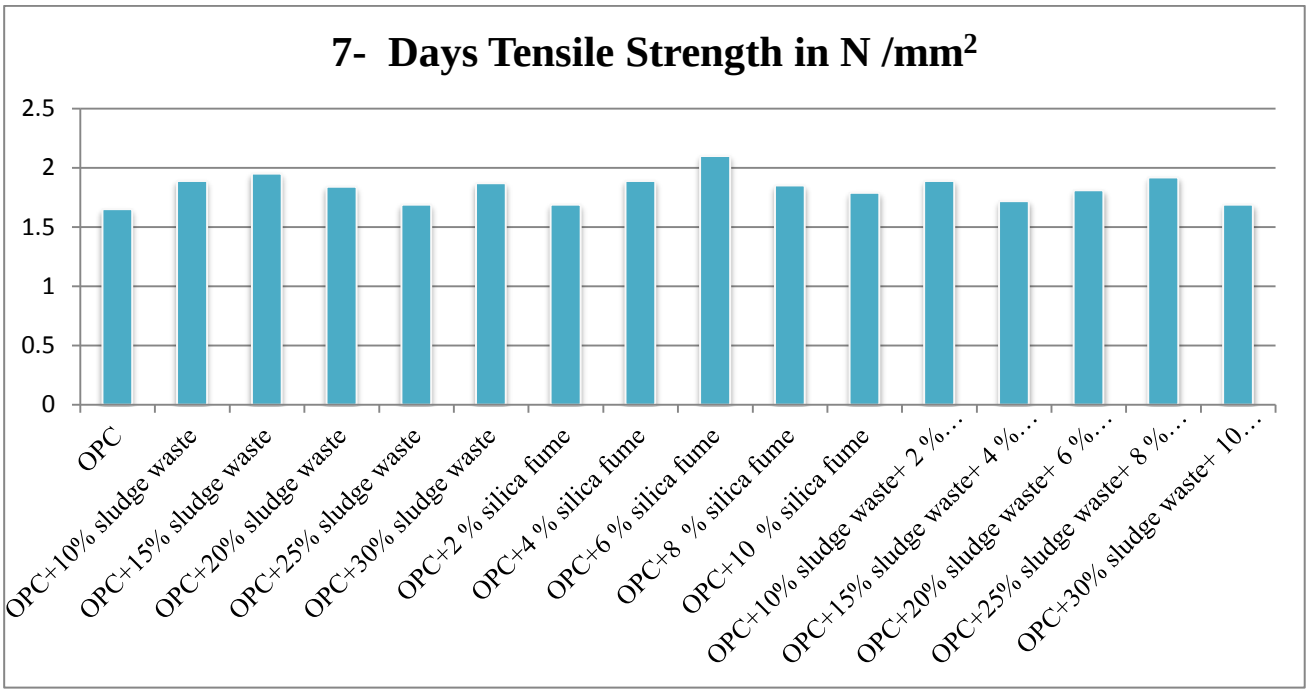

Figure: 4 7 – Days tensile strength of concrete

The 7 - days tensile strength of conventional concrete, OPC+10% sludge waste , OPC+15% sludge waste and OPC+6 % silica fume concrete 14.54 % ,18.18 % and 27.27% of tensile strength is increased when compared to the conventional concrete which is found that M20 mix ratio. The binary combination of OPC+25% sludge waste+ 8 % SF tensile strength is higher than the conventional concrete specimen. OPC+10% sludge waste+ 2 % SF, OPC+ 4 % silica fume , OPC+ 8 % silica fume and OPC+30% sludge waste is more or less same having M20. The Results of this test are show in Table .4 and Figure .4

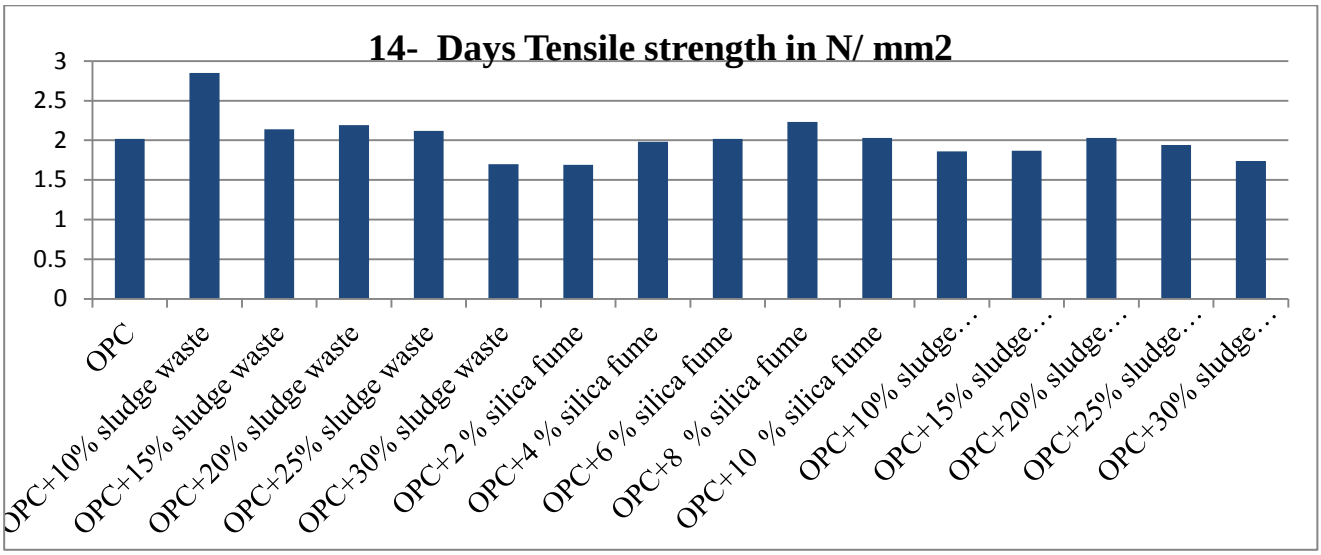

Figure: 5 14 – Days tensile strength of concrete

The 14- days tensile strength of conventional concrete, OPC+10% sludge waste , OPC+20% sludge waste and OPC+6 % silica fume concrete 41.08 % , 8.18 % and 11.27% of tensile strength is increased when compared to the conventional concrete which is found that M20 mix ratio. The binary combination of OPC+20% sludge waste, OPC+ 6 % SF tensile strength is higher than the conventional concrete specimen. OPC+10% sludge waste+ 2 % SF, OPC+ 4 % silica fume , OPC+ 6 % silica fume and OPC+25% sludge waste is more or less same having M20. OPC+30% sludge waste and OPC+ 2 % SF concrete specimen 39.31% and 37.52% is tensile strength reduced compare with conventional concrete. The Results of this test are show in table .8

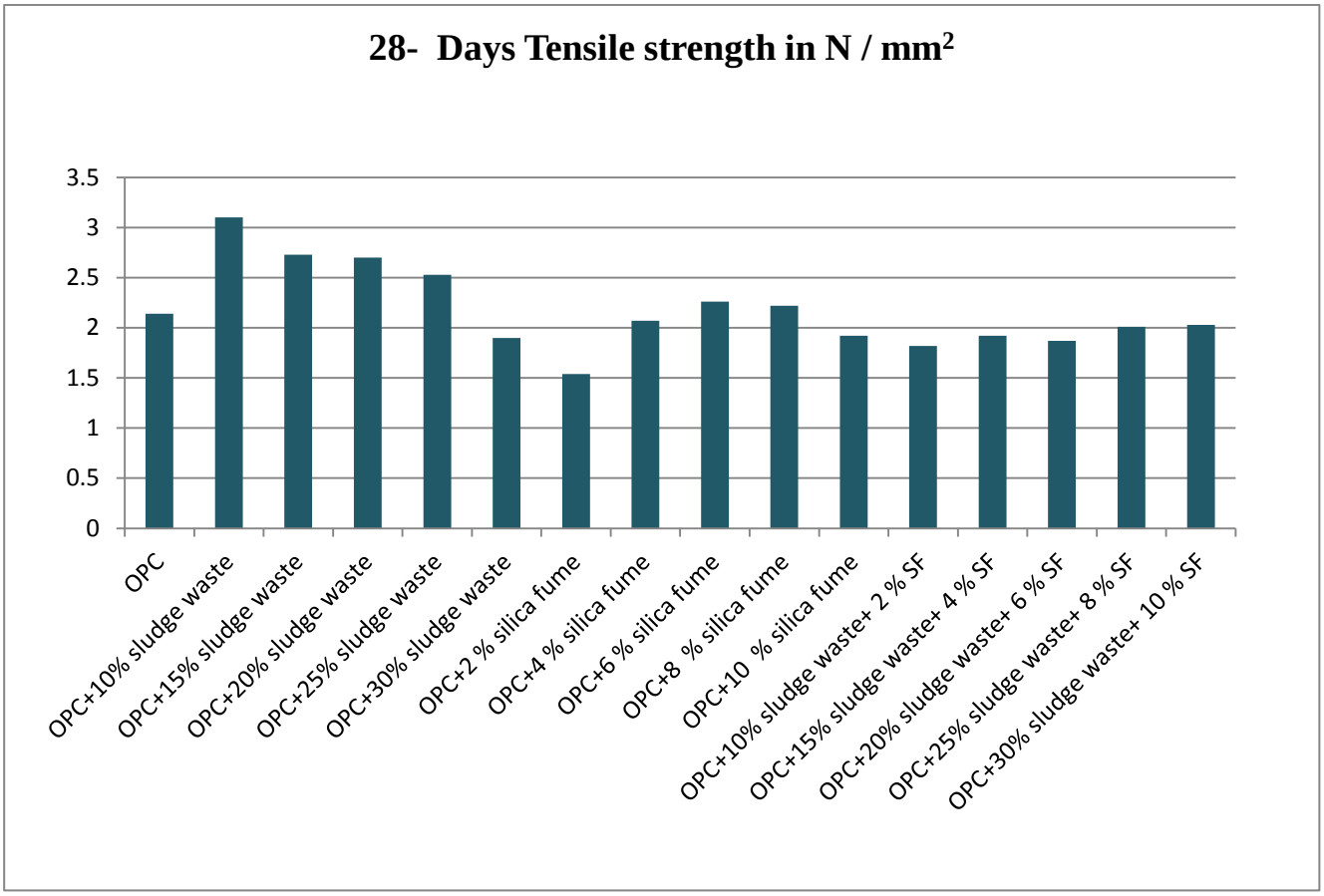

Figure: 6 28– Days tensile strength of concrete

The 28- days tensile strength of conventional concrete, OPC+10% sludge waste , OPC+20% sludge waste and OPC+6 % silica fume concrete 44.54 % , 18.18 % and 8.12.27% of tensile strength is increased when compared to the conventional concrete which is found that M20 mix ratio. The binary combination of all mixes having tensile strength is more or less same. The Results of this test are show in table .4

V. CONCLUSION

- The partially replacement of sludge waste by cement, the compressive strength and tensile strength is increased about 10% to 40% in replacement of 10 % to 15% of sludge waste.
- The binary combination OPC+10% sludge waste+2 % SF gives better compressive strength compare with other mixes.
- The OPC+10 % silica fume 19.2 % of compressive strength is reduced compare with control concrete specimen.

References

1. Bharat Nagar (etal) 2016 “Experimental Study On Effects Of Sludge Waste In Concrete” international journal of engineering sciences & research technology ISSN: 2277-9655.
2. A.YagüeS.Valls (etal) 2005 “Durability of concrete with addition of dry sludge from waste water treatment plants” Cement and Concrete Research Volume 35, Issue 6, June 2005, Pages 1064-1073.
3. Srinivasan (etal) 2016 “Replacement Of Fine Aggregate Using Sludge In Concrete” International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 - 0056 Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072.
4. S.Chandra, Waste materials used in concrete manufacturing – Noyes publications (1997), Ed. Satish Chandra, William Andrew Applied Science Publishers.
5. S.Das, T.K.Dan, S.V.Prasad, P.K.Rohatgi, Aluminium alloy – rice husk ash particle composites, *J. of. Mat. Sci. Lett*. 5 (1986) pp.562-564.
6. P.K.Mehta, Structure, properties and materials, N.J.Englewood Cliffs: Prentice-Hall, 1986.