International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 10 | Oct 2022 www.irjet.net p-ISSN: 2395-0072

STUDY ON COMBINATION OF HYPO SLUDGE AND SILICA FUME AS A PARTIAL REPLACEMENT TO CEMENT IN CONCRETE

S Vijaya[1], Sneha S D[2], Ashwin C A[3]

[1] *Dr. S Vijaya, Professor&HOD, Dept. Of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India*
[2] *Sneha S D, Assistant Professor, Dept. Of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India*
[3] *Ashwin C A, Assistant Professor, Dept. Of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India*

Abstract - *Concrete is the construction material which is used to a great extent than any other construction material. For a greener and sustainable future we have to develop innovative ways to save non renewable resource and mitigate carbon foot print which is caused by large scale cement production for concrete. Therefore, researches are going on in replacing the cement with alternate industrial waste which has cementitious properties. Hypo sludge is a paper industry waste which consumes a large percentage of local landfill space and is a source of environmental pollution. It has cementitious properties due to the presence of alumina, silica, magnesium and lime content. It contains less amount of silica which may reduce the strength of concrete, hence in the present work, silica fume is being used along with the hypo sludge as partial replacement of cement. Experimental investigation is carried out on strength of concrete and optimum percentage of the partial replacement of Hypo sludge and silica fume to cement for M25 grade concrete. The result shows that samples containing 20% silica fumes with 5% hypo sludge and 15% silica fumes with 10% hypo sludge give the strength equivalent to conventional M25 concrete.*

***Key Words*: Sustainable concrete, Green concrete, Carbon foot print, Hypo sludge, Silica fume.**

1. INTRODUCTION

Environmental sustainability means to strike the ecological balance by avoiding the depletion of natural resources that is usage of renewable resources has to be increased and depletion of non renewable resources has to be taken care. Concrete is the construction material which is used to a very large extent when compared to other construction materials. Concrete production involves usage of natural resources, which is causing a lot of negative impact on the environment. Portland cement is a major component in concrete which is made from natural resources like limestone and boulders. A ton of cement production produces 1.25 tons CO_2, so we need to find a better alternative material to replace the cement. Various pozzolonic industrial wastes such as fly ash, silica fume, GGBS, metakoline, Hypo sludge etc. can be substituted to cement at different percentages in concrete production to minimize the problems of disposal and pollution from these industrial waste.

1.1 Hypo Sludge

Paper mills generally produce a large amount of solid waste. This waste generated by sedimentation process contains broken, low-quality paper fibres which are also known as paper sludge. If the concentration of paper sludge is more it will contaminate groundwater. Some companies burn their sludge which contributes to air pollution.

As population increasing, natural resources are getting reduced to meet the demand of cement production. On the other side dumping of wastes produced from industries causes a major environmental issue. By using this Hypo Sludge as a partial replacement of cement above said issues can be addressed. Meanwhile, the price of cement was also gradually increasing every day, Hence hypo sludge waste if used decreases cost of concrete.

Hypo sludge is a new trend amongst other pozzolonic material, the main reason is it consists of little calcium, more calcium chloride, alumina, silica, magnesium and lime which contributes to the strength of concrete similar to OPC. The magnesium and silica enhance the property of setting time of the concrete. It also contains china clay, calcium carbonate, residual chemicals and cellulose fibers mixed with water.

1.2 Silica fumes

Silica fume (SF) is a by-product of the smelting process in the production of silicon and ferrosilicon alloys. It is also by-product in the production of other silicon alloys such as Ferro manganese, Ferro-magnesium, Ferro-chromium, and calcium silicon. It contains extremely fine amorphous particles of silicon dioxide (SiO_2) which usually make up more than 90% of SF constituents. Because of its extreme fineness and high silica content, has been recognized as a pozzolanic material conforming to specifications of ASTM C1240 for use as supplementary cementitious material in cement mortar and concrete to enhance mechanical and durability properties.

1.3 Objectives

To investigate the utilization of Hypo Sludge and Silica fume as supplementary cementitious materials and influence of them in combination on the Strength of concrete at various percentages of replacement with cement, following objectives are set;

1. To access the compressive strength of concrete with different percentage of hypo sludge and silica fume at 7, 14 and 28 days of curing.

2. To arrive at optimum percentage of replacement of hypo sludge and silica fume to cement.

3. EXPERIMENTAL PROGRAM

This work is concerned with experimental investigation on strength of concrete and optimum percentage of Hypo sludge and silica fume in combination as partial replacement to cement for M25 grade concrete. Cubical samples of concrete by replacing 25% of cement with different proportion of Hypo sludge and silica fume as shown in table-1 were casted. 3 cubes were casted in each set for 7, 14 and 28 days of curing. Compressive strength test was conducted for the curing period of 7, 14 and 28 days.

Table -1: Proportions for different sets

Set No.	Cement %	Hypo sludge %	Silica fumes %
1	100	0	0
2	75	0	25
3	75	5	20
4	75	10	15
5	75	15	10
6	75	20	5
7	75	25	0

2.1 Materials used

2.1.1 Cement

Ordinary Portland cement of 53 grades is used. Initial setting time of cement of 30 minutes, Specific gravity of 3 and Fineness Modulus of 7% were the resulted obtained after testing the sample of cement.

2.1.2 Hypo sludge

Hypo sludge was sourced from Mysore paper mills. Specific Gravity of 2.12 and Fineness modulus of 20% were the resulted obtained after testing the sample.

Table-2: Chemical composition of hypo sludge obtained from paper mill

Sl. No.	Component of Hypo Sludge	% in Hypo Sludge
1.	Silicon dioxide (SiO_2)	9.27
2.	Aluminium oxide (Al_2O_3)	1.45
3.	Iron oxide (Fe_2O_3)	1.60
4.	Calcium Oxide (CaO)	29.83
5.	Magnesium Oxide (MgO)	4.28
6.	Loss on Ignition	49.24

2.1.2 Silica fumes

Silica fumes were purchased online. Specific gravity of 2.3 and Fineness modulus of 2% were the resulted obtained after testing the sample

Table-3: chemical composition of Silica fumes obtained from seller

Sl. No.	Ingredients	% in Silica Fume
1	Silicon dioxide (SiO_2)	90
2	Aluminium oxide (Al_2O_3)	2.18
3	Iron oxide (Fe_2O_3)	2.2
4	Calcium Oxide (CaO)	1.52
5	Magnesium Oxide (MgO)	0.9
6	SO3	1.2
7	Alkalies (K_2O, Na_2O)	2

2.1.3 Natural Fine aggregate

The natural sand available in the vicinity is used in the present research work. It confirms to Zone 2 as per IS 383-2016.

Table-4: Physical properties of natural fine aggregates obtained from tests conducted

Sl. No.	Properties	NFA
1.	Specific gravity	2.6
2.	Water absorption	2%
3.	Gradation	Well graded
4.	Fineness modulus	4.2

2.1.4 Coarse aggregate

The coarse aggregates of 20mm downsize and 12mm downsize in the ratio of 60:40 were used for this research works.

Table-5: Physical properties of coarse fine aggregates obtained from tests conducted

Sl. No.	Properties	Natural aggregate	coarse	As per IS:383	-(1970)
1.	Specific gravity	2.8		-	
2.	Water absorption	0.7%		-	
3.	Impact value	31.11%		< 45% for concrete	
4.	Crushing value	21.33%		< 45% for concrete	

2.1.6 Water and super plasticizer

Casting and curing of specimens were done with the portable drinking water.

For this investigation Conplast SP430 was used. It is a brown liquid of specific gravity 1.21. The adopted dosage is 1.2 % of weight of cement and the percentage of reduction of water in concrete mix is 10%.

2.2 Mix proportion

Mix design was done for M25 grade concrete as per IS10262: 2009.

Table-6: Quantity of materials obtained per m^3 of concrete

Sl. No.	Materials	Quantity
1	cement	407 kg/m^3
2	fine aggregate	619.95kg/m^3
3	coarse aggregate	1200.341kg/m^3
5	water	177.44kg/m^3
6	super-plasticizer	1.2%

Table-7: Final mix proportion

Cement	F A	C A	W/c
1	1.52	2.95	0.44

3. RESULTS AND DISCUSSION

3.1 Compressive strength test

150 x 150 x 150 mm cube were casted, cured for 7, 14, 28 Days and compressive strength test was conducted as per IS code for M25 grade concrete. Results are as shown in Table-8.

Table-8: Compressive strength in N/mm^2 obtained for various set

Proportion	7 days	14 days	28 days
SET 1	20.99	24.23	32.33
SET 2	12.58	21.39	29.20
SET 3	15.73	22.77	31.17
SET 4	18.71	20.59	30.16
SET 5	16.08	18.21	26.47
SET 6	8.43	13.06	20.47
SET 7	9.80	13.28	21.81

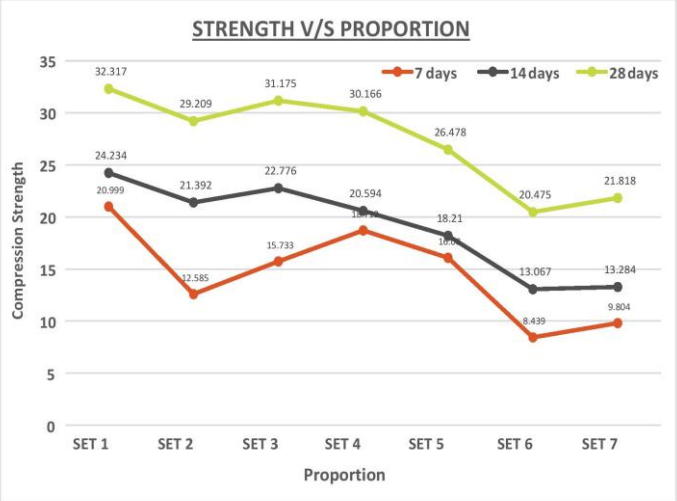

Chart -1: Graph of compressive strength for different sets at 7, 14 and 28 days of curing

From the results obtained we can observe that, strength for all the sets increases with the increase in curing period. Strength obtained for SET 3 (75%C, 5% HS, 20%SF) and SET 4 (75%C, 10% HS, 15%SF) are equivalent to the reference concrete (SET 1) and are above target mean strength for M25 grade concrete at 28 days of curing, that is 31.17 Mpa and 30.16 Mpa for set 3 and set 4 respectively.

Also as the percentage of Hypo sludge increases, the compressive strength of the concrete decreases due to the impurities present in the hypo sludge like free lime, loss in ignition, and other raw materials.

4. CONCLUSION

Based on the results and discussion the following conclusions can be drawn

1. Concrete with 20% silica fumes with 5% hypo sludge and 15% silica fumes with 10% hypo sludge gives the compressive strength equivalent to conventional M25 concrete.

2. As Hypo sludge percentage increases beyond 10%, compressive strength decreases irrespective of curing period.

3. From this work we can conclude that the optimum percentage of hypo sludge as a replacement to cement is 10% in concrete along with silica fumes.

4. The sets with different percentages of Hypo sludge(set 1 to 6) gives same workability as that of referral mix but for the mix with 25% of silica fume (set 7) to achieve desired workability 1.2% of Super plasticizer was used.

REFERENCES

[1] Mahesh Kumar Sahu, 'Study Of Partial Replacement Of Cement With Hypo sludge',*IJMR*, Vol 7,Issue 7,july 2021.

[2] V Mallikarjuna Reddy, B Sharada "Performance Of Concrete By Using Hypo Sludge As A Mineral Admixture", *ICMED* ,Vol 4,Issue 7 ,2020.

[3] K.P Ravikumar, A.Anita,P.Priya, "Experimental Investigation Concrete With Partial Replacement of Cement by Using Hypo sludge and Silica fume",*IJSDR*,Vol 5, Issue 4,April 2020.

[4] Santosh Ahirwar, Dr.Rajeev Chandak, "Effective Use of Paper Sludge in Concrete",*IJEDR* Vol 6,Issue 2,2018.

[5] Y.Suneelkumar,K.J. Brahma chari and Dr.N.Srujana, "Effect Of Strength Parameters In Concrete With Partial Replacement Of Cement Using Hypo sludge By Adding FibrES",*IJCIET*,Vol 8,Issue 4,April 2017.

[6] Shakir Ahmed, Mohammad Mannal Kaleem, Muhammad Bilal Zahid, "Use of Paper Industry Waste in Design Mix Concrete",*IJERT*,Vol 6,Issue 6,2017.

BIOGRAPHIES

Dr. S Vijaya, Professor&HOD,
Dept. Of Civil Engineering,

Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India

Sneha S D, Assistant Professor,
Dept. Of Civil Engineering,

Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India

Ashwin C A, Assistant Professor,
Dept. Of Civil Engineering,

Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India