

## Experimental Study on Partial Replacement of Cement by Hyposludge in Concrete

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Abstract:

The global cement industry contributes about 9% of greenhouse gas emission to the earth's atmosphere and industrial wastes are being produced by 420 million tonnes per annum by chemical process in India. In order to reduce cement manufacturing and disposal problem of paper waste, there is a need to develop alternative binders in construction field. Utilization of industrial waste products as Supplementary Cementitious Material (SCM) in concrete is very important aspect in view of economical, environmental and technical reasons. This work examines by using paper waste (hypo sludge) as partial replacement of cement & it is most essential to develop profitable building materials from hypo sludge. It is directed towards developing low cost concrete and light weight concrete from paper industry waste. The use of hypo sludge in concrete formulations as SCM was tested as an alternative traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength and split tensile strength up to 7 days and 28 days. In this work, M30 grade concrete was developed by replacing cement via 10%, 15%, 20%, 25% and 30% of hypo sludge. The strength on concrete made with hypo sludge are compared with normal concrete.

**Keywords:** Cement, hypo sludge, M<sub>30</sub> grade concrete, compressive strength, split tensile strength

### I. INTRODUCTION

Paper waste (hypo sludge) is a waste from paper and board industry. It is estimated that in India, 0.7% of total urban waste generated comprises of paper waste. Paper sludge is a major economic and environmental problem for the paper industry. Paper sludge varies with strong and weak fibres. Strong fibres of waste are taken for the recycling process to make recycled paper and the weak fibres are taken to the disposal site. Due to this disposal, it causes a severe problem of air pollution, water pollution and soil pollution. To reduce the disposal problem, paper sludge is replaced with cement where paper waste behaves like cement because of silica and magnesium properties which improve the setting time of cement. Hypo sludge was originally introduced as artificial pozzolana in which it consists of minimum amount of

silica, magnesium, considerable amount of lime which is the main property of cement. Hypo sludge is used as a replacement in producing mortar and was investigated on its mechanical, physical and chemical properties. Substitution of waste materials will conserve resources and will avoid environmental and ecological damages caused by quarrying and exploitation of raw materials for making cement. There is an increasing demand for concrete worldwide at low cost, by producing this concrete it will reduce the demand of concrete and reduce the emissions of CO<sub>2</sub> from cement industry. This project concisely explains the technical and environmental benefits of supplementary cementitious materials use and study the design parameters of concrete on inclusion of paper waste as partial replacement of cement.

### Benefits of Hypo sludge

- Environmental friendly
- Hypo sludge improves the setting of concrete due to presence of silica and magnesium.
- Hypo sludge is a light weight compare to conventional concrete.
- Hypo sludge improves the properties of fresh and harden concrete.

### Limitations

- Availability of hypo sludge
- Handling problem

### Scope of this project

- To control the environmental pollution.
- To produce low cost concrete.
- Economical and profitable substitute to landfills, incinerator.

## II.MATERIALS AND PROPERTIES

### The materials used in research are:

1. Portland Cement ( 53 grade)
2. Fine aggregate(4.75mm down)
- 3.Coarse aggregate(20mm down)
- 4.Hypo sludge
- 5.Water

### Cement

Cement is made by grinding calcined limestone and clay into a very fine, grey powder. Cement is one of the binding agent in this project. The cement and water forms a paste and binds the other materials together. The Ordinary Portland Cement(53 grade) conforming to IS:8112-1989 is being used.Many tests were conducted on cement.



S.no	Property of 53 grade cement	Result
1.	Specific gravity	3.15
2.	Consistency	33%
3.	Initial setting time	30 min
4.	Final setting time	600 min

### Fine aggregate

Fine aggregate used throughout the work comprised of clean river sand with maximum size of 4.75mm conforming to Zone I as per IS 383-1970. Sand is naturally occurring granular material composed of finely divided rock and mineral particles The physical properties of fine aggregate like specific gravity, fineness modulus and water absorption are tested in accordance with IS:2386.



S.no	Property	Result
1.	specific gravity	2.6
2.	Fineness modulus	4.67%
3.	Water absorption	1.0%
4.	Gradation	Zone I

### Coarse aggregate

Coarse aggregate consists of crushed granite or basalt rock, conforming to IS:383. Coarse aggregate are used in the size of 20mm. The physical properties of coarse aggregate like specific gravity, fineness modulus and water absorption are tested in accordance with IS:2386



S.no	Property	Result
1.	specific gravity	2.8
2.	Fineness modulus	13.7%
3.	Water absorption	0.5%

### Hyposludge

Hypo sludge is a waste material collected from the paper industry. Hypo sludge behaves like cement because of silica and magnesium properties. It is a good binding chain material for the concrete. The chains also pack regularly in places to form hard, stable crystalline region that gives the bundle chains even more stability and strength. Hypo sludge is used in concrete with the replacement of cement of 10%, 15%, 20%, 25% and 30%. The compressive strength and split tensile strength was also determined in 7 days and 28 days.



### Physical properties of Raw Hypo sludge

S.no	Property	Result
1.	Specific gravity	1.42

### Initial setting time and Final setting time

S.n o	Ingredients	Initial setting (min)	Final setting (min)
1.	Cement +10% hyposludge	31	598
2.	Cement +15% hyposludge	32	597
3.	Cement +20% hyposludge	33	597
4.	Cement +25% hyposludge	33	596
5.	Cement +30% hyposludge	34	595

### Chemical properties of hypo sludge

S.no	Constituent	Present in hypo sludge (%)
1.	Moisture	56.8
2.	Magnesium oxide (MgO)	4.5
3.	Calcium oxide (CaO)	46.1
4.	Loss on ignescent	27
5.	Acid insoluble	12.12
6.	Silica(SiO <sub>2</sub> )	4.0
7.	R <sub>2</sub> O <sub>3</sub>	3.6

### Comparson of cement and hypo sludge

S.no	Constituents	Cement(%)	Hypo sludge(%)
1.	Lime	62	38
2.	Silica(SiO <sub>2</sub> )	22	12
3.	Alumina	5	1
4.	Magnesium	2	2.9
5.	Calcium sulphate	5	0.85

### Water

Water is the essential ingredient to mix all the components in concrete. The quantity of water used is according to the workability of the

mix. The pH of water used should be from a range of 6.0 to 8.5. Water is required for preparation of cement mix and curing work.. The quality and quantity of has much effect on the strength of cement in concrete. It should be clean and free from impurities such as oil,alkali,acid,etc.. The drinking water should used for the concrete.



### III.DESIGN MIX METHODOLOGY

The concrete mix design was proposed by using IS10262:2009.The grade of concrete used was M30 with water to cement ratio 0.45. The mix design proportions for 1 m<sup>3</sup> of concrete

Hy po slu dg e %	w/c rati o	Cem ent(k g/m <sup>3</sup> )	F.A (kg /m <sup>3</sup> )	C.A( kg/m <sup>3</sup> )	Wa ter (kg /m <sup>3</sup> )	Hypos ludge( kg/m <sup>3</sup> )
0	0.45	425	684	1152	191	-
10	0.45	382	667	1123	191	42.5
15	0.45	361	660	1112	191	63.75
20	0.45	340	650	1096	191	85
25	0.45	318	643	1084	191	106
30	0.45	297	634	1068	191	128

F.A-fine aggregate

C.A-Course aggregate

### IV.EXPERIMENTAL INVESTIGATION

#### Test on fresh concrete

Slump cone test determines the consistency and workability of all concrete mixtures. Slump cone test utilizing a metallic slump mould. The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured.



% of Replacement	Slump cone value (mm)
0%	75
10%	76
15%	76
20%	78
25%	78
30%	78

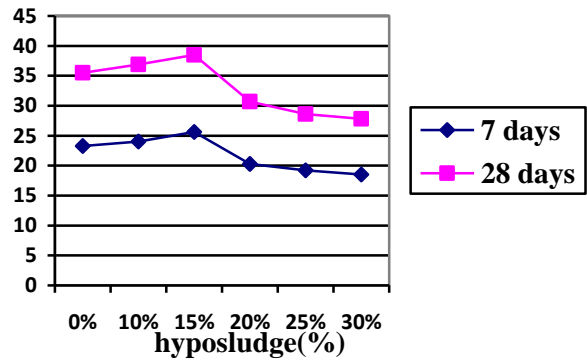
#### Casting of moulds

Casting of conventional concrete of M30 mix ratio and also casting of 10%,15%,20%,25% and 30% replacement of cement by hypo sludge. We casted conventional concrete with M30 mix design, we casted 36 cubes and 36 cylinders of around for conventional concrete of cube size 150mm×150mm×150mm. and cylinder size 150mmφ ×300 mm has been casted for the determination of compressive strength and spilt tensile strength respectively. The concrete specimens were cured under normal conditions as per IS 516-1979 and were tested at 7 days and 28 days for determining compressive strength and spitting tensile strength.



### Compressive strength Test results for cube specimens of size 150mm×150mm×150mm

In this test, the cubes are subjected to compressive force in a compression testing machine and the ultimate load at which the failure occurs is noted. Then the compressive stress is ultimate load by area exposed to load and stress value is obtained in N/mm<sup>2</sup>.



### Splitting tensile strength

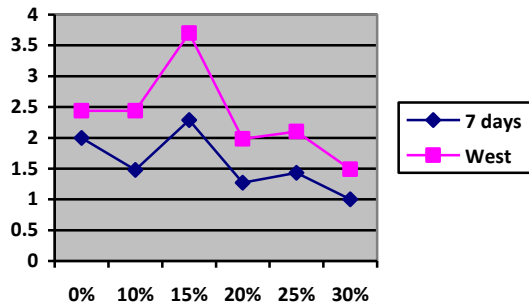
This test is carried out in a cylindrical specimen of 150 mm diameter and 300 mm length. The cylindrical specimen is placed horizontally between the loading surface of a compression-testing machine and the load is applied until failure of cylinder occurs along the vertical diameter. The split tensile strength is given by the formula  $2P / (IDL)$  and the stress value is obtained in N/mm<sup>2</sup>.



S.no	Hypo sludge	Compressive strength at 7 days(N/mm <sup>2</sup> )	Compressive strength at 28 days(N/mm <sup>2</sup> )
1.	0%	23.3	35.5
2.	10%	24	36.9
3.	<b>15%</b>	<b>25.6</b>	<b>38.5</b>
4.	20%	20.3	30.7
5.	25%	19.2	28.6
6.	30%	18.5	27.8

S.no	Hypo sludge	Split tensile strength at 7 days(N/mm <sup>2</sup> )	Spilt tensile strength at 28 days(N/mm <sup>2</sup> )
1.	0%	2	2.44
2.	10%	1.48	2.44
3.	<b>15%</b>	<b>2.29</b>	<b>3.7</b>

4.	20%	1.27	1.98
5.	25%	1.43	2.1
6.	30%	1	1.49



## V.CONCLUSION

Finally we conclude our project with various mixes with curing periods of 7 days and 28 days by partial replacement of cement with hypo sludge. Testing of cubes and cylinder in compression testing machine with capacity of 1000 kN. The compressive strength of concrete increases as the curing period for M<sub>30</sub> grade concrete and the replacement of hypo sludge is done from 0%,10%,15%,20%,25% and 30%. The maximum compressive strength for 7 days and 28 days is achieved for 15% replacement of cement and starts decreasing in strength from 20% to 30%. The maximum split tensile strength for 7 days and 28 days is achieved for 15% replacement of cement and starts decreasing in strength from 20% to 30%. The strength of concrete is attained in 15% replacement of hypo sludge with cement as compare to conventional concrete.

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