AN EXPERIMENTAL STUDY ON CONCRETE WITH PARTIAL REPLACEMENT OF HYPO SLUDGE IN CEMENT

MOHD ABDUL NAYEEM,
Student, Dept of Civil (Structural) Engineering, Shri Shirdi Sai Institute of Science and Engineering, India
nayeemmohd935@gmail.com

P. NAVEEN KUMAR
Assistant professor Dept of Civil (Structural) Engineering, Shri Shirdi Sai Institute of Science and Engineering, India

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 economic, 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. These tests were carried out to evaluate the mechanical properties like compressive strength and spilt tensile strength and flexural strength up to 7 days, 14 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. industrial wastes are being produced per annum by chemical and agricultural process in India. These materials possess problems of disposal and health hazards. The wastes like phosphonyls, fluor gypsum, hypo-sludge and red mud contain obnoxious impurities which adversely affect the strength and other properties of building materials based on them. To reduce disposal and pollution problems emanating from these industrial wastes. it is most essential to develop profitable building materials from them. This project is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement.

***Keywords**: Concrete, Compression Test, Hypo-Sludge, Industrial wastes, Split Tensile Strength*

1.0 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 are 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 are replaced with cement where paper waste behaves like cement because of silica and magnesium properties which improves the setting time of cement Hypo sludge was originally introduce 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 reduces the demand of concrete and reduces the emissions of CO2 from cement industry

Hypo Sludge

Hypo sludge is one of the by- product from the paper industry. The use of these by-products offers environmental advantages divert the material from the waste stream, reduce the energy used in processing virgin materials, use of virgin materials, and decreases pollution. India is a resourceful country for generation of the industrial wastes with an annual output of over 300 million tones, but utilization is still below 20 % in spite of quantum jump in last three to four years. Availability of consistent quality Hypo sludge across the country and awareness of positive effects of using Hypo sludge in the concrete.

Figure 1.1 Hypo sludge

Need For Hypo Sludge Utilization.

While producing paper the various wastes are comes out from the various processes in paper industries. From the preliminary waste named as hypo sludge, due to its low calcium is taken out for our project to replace the cement utilization in concrete. Due to the cement production greenhouse gases are emitted in the atmosphere. For producing 4 million T, of cement 1 million T greenhouse gases are emitted. Also, to reduce the environmental degradation this sludge has been avoided in mass level disposal in land.

SOURCE OF HYPOSLUDGE:

The process of formation of paper from pulp includes the following processes during which the Hypo sludge is formed as waste by- product is purely a chemical waste and do not contain any bio- degradable element**.** Most of the mills are using only woody raw material (bamboo, eucalyptus, casuarinas, poplar and other hardwood species), but some other mills are using bagasse in substantial quantity as raw material. Most of the paper mills in India prepare bleach liquor (calcium hypochlorite) using lime and elemental chlorine. Six mills among eight mills are using ClO2 as bleaching agent either as partial substitution of elemental chlorine or in final stage of bleaching to attain desired brightness level

Objectives:

- To investigate the utilization of Hypo Sludge as Supplementary Cementitious Material (SCM) and influence of this hypo sludge on the Strength of concrete.
- Influence on the cost of concrete made with different Cement replacement levels.
- To study the suitability of supplementary cementitious materials (SCMs) like hypo sludge.
- To find out the optimum percentage of hypo sludge in concrete in the place of cement.
- To compare the compressive strength of conventional concrete with hypo sludge concrete.
- To compare the cost of conventional concrete with hypo sludge concrete

Scope of the work

To find the optimum strength of the partial replacement of cement with hypo sludge. Minimize the max degradation in environment due to cement and safeguard ozone layer.

- Using the wastes in useful manner.
- To reduce the cost of the construction.
- It should be easily adopted in construction field.
- To provide a most economical concrete.
- Minimize the maximum demand for cement.

2.0 LITERATURE REVIEW

Pera J et.al (1998) found that despite a smaller kaolinite content, the burnt paper sludge exhibits more pozzolanic activity than commercially available metakaolin, especially at early ages. (109)

Ishimoto H. et.al (2000) reported that efforts to actively recycle paper have caused the amount of papermaking sludge to 'increase steadily each year, with current estimates of over 3,000,000 tons discharged annually throughout Japan. The Nippon Telegraph and Telephone Corporation has achieved success in converting ash derived from incinerated papermaking sludge into a new porous material with high caution exchange capacity by reacting this ash in an alkali solution.

Albinas Gailius et.al (2003) investigated workability and strength of concrete made with different proportions of waste paper sludge ash (WSA) and ground granulated blast furnace slag (GGBS) as binder, at two w/b rations: 0.5 and 0.4. The rate of development of strength of concrete made with WSA-GGBS binder achieved 1-day strength of about 2-6 % of its 28-day strength, while the 7-day strength was in the range 53-64 % of the 28-day strength.

J. Bai et.al (2003) Compressive strength and hydration characteristics of wastepaper sludge ash-ground granulated blast furnace slag (WSA-GGBS) blended pastes were investigated at water to binder (w/b) ratio of 0.5. The optimum blend composition to give maximum strength was 50% WSA-50% GGBS, and after 90 days, pastes manufactured from this blend exhibit compressive strengths close to 50% of those from an equivalent Portland cement paste

3.0 METHODS AND MATERIALS

The technical structures compose primarily of materials known as building materials or constructions. Prior to the final material selection for specific application, the working conditions of structures which are subject to a variety of materials and the different properties of materials such as solidity, shape, permeability, water pressure, temperature tolerance, physical and chemical properties must be carefully researched. A specific and appropriate material should be selected according to the necessary properties to increase the consistency and the quantity of a building structure. The lightweight, reinforced concrete is primarily made up of cement mixtures, light-weight aggregates, natural aggregates, air conditioning agents and admixtures. For the project implementation, the following content is selected:

- Cement
- Cinder Aggregates
- Silica fume
- Fly ash

Properties of Material

The various material used in the preparation of concrete are cement,

sand, cement coarse aggregates, hypo sludge and water.

Cement

Cement is made by grinding calcined limestone and clay into a very fine, grey powder. Cement is one of the binding agents in this project. The cement and water form 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

Fine aggregates:

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.

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 spilt tensile strength was also determined in 7 days and 28 days.

Figure: Manufacturing sand (M-SAND)

Mix Proportion Designations

- The mix design of concrete can be done by different methods such as,
- American Concrete Institute Method of Mix Design (ACI Committee 211.1 of 1991) Method.
- DOE Method of Concrete Mix Design Method.
- Indian standard Recommended method IS 10262-2009, IS 456 - 2000

4.0 RESULTS AND DISCUSSION

To determine the hardened properties of concrete, the Compression test, Splitting tensile test, flexural strength test and the Ultimate load carrying test on RCC beams were conducted. Concrete is much stronger in compression than in tension and so the compressive strength of concrete is an important property of the concrete. It is very difficult to directly measure the tensile strength of concrete, therefore the splitting tensile test, an indirect method, was adopted

Slump Cone Test:

The test was conducted for fresh concrete prepared before the moulding process. concrete mixes are prepared at different times. Workability Results obtained from slump cone test for M25 grade of concrete. Slump cone test determines the consistency and workability of all concrete

mixtures. Slump cone test utilizing a metallic slump mould

Table 4.1 workability of the given specimen

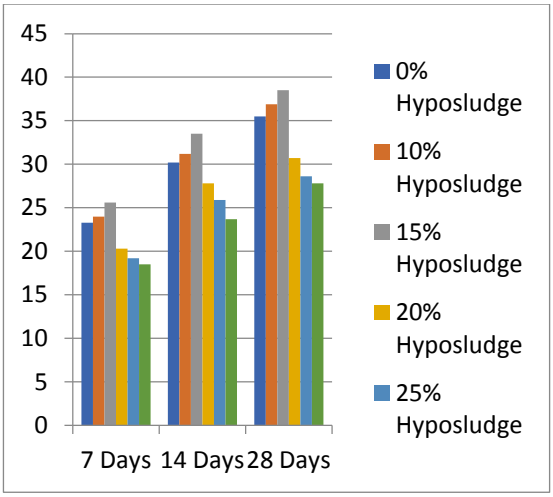
S NO	Specimen	Slump Values in mm
1	0% Hyposludge	70
2	10% Hyposludge	76
3	15% Hyposludge	76
4	20% Hyposludge	78
5	25% Hyposludge	78
6	30% Hyposludge	78

COMPRESSIVE STRENGTH TEST

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 15cm x 15cm x 15cm cube with proper compaction, after 24 hrs place the specimen in water for curing.

Table 4.2 Compressive strength of Hypo sludge cement concrete

S NO	Sample	% of Hyposludge cement	Compressive strength in N/mm2	Compressive strength in N/mm2	Compressive strength in N/mm2
			7 Days	14 Days	28 Days
1	H1	0	23.3	30.2	35.5
2	H2	10	24	31.2	36.9
3	**H3**	**15**	**25.6**	**33.5**	**38.5**
4	H4	20	20.3	27.8	30.7
5	H5	25	19.2	25.9	28.6
6	H6	30	18.5	23.7	27.8



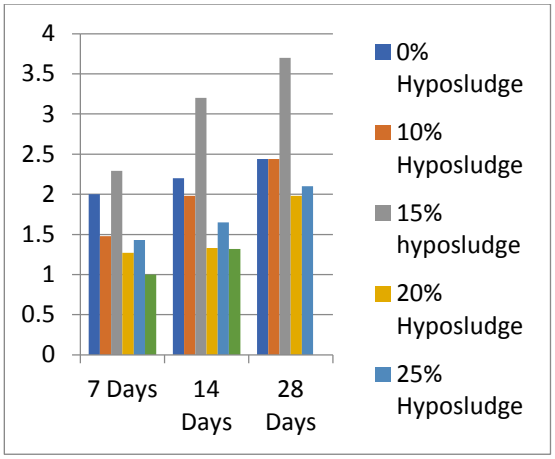
Graph 4.2: Compressive strength of concrete

SPLIT TENSILE STRENGTH TEST

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 10 cm x 30 cm cylinder with proper compaction, after 24 hrs place the specimen in water for curing

Table 4.3: Split tensile strength of Hypo sludge cement concrete

S NO	Sample	% of Hyposludge cement	Split tensile strength in N/mm2	Split tensile strength in N/mm2	Split tensile strength in N/mm2
			7 Days	14 Days	28 Days
1	H1	0	2	2.2	2.44
2	H2	10	1.48	1.98	2.44
3	**H3**	**15**	**2.29**	**3.2**	**3.7**
4	H4	20	1.27	1.33	1.98
5	H5	25	1.43	1.65	2.1
6	H6	30	1	1.32	1.49



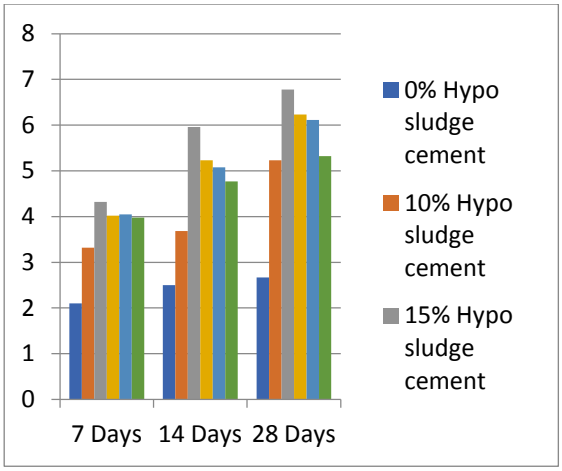
Graph 4.3: Split tensile strength of concrete

FLEXURAL STRENGTH TEST

Prepare the concrete in the required proportions and make the specimen by filling the concrete in the desired mould shape of 10x10x50cm prism with proper compaction, after 24 hrs place the specimen in water for curing.

Table 4.4: Flexural Strength of Geopolymer concrete by using Glass fibre

SNO	Sample	% of Hypo sludge cement	Flexural strength in N/mm2	Flexural strength in N/mm2	Flexural strength in N/mm2
			7 Days	14 Days	28 Days
1	H1	0	2.1	2.5	2.67
2	H2	10	3.32	3.68	5.23
3	**H3**	**15**	**4.32**	**5.96**	**6.78**
4	H4	20	4.02	5.23	6.23
5	H5	25	4.05	5.08	6.11
6	H6	30	3.98	4.77	5.32



Graph 4.4: Flexural strength of concrete

CONCLUSION:

Finally, we conclude our project with various mixes with curing periods of 7 days, 14 days and 28 days by partial replacement of cement with hypo sludge. Testing of cubes and cyclinder in compression testing machine with capacity of 1000 kN. The compressive strength of concrete increases as the curing period for M25 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, 14 days and 28 days is achieved for 15% replacement of cement and starts decreasing in strength from 20% to 30%. The maximum spilt tensile strength for 7 days, 14 days and 28 days is achieved for 15% replacement of cement and starts decreasing in strength from 20% to 30%. The maximum flexural strength for 7 days, 14 days and 28 days 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.

As per relevant IS-code practice based on the test results obtained from this study the following conclusion can be drawn.

- From the compressive strength test results, it is found that the higher strength is observed for the conventional concrete.
- There is strength reduction with the addition of Hypo Sludge due to the impurities present in Hypo Sludge like free lime, loss on ignition and other raw minerals.
- However, the strength attained with the mix of Hypo Sludge complies with the target strength up to a replacement of 15%.
- When the SF addition is greater than 15%, the strength produced by the concrete gets reduced than the target strength.

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