

Effective use of Paper Sludge (Hypo Sludge) in Concrete

¹ Santosh Ahirwar, ² Dr. Rajeev Chandak,

¹M.E.-Scholar, (Structural Engineering), ² Professor (Head of Department)

¹Department of Civil Engineering,
Jabalpur Engineering College, Jabalpur, India

Abstract—More than 300 million tonnes of industrial waste are produced per annum in India mainly by chemical and industrial waste. Hypo sludge is a type of waste obtained by paper production industries. Disposal of this waste become huge difficult. It means that the broken, low quality paper fibers are separated out to become waste sludge. This paper mill sludge consumes a large percentage of local landfill space for each and every year. To reduce disposal and pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them. Keeping this in view, large quantity of national and international references are studied and based on these the state of art of the research and investigations on the production of low cost concrete by blending various ratios of cement with hypo sludge is presented in this paper. Concrete specimens were prepared with 7.5%, 10%, 12.5% and 15% hypo sludge as a replacement of cement weight, The most important mechanical property of concrete is compressive strength and it is evaluated on 150X150X150 mm cubes by The compressive strength is obtained for 28 day strength and results are analyses

Index Terms— hypo sludge, Ordinary Portland cement (O.P.C.), Compressive strength.

I. INTRODUCTION

Interlocking Concrete Block Pavement (ICBP) has been extensively used in many countries for quite some time as a specialized problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. These are the solid, unreinforced pre-cast cement concrete paver blocks and are complementary products which are used for light, medium, heavy and very heavy traffic paving applications and other applications. ICBP technology has been introduced in India in construction, a decade ago, for specific requirement namely footpaths, parking areas etc. But now being adopted extensively in different uses where the conventional construction of pavement using bituminous mix or cement concrete technology is not feasible or desirable. Concrete or mortar is made up of cement, water and aggregates (Coarse and Fine Aggregate) and sometimes with necessary admixtures. Concrete has attained the status of a major building material in all the branches of modern construction. It is difficult to point out another material of construction which is as variable as concrete. Concrete is the best material of choice where strength, durability, impermeability, fire resistance and absorption resistance are required. Compressive strength is considered as an index to assess the overall quality of concrete and it is generally assumed that an improvement in the compressive strength results in improvement of all other properties. Hence strength investigations are generally centered on compressive strength. Even though concrete mixes are proportioned on the basis of achieving the desired compressive strength at the specified age, flexural strength often play a vital role in concrete making. Hypo sludge (paper industry waste) has a tremendous potential in this context and it is well documented that the use of hypo sludge in concrete results in a significant improvement in the rheological properties.

The aim of this project is to determine the optimum percentage (7.5%, 10%, 12.5% and 15%) of Hypo sludge as a replacement of cement for hardened concrete properties and, to compare the obtained results of the different types of concrete with gravel concrete regarding physical and mechanical properties on the properties of hardened concrete.

II. LITERATURE REVIEW:-

A lot of investigators have worked on the hypo sludge properties to evaluate its importance in various fields. Some of them are mentioned below:-

Jayesh kumar Pitroda (2013) focused on investigation of strength of concrete and optimum percentage of the partial replacement by replacing cement via 10%, 20%, 30%, and 40% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength and split strength.

Rushabh shah and J. Pitroda (2013) study the results of the cement mortar of mix proportion 1:3 in which cement is partially replaced with Hypo Sludge as 0%, 10%, 30% and 50% by weight of cement. Test results indicate the decreases in the strength properties of mortar with Hypo Sludge for strength at 7 & 28 days as partial replacement with the cement in the cement

mortar 1:3. So it can be used in non-structural elements in the low range compressive strength where strength is not required and low cost temporary structure is prepared.

Ritesh Patil and M.Jamnu (2014) study the various mechanical properties of concrete containing hypo sludge. Hypo sludge was used as a replacement to cement. Replacement percentages used during the present study were 10%, 15%, 20%, 25%. Compressive strength of cubes were found on 3days, 7days, and 28days. The 28th day flexural strength and split tensile strength of the specimens was found on the respectively beams and cylinders. It is found that replacement of hypo sludge have beneficial effects on the mechanical properties of concrete.

R. Balamurugan and R. Karthickraja (2014) produce low cost concrete by blending various ratios of cement with hypo sludge. Work is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing cement via 5%, 10%, 15%, and 20% of Hypo Sludge.

Abdullah Shahbaz Khan (2014) present dissertation work is directed towards developing low cost concrete from paper industry waste. Dissertation work is carried out with M20 & M30 grade concrete with W/c ratio of 0.55 & 0.45 respectively as a control specimen and hypo sludge is replaced in different percentages such as 10%, 20%, and 30% by weight of cement. Test was conducted to study the mechanical properties of concrete, such as compressive strength, split tensile strength and flexural strength. The curing period should be 3, 7 and 28 days.

III. EXPERIMENTAL PROGRAM:-

Material :- The various material used in the preparation of concrete are cement, sand, cement coarse aggregates, hypo sludge and water.

Hypo Sludge:- Hypo Sludge is a waste material collected from the Paper Industry. It is used as cement replacement in producing concrete and was investigated on its chemical and physical properties. Construction material with natural resources now become limited and causes of air pollution and environmental problems. it becomes a new innovation material that can be used as material to support the green technology. its behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of the concrete. the hypo sludge which is collected from orient paper mill amlai distt-shahdol.

Table 1. Typical physical properties of hypo sludge

Property	Value
Gradation (75% passing)	0.030mm (no. 450 sieve)
Maximum particle size	0.300mm (no. 50 sieve)
Specific surface (cm ² /g)	4600–14000
Specific gravity	2.7–2.9

Table 2. Typical chemical composition of hypo sludge.

Compound	Percentage composition
Calcium oxide (CaO)	47.57
Silicon oxides (SiO ₂)	5.2
Aluminum oxide (Al ₂ O ₃)	0.1
Iron oxide (Fe ₂ O ₃)	0.64
Magnesium oxide (MgO)	6.25
Sulfur oxide (SO ₃)	0.17
Loss on ignition (LOI)	38.25

Cement: Ordinary Portland Cement (43 Grades) which is easily available in market is used.

Fine Aggregate: The natural river sand available in local market which passes through 4.75mm sieve with specific gravity of 2.62. Conforming to Zone II.

Coarse Aggregate: Crushed granite conforming to IS 383 - 1987 is used in this study. Coarse aggregate passing through 20mm and retained on 16 mm sieve and specific gravity 2.82 was used.

Water: Water is an important ingredient of concrete as it actively participated in chemical reaction with cement, clean portable water which is available in our college campus is used

Mix Proportion: The mixture proportion for the controlled concrete of M40 grade was arrived from the trial mix as per IS 10262-2009.

Table 3. Mix proportion

S.no.	% of cement replace as materials	Cement (Kg/m ³)	Hypo sludge (Kg/m ³)	Fine aggregate (Kg/m ³)	Coarse aggregate (Kg/m ³)	Water (Kg/m ³)	w/c ratio
1.	0	437.5	0	696.42	1238.29	180	0.40
2.	7.5	404.69	32.81	696.42	1238.29	180	0.40
3.	10	393.75	43.75	696.42	1238.29	180	0.40
4.	12.5	382.81	54.68	696.42	1238.29	180	0.40
5.	15	371.87	65.62	696.42	1238.29	180	0.40

IV. METHODOLOGY

Replacement levels of OPC by Hypo Sludge of 7.5%, 10%, 12.5% and 15% were chosen for this research work. Batching was carried out by weighing as per calculated amount of each concrete constituent according to the mix ratio of 1 : 1.59 : 2.83 and M-40 grade of concrete was adopted. The constituents were then mixed thoroughly until a uniform mix was obtained. Water was then added and the mix was repeated. The fresh concrete mix was then placed in a mould of size 150 mm, compacted, and left for 24 h before testing. Compressive specimens were tested at the ages of 7 and 28 days.

V. Results and discussion

Compressive Strength

The results of compressive strength presented in Table 4. The test was carried out to obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using Compression Testing Machine (CTM) of capacity 2000KN available in structures lab. From Fig1 the compressive strength is up to 33.91 N/mm² and 48.44 N/mm² at 7 and 28 days. The maximum compressive strength is observed at 10% replacement of Hypo Sludge. If higher percentages of ash were used, then compressive strengths decreased. There is a significant impurities present in Hypo Sludge like alumina, free lime and others.

Table 4. Compressive strength test result of Hypo Sludge concrete at different ages.

Serial no.	Name of cube sample	Replacement of Hypo Sludge (%)	Average Ultimate strength(N/mm ²)	
			(7 days)	(28 days)
1.	H 0	0	33.91	48.44
2.	H 7.5	7.5	34.74	49.92
3.	H 10	10	35.89	51.03
4.	H 12.5	12.5	35.04	50.07
5.	H 15	15	34.01	48.59

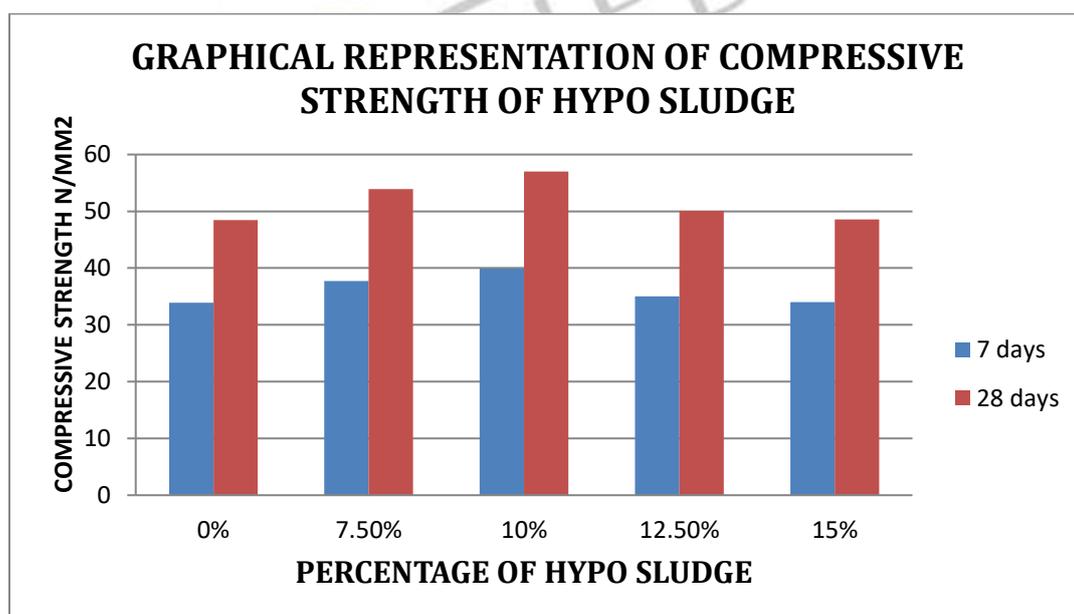


Figure:- Relationship between compressive strength and different percentage of Hypo Sludge at age of 7 and 28-days.

VI. CONCLUSION

In this study series of the experiments have been conducted on concrete with the addition of Hypo Sludge as partial replacement of OPC. In the Hypo Sludge was used as partial replacement of OPC in different percentage that is 7.5%, 10%, 12.5% and 15% of the dry weight of the cement. the experiments were conducted on M-40 grade of concrete as per relevant IS-code practice based on the test results obtained from this study the following conclusion can be drawn.

1. From the compressive strength test results, it is found that the higher strength is observed for the conventional concrete.
2. 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.
3. However the strength attained with the mix of Hypo Sludge complies with the target strength up to a replacement of 10%.
4. When the SF addition is greater than 10%, the strength produced by the concrete gets reduced than the target strength.

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