

STUDY ON THE HYPO SLUDGE AND BRINE SLUDGE IN CONCRETE AS A SUPPLEMENTARY BUILDING MATERIAL

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Abstract- Portland cement is that the most vital ingredient of concrete and may be a versatile and comparatively high value material. Massive scale use of cement is inflicting environmental issues on one hand and depletion of natural resources on different hand. This work examines the likelihood of victimization paper sludge (hypo sludge and brine sludge) to provide an occasional value concrete by mixing varied ratios of cement and fine combination (sand) with hypo sludge and brine sludge and to cut back land disposal issues thanks to paper sludge. The innovative use of hypo sludge and brine sludge in concrete as a supplementary building material and fine combination material was tested as another to concrete. during this study hypo sludge and brine sludge was partly replaced from 3%, 5%, 7%, 10% and 12% in cement to induce optimum for M30 and M40 grades of concrete and conjointly hypo sludge and brine sludge was partly replaced from 5%, 10%, 15% and 20% in fine aggregate to induce optimum purpose in concrete for M40 combine and tested for its compressive strength, up to twenty-eight days of strength and compared with standard concrete. This study was supported the comparison of hypo sludge concrete and brine sludge concrete with partial replacement of cement and fine combination severally. The study results indicate that use of paper sludge ash in concrete has improved the performance of concrete in strength and economic side. The optimum strength was achieved at 7% once replaced with cement and at 15% once replaced with fine aggregate.

Keywords: Hypo Sludge, Brine Sludge, Concrete, cement, fine aggregate, Optimum Strength, Ash, & Paper Sludge.

1. INTRODUCTION

In developing countries like India generation of waste from industries are in huge amount, so it is very necessary to properly utilize the wastes generating from different industries so that they do not cause pollution in the environment. Paper industry is among the industries which generate lot of waste which harms environment one such waste produced from paper mills is Brine Sludge. This type of waste contain minimum amount of calcium and silica content. Due to its low calcium this paper waste is taken out for our project. And as we know during the production of cement large amount of green house gases are emitted in to the environment hence there is a need to find out some other materials in the construction. By using these waste strength will be increased and cost of construction will be reduced [3].

Paper industry wastes are one of the major issues related to the pollution and environment. The re-use of waste is very necessary as it not only decreases the pollution and prevents green house effects but also helps in saving energy in production process by recycling. During

the cement production green house gases and CO₂ is emitted in the atmosphere which is harmful to environment. Concrete is a mixture made with Cement, water, coarse, fine aggregates and admixtures. Paper making generally generates a huge amount of solid waste. Paper fibers can be recycled only a limited number of times before they become too weak or short to make high quality paper. It means that the broken, low- quality paper fibers are removed out to become waste sludge. The chemical composition of paper will depend on the type or quality of paper. Basically most grades of paper consist of organic and inorganic material. Brine-Sludge which is available in abundance in the vicinity of every paper mill is not a waste but a useful material which can be used in concrete manufacturing [6].

1.1 Hypo Sludge

Hypo sludge obtained as waste is purely a chemical wastes and do not contain any bio-degradable element. Most of the paper mills in India prepare bleach liquor (calcium hypochlorite) using lime and elemental chlorine [4]. Hypo sludge

contains low calcium and maximum calcium chloride and minimum amount of silica [5]. Hypo Sludge becomes a new innovative material that can be used as material to support the green technology [6]. But the specific gravity of hypo sludge is nearly 2.17. The bulkiness of hypo sludge is more concern to be use as a replacement of sand. So we can use hypo sludge as a partial replacement of sand in low weight concrete. The cost of hypo sludge is generally less than the cost of sand depending on transportation. Significant quantities may be substituted for sand in concrete mixtures and yet increase the long term strength and durability. Thus, the use of hypo sludge may impart considerable benefits to the concrete mixture over a plain concrete for less cost. These are the main reasons to use hypo sludge in concrete and reduce the cost of concrete production, Improve the quality of fresh and hardened concrete, Extend the concrete life [7].

Table 1: Chemical Composition of Hypo Sludge

Composition	Mass in %
Silica	3.01%
$Al_2O_3+Fe_2O_3$	9.64%
CaO_2	43.17%
Magnesia	2.85%
Loss of Ignition	2.78

1.2 Brine Sludge

Brine sludge is also obtained from paper industry likely as hypo sludge but the basic difference between these two is their process of obtaining. Brine sludge is a waste of chlorine-alkali manufacturing industry is generated during the chlorine and caustic soda production through the electrolysis of brine. But the hypo sludge is obtained by using calcium hypo chlorite in final stage of paper production for bleaching solid waste generated during calcium hypo chlorite.

Table 2: Chemical Composition of Brine Sludge

Composition	Mass in %
SiO_2	9.16%
$Al_2O_3+Fe_2O_3$	5.22%
CaO	9.32%
MgO	7.65%
BaO	40.03%
SO_3	12.32%
Cl_2	5.30%

Table 3: Compositional Difference between Hypo and Brine Sludge

Composition	Hypo Sludge	Brine Sludge
SiO_2	3.01%	9.16%
$Al_2O_3+Fe_2O_3$	9.64%	5.22%
CaO	43.17%	9.32%
Magnesia	2.85%	7.65%

Conventional Concrete is most widely used man made construction material used since hundreds of years ago and is the largest production of all the materials used in construction industry. Concrete is basically made of cementing materials which have to properly bind themselves together, as well as with other materials to form a solid mass. Concrete is made up of cement, water and aggregates (coarse and fine aggregate) and sometimes with necessary admixtures [8]. But the composition of ancient concrete and present industrial concrete is very different.

2. PROBLEMS IDENTIFICATION & OBJECTIVE

The Problem identification of this study is to derive the feasibility of various industrial waste in concrete and to introduce as a eco-friendly building material in terms of fine aggregate and to see how the concrete behaves on replacing fine aggregate (sand) with the hypo sludge and brine sludge in various proportions. Determine the variation in strength of waste mix concrete in terms of compressive strength. It also helps with the disposal and pollution problems associated with paper industry waste. As we know the consumption of fine aggregate is increasing day by day, the fine aggregate is mainly obtained from river mining therefore the mining of sand is increased, it affect the river depth as well as environment during the mining of fine aggregate. This cause scarcity of sand and hence results in hike prices. Therefore our aim is to use fine aggregate smartly in concrete so that its consumption does not increase rapidly. For this, utilization of paper mill waste as fine aggregate (sand) and by replacing fine aggregate with brine sludge and hypo sludge effectively protect our environment from pollution and utilize paper waste to maintain economy of construction work. The aim of this study is to use Brine Sludge (paper industry waste) in Concrete

and to introduce Brine sludge as an economic and eco-friendly building material and to examine the possibility of utilization of Brine Sludge as a partial replacement of cement. As the cement consumption has been increasing rapidly therefore production of cement is also increasing which causes pollution, so to use cement smartly brine sludge has been used in this study. Thus our main target is to decrease the cement consumption, decrease pollution and to make concrete economical.

3. METHODOLOGY

In this chapter discussion is about the raw material used and their properties as per Indian standards code (IS: 383-1996) procedures. Mix design for concrete proportion has been developed as per IS:10262-2009. The Casting, compaction and curing of the concrete specimens has been done as per Indian standards procedures.

3.1 Raw Material Used

• Cement

Cement is a fine mineral powder manufactured with very precise processes. Mixed with water, this powder transform into a paste that binds and hardens when submerged in water. Because the composition and fineness of the powder may vary, cement has different properties depending upon its makeup. Cement is the main component of concrete. It's an economical, high-quality construction material used in construction project worldwide. Cement is made by grinding together a mixture of limestone and clay, which is then heated at a temperature of 1450° C. What results is a granular substance called "clinker", a combination of calcium, silicate, alumina and iron oxide. The clinker is then ground with small quantities of gypsum to produce fine powder called ordinary Portland cement (OPC). Cement is a hygroscopic material meaning that it absorbs moisture. In presence of moisture it undergoes chemical reaction termed as hydration. Therefore cement remains in good condition as long as it does not come in contact with moisture. If cement is store for more than three month then it should be tested for its strength before being taken it for use [31].

3.1.1 Aggregate

Aggregates are the important constituents in concrete. Aggregate are inert granular materials such as sand, gravel, or crushed stone along with water and Portland cement, an essential ingredient in concrete. For a good concrete mix, aggregate need to be clean, hard, strong, particles free of absorbed chemicals or coatings of clay and fine materials that could cause the deterioration of concrete. Aggregates, which account for 60 to 75 % of the total volume of concrete, are divided into two distinct categories- Fine and Coarse. Fine and coarse aggregates made up the bulk of a concrete mixture. Aggregate strongly influence concrete's freshly mixed and hardened properties, mixture proportions, and economy. Consequently, selection of aggregate is an important process. Although some variation in aggregate properties is expected, characteristics that are considered include grading, durability, Particle shape and surface texture, Unit weight, voids, absorption and surface moisture [31].

3.1.2 Fine Aggregate

In the investigation fine aggregate is natural sand from local market is used, confirming grading zoneII as per IS: 383-1997. The physical properties of fine aggregate like specific gravity, gradation and fineness modulus are tested in accordance with IS:2386. Specific gravity of fine aggregates used in this study is 2.72. Before using fine aggregate sieve analysis and bulking of sand was performed.

3.1.3 Coarse Aggregate

Coarse aggregate crushed granite of 20 mm down size was used as coarse aggregate. The physical property of coarse aggregate like specific gravity, gradation and fineness modulus are tested in accordance with IS: 2386 (Part 1) - 1963. Specific gravity of coarse aggregates used in this study is 2.72. According to IS: 10262 - 2009 the ratio of fine aggregate and coarse aggregate is taken as 0.4:0.6 for zone II. To check the strength of coarse aggregate impact value test and abrasion test were performed.

3.1.4 Hypo Sludge

Hypo sludge is a waste which is obtained as an end product of paper mill waste. While producing paper the various wastes are comes out from the various processes in paper industries. From the preliminary waste named as hypo sludge, we collect hypo sludge from Orient paper mill Pvt. Ltd. district Shahdol, Madhya Pradesh. The hypo sludge obtained from paper mill has different properties such as different particle size and moisture; to remove moisture it is dried in oven at $100 \pm 50^\circ\text{C}$ for 24 hours and then sieved the material through IS sieve to obtained uniform particle size so that it was replaced as sand. The specific gravity of hypo sludge is calculated by using pycnometer method. The specific gravity of hypo sludge used is 2.17.

3.1.5 Brine Sludge

Brine sludge is also known as paper industry waste. It is the by product of the paper waste produced at the time of whitening of paper. Brine sludge obtained from Orient paper mill Pvt. Ltd. district Shahdol, Madhya Pradesh. The brine sludge obtained from paper mill has different properties such as different particle size and was in wet form. So it is dried in oven at $100 \pm 50^\circ\text{C}$ for 24 hours and then sieved the material through IS sieve to obtained uniform particle size so that it is replaced as sand. The specific gravity of brine sludge is calculated by using pycnometer method. The specific gravity of brine sludge used is 3.20.

3.1.6 Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 stages, namely the plastic and hardened state. If the plastic concrete is not workable, it cannot be properly placed and compacted. The compressive strength of hardened concrete which is generally consider to be an index of other properties, depends up on many factors e.g. quality and quantity of cement, water and aggregate, batching and mixing,

placing, compacting and curing [10]. The concrete mix design for M40 & M30 concrete with and without replacement is calculated using IS: 10262-2009 as shown in table below.

Table 4: Mix Names when Cement replaced with hypo sludge

Cement	Hypo Sludge	Mix Name	
		M30	M40
100%	0%	CC30	CC40
97%	3%	HC30A	HC40A
95%	5%	HC30B	HC40B
93%	7%	HC30C	HC40C
90%	10%	HC30D	HC40D
88%	12%	HC30E	HC40E

4. RESULTS AND ANALYSIS

In this investigation the hardened properties of Hypo sludge concrete and Brine sludge concrete for various Partial replacement percentages of Hypo sludge and brine sludge with cement and fine aggregate are determined

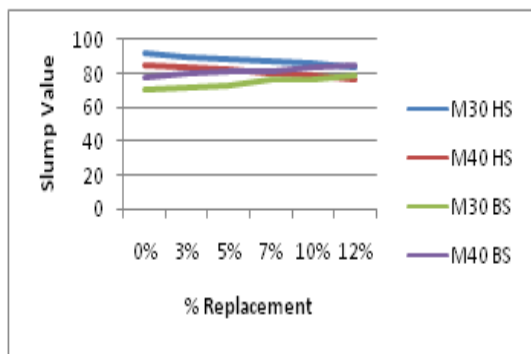
Comparison of Hypo Sludge and Brine Sludge when Replaced with Cement Slump Cone Test

Table 5: Slump values of different mix when cement replaced with Hypo Sludge

Mix Name	Slump Value	Mix Name	Slump Value
CC30	92	CC40	85
HC30A	90	HC40A	84
HC30B	89	HC40B	82
HC30C	87	HC40C	80
HC30D	86	HC40D	78
HC30E	84	HC40E	76

Table 6: Slump values of different mix when cement replaced with Brine Sludge

Mix Name	Slump Value	Mix Name	M40 Grade
CC30	70	CC40	78
BC30A	71	BC40A	80
BC30B	73	BC40B	81
BC30C	76	BC40C	82
BC30D	77	BC40D	84
BC30E	79	BC40E	85

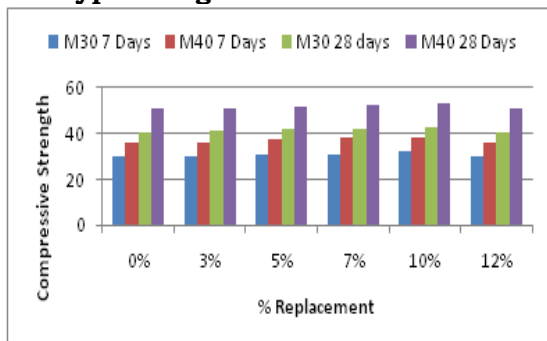


Graph 1: Comparison of slump values of different mix.

4.1 Compressive Strength Test

In order to find the mechanical properties Compressive strength tests were conducted at 7 and 28 days of cube (150 X 150 X 150 mm) specimens. For each combination, three specimens were tested and the average strength values reported in this paper. Compressive strength tests were performed on compression testing machine using cube samples.

4.2 Hypo Sludge Concrete



Graph 2: Comparison of Compressive Strength of different mixes of Hypo Sludge Concrete

For Hypo Sludge at 12 % the compressive strength of concrete is 40.6 N/mm² which slightly less than that of conventional concrete i.e., 40.74 N/mm² which shows that the compressive strength decreases at 12% replacement for M30 grade of Concrete. For M40 grade of concrete At 12 % the compressive strength of concrete is 51.70 N/mm² which was slightly less than that of conventional concrete i.e., 51.89 N/mm² which shows that strength will further decreased as cement was replaced. So, on comparing results it is clear that 10% replacement of cement with Hypo sludge is optimum for this study.

4.3 Brine Sludge Concrete



Graph 3: Comparison of compressive strength of different mixes of Brine Sludge Concrete

For Brine Sludge the Compressive Strength of M30 Grade of concrete reached to 41.19 N/mm² at 7% cement replacement with Brine Sludge. At 10 % the compressive strength of concrete is 39.33 N/mm² which nearly same to that of conventional concrete i.e., 39.5 N/mm² the compressive strength decreases further when 12% cement was replaced. The Compressive Strength of M40 Grade of concrete reached to 50.23 N/mm² at 7% cement replacement with Brine Sludge. At 10 % the compressive strength of concrete is 48.91 N/mm² which nearly same to that of conventional concrete i.e., 49.1 N/mm² the compressive strength decreases further when 12% cement was replaced. So, on comparing results it is clear that 7% replacement of cement with brine sludge is optimum for this study.

5. CONCLUSION

The Compressive Strength of Concrete increased when the Cement is replaced by Hypo Sludge up to 10% by weight of Cement. The Compressive Strength of Concrete increases when the replacement of Cement with Brine Sludge up to 7% replacement by weight of Cement. The Compressive Strength of Concrete increases when the replacement of Fine Aggregate with Hypo Sludge up to 10% replacement by weight of Sand. The Compressive Strength of Concrete increases when the replacement of Fine Aggregate with Brine Sludge up to 10% replacement by weight of Fine Aggregate. Comparatively Hypo Sludge give more compressive strength till 10 % than Brine Sludge but when replaced with fine aggregate the optimum replacement for

both sludge is 10%. Hypo Sludge and Brine Sludge are a better innovative supplementary cementitious construction material which is used in concrete, so it can save the paper industries waste disposal costs and produce a greener concrete for construction. This research concludes that hypo sludge and brine sludge can be innovative supplementary cementitious and fine aggregate Construction Material in Concrete up to certain extent.

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