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EXPERIMENTAL INVESTIGATION IN PARTIAL REPLACEMENT OF HYPO SLUDGE

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ABSTRACT - *Over 300 million tons of industrial wastes are being produced per annum by chemical and agricultural process in India. These materials pose problems of disposal and health hazards. Paper making generally produces a large amount of solid waste. Paper fibers can be recycled only a limited number of times before they become too short or weak to make high quality paper. It means that the broken, low-quality paper fibers are separated out to become waste sludge. All the inks, dyes, coatings, pigments, staples and "stickies" (tape, plastic films, etc.) are also washed off the recycled fibers to join the waste solids. The shiny finish on glossy magazine-type paper is produced using a fine kaolin clay coating, which also becomes solid waste during recycling. This paper mill sludge consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread on cropland as a disposal technique, raising concerns about trace contaminants building up in soil or running off into area lakes and streams. Some companies burn their sludge in incinerators, contributing to our serious air pollution problems. 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, investigations were undertaken to produce low cast concrete by blending various ratios of cement with hypo sludge. This project is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing cement via 10%, 20%, 30%, and 40%, of Hypo Sludge.*

1. INTRODUCTION:

Energy plays a crucial role in growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building Materials like cement, the importance of using industrial waste cannot be underestimated. During manufacturing of 1 tons of Ordinary Portland Cement (OPC) we need about 1…1⅓ t of earth resources like limestone, etc. Further during manufacturing of 1 t of Ordinary Portland Cement an equal amount of carbondi-oxide are released into the atmosphere. The carbon-di-oxide emissions act as a silent Killer in the environment under various forms. In this Backdrop, the search for cheaper substitute to OPC is a needful one.

1.2. Solid waste from paper industry

a) Hypo Sludge Properties

Where, this hypo sludge contains, low calcium and maximum calcium chloride and minimum amount of silica. Hypo sludge behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of concrete.

Fig.1 – Raw Hypo sludge disposal from TNPL

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. To eliminate the ozone layer depletion, production of cement becomes reduced. For this, the hypo sludge is used as partial replacement in the concrete as high performance concrete. By utilizing this waste the strength will be increased and also cost reduction in the concrete is achieved.

1.3 Objectives

To investigate the utilization of Hypo Sludge as Supplementary Cementitious Materials (SCM) and influence of these hypo sludge on the Strength on concretes made with different Cement replacement levels.

1.4 Scope

a) To provide a most economical concrete.

b) It should be easily adopted in field.

c) Using the wastes in useful manner.

d) To reduce the cost of the construction.

e) To find the optimum strength of the partial replacement of concrete.

f) Minimize the maximum demand for cement.

g) Minimize the maximum degradation in environment due to cement and safeguard the ozone layer from greenhouse gases.

1.5 Methodology

a) Tested the material properties as per Indian standards code (IS 383 –1996) procedures.

b) Mix design for concrete proportion has been developed as per IS 10262 – 1982.

c) Casted and cured the concrete specimens as per Indian standards procedures.

d) The characteristic strength of hardened concrete specimen was tested as per IS 456 – 2000.

e) Finding the optimum strength of optimum replacement of hypo sludge as cement.

2. Literature review

Felix F.U d o e y o, Hilary I n y a n g, David T.Y o u n g and Edmund E. O p a r a d u are the authors of a recent paper in this field of articles [1]. The enormous amount of wastes produced during wood processing operations in many countries provides challenging opportunities for the use of wood waste as a construction material. In this research, wood waste (saw dust and wood shaving) ash (WWA) of pretreated timber of 0, 5, 10, 15, 20, 25and 30% by weight of cement was added as a supplement to a concrete of a mix proportion 1:2:4:0.56 (cement: sand: coarse aggregate: water cement ratio), and the strengths and the water absorption of the matrix were evaluated. Also, the metal leachability of WWA was analyzed. The compressive and the flexural strengths of WWA concrete for the ages investigated ranged from 12.83 to 28.66 N/mm2, and 3.652 to 5.57 N/mm2, respectively, with the lowest values obtained at 30% additive level of ash. When compared with strength of plain concrete (control), the compressive and the flexural strengths of WWA concrete were between 62 and 91% and 65 and 95%, respectively, of the former. The trend of the water absorption of WWA concrete was a reversal of those of the strengths, that is, the highest water absorption values were recorded for the concrete specimens with the highest additive level of ash. A batch leaching test also performed at an Ashlea chant volumetric ratio of 20 produced leachate containing chromium, arsenic, iron, copper and zinc with the following concentrations:410; 6,720; 150; 280 and 1,690 μg/L, respectively, when leached at a pH = 4, and 400; 10; 670; 0; 100; 1,470 μg/L, respectively, when leached at a pH = These concentration levels exceed the EPA fresh water acute criteria limits. Shi C o n g K o u, Chi S u n P o o n and Dixon C h a n published the results of a research [2] concerning the use of high percentages of recycled aggregates in concrete which would usually worsen the concrete properties. This paper tries to address the deficiency of the use of recycled aggregates by systematically presenting results on the influence of incorporating Class F fly ash on concrete properties. In this study, two series of concrete mixtures were prepared with water-to-binder (W/B) ratios of 0.45 and 0.55; the recycled aggregate was used as 0, 20, 50, and 100% by weight replacements of natural aggregate. In addition, fly ash was used as 0, 25, and 35% by weight replacement of the cement. The obtained results showed that the compressive strengths, tensile strength and static modulus of elasticity values of concrete at all ages decreased as the recycled aggregate and the fly ash contents increased. Further, an increase in the recycled aggregate content decreased the resistance to chloride ion penetration and increased the drying shrinkage and creep of concrete. Nevertheless, the use of fly ash as a substitute for cement improved the resistance to chloride ion penetration and decreasing the drying shrinkage and creep of the recycled aggregate concrete. The results showed also that one of the practical ways to utilize a high percentage of recycled aggregate in structural concrete is by incorporating 25…35% of fly ash as some of the drawbacks induced by the recycled aggregates in concrete could be minimized.

3. MATERIALS USED

3.1. Cement

The most common cement used is an ordinary Portland cement grade 43. The Type 1 is preferred according to IS269-1976, which is used for general concrete structures. Out of the total production, ordinary Portland cement accounts for about 80…90%. Many tests were conducted on cement; some of them are consistency tests, setting tests, soundness tests, etc.

3.2. Aggregate

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Good grading implies that a sample fractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste will mean less quantity of cement and less water, which will further mean increased economy, higher strength, lower shrinkage and greater durability. Aggregate comprises about 55% of the volume of mortar and about 85% volume of mass concrete. Mortar contains a size of 4.75 mm and concrete

a) Coarse Aggregate

The fractions from 80 mm to 4.75 mm are termed as coarse aggregate.

b) Fine aggregate

Those fractions from 4.75 mm to 150 microns are termed as fine aggregate. Contains aggregate up to a maximum size of 150 mm.

3.3 Water

Water is an important ingredient of concrete as it participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be considered very carefully.

3.4. Hypo Sludge

The Tables 1,2, and 3 show the hypo sludge chemical properties and comparison between cement and hypo sludge.

Table 1

Properties of Hypo Sludge

S:NO	CONSTITUENT	PRESENT IN HYPO SLUDGE.[%]
1.	Magnesium oxide (MgO)	3.3
2.	Calcium oxide (CaO)	46.2
3.	Loss on ignescent	27.0
4.	Acid insoluble	11.1
5.	Silica (SiO^2)	9.0
6.	Alumina	3.6

Table 2

Comparison of Cement and Hypo Sludge

Sl. No	Constituent	Cement %	Hypo Sludge
1.	Magnesium	1	3.33
2.	Calcium oxide	62	46.2
3.	Silica	22	9
4.	Calcium sulphate	4	4.05
5.	Alumina	5	3.6

Table 3

Setting Time for Cement and Hypo Sludge

Sl. No	Ingredients	Initial, [min]	Final, [max]
1.	Cement	30	600
2.	Cement + 10% hypo sludge	31	598
3.	Cement + 20% hypo sludge	33	597
4.	Cement + 30% hypo sludge	34	595
5.	Cement + 40% hypo sludge	36	593

4. MIX DESIGN:

A mix M25 grade was designed as per Indian Standard method and the same was used to prepare the test samples. The design mix proportion is done in Table 4.

Table 4

Design Mix Proportion

	Water	Cement	Fine aggregate	Coarse aggregate
By weight	186	465	628	1083
By volume	0.4	1	1.3	2.3

5. DETAILS OF THE EXPERIMENTAL STUDY

5.1 Compressive Strength Test

150 mm × 150 mm × 150 mm concrete cubes were casting using M25 grade concrete. Specimens with ordinary Portland cement (OPC) and OPC replaced with hypo sludge at 10%, 20%, 30%, and 40% levels were cast. During casting the cubes were mechanically vibrated by using a table vibrator. After 24 h the specimens were removed from the mould and subjected to water curing for 7 and 28 days. After curing, the specimens were tested for compressive strength using a calibrated compression testing machine.

6. RESULTS AND DISCUSSIONS:

The obtained results are given in Table

Table 6

Compressive Strength of Cubes at 7 Days

Partial replacement %	Number of specimen	Ultimate load, [kN]	Ultimate compressive strength, [N/mm^2]
0	3	380	16.8
10	3	396	17.6
20	3	412	18.3
30	3	447	19.8
40	3	276	12.2

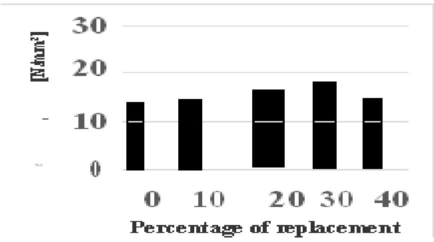
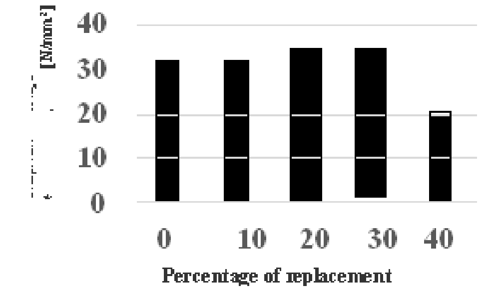


Table 7

Compressive strength of cubes at 28 days

Partial replacement %	Number of specimen	Ultimate load, [kN]	Ultimate compressive strength, [N/mm^2]
0	3	663	29.6
10	3	679	30.2
20	3	710	31.7
30	3	730	32.4
40	3	477	21.2



7. CONCLUSIONS:

Based on limited experimental investigation concerning the compressive strength of concrete, the following observations are made regarding the resistance of partially replaced hypo sludge:

A. Compressive strength of the concrete is increased when the percentage of replacement is increased up to 40% and further replacement increased compressive strength become reduced

B. From this level, replacement of cement with this waste of hypo sludge material provides maximum compressive strength at 30% replacement

C. Cost of cement should become low from this project

D. Environment effects from wastes and maximum amount of cement manufacturing is reduced through this project

E. A better measure by a New Construction Material is formed out through this project.

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