Effectively Incorporating Hyposludge into Concrete Enhances Its Utility and Sustainability

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Abstract—Concrete possesses formidable strength and durability, yet it is inherently permeable, allowing interaction with its ambient surrounding. creating inexpensive concrete by blending different cement-to-hypo sludge ratio and mitigating disposal and pollution issues arising from hypo sludge is essential. Creating financially viable construction material using hypo sludge is a key objective. producing high quality paper necessities, the limited use of recycled paper fibers, leading to a significant volume of solid waste. The creative use of hypo sludge in concrete mixtures as a supplementary cementatious material was tested as an substitute to traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days. This research work is concerned with experimental investigation on strength of mortar and optimum percentage of the partial replacement by replacing cement via 4% to 16% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of mortar while adding of waste with different proportions of Hypo sludge in mortar by using tests like compression strength.

Index Terms— hypo sludge, Ordinary Portland cement (O.P.C.), Compressive strength. Cement, Fine, Aggregate, Coarse aggregate

I. INTRODUCTION

In india about 3100 million tones of industrial wastes are being produced per annum by chemical and agricultural process in India. These materials present health risks as well as disposal issues. The presence of unpleasant contaminants in wastes such as phosphogypsum, fluorogypsum, and red mud negatively impacts the strength and other characteristics of construction materials that are made from them. Out of several wastes being produced at present, the use of phosphogypsum, flurogypsum, lime sludge, hypo sludge, red mud, and mine tailing is of paramount significance to protect the environment. Paper making generally produces a large amount of solid waste. Only a certain amount of recycling can be done to paper fibers before they become too weak or short to be used to produce high-quality paper. It means that the broken, subpar paper fibers are removed and processed into waste sludge. In order to combine with the waste materials, all inks, dyes, coatings, pigments, staples, and "stickies" (tape, plastic films, etc.) are also removed from the recycled fibers. A fine kaolin clay coating is used to provide the glossy finish on glossy magazine-style paper; nevertheless, when recycling, this coating turns into solid trash. Every year, a sizable portion of the local landfill is filled with this paper mill muck. Even worse, some of the wastes are disposed of by spreading them over fields, which raises questions about traces of toxins accumulating in the soil or seeping into nearby areas. lakes and streams. Certain firms contribute to our severe air pollution issues by burning their sludge in incinerators. It is crucial to turn these industrial wastes into viable building materials in order to lessen the problems with disposal and pollution that result from them.

II SCOPE OF THE PROJECT

- As the cement is costly the usage of pulp waste as cement is more economical.
- Pulp waste is the waste material which can be easily collected from paper industries.

OBJECTIVES OF THE PROJECT:

- To find the compressive strength of concrete and optimum percentage of the partial replacement by replacing cement via 5%, 10% and 15% of pulp.
- To determine the split tensile strength of the concrete
- To find the flexural strength of the concrete

III RESEARCH METHODOLOGY

This chapter briefly explains the methodology adopted in this experimental work. It has already been discussed in the previous chapter about the advantages of hypo sludge in concrete. The following methodology has been adopted to achieve the objective.

The preliminary tests were conducted for various material properties, and using these properties, IS method was adopted for M30 grade concrete for computing control mix ratio.

Materials that are used for making concrete were tested before casting the specimens. The properties obtained from the tests were used in mix design. The preliminary tests were conducted for the following materials.

- Cement (Maple Leaf 43 grade cement)
- Fine Aggregate (River Sand)
- Coarse Aggregate
- Water
- Paper pulp

1V MATERIAL SPECIFICATIONS

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CEMENT

Maple leaf 53 grades Portland pozzolanic cement (PPC) has been used throughout this investigation. Cement is the most widely used cementations ingredient in present day concrete. The function of cement is first, to bind the fine aggregates and coarse aggregates together and second to fill the voids in between fine aggregate and coarse particles to form a compact mass. Although cement constitutes only about 10% of the volume of the concrete mix it is the active portion of the binding medium and the only scientifically controlled ingredient of concrete.

COURSE AGGREGATE

In this investigation, crushed hard blue granite of 20 mm size conforming toIS: 383-1970 have been successfully as coarse aggregate. The specific gravity of coarse aggregate is 2.5 and fineness modulus of 2.88. The crushing value of the coarse aggregate used was 31.25%. The particle size distribution is given under 5.1.1.1. In order to produce optimum compressive strength with high cement contents and low w/c rates the maximum size of coarse aggregate should be kept to a minimum at 20mm or 10mm.The strength increases are caused by the reduction on average bond stress.

Due to increased surface area of the individual aggregate. Another reason is the lesser concentration of stress around the particles caused by differences in the modulus of the paste and the aggregate. The ideal aggregates should be clean, cubical, angular, cent percent crushed with a minimum of flat and elongated particle.

FINE AGGREGATE

The natural river sand obtained from Nagercoil was used as fine aggregate. It is having fineness modulus of 2.27 and it corresponds to grading zone II of I.S.383-1970 grading requirement. The specific gravity of fine aggregate is 2.7. The particle size distribution is given in 5.1.2.1. The optimum gradation of fine aggregate is determined more by its effect on water requirement than on physical packing. It is found that sand with a fineness modulus below 2.5 give the concrete said with a fineness modulus of about 3.0 gives the best workability and compressive strength.

WATER

As a general rule, water fit for drinking is also good for making concrete. Potable clean drinking available in the college supply system was used for mixing of concrete and curing of the test specimen. Water is needed for hydration of cement and molding of concrete to the desired shape. The relationship between compressive strength and water5 cement ratio is well established. Smaller the w/c ratio higher is the compressive strength. A w/c ratio of about 0.28 provided sufficient water for hydration. However a w/c ratio of about 0.6 is needed to obtain a plastic workable mixture that can be transported, placed, properly compacted and finished to the final form. Usually water for concrete is specified to be of potable quality in PH ranges 6-8. The dissolved organic solids, inorganic solids, sulphates, chlorides and suspended matters should be limited to 0.02, 0.03, 0.05, 0.1and 0.2 percent respectively. In cases, where water of a lower quality has to be used, trial mixes shall by produced and tested at 29 days. The results should be compared with the same mix made using distilled water. If the results are within the 90% of the standard mix, the water may be used.

HYPOSLUDGE

Pulp waste was collected from SPB PAPERS LIMITED in Tirunelveli. This is the major paper industrial waste having the properties similar to that of cement. This hypo sludge is compared with cement by performing various tests like setting times test, specific gravity tests etc. The compressive, splitting tensile and flexural strength increased up to 10% addition of waste paper pulp and further increased in wastepaper pulp reduces the strengths gradually which also provides easily workable, binding etc.

V TESTS ON HARDENED CONCRETE

General

One of the purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength. Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. Systematic testing of raw materials, fresh and hardened concrete are inseparable part of any quality control programme for concrete, which helps to achieve higher efficiency of the material used and greater assurance of the performance of the concrete with regard to both strength and durability. The test methods should be simple, direct and convenient to apply. The concrete was cast and the tests for hardened concrete such as compressive strength, split tensile strength and flexural strength were done.

COMPRESSIVE STRENGTH

The compressive strength test for cubes was conducted in compression testing machine as per IS 516 : 1964. The cubes were tested in compressive testing machine at the rate of 140 kg/cm^2/min and the ultimate loads were recorded. The bearing surface of machine was wiped off clean and the surface of the specimen was cleaned. The sample was placed in machine in such a manner, load was applied to opposite sides of the cubes such that casted side of specimen was not upper and lower. The axis of the specimen was carefully positioned at the center of loading frame. The load applied was increased continuously at a steady rate until the resistance of the specimen to the increasing load breaks down and no longer can be maintained. Maximum load applied on specimen was recorded.

SPLIT TENSILE STRENGTH

The split tensile strength test for cylinders was carried out as per IS 516 : 1964. This test was carried out by placing a cylinder specimen horizontally between the loading surfaces of a universal testing machine and the load was applied until failure of the cylinder along the vertical diameter. When the load was applied along the generatrix an element on the vertical diameter, the cylinder is subjected to a horizontal stress and the split tensile strength was found using subsequent formula.

Split tensile strength, f_{cr} (N/mm^2) = $2P/\pi LD$

Where,

P = Ultimate load (N)

L = Length of cylinder (mm)

D = Diameter of cylinder (mm)

FLEXURAL STRENGTH

The flexural tests were carried out on beam specimens under standard two points loading was done confirming to IS516-1959 (Reaffirmed-1999). The flexural strength was determined by testing standard test specimens of 150mm × 300mm × 1500mm under two pint loading. Load vs. deflections measurement were observed. The ultimate load at failure was noted. Stiffness at yield load and ultimate load were determined. Deflection ductility was also calculated.

The test set-up for RCC beam is shown in fig 5.2 Two concentrated loads at one-third span were applied on beams. The flexural strength depends on the dimension of the beam and manner of the supporting span that is spaced at 433 mm center to center or on either side of beam was place perpendicular to the applied force without eccentricity. Two dial gauges fixed at the middle and one third of the span of the set up.

At the end of each load increment, observations and measurements were recorded for load points deflection, mid-point deflection and crack development. The load at first crack, ultimate load, type of failure etc., were carefully observed and recorded. The specimens were loaded continuously at a constant rate till failure.

The specimens were beams of size 150mm x 300mm x 1500mm, reinforced with 2 numbers of 12mm diameter HYSD bars in tension

Table 5. 1 Test Results for M30 Concrete with Replacement of cement with hyposludge from 10% to 40%

Sl. No	Description	M30	Percentage of LWA			
			10%	20%	30%	40%
1	Slump value	80	76	73	69	65
2	Average 7th day compressive strength of cubes (N/mm^2)	31.30	32.66	28.55	26.51	22.90
3	Average 28th day compressive strength of cubes (N/mm^2)	42.22	42.10	40.20	37.30	34.77
4	Average split-tensile strength of cylinders (N/mm^2)	3.89	3.85	3.78	3. 70	3.72

and 2 numbers of 10mm diameter HYSD bars in compression zone as hanger rods. The specimen was also provided with shear reinforcements in the form of 8mm diameter mild steel bar two legged stirrups at 200 mm centre to center. The reinforcement details were shown. The specimens were cast in steel mould with machine mixed concrete and well vibrated with needle vibrator.

VI RESULTS AND DISCUSSION

The results of the investigation carried out for finding the optimum percentage of hypo sludge by determining the mechanical properties of concrete were as mentioned below

SLUMP VALUE

It was observed that the slump value decreased with increase in percentage of lightweight aggregate. The graphical representation is shown in figure .

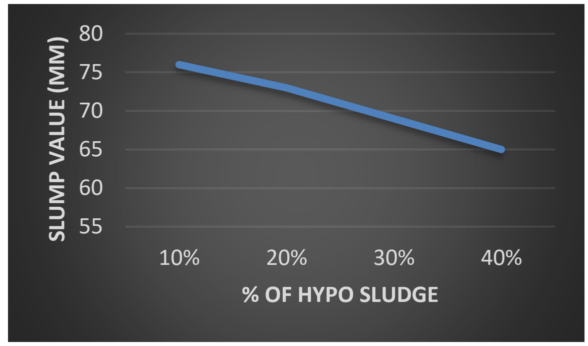

Figure 6.1 Variation of Slump Value for M30

COMPRESSIVE STRENGTH

It was observed that, average compressive strength at 7 days and 28 days increased with increase in percentage of lightweight aggregate up to 30% and then decreased for 40% and 50%. The graphical representation of the variation of average compressive strength at 7 days and 28 days is shown in figure.

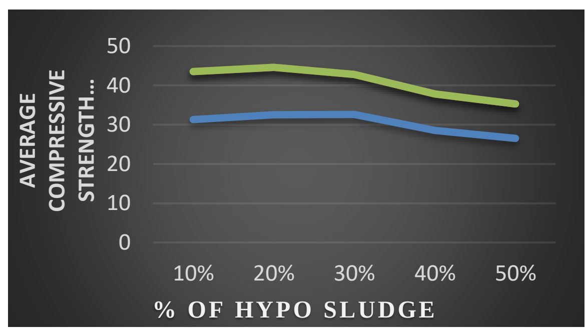

Figure 6.2 Variation of Compressive Strength at 7 and 28 days for M30 Concrete with Replace.1ment of cement with hypo sludge from 10% to 40%

SPLIT TENSIL STRENGTH

It was observed that, average compressive strength at 7 days and 28 days increased with increase in percentage of lightweight aggregate up to 30% and then decreased for 40% and 50%. The graphical representation of the variation of average compressive strength at 7 days and 28 days is shown in figure.

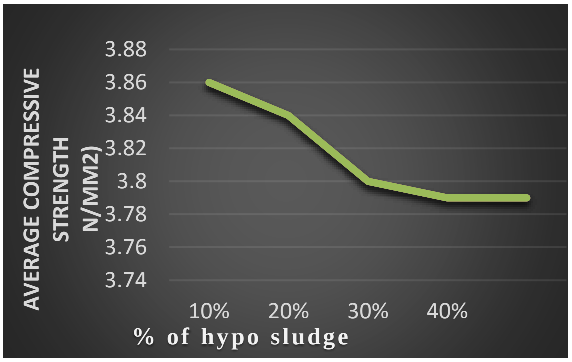

Figure 6.3 Variation of Split-Tensile Strength at 28 days for M30 Concrete with Replacement of cement with hypo sludge from 10% to 40%

FLEXURAL STRENGTH

The concrete strength used in the design of concrete pavements is founded on AASHTO Test Method T-97 or ASTM C78, Flexural Strength of Concrete using a Simple Beam with Third-Point Loading (see Figure 1 below). These flexural tests (also called Modulus of Rupture tests or Third-Point Loading tests) are performed using concrete beams that have been hurl and healed in the field, to mimic field circumstances. For AASHTO thickness design, it is significant that the **third point loading 28-day** flexural strength be utilized use in the AASHTO equation. If the strength moral are quantified using some other test method, it must be transformed to the 28-day third-point strength.

Table 6.1flexural strength

Partial replacement in %	Ultimate strength N/mm^2 7 days	Ultimate strength N/mm^2 28 days
0	3.81	5.20
10	3.74	5.10
20	3.71	4.97
30	3.57	4.95
40	3.50	4.90

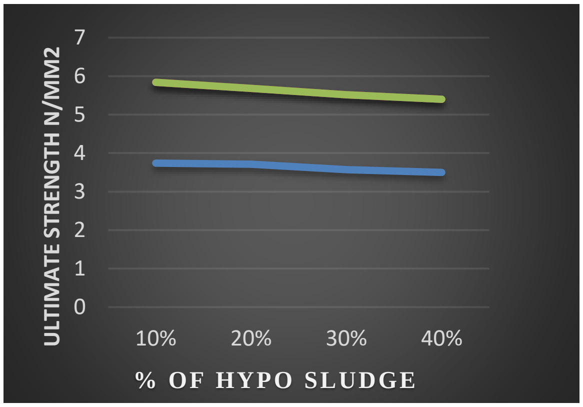

Figure 6.4 Variation of ultimate Strength at 7&28 days for M30 Concrete with Replacement of cement with hypo sludge from 10% to 40

VII. CONCLUSION

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

- Workability reduces at higher replacement of fly ash with cement and vice versa it increase with higher replacement of hypo sludge
- Compressive strength of the concrete measured after 7 days decreases when the percentage of replacement of fly ash increases and if replacement of 10 % hypo sludge compressive strength increases after 7 days
- Compressive strength of the concrete measured after 28 days if replacements of 20 % hypo sludge compressive strength increases after 28 days.
- When government implement the projects for temporary shelters for who those affected by natural disaster, this material can be used for economic feasibility.
- Environmental effects from wastes and residual amount of cement manufacturing can be reduced through this low cost concrete.

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