

Durability Study on Hypo Sludge Concrete with Replacement of Fine Aggregate

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ABSTRACT - The rapid increase in construction activities leads to active shortage of conventional construction Materials such as cement, fine aggregate and coarse aggregate. To produce low cost concrete by blending various ratios of fine aggregate with hypo sludge and to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge. These tests were carried out to evaluate the durability studies for after 28 days. This research work is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing fine aggregate via 5%, 10%, 15%, and 20% 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 acid attack, sulphate attack, Rapid chloride penetration, sorptivity test were conducted. The mix design was carried out for M20 grade concrete as per IS: 10262-2009.

KEYWORDS - Cement, Hypo sludge, Paper waste.

I. INTRODUCTION

Over 300 million tones of industrial wastes are being produced per annum by chemical and agricultural process in India, 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. 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. To reduce disposal and pollution problems emanating from these industrial wastes, this project is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing fine aggregate via 10%, 20%, 30%, and 40% of Hypo Sludge.

II. LITRATURE REVIEW

Jayeshkumar pitroda et al, (2013) this paper deals with the innovative use of hypo sludge in concrete formulations as a supplementary cementitious material

was tested as an alternative to traditional concrete. The cement has been replaced by waste paper sludge accordingly in the range of 0% (without Hypo sludge), 10%, 20%, 30% & 40% by weight for M-25 and M-40 mix. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days and split strength for 56 days are taken. 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.

Balamurugan et al, (2014) this paper deals with make good quality paper limited number of times recycled Paper fibers can be used which produces a large amount of solid waste. The partial replacement by replacing cement via 5%, 10%, 15%, and 20% 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 test, slump test. The mix design was carried out for M25 grade concrete as per IS: 10262-2009.

Abdullah shahbaz khan et al, (2014) this paper presented on Hypo sludge behaves like cement because of silica and magnesium properties. The silica and magnesium improve the setting of concrete. 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% to 30% by weight of cement. Cubes of 150mm x 150mm size, Cylinders of 100 mm dia and 200mm height, and prisms of 100 mm x 100mm x 500mm are casted for conventional concrete and RPH (Replacement of hypo sludge by weight of cement) test specimen respectively, 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 INVESTIGATION

MATERIALS USED

Cement, Coarse aggregate, Fine aggregate, Water, Super plasticizer, Hypo sludge.

HYPO SLUDGE



Fig.1 Factory Outlet Hypo sludge

SUPER PLASTICIZER (CONPLAST 430-DIS)

The purpose of using a super plasticizer is to produce flowing concrete with very high slump. The ability of a super plasticizer to increase the slump of concrete depends on such factors as the type, dosage, and time of addition, w/c and the nature or amount of cement, the super plasticizer improves the workability of concrete.

PRELIMINARY TEST FOR THE MATERIALS

Table 1 Preliminary Test Results

Sl no	Specific gravity of the material	Test results
1	Specific gravity of cement	3.106
2	Specific gravity of fine aggregate	2.62
3	Specific gravity of coarse aggregate	2.58
4	Specific gravity of hypo sludge	2.34
5	Fineness modulus of fine aggregate	2.69
6	Fineness modulus of coarse aggregate	2.9

MIX PROPORTIONS

The concrete mix is designed as per IS 10262-2009 and IS 456-2007 for the conventional concrete. Finally the super plasticizer, conplast which is 13 ml by weight of cement is added to the concrete. The grade of concrete which we adopted is M20 with water cement ratio of 0.47. The mix proportion ratio used in experimental programme is given in Table - 2

Table 2 Mix Proportions For Conventional And Hypo Sludge Concrete

Mix	CC (kg/m ³)	FA (kg/m ³)	CA (kg/m ³)	HS (kg/m ³)	W/C	Mix Ratio
C/C	395.7	605.4	1074.2	-	186	1:1.52:2.71
					0.7	
10%	395.7	544.8	1074.2	60.5	186	1:1.3:2.7:0.1
					0.47	
20%	395.7	484.3	1074.3	121.0	186	1:1.2:2.7:0.3
					0.47	
30%	395.7	423.8	1074.3	181.6	186	1:1.0:2.7:0.4
					0.47	
40%	395.7	363.2	1074.3	242.1	186	1:0.9:2.7:0.6
					0.47	

DURABILITY STUDIES

The following test are conducted for the durability studies

- ✦ Acid attack test
- ✦ Sulphate attack test
- ✦ Rapid chloride penetration test
- ✦ Sorptivity test

ACID ATTACK TEST

The concrete cube specimens of size 150 mm × 150 mm × 150 mm were casted. After 28 days of water curing, the specimens were weighed and immersed in water dilute with hydrochloric acid (HCL). The PH was maintained throughout the period of 28 days. After 28 days of immersion, the concrete cubes were taken out of acid water. Then the weight of specimens were taken and tested for compressive strength, the resistance of concrete to acid attack was found by the percent loss of weight of specimen and the percent loss of compressive strength on immersing concrete cubes in acid water.



Fig. 2 Test setup of acid attack

SULPHATE ATTACK TEST

The 150 mm×150 mm ×150 mm size cube specimens are taken out from the curing tank of 28 days of curing. Then 5% Na₂So₄ salts are mixed per litre of ordinary water. Cube specimens are then immersed completed in the sulphate solution for the period of 28 days. After 28 days curing of sulphate water the specimens are taken out from the sulphate solution and kept dried. Then the specimens are weighed and the surface of the specimen are noted and tabulated.



Fig.3 Test setup of sulphate attack

RAPID CHLORIDE PENETRATION TEST

The test method consist of monitoring the amount of electrical current passed through 50 mm thick slices of 100 mm nominal diameter cores or cylinders during 6 hours at 30 minutes interval. A potential difference of 60v dc is maintained across the ends of the specimens, one of which is immersed in a sodium chloride solution, the other in a sodium hydroxide solution. The total charge passed in coulombs, has been found to be related to the resistance of the specimen to chloride ion penetration.

$$Q=900(I_0+2I_{30}+2I_{60}+.....+2I_{300}+2I_{330}+2I_{360})$$

Where,

Q – Charge passed (coulombs)

I₀ – Current (amperes) immediately after voltage is applied

I_t – Current (amperes) at t min after voltage is applied

$$Q_s = Q \times (95/x)^2$$

Where,

Q_s – Charge passed (coulombs) through a 100 mm diameter specimen

Q_x – Charge passed (coulombs) through x (mm) diameter specimen

x – Diameter of the non standard specimen.

Table 3 Recommended values from ASTM C 1202

Charge passed (coulombs)	Chloride penetration
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible



Fig. 4 Test setup of Rapid chloride penetration

SORPTIVITY TEST

Sorptivity test was conducted on 100 mm diameter and 50 mm slice thickness specimen curing at 28 days. The initial sorptivity rate of the concrete samples, which is the average of four values from each mix after 6 hours of test. The cube’s side surfaces were coated with an impermeable epoxy coating to prevent absorption through side surface during the test. After taking the initial weight, the specimen was placed on small supports in water and the water level was maintained during the test. The weight of the specimen was taken for 361 min continuously at 4, 9, 25, 64, etc.

$$I = S \times t^{1/2}$$

$$S = \frac{I}{t^{1/2}}$$

Where,

S=Sorptivity in mm

t=elapsed time in mint

$$I = \frac{\Delta w}{A \Delta t}$$

Where,

A= area of the specimen = w₂-w₁

d= density of water =1kg/m³

$$\text{Area} = \frac{\pi d^2}{4} = \frac{\pi(100)^2}{4} = 7853.98 \text{ mm}^2$$



Fig. 5 Test setup of Sorptivity Test

IV.RESULT AND DISCUSSION

DURABILITY OF CONCRETE

ACID RESISTANCE TEST

The average percentage of weight loss and compressive strength were calculated for acid test is shown in table.5

Table 5 Acid resistance Test Result

S. No	Description	% Of Weight Loss	% Of Strength Loss
1	Conventional concrete	1.957	7.5
2	20 % of hypo sludge concrete	3.246	8.07

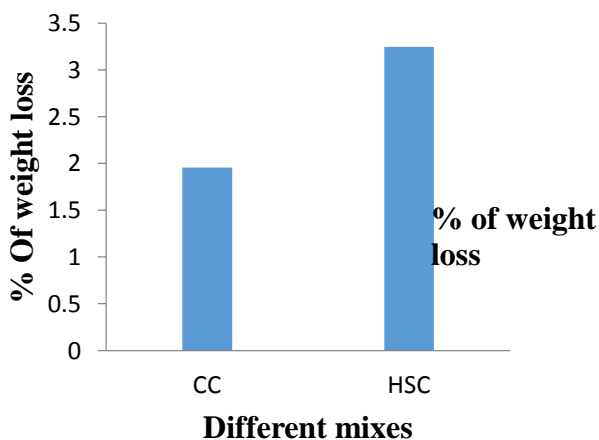


Fig. 6 Comparison of acid attack weight loss results

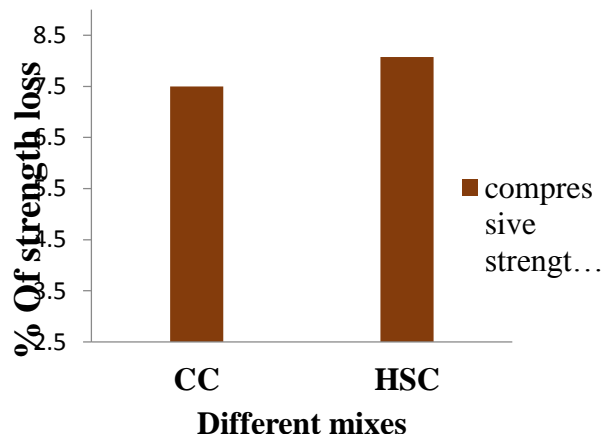


Fig. 7 Comparison of acid attack compressive strength loss results

SULPHATE RESISTANCE TEST

The average percentage of weight loss and compressive strength were calculated for acid test is shown in table

Table 6 sulphate resistance Test Results.

S. No	Description	% of weight loss	% of compressive strength loss
1	Conventional concrete	0.13	0.5
2	20% of hypo sludge	0.15	0.86

Fig. 5.6 Comparison of sulphate attack weight loss results

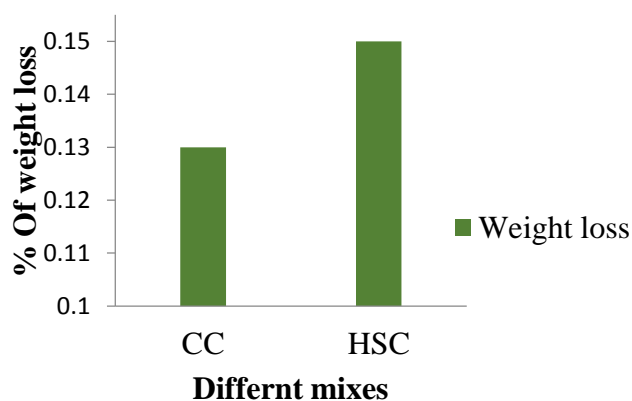


Fig. 5.6 Comparison of sulphate attack weight loss results

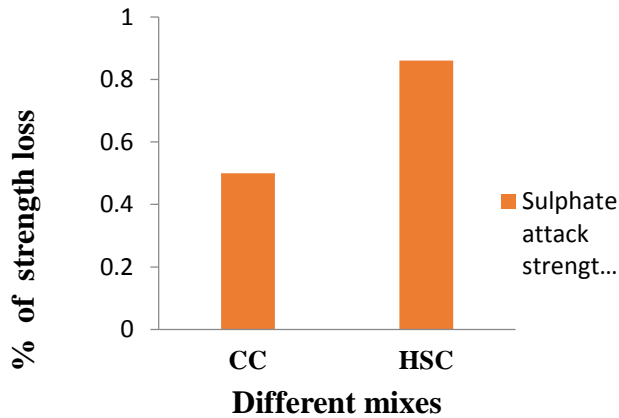


Fig. 8 Comparison of Sulphate Attack Compressive Strength Loss Results

RAPID CHLORIDE PENETRATION TEST

The rapid chloride penetration test (RCPT) was carried 100 mm diameter specimens with 50 mm long. RCPT test was provided for conventional concrete and 20% replacement of hypo sludge concrete. The test was provided for 6 hours

Table 5.7 Rapid chloride penetration test results

S.No	Time (Mints)	Conventional Concrete		Hypo Sludge As Fine Aggregate In Concrete	
		Trial 1	Trial 1	Trial 2	Trial 2
1	Initial	32	34	38	38
2	30	33	35	39	39
3	60	35	36	40	41
4	90	37	36	41	42
5	120	38	37	41	43
6	150	40	38	42	43
7	180	41	39	43	44
8	210	43	41	46	45
9	240	45	42	47	47
10	270	46	43	47	48
11	300	47	46	48	49
12	330	47	47	49	50
13	360	48	47	50	51
	AVERAGE	1032		1104	

SORPTIVITY TEST RESULTS

Sorptivity test was conducted on 100 mm diameter and 50 mm slice thickness specimen curing at 28 days. The initial sorptivity rate of the concrete samples, which is the average of two values from each mix after 6 hours of test. The results shown in Figure 5.8

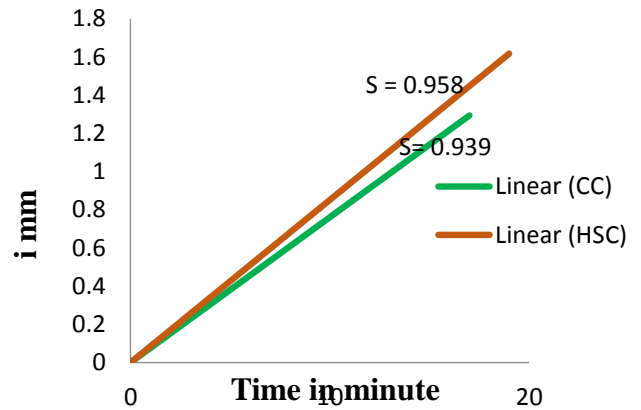


Fig.9 Comparison of Sorptivity Test Results

CONCLUSION

- The various replacement of hypo sludge concrete, the optimum strength is obtained at 20% replacement of hypo sludge as fine aggregate.
- The Compressive strength of concrete by partial replacement of hypo sludge as fine aggregate with different curing periods which are 7,14,28 days. The strength of the hypo sludge is 3.9% more than the conventional concrete.
- The 30%, 40% replacement is starting to decreasing in strength.
- The durability properties of hypo sludge concrete under acid attack, sulphate attack, and RCPT and sorptivity test results are very low penetration compare to conventional concrete.
- The use of hypo sludge the environment effects from waste is reduced through this project.

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