

An Experimental Study on Economic Feasibility and Strength of Concrete by Partial Replacement of Cement with Hypo Sludge

Mahesh Shirur¹, Yashwanth M. K²

¹Assistant professor, Department of Civil Engineering, KLE College of Engineering and Technology, Chikodi, Belgaum, Karnataka, India

²Assistant Professor, Department of Civil Engineering, MIT Mysore, Mandya, Karnataka, India

Abstract: To produce low cost concrete by blending various ratios of cement 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. The innovative use of hypo sludge in concrete formulations as a supplementary cementitious material was tested as an alternative to normal concrete. In this study, hypo sludge is physically and chemically characterized and partially replaced in the ratio of 0%, 10%, 20%, 30%, 40%, 50%, 60% and 70% by weight of cement, natural River sand as fine aggregate and normal coarse aggregate were used to produce concrete. Mix design of concrete is done as per bureau of Indian standards; the fresh properties of concrete like slump test and compaction factor test and hardened properties like compressive strength and split tensile strength were carried out. The test results indicated that fresh and hardened properties of the concrete increases as the percentage of replacement of hypo sludge increases up to 30% and economic feasibility of hypo sludge based concrete is less compared to conventional concrete.

Keywords: Hypo sludge; Fresh properties; compressive Strength; split tensile strength; economic feasibility

1. Introduction

To save energy and to earn carbon credit is very much essential for the betterment of mankind. To produce 1 tons of Ordinary Portland Cement we use earth resources like limestone, etc & during manufacturing of 1 t of Ordinary Portland Cement an equal amount of carbon-dioxide are released into the atmosphere which is harmful to the environment. Energy plays an important role in era of developing countries like India. By earning carbon credit by using industrial waste (hypo sludge) for Building Materials like cement, the energy & environment can be saved. Concrete is a composite construction material composed of cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and/or admixtures. Concrete is made by mixing: Cement, water, coarse, fine aggregates and admixtures (if required). The objectives are to mix these materials traditionally to make concrete that is easy to: Transport, place, compact, finish and to give a strong and durable product. The proportionate quantity of each material (i.e. cement, water and aggregates) affects the properties of hardened concrete.

Hypo 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. 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 cost concrete by blending various ratios of cement with hypo sludge. Paper making generally produces a large amount of solid waste. Paper fibres 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 fibres 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 fibres to join the waste solids. This paper mill sludge consumes a large percentage of local landfill space for each and every year.

2. Literature Survey

With the ever increasing demand and consumption of cement and in the backdrop of waste management, scientists and researchers all over the world are always in quest for developing alternate binders that are environment friendly and contribute towards sustainable management. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw material for construction industry.

3. Material Properties

3.1 Cement

Ordinary Portland cement conforming to IS: 8112-1989 was used. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 1.

Table 1: Physical properties of cement

Test	Result
Specific Gravity	3.12
Normal consistency (%)	34
Initial setting time(min)	41
Fineness of cement	6%

3.2 Hypo sludge

Table 2: Properties of hypo sludge as cement ingredient

Sl No	Constituent	Present in Hypo Sludge, [%]
01	Magnesium oxide (MgO)	3.3
02	Calcium oxide (CaO)	46.2
03	Loss on ignescent	27.00
04	Acid insoluble	11.1
05	Silica (SiO2)	9.0

Table 3: Setting Time of cement replaced with hypo sludge

Sl No	Ingredients	Initial (min)
01	Cement + 0%Hypo sludge	31
02	Cement + 10%Hypo sludge	33
03	Cement + 20%Hypo sludge	34
04	Cement + 30%Hypo sludge	36
05	Cement + 40%Hypo sludge	37
06	Cement + 50%Hypo sludge	39
07	Cement + 60%Hypo sludge	40
08	Cement + 70%Hypo sludge	42

3.3 Fine Aggregate

Fine aggregate which passes through 4.75 mm IS sieve and retained on 75 micron and conforms to IS 383-1970, zone-2 used in entire work. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 4.

Table 4: Table shows the results of test on fine aggregate

Test	Result
Specific Gravity	2.5
Fineness modulus	3.5

3.4 Coarse Aggregate

Coarse aggregate which passes through 20 mm IS sieve and retained 4.75 mm, naturally occurring crushed stone used in the work. The properties of coarse aggregate are determined as per relevant Indian standards and the test results obtained are shown in table 5.

Table 5: Table shows the results of test on coarse aggregate.

Test	Result
Aggregate Impact value	28%
Aggregate crushing value	17.86%
Flakiness Index (%)	7.08
Elongation Index (%)	19.1

3.5 Water

The potable water was used here for making concrete mix.

4. Methodology

After procuring the constituents for making the design of concrete mixes for M-20 grade concrete cubes of sufficient number were casted by mixing the different proportions as obtained in the design mix. The workability of concrete mixes was measured by the slump tests and compaction factor tests. Curing of concrete cubes for 14 and 28 days was done. Three cubes of concrete of size 150 x 150 x 150 mm of all designed grades were tested for crushing strength at

the end of 14 and 28 days. The specimens were demoulded after 24 hours of casting and cured at 27 ± 2 °C until the test age.

5. Results and Discussions

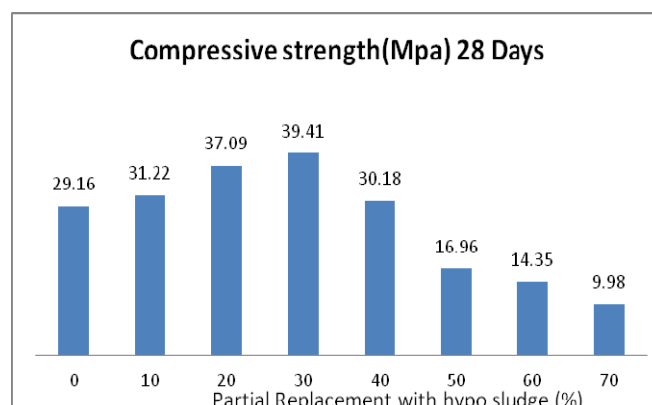
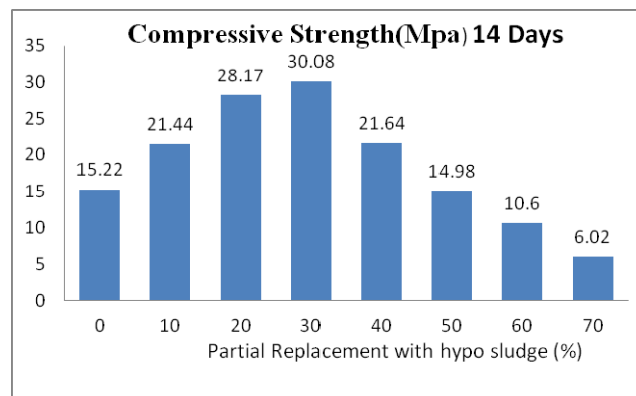
5.1 Workability

The workability tests were performed according to IS 1199-1959. The value is presented in table below:

Sl. No	Test	Result
1	Slump Test	120mm
2	Compaction Factor Test	0.9
3	Vee- bee Consistometer Test	17 sec

5.2 Compressive strength

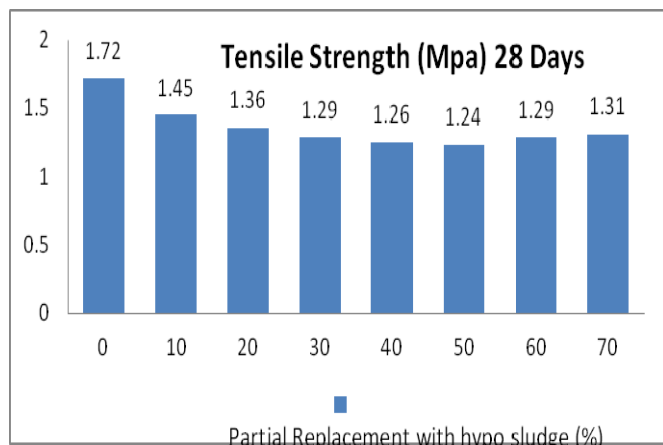
As per design obtained in accordance to code IS-10262 2009, mix proportion of various materials (viz. Cement, Sand, Aggregate and Water) is calculated for M-20grade of concrete. The cubes were crushed in the laboratory. The results of crushing strength of cubes for 14 and 28 days as per mix design are shown below: It is observed that the compressive strength of concrete increased as the percentage of replacement of hypo sludge increases up to 30% at 14 and 28 days.



3.3 Split tensile strength

As per design obtained in accordance to code IS-10262 2009, mix proportion of various materials (viz. Cement, Sand, Aggregate and Water) is calculated for M-20grade of concrete. The cubes were crushed in the laboratory. The results of tensile strength of concrete for 28 days as per mix design are shown below: It is observed that the split tensile

strength of concrete decreased as the percentage of replacement of hypo sludge increased at 28 days.



6. Economic Feasibility

Cost analysis is carried out for the optimum proportion of percentage of hypo sludge in concrete. The cost is compared to the conventional concrete.

Cost of materials

Cost of cement per bag = 340 Rs

Cost of sand per cum = 1060 per cum

Cost of hypo sludge per kg = 1 Rupee

Cost of coarse aggregate per cum = 883 per cum

Cost of material of normal concrete per cum

Description	Quantity, (kg/m ³)	Cost,(Rs)	Cost of material, (Rs)
Cement	394	6.8 per kg	2679.2
Hypo sludge	-	1 Rupee per kg	-
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	3556.42

Cost of material of 30 % (optimum) partially replaced concrete per cum

Description	Quantity, (kg/m ³)	Cost,(Rs)	Cost of material, (Rs)
Cement	275.8	6.8 Per kg	1875.44
Hypo sludge	118.2	1 Rupee per kg	118.2
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	2870.86

The above tables show cost values of 30% replacement and the difference in cost from normal concrete to partially replaced concrete was **685.56 Rs**

7. Conclusions

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

- 1) Workability of the concrete can be increased with the increase in hypo sludge.
- 2) Compressive strength of the concrete is increased when the Percentage of replacement of hypo sludge is increased

up to 30% beyond that Compressive strength becomes decreases.

- 3) The split tensile strength is decreased when the percentage of the replacement is increased.
- 4) Use of hypo sludge in concrete can save the paper industry disposal costs and produces a sustainable concrete for construction.
- 5) Disposal problem of the hypo sludge can be minimized by this project now days it is a big problem of getting the landfill.
- 6) The cost analysis indicates that at 30% replacement of hypo sludge with cement there will be reduction in cost of concrete.

8. Future Scope

Large scale exploitation of lime stone for producing cement and emission of carbon from cement, it has become necessary to find any other alternative cementitious material. Replacement of cement will not only save the natural sources for future generation but will also prevent the environment by using waste material as cement.

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