



An Experimental Investigation on Strength of Concrete by Partially Replacing of Cement with Hypo Sludge

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ABSTRACT-

The increasing amount of waste is a reality regarding environmental sustainability. A large amount of hypo sludge (from the paper mill industry) is produced about 300 million tons per year. Their general disposal in landfills leads to environmental pollution. Also, cement production causes global warming by releasing carbon dioxide. Current project work is aimed at developing low-cost concrete from paper industry waste. It is made with M30 grade concrete with a w/c ratio of 0.45 as a control sample and hypo sludge is replaced with different percentages such as 10%, 20%, and 30% by weight of cement. Cubes of size 150mm x 150 mm and cylinders of 100 mm dia and 200mm height, were hammered to obtain normal concrete and RPH (Replacement of hypo sludge by weight of cement) test sample respectively. Tests are conducted to study the mechanical properties of concrete, such as compressive strength and tensile strength. The treatment period should be between 7 and 28 days.

Keywords: Cement, Hypo Sludge, Compressive strength, Workability, Split tensile Strength.

INTRODUCTION

Concrete, is the most widely used man-made building material and is the largest product of all materials used in the construction industry. Concrete is basically made of cement materials that must bind well together, and other materials to form a strong mass. Concrete or mortar is made up of cement, water and aggregates (coarse and fine aggregate) and sometimes the necessary admixtures. Concrete has reached the status of a major building material in all branches of modern construction. It is difficult to identify another building material as flexible as concrete. Concrete is the best material of choice when strength, durability, impermeability, fire resistance and absorption resistance are required. The compressive strength is considered as an index to evaluate the overall quality of concrete and it is generally assumed that the improvement of the compressive strength leads to the improvement of all other properties. Therefore the investigation of strength usually focuses on compressive strength. Although concrete mixes are rated on the basis of achieving the desired compressive strength at specified ages, flexural strength often plays an important role in concrete performance. Hypo sludge (waste from the paper industry) has great potential in this context and it is well documented that the use of hypo sludge in concrete results in a significant improvement in rheological properties [Chavan et al. (2020)].

During the production of paper various wastes come out of various processes in the paper industry. In the first waste named as hypo sludge, due to its low calcium content it is removed for our project to replace the use of cement in concrete. There, this hypo mud contains, low calcium and high calcium chloride and a small amount of silica. Hypo sludge behaves like cement due to the properties of silica and magnesium. This silica and magnesium improve the setting of concrete.

LITERATUREREVIEW

Abishek (2017) Concrete is a strong and durable material but it is a porous material that interacts with the environment. The strength of concrete is highly dependent on the flow of water and gas in and out of it. Producing low-cost concrete by mixing different proportions of cement and hypo sludge and reducing waste and pollution problems due to hypo sludge is very important to create profitable construction materials from hypo sludge. Making good quality paper that can be recycled several times Paper fibers that produce a lot of solid waste can be used. The new use of hypo sludge in concrete construction as a cementitious material was explored as an alternative to traditional concrete. This research work deals with the investigation of concrete strength test and the maximum percentage of component replacement by replacing cement with 10%, 20%, 30% and 40% of hypo Sludge. To keep all this idea, the purpose of the investigation is the behavior of concrete while adding waste in different proportions of Hypo sludge to concrete by using tests such as compressive strength, tensile strength and flexural strength.

Devi et al. (2018) The rapid increase in construction activities leads to an effective shortage of common construction materials such as cement, fine aggregate and strong aggregate. Producing low-cost concrete by mixing different proportions of fine aggregate with hypo sludge and reducing waste and pollution problems due to hypo sludge is very important to create profitable construction materials from hypo sludge. These tests are designed to test the durability of the subjects after 28 days. This research work deals with the investigation of the strength test of concrete and the total percentage of component replacement by adding a fine amount of 5%, 10%, 15%, and 20% of hypo Sludge. To keep all this idea, the objective of the investigation

is the behavior of concrete while adding waste with different proportions of Hypo sludge to concrete by using tests such as acid attack, sulfate attack, rapid chloride penetration, sorptivity tests are carried out. Mix design is done for M20 grade concrete as per IS: 10262-2009.

Chavanet al. (2020) The growing amount of waste is a reality related to the emergence of environmental sustainability issues. about 300 million tons are produced annually. Their general disposal in landfills leads to environmental pollution. Also, cement production causes global warming by releasing carbon dioxide. So the new use of industrial waste in the construction of concrete (reinforced pavement) as additional cement material can help to reduce the environmental problem. This research work deals with the investigation of strength testing of concrete mixed with hypo sludge. Instead of cement, hypo sludge is added in the range from 10% to 40% of the weight of cement. Concrete mixes were produced, tested and compared with conventional concrete mixes in terms of workability, compressive strength and tensile strength. Tests were performed after 7 and 28 days. A gradual increase was seen in the compressive strength and tensile strength of concrete mixed with 10% to 40% hypo sludge content for all curing ages. Beyond that there is a huge drop in power. The ultimate compressive strength and ultimate tensile strength of M20 concrete mix were 31.6 N/mm² and 3.5 N/mm². And the cost analysis shows that with the installation of hypo sludge it reduces the cost of concrete.

Aravindh Rajet al. (2020) Concrete is a strong and hard-hitting material but it is also durable and interacts with the environment. The strength of concrete is highly dependent on the movement of water and gas into and through it. Producing low-cost concrete by mixing different proportions of cement and hypo sludge and reducing waste and pollution problems due to hypo sludge is very important to create profitable construction materials from hypo sludge. Making good quality paper that can be recycled several times Paper fibers that produce a lot of solid waste can be used. The new use of hypo sludge in concrete construction as a cementitious material was explored as an alternative to traditional concrete. These tests are designed to test mechanical properties such as compressive strength for up to 28 days.

This research work deals with the investigation of concrete strength test and the maximum percentage of component replacement by replacing cement with 5%, 10%, and 15% of Hypo Sludge. The grade of concrete was M25. Keeping all this idea, the aim of the investigation is the behavior of concrete while adding waste with different proportions of hypo sludge to concrete by using tests such as compressive strength and tensile strength.

MATERIALS USED AND THEIR PROPERTIES

A. CEMENT

Ordinary Portland Cement (OPC) conforming to IS 12269 (53 Grade) was used for the experimental work.

B. FINE AGGREGATE

Local river sand was used. Laboratory tests are carried out on fine scales to determine different physical properties. The fine aggregate used conforms to the specifications of IS 383:1970 (Part II).

C. COARSE AGGREGATE

An aggregate size between 20 mm and 4.75 mm is considered coarse aggregate. Laboratory tests are carried out on coarse samples to determine different physical properties as per IS 383 (Part III)-1970.

D. HYPO SLUDGE

Hypo sludge is also known as paper industry waste. It is a by-product of paper waste. This hypo sludge contains low calcium and small amounts of silica. Hypo sludge behaves like cement due to the properties of silica and magnesium.

E. WATER

Water is an important in gradient of concrete as it actually participates in the chemical reaction with cement.

EXPERIMENTAL PROGRAM

A. MIXPROPORTION

The assembly design was optimized for a maximum size of 20mm. The grade of concrete prepared for the experimental study was M30. The mixture ratio was (1 : 1.065: 2.45) with a water cement ratio of 0.45. The cement content of the concrete was 438 kg/m³.

Cube samples of size (150 x 150x 150) mm and cylindrical sample of size (100 x 200) mm were used in the study to determine compressive strength and tensile strength. The samples were remade after 24 hours of molding and kept in a cooling tank to cool the water. The samples to be tested were taken from the cooling tank at 7 and 28 days.

Table1: Material for 1 m³concrete

Sl. No.	Ingredients	Mix			
		Design			
		CC	Sample 1	Sample 2	Sample 3
1	Cement (kg/m ³)	440	396	352	320
2	Fine aggregate(kg/m ³)	710	710	710	710
3	Coarse aggregate (kg/m ³)	1110	1110	111	111
4	Hypo-sludge (kg/m ³)	0	44	88	120

B. WORKABILITY

The workability of various mixes were assessed by determining the slump value as per the IS 1199:1959.

Table 2: Slump value for various concrete mixes

Sl. No.	Name of Mix	Slump value
1	MIX 1 (Normal concrete)	55
2	MIX2(10% hypo sludge)	54
3	MIX 3 (20% hypo sludge)	53
4	MIX 4(30% hypo sludge)	50

C. CASTINGANDCURINGOFSPECIMENS

**Figure 1:** Casting specimen for test on hardened concrete.

D.COMPRESSIVE STRENGTH

Cement, fine aggregate, hard aggregate and hypo sludge are mixed in a dry state and then the required amount of water is added and the whole concrete is mixed for 5 minutes, the concrete is poured into a mold cut firmly. The concrete is poured into the mold in 3 layers by pressing with a stick to crush the cubes (150 x 150 x 150) the size of millimeters tested for compression. The cast specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7 and 28 days the specimens are tested for compressive strength as shown in Table 3. These results are compared to conventional concrete (CC).

Table 3: Compressive strength of hypo sludge replacement concrete

Sl. No.	Name of Mix	Compressive strength(N/mm ²)	
		7 days	28 days
1	MIX 1 (Normal concrete)	24.58	30.47
2	MIX2(10% hypo sludge)	26.25	31.82
3	MIX3(20% hypo sludge)	21.95	25.46
4	MIX4(30% hypo sludge)	17.22	20.33

D. Split Tensile Strength

Concrete is poured into the mold 3 layers by stuffing with a tamping rod for a cylinder of (100 mm wide x 200 mm high) size was tested for breaking strength. The cast specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7 and 28 days the specimens are tested for tensile strength and the results are obtained as in Table 4. These results are compared to conventional concrete.

Table 4: Split tensile strength of hypo sludge replacement concrete

Sl. No.	Name of Mix	Split tensile strength (N/mm ²)	
		7days	28days
1	MIX 1 (Normal concrete)	4.16	5.32
2	MIX 2 (10 % hypo sludge)	5.17	6.28
3	MIX 3 (20 % hypo sludge)	3.80	4.69
4	MIX 4 (30 % hypo sludge)	3.14	3.67

RESULTS AND DISCUSSIONS

5.1 Fresh Concrete

The replacement of cement with hypo sludge the workability is very low in concrete.

1 Hardened Concrete

A. Compressive Strength

The results presented in Fig.2 show that hypo sludge increases its compressive strength up to 10% of hypo sludge compared to the compressive strength of normal concrete. At 28 days of curing, the compressive strength of normal concrete was found to be 30.47 N/mm², 10% replacement of hypo sludge was found to be 31.82 N/mm². At 28 days, the 10% replacement of hypo sludge increased compared to the compressive strength of conventional concrete. Compressive strength decreased by 20% and 30% instead of hypo sludge.

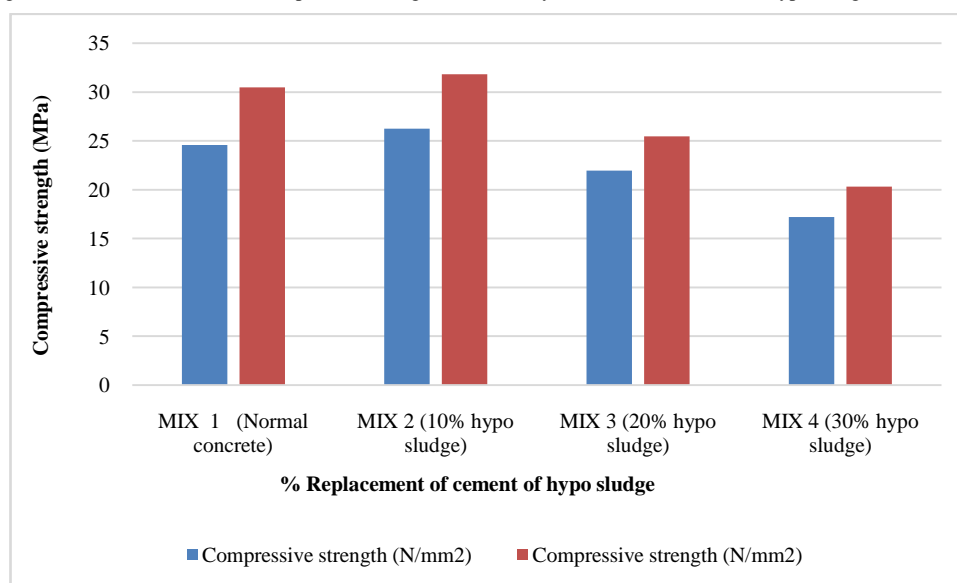


Figure 2: Compressive strength of hypo sludge replacement concrete

B. SPLITTENSILE STRENGTH

Cylindrical specimens of normal concrete, and hypo sludge concrete were tested for fracture toughness and the results obtained are shown in Fig 3. It is observed that up to 10% replacement of hypo sludge, the tensile strength of the concrete sample increases and from -MIX 3 in different wards the strong power keeps going down. However in MIX 2 the tensile strength is greater than that of the normal concrete mix. Maximum separation intensity is found in MIX 2.

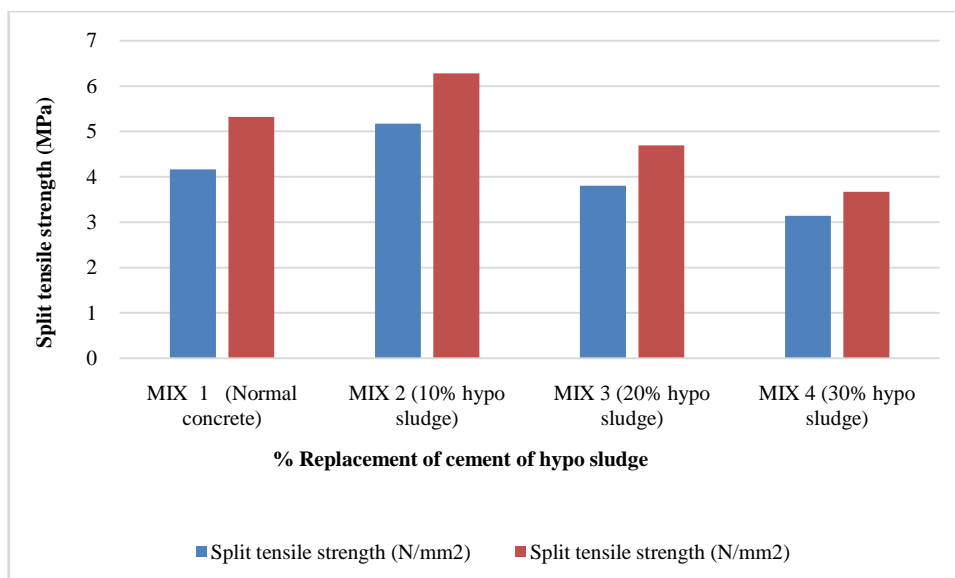


Figure 3: Split tensile strength of hypo sludge replacement concrete

VII. CONCLUSIONS

Based on the present investigation the following conclusions are drawn

- (i) Replacement of cement with hypo mortar has no significant effect on the performance of concrete.
- (ii) The compressive strength of concrete when mixed with 10% hypo sludge is found to be greater than normal concrete mix.
- (iii) 7 days and 28 days of curing resulted in a 10% increase in the compressive strength of the hypo sludge model and the simulation of the vehicle suspension system, combined with concrete compared to normal concrete.
- (iv) The tensile strength of concrete mixes, up to 10% instead of working with hypo mortar, is greater than normal concrete mix.
- (v) The use of hypo sludge in concrete is not only to reduce environmental pollution but also to reduce the economic cost of construction.
- (vi) This is the best way to dispose of paper waste in an efficient manner.

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