



AN EXPERIMENTAL STUDY ON CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY USING HYPO-SLUDGE

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ABSTRACT

Over 300 million tones of industrial wastes are being produced per annum by chemical and agricultural process in India. These materials possess problems of disposal and health hazards. The wastes like phosphogypsum, fluorogypsum, hypo-sludge and red mud contain obnoxious impurities which adversely affect the strength and other properties of building materials based on them. To reduce disposal and pollution problems emanating from these industrial wastes. it is most essential to develop profitable building materials from them. This project is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement. By replacing the cement by 0%, 10%, 20%, 30%, 40%, 50%, 60%, and 70% of Hypo-sludge. And testing compression and split tensile strength of the cubes and cylinder's.

Keywords: Concrete, Compression Test, Hypo-Sludge, Industrial wastes, Split Tensile Strength

I INTRODUCTION

1.1 General

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 cost concrete by blending various ratios of cement with hypo sludge. 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.



1.2 Hypo Sludge

Hypo sludge is one of the by- product from the paper industry .The use of these by-products offers environmental advantages divert the material from the waste stream, reduce the energy used in processing virgin materials, use of virgin materials, and decreases pollution.

India is a resourceful country for generation of the industrial wastes with an annual output of over 300 million tones, but utilization is still below 20 % in spite of quantum jump in last three to four years. Availability of consistent quality Hypo sludge across the country and awareness of positive effects of using Hypo sludge in the concrete.

1.3 Need For Hypo Sludge Utilisation.

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 green house gases are emitted in the atmosphere. For producing 4 million T, of cement 1 million T green house gases are emitted. Also, to reduce the environmental degradation this sludge has been avoided in mass level disposal in land.

II OBJECTIVES

1. To investigate the utilization of Hypo Sludge as Supplementary Cementitious Material (SCM) and influence of this hypo sludge on the Strength of concrete.
2. Influence on the cost of concrete made with different Cement replacement levels.

III SCOPE

- 1) To find the optimum strength of the partial replacement of cement with hypo sludge.
- 2) Minimize the max degradation in environment due to cement and safeguard ozone layer.
- 3) Using the wastes in useful manner.
- 4) To reduce the cost of the construction.
- 5) It should be easily adopted in construction field.
- 6) To provide a most economical concrete.
- 7) Minimize the maximum demand for cement.

IV METHODOLOGY

- a) Mix design for concrete proportion has been developed as per IS10262 – 2004
- b) Casted and cured the concrete specimens as per Indian standards procedures.
- c) The characteristic strength of hardened concrete specimen was tested as per IS 456 – 2000.



- d) Finding the optimum strength of partial replacement of hypo sludge as cement.
- e) Comparing the results of conventional concrete with partial replacement concrete.

V DETAILS OF THE EXPERIMENTAL STUDY'S

Concrete cubes of size 150 mm × 150 mm × 150 mm were casting using M₂₀ Grade of concrete. Specimens with ordinary Portland cement (OPC) and OPC Replaced with hypo sludge at 10%, 20%, 30%, 40%, 50%, 60% and 70% 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 14 and 28 days. After curing, the specimens were tested for Compressive strength using a calibrated compression testing machine of 2,000kN capacity.

5.1 Compressive Strength Test

Compression test is the most common test conducted on the hardened concrete, partly because it is an easy to perform, and partly because most of desirable properties of concrete are qualitatively to its compression strength.

The compression test is carried out on a specimen cubical or cylindrical in shape. Prism is also sometimes used, (Ref.8) but it is not common in our country.

The cube specimen of the size 150×150×150 mm, if the largest nominal size of the does not exceed 20mm, 100 mm size cubes may be used as an alternative. Cylindrical test specimens have a length equal to twice the diameter.

Compressive Strength=Load/Area

5.2 Split Tensile Strength

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have been designed which assure uniform distribution of the pull applied to the concrete while a number of investigations involving the direct measurement of tensile strength have been made. Beam tests are found to be dependable to measure flexural strength property of concrete.

Calculation:

Calculate the splitting tensile strength of the specimen as follows:

$$T = (2 P) / (\pi \times L \times D)$$

Where:

T = Splitting tensile strength, Mpa

P = Maximum applied load indicated by the testing machine, KN

l = Length, in m

d = Diameter, in m

VI RESULTS AND DISCUSSION

Table No 6.1.1 Compressive Strength of cubes at 14 days

Partial replacement %	Number of specimen	Ultimate load(KN)	Ultimate compressive strength(Mpa)
0	3	342.45	15.22
10	3	482.40	21.44
20	3	633.82	28.17
30	3	676.80	30.08
40	3	486.90	21.64
50	3	337.05	14.98
60	3	238.50	10.60
70	3	162.67	6.02

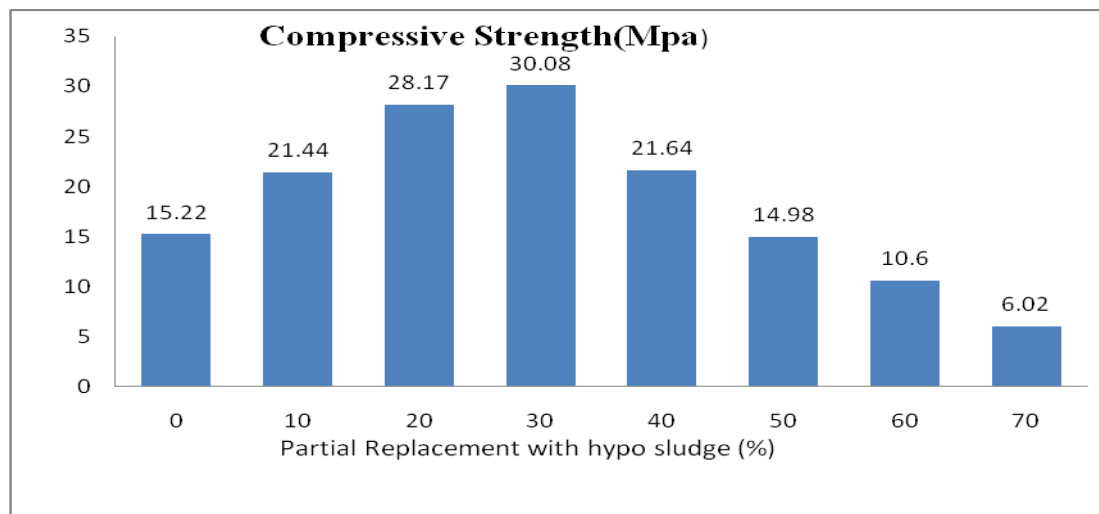


Fig 6.1.1 Compressive strength of at 14 days of curing

Table No 6.1.1.2 Compressive Strength of cubes at 28 days

Partial replacement %	Number of specimen	Ultimate load(KN)	Ultimate compressive strength(Mpa)
0	3	656.10	29.16
10	3	702.45	31.22

20	3	834.5	37.09
30	3	886.72	39.41
40	3	679.05	30.18
50	3	381.60	16.96
60	3	322.87	14.35
70	3	224.55	9.98

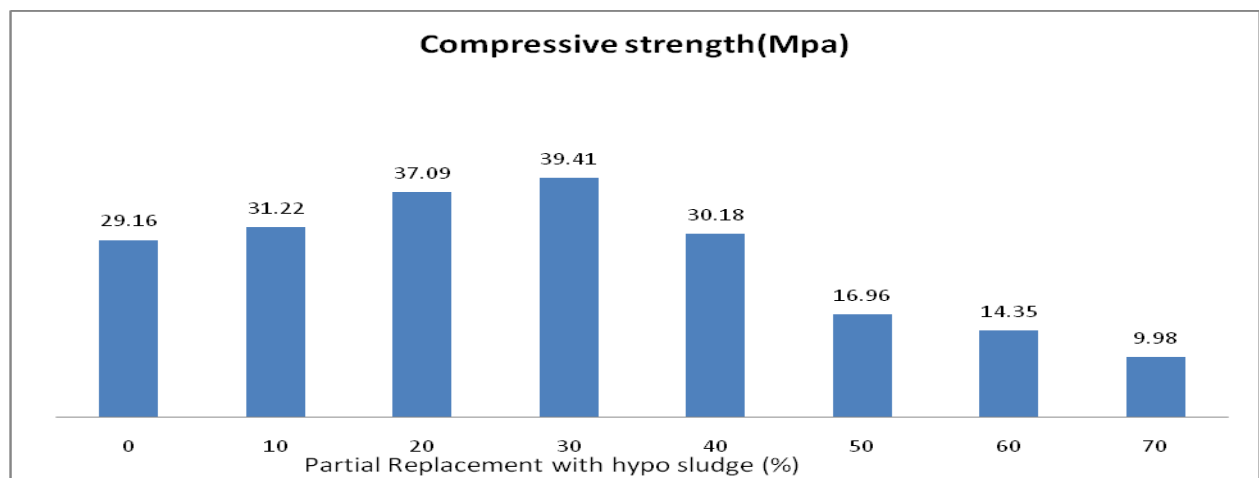


Fig 6.1.1.2 Compressive strength of concrete at 28 days of curing

Table No 6.2.1 Split Tensile Strength of Cylinder at 28 days

Partial replacement %	Number of specimen	Ultimate load(KN)	Ultimate compressive strength(Mpa)
0	3	121.57	1.72
10	3	102.49	1.45
20	3	96.132	1.36
30	3	91.18	1.29
40	3	89.06	1.26
50	3	87.65	1.24
60	3	91.18	1.29
70	3	91.89	1.31

Split tensile strength of cylinder at 28 days

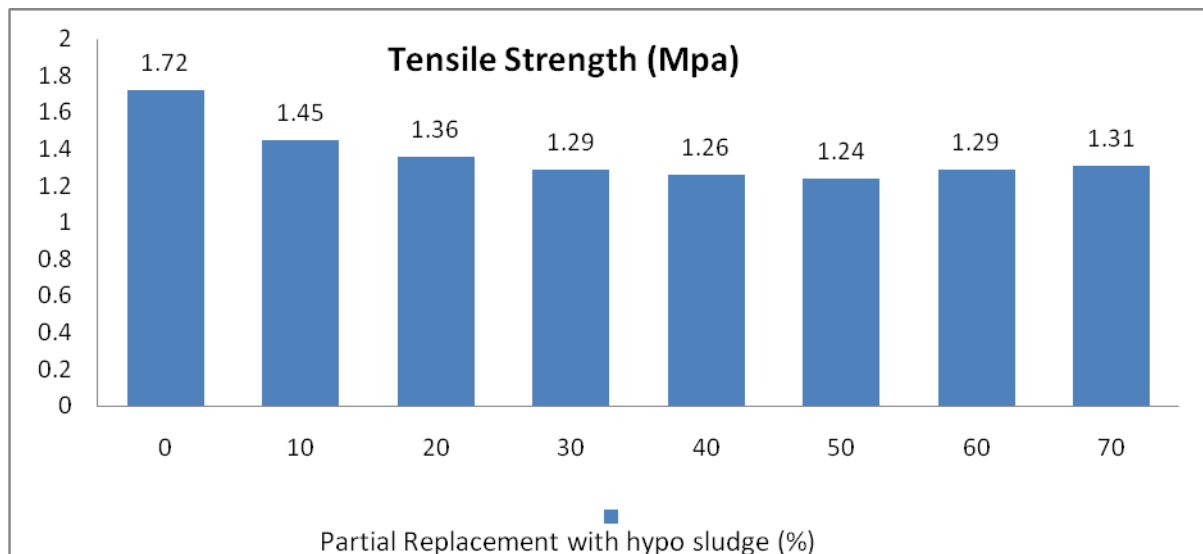


Fig.6.2.1 Split tensile strength of concrete at 28 days of curing

VII ECONOMIC FEASIBILITY

Cost analysis is carried out for the optimum proportion of percentage of hypo sludge in concrete. This project was carried out in our college campus. The cost is compared to the conventional concrete.

A) 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

Table No 7.1 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



Table No 7.2 Cost of material of 10% partially replaced concrete per cum

Description	Quantity,(kg/m ³)	Cost,(Rs)	Cost of material,(Rs)
Cement	354.6	6.8 Per kg	2411.28
Hypo sludge	39.4	1 Rupee per kg	39.4
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	3327.9

Table no 7.3 Cost of material of 20% partially replaced concrete per cum

Description	Quantity,(kg/3	Cost,(Rs)	Cost of material,(Rs)
Cement	315.2	6.8 Per kg	2143.36
Hypo sludge	78.8	1 Rupee per kg	78.8
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	3099.38

Table no 7.4 Cost of material of 30% 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	1Rupee per kg	118.2
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	2870.86

Table no 7.5 Cost of material of 40% partially replaced concrete per cum

Description	Quantity,(kg/m ³)	Cost,(Rs)	Cost of material,(Rs)
Cement	236.4	6.8 Per kg	1607.52
Hypo sludge	157.6	1 Rupee per kg	157.6
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	2642.34



Table no 7.6 Cost of material of 50% partially replaced concrete per cum

Description	Quantity,(kg/m ³)	Cost,(Rs)	Cost of material,(Rs)
Cement	197	6.8 Per kg	1339.6
Hypo sludge	197	1 Rupee per kg	197
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	2413.82

Table no 7.7 Cost of material of 60% partially replaced concrete per cum

Description	Quantity,(kg/m ³)	Cost,(Rs)	Cost of material,(Rs)
Cement	157.6	6.8 Per kg	1071.68
Hypo sludge	236.4	1 Rupee per kg	236.4
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	2185.3

Table no 7.8 Cost of material of 70% partially replaced concrete per cum

Description	Quantity,(kg/m ³)	Cost,(Rs)	Cost of material,(Rs)
Cement	118.2	6.8 Per kg	803.76
Hypo sludge	275.8	1 Rupee per kg	275.8
Sand	648	1060 per cum	429.3
Coarse aggregate	1116	883 per cum	447.92
		Total cost	1956.78

The compared values of cost show gradual decrement in total cost of per cubic meter concrete. The above tables show cost values up to 30% replacement and the difference in cost from normal concrete to partially replaced concrete was **685.56 Rs**

VIII 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) Compressive strength of the concrete can be increased when the Percentage of replacement is increased up to 30% and when the replacement is increased above 30% Compressive strength decreases.



- 2) The split tensile strength of concrete has decreased when the percentage of the replacement with hypo sludge is increased.
- 3) Use of hypo sludge in concrete can save the paper industry disposal costs and produces a greener' concrete for construction.
- 4) Disposal problem of the hypo sludge can be minimized by this project now days as it is a big problem of getting the landfill.
- 5) Environmental effects from wastes and residual amount of cement manufacturing can be reduced through this low cost concrete.
- 6) From this level, replacement of cement with this waste of hypo sludge Material provides maximum compressive strength at 30% replacement
- 7) Cost of cement has become low from this project.
- 8) A better measure by a New Construction Material is formed out through this project.
- 9) The cost analysis indicates that percentage of cement reduction decreases the cost of concrete, but at the same time the strength also decreases beyond optimum addition of 30% hypo sludge.
- 10) This research concludes that hypo sludge can be innovative supplementary Cementitious Construction Material

REFERENCE

- [1] Udoeyo F.F., Inyang H., Young D.T., Oparadu Ed.E., Potential of Wood Waste Ash As an Additive in Concrete. J. of Msater. in Civil Engng., ASCE, 605-612 (2006).
- [2] Shi Cong Kou, Chi Sun Poon, Dixon Chan, Influence of Fly Ash as Cement replacement on the Properties of Recycled Aggregate Concrete. J. of Mater. In Civil Engng. ASCE, 709 (2007)
- [3] Ganesan K., Rajagopal K., Thangavelu K., Effects of the Partial Replacement of Cement with Agro Waste Ashes on Strength and Durability of Concrete. Proc.of Internat. Conf. on Recent Adv. in Concrete a. Constr. Technol., organised by Dept. of Civil Engng, S.R.M. Engng. College, Chennai, Dec. 7-9, 2005.
- [4] Specifications for Coarse and Fine Aggregates from Natural Sources for concrete. Bureau of Indian Standards, New Delhi, IS 383 -1970.
- [5] IS Method of Mix Design. Bureau of Indian Standards, New Delhi, IS 10262-2009.
- [6] Concrete Technology by M.S SHETTY.
- [7] Properties of concrete by Neville A.M – ELBIS Edition, Long man ltd London
- [8] Methods of Tests for Strength of Concrete. Bureau of Indian Standards, New Delhi, IS 516 -1959.
- [9] Code of Practice for Plain and Reinforced Concrete. Bureau of Indian Standards, New Delhi, IS 456 -2000.
- [10] Jayraj Vinodsinh Solanki GRA - GLOBAL RESEARCH ANALYSIS X 40 Volume : 2 | Issue : 1 | Jan 2013 • ISSN No 2277 - 8160