IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 22-27

Comparison of Characteristics Strength of Conventional Concrete with GGBFS Concrete and Hypo Sludge Concrete

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Abstract- *This experimental investigation on strength of concrete and optimum percentage of the partial replacement by preparing a mix M20 grade was designed as per Indian Standard method and the same was used to prepare the test samples. In the design mix proportion used in conventional Concrete, cement is replace by 10%, 20%, 30% and 40% of industrial waste like GGBFS and hypo sludge. In the test performed, the optimum compressive strength obtained by utilizing paper waste was at 20% replacement and by utilizing GGBFS was at 30%. At the place where strength is not of more importance or rather structure is for temporary basis then design mix proportion up to 40% replacement can also be utilized. Test also point towards developing low cost concrete by varying design mix proportion from 10%replacement to 40%replacement. To investigate the utilization of GGBFS and hypo sludge as Supplementary Cementitious Materials (SCM) and influence of these GGBFS and hypo sludge on the Strength of concretes made with different Cement replacement levels and compare with conventional concrete*
Keyward: *GGBFS, Hypo sludge Supplementary Cementitious Materials (SCM).*

I. Introduction

Ground granulated blast furnace slag (GGBFS) is the by-product of smelting ore to purify metal and while producing paper the various wastes are comes out from the various processes in paper industries, from the preliminary waste named as hypo sludge. The use of these by-products offers environmental advantages divert the material from the waste stream, reduce the energy used in processing waste materials, use of waste materials, and decreases pollution. India is a resourceful country for GGBFS and hypo sludge generation with huge annual output of several million tones, but utilization is still very small in spite of quantum jump in last three to four years. Availability of consistent quality GGBFS and hypo sludge across the

Country and awareness of positive effects of using GGBFS and hypo sludge in concrete are pre requisite for change of perception of GGBFS and hypo sludge from waste material to resource material. Although both GGBFS and hypo sludge offers environmental advantages, it also improves the performance and quality of concrete. GGBFS affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. Both GGBFS and hypo sludge increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate resistance, and reduces alkali-aggregate reaction. GGBFS reaches its maximum strength more slowly than concrete made with only Portland cement.

The paper mill sludge as well as GGBFS consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread on agricultural land or running off into area lakes and streams. 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 desire to develop profitable materials from them. Keeping this in view, investigations were undertaken to produce low cost concrete by blending various ratios of cement with GGBFS and with hypo sludge. So we take GGBFS and hypo sludge for compare it with cement.

II. Review Of Literature

Review of literature on GGBFS in concrete

S. C. Maiti, Raj K. Agrawal and Rajjebkumar (2006) [1] concluded that relationship between water-cement ratio and 28 days compressive strength of concrete have been arrived at based on experimental data from different construction sites. Such concrete contain OPC or PPC or (OPC + fly ash) or (OPC + GGBFS) and a superplasticiser. These relationships however are for two levels of 28 days compressive strength of cement, viz. 43-50 Mpa, and greater than 53 Mpa. It is observed that these relationships are almost same as given in IS 10262 for two grades of OPC (43 grade and 53 grade). This indicates that mineral admixtures, like fly ash and GGBFS contribute to the strength development process at 28 days, similar to that of OPC in

concrete. These relationships however cannot be used for very high strength concrete that is, for concrete having 28 days compressive strength above 80 Mpa.

Fulton (1974) [2] investigated workability in great detail and suggested that a cementitious matrix containing slag cements exhibited greater workability due to the increased paste content and increased cohesiveness of the paste.

Wood (1981) [3] reported that the workability and placeability of concrete containing slag cement was improved when compared with concrete containing no slag cement. He further stated that this result was due to the surface characteristics of the slag cement, which created smooth slip planes in the paste. He also theorized that, due to the smooth, dense surfaces of the slag cement particles, the slag cement absorbed little if any water during initial mixing, unlike Portland cement. Most producers of ready-mixed concrete that use slag cement do so in proportions of 50% of total cementitious material during warm weather (Wood 1981). This proportion usually produces the greatest strength and most favourable cost-to-benefit ratio. Proportions of slag cement as low as 20 to 30% have been used during periods of colder weather when setting time and rate of strength gain might be slower. In those jobs requiring performance characteristics, such as sulphate resistance or reduced heat of hydration, concrete mixtures containing more than 50% slag cement might be more appropriate. On the other hand, when early strengths are required to facilitate quick form removal or when thin sections are placed at low temperatures, blends containing less than 50% are recommended.

III. Literature Review On Hypo Sludge In Concrete

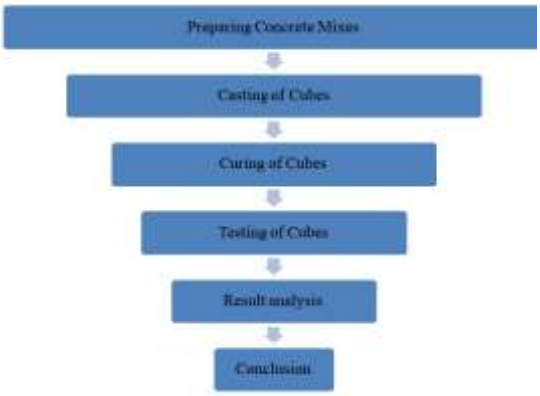
Jayraj Vinodsinh Solank, Student of final year M.E. C E & M, B.V.M. engineering college, Vallabh Vidyanagar[1] He carried out the investigation concerning workability and compressive strength of concrete regarding the resistance of partially replaced hypo sludge. Workability increases with higher replacement of hypo sludge. Compressive strength of the concrete measured after 7 days decreases when the percentage of replacement of hypo sludge increases and replacement of 10 % hypo sludge compressive strength increases after 7 days. Compressive strength of the concrete measured after 28 days increases when the percentage of replacement of hypo sludge increases up to 30%.

Prof. Jayeshkumar Pitroda, Assistant Professor & Research Scholar, Department of Civil Engineering, B.V.M. Engineering College, Gujarat[2]. He concludes that the incorporation of a Hypo Sludge in mixed cement is not feasible for making masonry mortars for high strength. Adequate strength developments were not found in mortars made of the mixed cement and Hypo Sludge as cement replacement for 1:3 mortars at 28 days. Hypo Sludge may be used in masonry mortar to improve the long-term bond strength. Partial replacement of the Portland cement with Hypo Sludge does not improve the masonry bond strength at early age of 7 days. Hypo Sludge can be used to prepared low cost temporary structure. He state that the % change in cost reduces up to 34.59 for 50% replacement of Hypo Sludge.

Dr. L.B.Zala,Dr.F. S. Umrigar(2013)[3], he carried out the investigation concerning the compressive & split strength of concrete. He concludes that compressive strength reduces when cement replaced hypo sludge. As hypo sludge percentage increases compressive strength and split strength decreases. He analysed that percent cement replacement decreases cost of concrete, but at the same time strength also decreases.

IV. Experimental Program

In order to achieve the stated objectives, the study was carried out in few stages. On the initial stage all the material and equipments needed must be gathered or checked for availability. Then, the concrete mixes according to the predefined proportions. Concrete cubes were tested on UTM (Universal Testing Machine) for compressive strength. Finally the result obtained where analyzed to draw out conclusion.



Flow chart of Experimental Program

Mix proportions

IS code method of design was used for mix design of M20 grade of concrete. Concrete specimens with various percentages of slag & hypo sludge were prepared.

Details of concrete mix proportion for one cube of concrete for slag

Sr. No.	Slag (%)	Water/cement ratio	Mix proportion (gram)				
			cement	slag	sand	aggregate	water
1	0	0.4	1500	0	2250	4500	600
2	10	0.4	1350	150	2250	4500	600
3	20	0.4	1200	300	2250	4500	600
4	30	0.4	1050	450	2250	4500	600
5	40	0.4	900	600	2250	4500	600

Details of concrete mix proportion for one cube of concrete for hypo-sludge.

Sr. No.	Slag (%)	Water/cement ratio	Mix proportion (gram)				
			cement	slag	sand	aggregate	water
1	0	0.4	1500	0	2250	4500	600
2	10	0.4	1350	150	2250	4500	600
3	20	0.4	1200	300	2250	4500	600
4	30	0.4	1050	450	2250	4500	600
5	40	0.4	900	600	2250	4500	600

V. Testing Of Specimen

The specimens cubes, after curing period of 7 and 28 days were tested for compressive strength on a universal testing machine of 1000KN capacity. The compression test was carried out on specimens cubical in shape both on GGBFS concrete as well as conventional concrete. The cube specimen is of the size 150 mm x 150 mm x 150 mm were used to conducting the compressive testing. Standard proportions of concrete ingredients were mixed thoroughly to form specimens of GGBFS concrete and conventional concrete for test. The specimens were made in 150mm standard cube mould. The concrete was placed in three layers by manually and each layer was tamping 25 times with 16mm diameter and 60cm in length of rod after that mould was placed on the vibrator. The cubes are first cured under gunny for first 24 hours. Then they were removed from mould and cured in curing tank at a room temperature of 24'C TO 30'C for 7 and 28 till it is to be tested under wiped dry conditions. After 7 and 28 days cubes were taken out from curing tank for testing. The cubes were tested on compression testing machine. The dimensions of cubes were first measured and then tested in compression testing machine.

The cubes were placed in UTM as shown in figure the load being applied to the sides of the specimen as cast. All specimens were tested at the rate of loading 0.5 kN/mm2 per minute till failure of cube occurs. The load at failure per c/s area cube is taken as compressive strength of concrete. The average strength of set of two samples of each 7 days, and 28 days is taken as the cube strength.

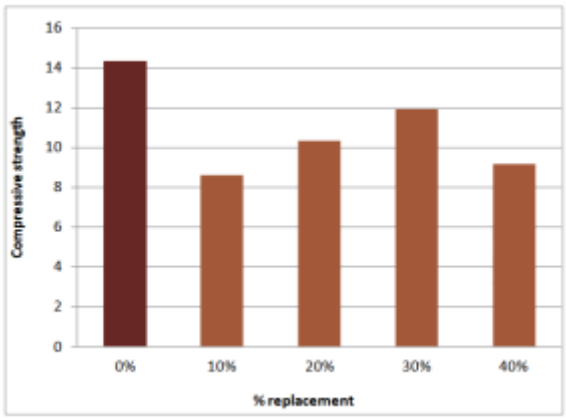
VI. Results And Discussion

The data includes the results from the cube test. The performances of slag and hypo sludge in concrete were analyzed based on the comparison with the conventional concrete. In order to indicate the results of the analysis graphs, tables and figures are used. The purpose of this analytical method is to accurately predict the compressive behavior of concrete strengthened by using GGBFS and hypo sludge.

1) Compressive strength of concrete when cement replace by GGBFS

- **Compressive strength of cubes at 7 days**5

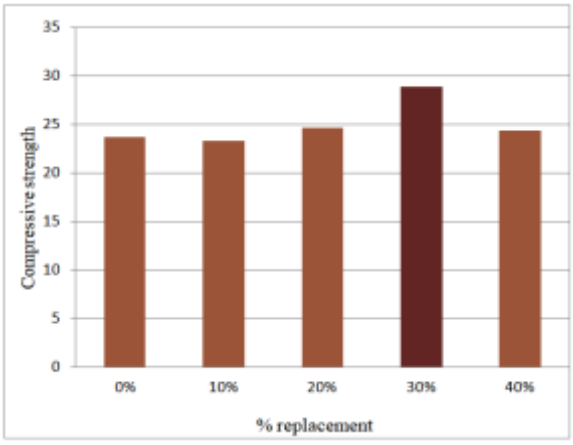
Sr. No.	Partial replacement	Number of specimen	Ultimate load in kN	Ultimate compressive strength in N/mm^2
1.	0 %	2	321.5	14.29
2.	10%	2	192.5	8.56
3.	20%	2	231	10.27
4.	30%	2	267.5	11.89
5.	40%	2	205	9.11



Compressive strength of cubes at 7 days

- **Compressive strength of cubes at 28 days**

Sr No	Partial replacement	No. of specimen	Ultimate load in kN	Ultimate compressive strength in N/mm^2
1.	0 %	2	533.5	23.71
2.	10%	2	523.5	23.27
3.	20%	2	577.5	25.67
4.	30%	2	649.5	28.87
5.	40%	2	586	26.04

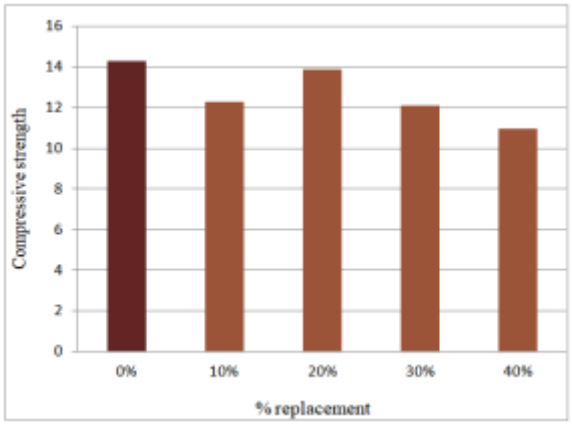


Compressive strength of cubes at 28 days

2) Compressive strength of concrete when cement replace by hypo sludge

- **Compressive strength of cubes at 7 days**

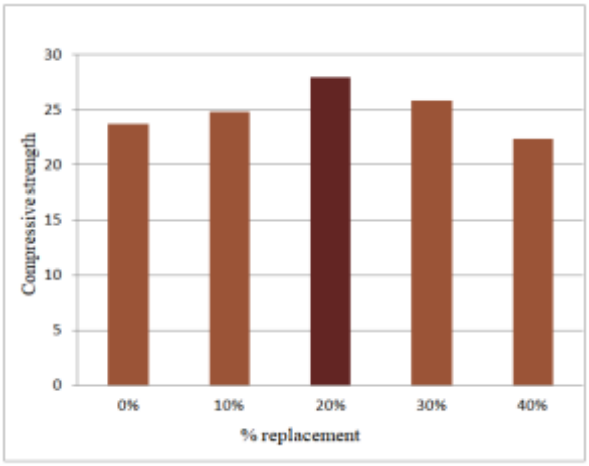
SrNo	Partial replacement	Number of specimen	Ultimate load in kN	Ultimate compressive strength in N/mm^2
1.	0 %	2	312.5	14.29
2.	10%	2	276	12.27
3.	20%	2	312.5	13.89
4.	30%	2	272	12.09
5.	40%	2	247	10.98



Compressive strength of cubes at 7 days

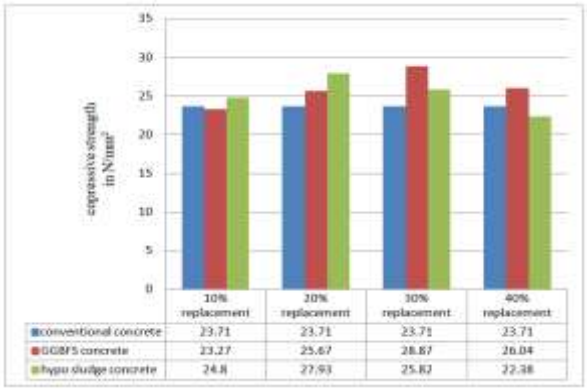
- **Compressive strength of cubes at 28 days**

SrNo	Partial replacement	Number of specimen	Ultimate load in kN	Ultimate compressive strength in N/mm^2
1.	0 %	2	533.5	23.71
2.	10%	2	558	24.8
3.	20%	2	628.5	27.93
4.	30%	2	581	25.82
5.	40%	2	503.5	22.38



Compressive strength of cubes at 28 days

- **Comparisons of 28 days compressive strength of conventional concrete with GGBFS concrete and hypo sludge concrete**



VII. Conclusion

The following conclusions are drawn on basis of experimental result.

1) The optimum percentage for partial replacement of cement by ground granulated blast furnace slag is 30%.
2) Ground granulated blast furnace slag a by-product of steel manufacturing process which is very cheaper than OPC thus decreasing our concrete cost.
3) The rate of gain of compressive strength of GGBFS concrete is slow in the initial stage i.e. up to 7 and as the curing period increases strength also increases.
4) With increase in GGBFS content, workability of concrete increases.
5) GGBFS has a positive effect on compressive strength of concrete for 28 days.
6) 20% replacement of cement by hypo sludge increases compressive strength of concrete at 14 and 28 days.
7) Cement in concrete can be replaced by hypo sludge up to 20% by weight showing 18% increase in compressive strength at 28 days.
8) With increase in hypo sludge content, workability of concrete decreases.
9) Environmental effects from wastes and residual amount of cement manufacturing can be reduced through this research.
10) Use of hypo sludge in concrete can save the paper industry disposal costs and produces a 'greener' concrete for construction.

Reference

[1]. M.L. Gambhir "Concrete Technology" Tata McGraw Hill Company, New Delhi.
[2]. IS 456:2000. Code of practice for plain and reinforced concrete, fourth revision, Bureau of Indian Standard, New Delhi.
[3]. IS 383:1970. Specification for course and fine aggregates from natural source for concrete Bureau of Indian Standards, New Delhi.
[4]. M. S. Shetty "Concrete Technology Theory and Practice" S. Chand & Company New Delhi.
[5]. IS: 2386-1963. Methods of test for aggregates for concrete - Part 1: Particle size and shape. Bureau of Indian Standard, New Delhi.
[6]. IS 12269-1987. Specification for OPC-53 grade cement. Bureau of Indian Standard, New Delhi.
[7]. Journal of Indian Building Congress On "Low Cost Housing", volume seventeen, 2010.
[8]. www.engineeringcivil.com/lowcostconcrete/ggbfsconcrete/
[9]. http://www.ecocem.ie/downloads/Working_with_GGBS_Concrete.pdf
[10]. http://www.scribd.com/doc/99591658/Experimental-Investigation-in-Developing-hyposludge-Concrete.pdf
[11]. http://www.academia.edu/5283494/A_Techn-Economic_Study_on_Paper_Industry_Waste-_Hypo_Sludge_Concrete_in_Rigid_Pavement
[12]. S. C. Maiti, Raj K. Agrawal and Rajjebkumar (2006**),** journal of **"**Slag cement in concrete and morta"r, reported by ACI Committee 233R-03.
[13]. Sajad Ahmad, M. Iqbal Malik, (B.Tech Civil Engineering; Assistant professor IUST Kashmir) IOSR Journal of Engineering (IOSRJEN) Vol. 3, Issue 11 (November. 2013), Page 06-15.
[14]. Jayeshkumar Pitroda, Assistant Professor & Research Scholar, Civil Engineering Department, B. V. M. Engineering College, Vallabh vidhyanagar-Gujarat-India, Volume 2 , Issue 1st Jan 2013.