Effect of Hypo Sludge and Ggbs on Mechanical Properties of Concrete

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Abstract- *Concrete is strengthing and tough material but it is porous material which interacts with the surrounding environment. Presently the construction industry is in need of finding cost effective material to improve the strength of concrete. by reusing the waste material such as Ground Granulated Blast Furnace Slag (GGBS) & Hypo Sludge. Paper manufacturing industry generates various wastes coming out from the various processes. There is a preliminary waste named as hypo sludge, due to its calcium is taken out to replace the cement in concrete. Major initiatives are needed in India to use these large volumes in construction industry to minimize the pollution of environment. GGBS and Hypo sludge is obtained as waste product from the iron and paper industry. The experimental result analyses are investigated for mechanical properties of concrete equipped with GGBS and hypo sludge. Concrete grade M60, M70 and M80 was taken for study. GGBS (0%,10%,20%,30%,40%) and hypo sludge (0%,10%,20%,30%) were replaced for various ratio by weight of ordinary cement. study the effect on compressive strength, tensile strength and flexural strength and other test carried out like durability test and slump test for partial replacement with cement and reduce the disposal also pollution problems due to Hypo Sludge and GGBS. It is most essential to develop profitable building materials from both waste products.*

Keywords- Hypo sludge, GGBS, compressive strength, split tensile strength, flexural strength, acid attack test

I. INTRODUCTION

India cement demand and production are increasing, the total output of cement in india may reach 425 million tonnes in 2017. A conservative estimate for 1 tonne of cement produced give approximately of 1 tonne of C02. Not only CO2 is release from cement industry, but also SO2 and NO_x, which can cause the greenhouse effect and acid rain.

The resource efficiency of construction and building materials is a major contemporary issue facing industry. Many regions of the world are experiencing problems disposing of increasing amounts of municipal solid waste and miscellaneous industrial wastes. In addition, given the major CO_2 emissions associated with the Portland cement manufacture process, much research in the field of construction materials is focused on using environmentally-sustainable raw materials like hypo sludge and GGBS.

Concrete may be a composite construction material composed of cement, mixture (generally a rough mixture made from gravels or crushed rocks like sedimentary rock, or granite, and a fine mixture like sand), water, and/or admixtures. Concrete is formed by mixing: Cement, water, course fine aggregates and admixtures (if required). The objectives square measure to combine these materials historically to form concrete that's simple to: Transport, place, compact, end and to offer a powerful and sturdy product. The proportionate amount of every material (i.e. cement, water and aggregates) affects the properties of hardened concrete.

A large amount of solid waste is produced in the process of paper making recycling of paper fiber can be carried out only a limited number of times before they become too short or weak to make high quality paper. Thus, it can be seen that the broken low-quality paper fiber are separated out to become waste sludge. The waste solid also include inks, dyes, coaling, pigments, etc. which are washed off the recycled fiber. A fine kaolin clay coating is applied on glossy-magazine type paper to give it a shiny finish so that it can be also be treated as solid waste during recycling. A large percentage of local landfill space is occupied by paper mill sludge for each and every year.

II. EXPERIMENTALWORK

A. MATERIALS

Cement

Ordinary Portland Cement of 53 Grade manufactured by sanghi cement company was used in concrete mixes corresponding to IS-8112. The specific gravity of cement is 3.15.

Sand

Natural river sand is used as fine aggregate. As per IS: 2386 (Part III)-1963 , the bulk specific gravity in oven dry condition and water absorption of the sand are 2.6 and 1% respectively.

Aggregate

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are used. The Flakiness Index and Elongation Index were maintained well below 15%.

Hypo sludge

The raw materials used in study ware the waste materials hypo sludge. hypo sludge is obtained from J.K.Papers mill Pvt.Ltd, plant. This plant is located near Songadh in Tappi District in Gujarat State. Hypo sludge contains, low calcium and maximum calcium chloride and minimum amount of silica. Hypo sludge behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of the concrete.

Table 1. Physical properties of hypo sludge

Properties	value
Bulk Density	743 kg/m^3
Specific Gravity	2.17
Water absorption	7%

Table 2. Chemical properties of hypo sludge

CHEMICAL COMPONENTS	HYPO SLUDGE
C_aO	47.84%
Al_2O_3	0.09%
FE_2O_3	0.73%
SIO_2	9.28%
MGO	6.41%
K_2O	1.21%
SO_3	0.19%
LOI	34.10%

Figure. 2 GGBS

GGBS

The data for GGBS is collect from Arrhum enterprise, ahmedabad. Ground granulated blast furnace is a by-product from the blast furnace used to make iron and purify metals. The compressive strength is increased by pozzolanic reaction of GGBS. The physical properties of GGBS as are shown in Table below.

Table 3. Chemical properties of GGBS

CHEMICAL COMPONENTS	HYPO SLUDGE
C_aO	41.9%
Al_2O_3	11.59%
FE_2O_3	0.35%
SIO_2	35.35%
MGO	8.04%
K_2O	0.87%
SO_3	0.23%
LOI	1.57%

Table 4. Physical properties of GGBS

Properties	Value
Bulk Density	1260 kg/m^3
Specific Gravity	2.17
Fineness modulus	3.36%

Figure. 2 GGBS

Mix design

A standard mix M60,M70 and M80 grade was calculated as per Indian Standard (IS 10262-2009). The concretes were prepared at cementitious materials. For each material content, the W/C ratio is different. Hypo sludge and GGBS is replaced by different percentage with cement for fixed proportion. The mix design is given in Table5.

Table 5. mix design for M15 grade of concrete

Grade	M60	M70	M80
Mix Ratio	1:1.38:2.74	1:1.33:2.65	1:1.22:1.48
Water	158 lit	158 lit	158 lit
Cement	415 Kg	464 Kg	493 Kg
Sand	625.194 Kg	621.43 Kg	604.19 Kg
Aggregate	1239 Kg	1232 Kg	1225 Kg
W/C ratio	0.35	0.34	0.32
Admixture	9.02 lit	9.28 Kg	9.86 Kg

B. Testing Procedure

For preparing cube, cylinder and beam mixing of concrete is done either by hand or by machine, a batch mixer was used. First coarse aggregates, fine aggregates, cement, hypo sludge and GGBS, were mixed with ½ of the mixing water for 2 min. After this material is poured in to concrete block mould and pressing it.

For Compressive strength, split tensile strength and flexural strength tests were conducted on 150x150x150 mm cube,150x100 mm diameter cylinder and 700x150x100 mm beam are casted and after 28 days of proper curing and test were conducted. 3 cube,2 cylinder and 1 beam were casted and tested for each combination. Also in durability acid attack test were conducted on 150x150x150 mm cube are casted and tested after 90days.

Figure. 3 mixing of concret

C. Concrete mix proportions

Table 6. Concrete Mix proportions of grog.

combination	Hypo sludge (%)	GGBS (%)
H0G0	0	0
H0G10	0	10
H0G20	0	20
H0G30	0	30
H0G40	0	40
H10G0	10	0
H10G10	10	10
H10G20	10	20
H10G30	10	30
H10G40	10	40
H20G0	20	0
H20G10	20	10
H20G20	20	20
H20G30	20	30
H20G40	20	40
H30G0	30	0
H30G10	30	10
H30G20	30	20
H30G30	30	30
H30G40	30	40

III. TEST RESULTS AND DISCUSSION

A. Compressive strength

The compressive strength of cube is measured at 28 days. Cube size is 150x150x150 mm and Average of three cube is taken for each combination. For compressive strength test procedure as per IS 2185 part 1 (2005).

Table 7. Compressive strength of cube

Combination	Compressive strength N/mm²		
	M60	M70	M80
H0G0	61.56	72.22	82.11
H0G10	62.88	73.11	83.78
H0G20	64.22	73.33	84.88
H0G30	64.88	73.78	86.00
H0G40	66.11	74.00	86.67
H10G0	65.78	72.44	82.89
H10G10	66.88	74.67	86.67
H10G20	67.33	75.11	87.33
H10G30	68.44	75.56	88.89
H10G40	67.78	73.11	87.78
H20G0	64.89	72.22	82.66
H20G10	65.56	72.66	83.33
H20G20	65.78	72.00	84.67
H20G30	65.33	71.55	84.00
H20G40	64.22	70.66	83.78
H30G0	63.11	69.33	82.00
H30G10	63.55	71.55	84.67
H30G20	62.22	72.66	83.11
H30G30	61.77	72.00	82.89
H30G40	61.33	70.66	81.78

Figure. 4 Test setup for compression test

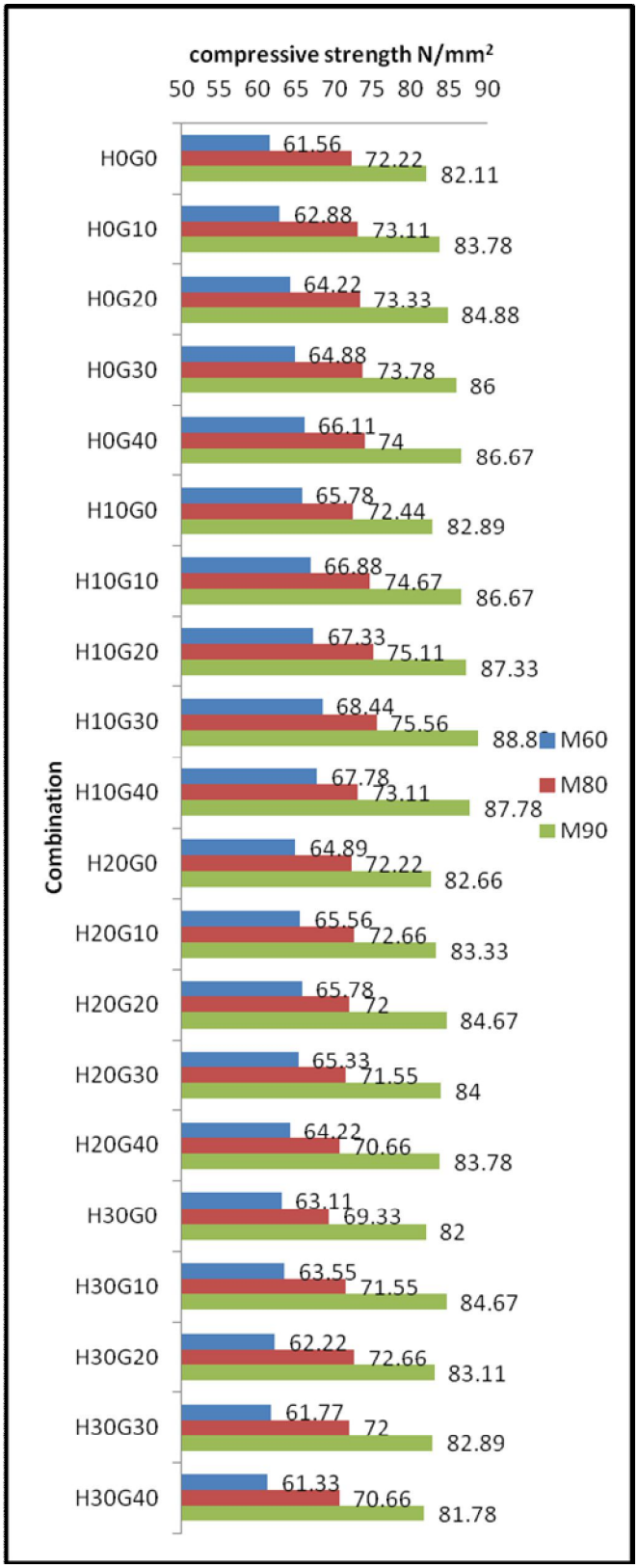

Figure. 5 graph of compressive strength at 28 days

B. Split tensile strength

Split tensile strength of cylinder is measured at 28 days. Cylinder size is 150mm x 100mm diameter and Average of two cylinder is taken for each combination. For split tensile strength strength test procedure as per IS 2185 part 1 (2005).

Table 8. split tensile strength of cylinder

Combination	Split tensile strength N/mm²		
	M60	M70	M80
H0G0	5.6	6.13	7.05
H0G10	5.71	6.2	7.12
H0G20	5.85	6.35	7.26
H0G30	6.06	6.56	7.47
H0G40	6.13	6.63	7.54
H10G0	4.86	5.78	6.77
H10G10	5.08	5.99	6.91
H10G20	5.22	6.06	7.98
H10G30	5.36	6.2	7.05
H10G40	5.43	6.2	7.19
H20G0	4.58	5.43	6.63
H20G10	4.72	5.6	6.70
H20G20	4.86	5.64	6.84
H20G30	4.93	5.78	6.98
H20G40	5.08	5.85	7.05
H30G0	4.02	5.22	6.20
H30G10	4.09	5.36	6.42
H30G20	4.23	5.43	6.56
H30G30	4.3	5.58	6.63
H30G40	4.51	5.78	6.84

Figure. 6 Testing of cylinder

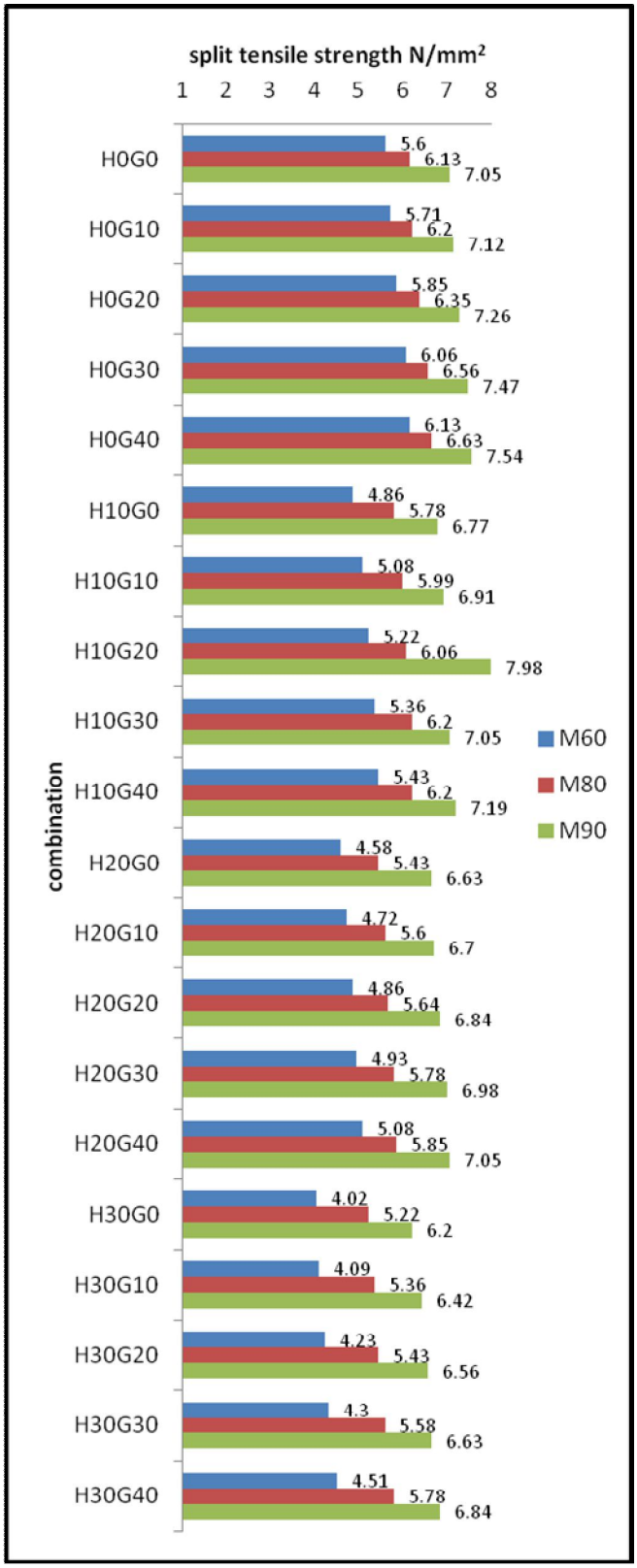

Figure. 7 graph of compressive strength at 28 days

C. Flexural strength test

The flexural strength of beam is measured at 28 days. Cylinder size is 700x150x100 mm and one beam is taken for each combination. For flexural strength test procedure as per IS 2185 part 1 (2005).

Table 9. flexural strength of beam

Combination	Flexural strength N/mm²		
	M60	M70	M80
H0G0	5.68	6.47	7.10
H0G10	5.12	5.89	6.31
H0G20	5.24	5.93	6.39
H0G30	5.3	5.64	6.20
H0G40	5.47	5.55	6.01
H10G0	4.45	5.14	5.64
H10G10	4.87	5.26	5.79
H10G20	4.95	5.3	5.91
H10G30	5.04	5.2	5.60
H10G40	4.99	4.99	5.54
H20G0	4.21	4.83	5.43
H20G10	4.33	4.95	5.37
H20G20	4.41	5.01	5.35
H20G30	4.29	4.97	5.26
H20G40	4.14	4.74	5.14
H30G0	3.92	4.65	4.99
H30G10	4.02	4.78	5.02
H30G20	4.08	4.95	5.03
H30G30	3.87	4.55	4.83
H30G40	3.71	4.45	4.74

Figure. 8 test setup for beam

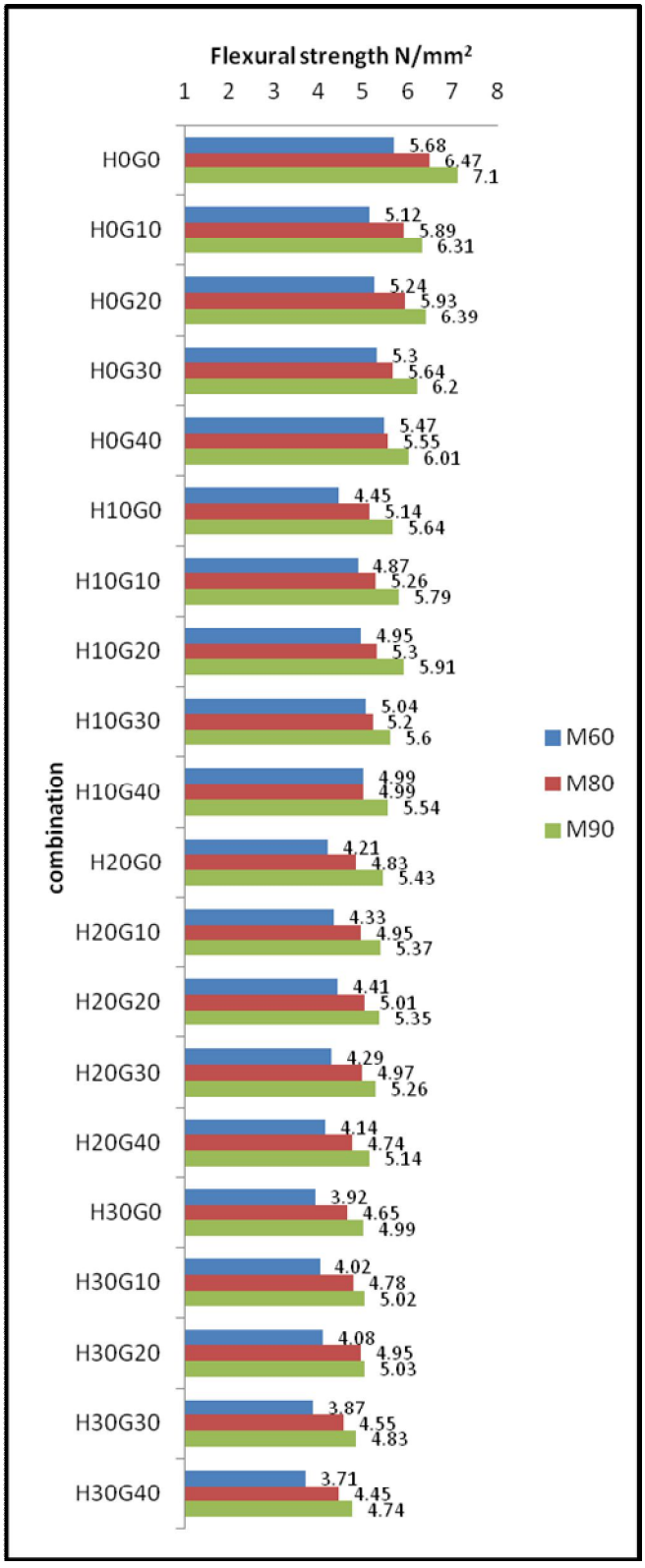

Figure.9 graph of flexural strength at 28 days

D. Workability test

The concrete slump take a look at measures the consistency of contemporary concrete before it sets. it's

performed to ascertain the workability of freshly created concrete, and so the convenience with that concrete flows. It also can be used as associate degree indicator of associate degree improperly mixed batch. The take a look at is in style attributable to the simplicity of equipment used and straight forward procedure .

Table 10. workability test results

combination	Slump value (mm)
H0G0	56
H0G10	59
H0G20	64
H0G30	70
H0G40	75
H10G0	52
H10G10	55
H10G20	60
H10G30	66
H10G40	71
H20G0	49
H20G10	53
H20G20	57
H20G30	63
H20G40	68
H30G0	47
H30G10	50
H30G20	54
H30G30	60
H30G40	64

Table 10. slump

E. Acid attack test

The concrete cube specimens of various concrete combination of size 150x150x150 mm were cast and after 28 days of water curing, the specimens were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. The acid attack take look at on concrete cube was conducted by immersing the cubes within the acid water for 90 days after 28 days of curing. Hydrochloric acid (HCL) with pH of about 2 at 5% weight of water was added to water in which the concrete cubes were stored. The pH was maintained throughout the period of 90 days. After 90 days of immersion, the concrete cubes were taken out of acid water. Then, the specimens were tested for compressive strength. The resistance of concrete to acid attack was found by the % loss of weight of specimen and the % loss of compressive strength on immersing concrete cubes in acid water.

Table 11. acid attack test results

combination	Compressive strength N/mm^2	Loss in strength (%)
H0G0	51.11	18%
H0G10	50.22	20%
H0G20	50.66	21%
H0G30	50.00	23%
H0G40	50.66	23%
H10G0	56.00	15%
H10G10	55.56	17%
H10G20	53.78	20%
H10G30	54.00	21%
H10G40	52.22	23%
H20G0	57.11	12%
H20G10	56.44	14%
H20G20	56.00	15%
H20G30	53.56	18%
H20G40	51.33	20%
H30G0	57.55	9%
H30G10	56.44	11%
H30G20	53.55	14%
H30G30	51.77	16%
H30G40	49.78	19%

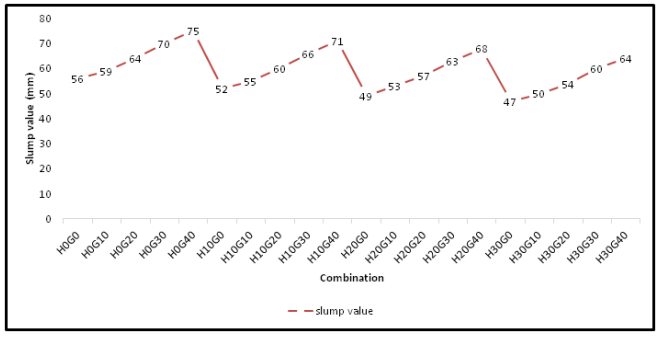

Figure.11 graph of slump value

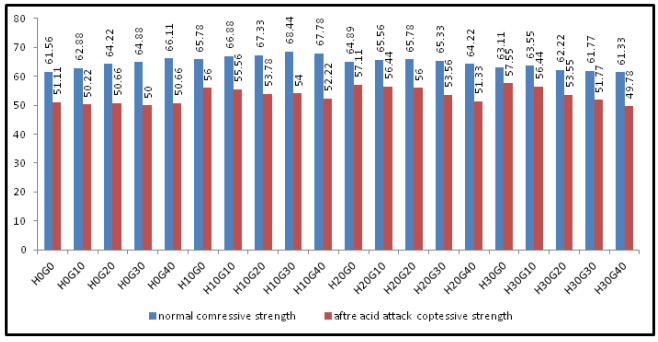

Figure.11 graph of acid attack test

IV. CONCLUSION

Based on the limited excremental studies, following conclusion were drawn in accordance to compressive strength, split tensile strength, flexural strength, workability and durability of concrete.

- As compared to conversional concrete, the compressive strength increase by 11% for the combination of hypo sludge (10%) and GGBS (30%) in all grade of concrete.
- Split tensile strength increase with the addition of GGBS and decreases with addition of hypo sludge.
- On addition of hypo sludge and GGBS, the flexural strength of concrete decreases.
- Workability of concrete is improved with the expansion of GGBS while the expansion of hypo sludge results in the decrease of workability.
- The results of acid attack(after 90 days) show that When GGBS is added up to 40%, a considerable decrease of 23% in the strength of concrete is observed. On other hard when hypo sludge is added up to 30%, only 9% decrease in the strength of concrete.
- Use of hypo sludge and GGBS in concrete will sway be economical because it is non helpful waste and freed from value.
- Use of hypo sludge and GGBS in concrete can eradicate the disposal downside of paper sludge ash ,reduce emission of harmful pollutants by cement manufacture business into atmosphere our surroundings the environment and so sway be environment friendly, paving means for greener concrete.
- Use of hypo sludge and GGBS in concrete can preserve natural resources that area unit used for cement manufacture and so build concrete housing industry property and paper sludge will be used as fuel before mistreatment its ash in concrete for partial cement replacement and additionally the disposal downside for paper industries for this waste product is totally resolved

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