Experimental study on durability properties of M30 grade of super concrete

Gavit Mrunali[1], Rana Rizwana[2], Joshi Ripal[3], Shah Adarsh[4],
Asst Prof.Trivedi Nagesh[5], Asst Prof. Pal Shailesh[6]
BE student, Dept. of civil engineering Dr Jivraj Mehta Institute of Technology, Anand, Gujarat, India
Dept. of civil engineering Dr Jivraj Mehta Institute of Technology, Anand, Gujarat, India
Dept. of civil engineering Dr Jivraj Mehta Institute of Technology, Anand, Gujarat, India
Dept. of civil engineering Dr Jivraj Mehta Institute of Technology, Anand, Gujarat, India

ABSTRACT

Concrete occupied an important place in construction industry in the past few decades. Cement is major constituent material of the concrete which produce by natural raw material like lime, and silica. This situation leads to think to do research work on cement replacing material and use of it. Industrial waste GGBS, fly ash, silica fume etc. so chemical properties similar to cement. These material when combine with calcium hydroxide exhibits cementitious properties. This experiment deals with the experimental investigation on concrete specimens. In this experimental study an attempt has been made to reduce the consumption of cement with concrete mix grade M30 by studying the mechanical behaviour of these concrete mixes by replacing with advanced mineral admixture GGBS in concrete mixes as partial replacement of cement. GGBS is a waste industrial by-product from the blast furnaces used to make iron. Use of GGBS helps to reduce the impact on environment by consuming the material generally considered as waste product. In this project, properties of concrete have been assessed by partially replacing cement with GGBS. The cement has been replaced by GGBS accordingly in the range of 10%, 20%, 30% and 40% by weight of cement for M_{30} mix. Experimental results are reported including compressive strength of concrete specimens at 14 days and 28 days and also to analyse the durability characteristics of concrete to check the durability of concrete acid attack is conducted by use of HCL for conventional concrete and GGBS concrete. Concrete mixtures were produced, tested and compared in terms of compressive strength with the conventional concrete.

KEYWORD: *Compressive strength, ground granulated blast furnace slag (GGBS)*

1. INTRODUCTION

In the present scenario, the most suitable and widely used construction material is concrete and the most important part of concrete is cement. Now days, as a result of continuous growth in population, rapid industrialization and rapid production of cement, there is increase in rate of discharge of pollutants in the atmosphere. The biggest environment problem is emission of CO2 in the production process of cement. We know that CO2 emission is very harmful which creates lots of environmental changes. The most effective way to decrease the CO2 emission of cement industry, is to substitute a proportion of cement with other materials like ground granulated blast furnace slag (GGBS), fly ash (FA), silica fume (SF), GGBS is one of the industrial waste which comes out from blast furnace used to make iron.

2. MATERIAL AND PROPERTIES

A. Cement: Cement acts as a building agent for materials. Cement as applied in civil engineering industry is produced by calcining at high temperature. It is admixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. Cement is the most expensive materials in concrete. The cement used in this experimental work is Sanghi cement of 53 grade ordinary Portland cement. The specific gravity of cement is 3.15; standard consistency of cement if 31.3%. All properties of cement are tested by references of IS 12269-1987.

B. Fine aggregates: Locally available sand passes through of 4.75mm IS sieve is to be used. The specific gravity of sand is 2.60 and fineness modulus of 2.84 is used. Water absorption of sand is 1.23%

C. coarse Aggregates: The coarse aggregates with the sizes of 20mm and 10mm aggregates are used. Specific gravity of 20mm coarse aggregates is 2.88 and for 10mm it is 2.87. And fineness modulus is 7.38.

D. **water:** Water should be free from all injurious amount of acids, organic and inorganic impurities, and it should be used for proper mixing and curing of concrete.

E. GGBS: Ground granulated blast furnace slag is obtained by rapidly chilling the molten ash from the furnace with the help of water. During this process, the slag gets fragmented and transformed into amorphous granules (glass). GGBS is also referred as slag cement that significantly improves durability and strength of concrete.Slag cement begins in an iron blast furnace. Which is carefully controlled amount of iron ore along with limestone. Which are further fed into blast furnace and heated to 1400 C. to 1600 C. during molten state iron is tapped for production of steel and diverted to a granulator. Slag is rapidly quenched with large quantities of water along with the process it minimizes the crystallization and develops granulated slag, which is basically composed formation of calcium alumina silicate glass. At this stage, the slag is the uniform fine sand and develops up to fine powder to from granulated blast furnace slag (GGBS) or slag cement.

Table:1 Physical properties of GGBS

Characteristic	Requirement as per BS:6699	Test result
Fineness (kg/m2)	275 (min)	420.00
Reside by wet sieve on 45u (%)	-	2.00
Initial setting time (min)	Not less than IST of OPC	195
Ph value	-	9-11
Specific gravity	-	2.58
Density kg/m3	-	2067.06
Insoluble reside(%)	1.5(max)	0.28
Magnesia content (%)	14.0(max)	8.06
Sulphide sulphur (%)	2.00(max)	0.53
Sulphate content (%) as SO3	2.50 (max)	0.24
Loss on ignition (%)	3.00 (max)	0.29
Manganese content (%)	2.00 (max)	0.23
Chloride content (%)	0.10(max)	0.001
Moisture content (%)	1.00(max)	0.03
Glass content (%)	67 (min)	94.00
Compressive strength (N/mm2)	-	-
After 7 days	12.0(min)	24.74
After 28 days	32.5(min)	46.24

3. METHODOLOGY:

A. Mix proportion

The mix proportion shown in table 2 was made for a concrete with the slump of 40mm (25mm-50mm),the design of M30 OPC concrete as per IS:10262-2009

Table 2: Mix proportion

Material	Weight kg/m3
Cement	478.95
Fine aggregate	717.158
Course aggregate (20mm)	1173.73
Water	191.58

B. Casting and Curing

The size of cube specimen 150mm x 150mm x 150mm. The concrete strength is to determine Partial replacement of cement by 10%, 20%, 30% and 40% with GGBS. Curing of concrete is done for 14 and 28 days. After respective days half of the cubes of same replacement of GGBS were cured in Acid (HCL). Then both the cubes (water and acid cured) were tested.

4. TESTING

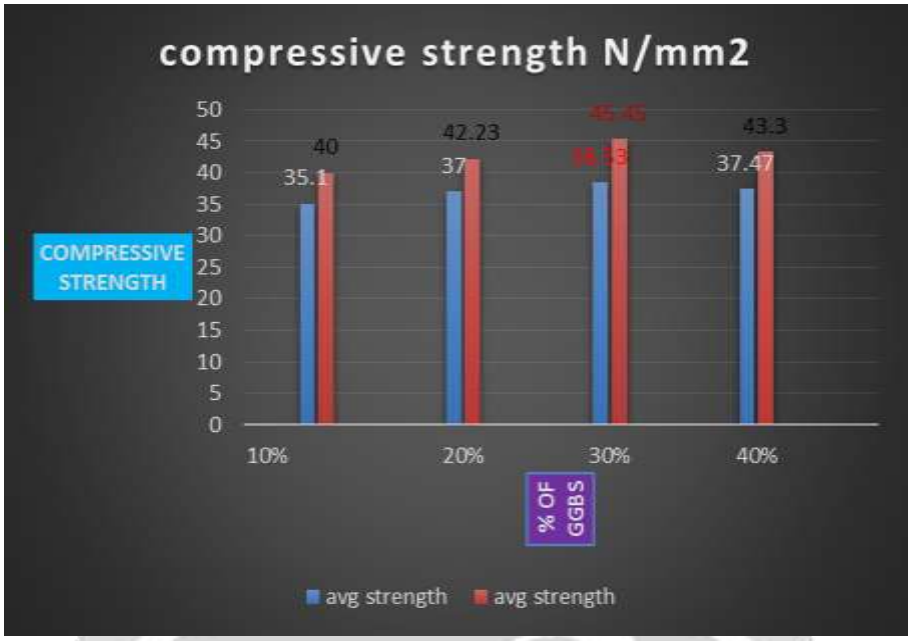
To find out the mechanical properties of concrete 14days and 28day by mix proportion by compressive strength test.

COMPRESSIVE STRENGTH TEST

Compression test of the concrete specimen is most widely used test to measure its compressive strength. Cubes for compression test are casted in cast-iron moulds of prescribed dimensions. Compaction of each layer is achieved by not less than 35 strokes for 150mm cubes or 25 strokes for 100mm cubes. A standard tamping bar of a 25mm square of steel section is used for this test. Compaction by vibration may also be used. The most common age at testing is 28 days, but test can be made at 1,3,7,14,28,56,&91 days also. At the time of testing, the specimen is placed in a compression testing machine with the position of cube at the angles of the position of cast. The load is applied at a constant rate of stress within the range of 0.2 to 0.4MPA/sec.

Table-3: compressive strength result at 14 & 28 days

GGBS	compressive strength		avg strength	avg strength
	14 days	28 days	14 days	28 day
10%	35.29 34.93 35.1	39.58 40.32 40.1	35.1	40
20%	37.13 36.21 37.66	41.76 42.33 42.6	37	42.23
30%	38.42 39.02 38.12	45.57 45.15 45.64	38.53	45.45
40%	37.65 37.79 36.98	42.97 43.48 49.47	37.47	43.3



ACID ATTACK TEST

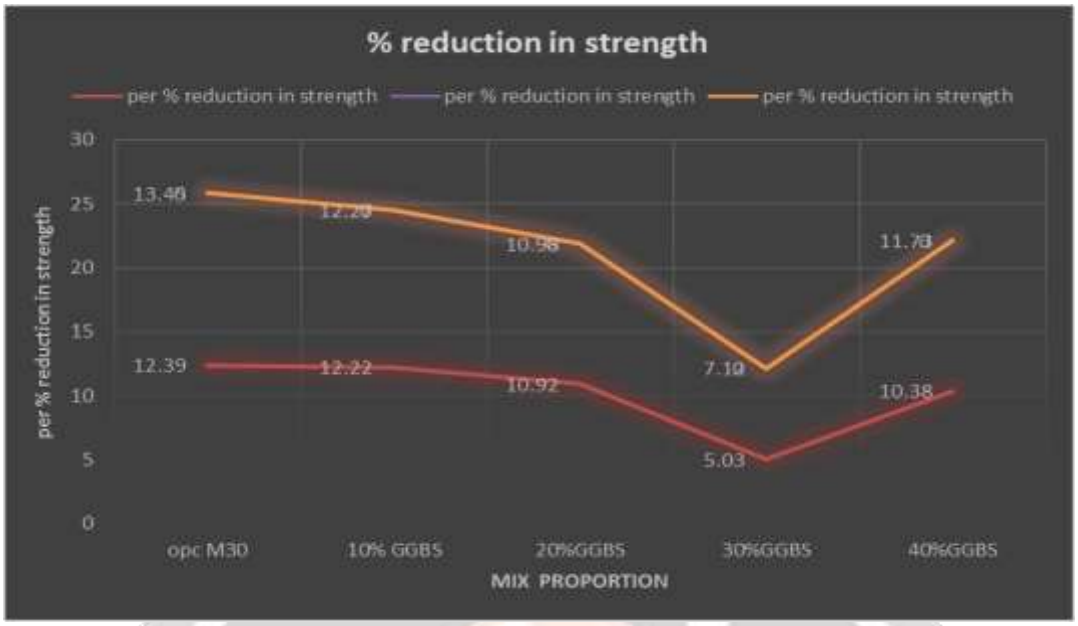
The concrete cube specimens of concrete mix of size 150mm x 150mm x 150mm were casted and often 14 and 28 days of water curing. The specimens were removed from the curing tank and allowed to dry for 2 days. The weights of concrete cubes specimen were taken. The acid attack test on concrete cube was conducted by immersing the cubes in the acid water for 28 days. Hydrochloric acid (HCL) with pH of about 2 at 5% weight of water was added to water in which the concrete cubes were placed. After 28 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 percentage loss of weight of specimen and the percentage loss of compressive strength on immersing concrete cubes in acid water.

Table-4: Percentage reduction in mass due to acid attack

Mix proportion	Percentage reduction in mass%	
	14 days	28 days
OPC M30.	5.89	6.35
10%	5.08	6.10
20%	4.76	5.43
30%	2.05	2.60
40%	3.02	4.11

Table-5: Percentage reduction in strength due to acid attack

MIX	compressive strength		Acid effect compressive		per % reduction in strength	
PROPORTION	14 days	28 days	14 days	28 days	14 days	28 days
opc M30	32.1	39.02	**25.12**	**33.77**	12.39	13.45
10% GGBS	35.1	40.4	**30.67**	**35.09**	12.22	12.27
20%GGBS	37	42.23	**32.96**	**38.19**	10.92	10.98
30%GGBS	38.53	45.45	**36.59**	**42.21**	5.03	7.12
40%GGBS	37.47	43.3	**33.58**	**38.22**	10.38	11.73



5. CONCLUSION

1. The concrete mixture with 30% GGBS has the highest compressive strength. At 14 days & 28 days increase in compressive strength is 16.68 % & 14.14 % respectively compared with control concrete.
2. The reduction in strength & mass was observed in concrete due to acid attack. At 14 days & 28 days percentage reduction in strength is 5.03 % & 7.12 % respectively in compared with control mix which is 12.39 % & 13.45 %.
3. At optimum value the mass was reduced at 2.05 % & 2.60 % for 14 days & 28 days compared to result achieved.
4. GGBS can be used as one of the best alternative material for the cement.

6. REFERENCES

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