International Journal of Emerging Technologies in Engineering Research (IJETER)
Volume 6, Issue 5, May (2018) www.ijeter.everscience.org

Effect of Iron Ore Mine Tailing And Ground Granulated Blast Furnace Slag on Compressive and Flexural Strength of Concrete

Akshay Jain [1], Anubhav Rai [2], Y.K.Bajpai [3]
[1] Research Scholar, Department of Civil Engineering, G.G.I.T.S. Jabalpur, M.P, India
[2] Assistant Professor, Department of Civil Engineering, G.G.I.T.S. Jabalpur, M.P, India
[3] Professor and Head of the Department of Civil Engineering, G.G.I.T.S. Jabalpur, M.P, India

Abstract – Concrete is the most widely used construction material in civil engineering. Iron ore tailing and Ground granulated blast furnace slag, are the waste material which is obtained from iron ore industry and steel industry. Millions of tonnes of IOT and GGBFS produced every year in India and disposal of the same is a huge problem as it cause to environmental pollution. On other hand manufacturing of cement causes large amount of CO2 emission, affecting environment. Hence, in this work, the effects of partial replacement of cement by Iron ore tailing and Ground granulated blast furnace slag on the compressive strength and flexural strength of concrete are experimentally studied. In the present work iron ore tailing and Ground granulated blast furnace slag were used as partial replacement to cement at levels of 0%, 5%, 10%, 15% .Experimental investigation was done using M35 design mix and the mix proportions used for concrete are 1:1.39:2.54 . Tests were carried out as per recommended procedures by relevant codes.

KEYWORDS: - Compressive strength, Flexural strength, Ground Granulated blast furnace slag, Iron ore tailing.

1. INTRODUCTION

Cement is the most important constituent of concrete. It is a binding material for the discrete ingredients. Cements are obtained by burning a mixture of calcareous (calcium) and argillaceous (clay) material at a very high temperature and grinding the clinker so produced to a fine powder. The cements come in various types and chemical compositions. It provides strength and enhances the binding properties in concrete. Concrete is a manmade construction material which is most commonly used in construction work in the world. It is obtained by mixing of water, cement, fine aggregate, coarse aggregate and some minerals admixtures in necessary proportions are known as concrete. The hardened concrete can be worked as an artificial stone in which the voids of coarse aggregate are filled by the fine aggregates and cement. The hardening of concrete is caused by chemical reaction between cement, water and reaction for a long time and hardening of concrete strong with the age. The properties of concrete depend on the quantity and proportion of the ingredients used in the mix and the control exercised during various operations starting from mixing of aggregate to its placement in formwork and curing.

2. MATERIALS

1. CEMENT-:

Cement is a binding material of concrete. Cement is used in various type of construction work like building work and other heavy structure. Cement properties and characteristics depend upon its chemical composition. By changing the fineness of grinding or the oxide composition, cement can be made different properties and characteristics. Different types of Portland cement are used in construction work.

2. Fine Aggregate:

Aggregate passes through 4.75 mm IS sieve, passed aggregate is known as fine aggregate. It should be free from organic matter, durable, hard, chemically inert, clean and free from adherent coatings, etc. It should not be containing any appreciable amount of clay balls or pellets and harmful impurities for example alkalis, salts, coal, mica, shale or similar laminated materials etc. Fine aggregate consist of natural sand, crushed stone sand, crushed gravel sand stone dust or marble dust, fly ash. The sum of the percentages of all deleterious material should not exceed 5%.

3. Coarse Aggregate-:

Aggregate retained on 4.75 mm IS sieve and fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate is a large type of coarse material used in construction, including sand, gravel, crushed stone, slag, recycled concrete.

4. Iron Ore Tailing -:

Iron Ore Tailing is the materials left over, after the process of separating the valuable fraction from the worthless fraction of an ore. The Iron Ore Tailings are taken from Hargrah near Sihora, Jabalpur Madhya Pradesh (India). It is a very fine residue, major problem is its disposal on land as it effects the land cultivation.

Table 1: Physical properties of IOT

Parameters	IOT
Particle shape	Spherical
Density	14.4 kN/ m^3
Specific gravity	3.10
Colour	Dark tan (brown)
Optimum dry density (ODD)	1.71 gm./cc
Optimum moisture content (OMC)	21 %

5. Ground granulated blast furnace slag-:

Ground granulated blast furnace slag, a fine powder which is obtained by quenching of molten iron slag from a blast furnace in water.

Table 2: Physical properties of GGBFS

Parameters	GGBFS
Colour	Off white
Density units	2.94
Specific gravity	2.9
Fineness	450m^2/kg

6. Water -:

In this investigation portable water which is free from organic substances is used for mixing and curing.

3. EXPERIMENTAL INVESTIGATION

In present study M35 grade concrete were designed as per IS: 10262-2009.

A. Compressive Strength Test:

In this investigation, M35 mix concrete is considered to perform the test by-weight basis with 0%, 5%, 10%, 15% of cement replaced by Iron ore tailing and Ground granulated blast furnace slag and combination of both IOT and GGBS. For Compressive strength test 120 cubes were casted of size 150mm x 150mm x 150mm for 7, 14, 21 and 28 days for M35 grade. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes were properly compacted. All the concrete cubes were de-moulded within 24 hours after casting. The demoulded test specimens were properly cured in water available in the laboratory at an age of 7, 14, 21 and 28 days. Compression test was conducted on a 2000KN capacity universal testing machine. The load was applied uniformly until the failure of the specimen occurs. The specimen was placed horizontally between the loading surfaces of the compression testing machine and the load was applied without shock until the failure of the specimen occurred.

Fig1 Testing of cube in UTM machine

Table.3 Compressive Strength of concrete replaces cement by IOT

S.NO	IOT Content	Compressive strength N/mm^2			
		7days	14day	21day	28day
1	0%	33.58	35.45	40.35	43.40
2	5%	40.81	42.52	43.85	46.10
3	10%	43.96	43.56	46.52	50.56
4	15%	40.96	45.26	47.74	53.46

B. Flexural Strength

In this investigation, M35 mix concrete is considered to perform the test by-weight basis with 0%, 5%, 10%, 15% of cement replaced by Iron ore tailing and Ground granulated blast furnace slag and combination of both IOT and GGBFS. For Flexural strength test 30 beams were casted of size 700 x 150 x 150mm for 28 days for M35 grade. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved.

Fig 2 Testing of beam specimen under three point loading in UTM machine

4. RESULTS

A. Compressive Strength Test:

The compressive strength of concrete was achieved in 28 days of various proportions and presented below .The specimens were cast and tested as per IS: 516-1959.

Table 4 Compressive Strength of concrete replaces cement

S.NO	IOT+GGBFS Content	Compressive strength N/mm^2			
		7days	14day	21day	28day
1	0%	33.58	35.45	40.35	43.40
2	5%	34.96	38.07	42.11	46.42
3	10%	37.78	41.19	46.81	50.82
4	15%	39.81	45.56	48.44	54.51

Table 5 Compressive Strength of concrete replaces cement by GGBFS +IOT

S.NO	GGBFS Content	Compressive strength N/mm^2			
		7days	14day	21day	28day
1	0%	33.58	35.45	40.35	43.40
2	5%	35.25	39.63	43.2	46.24
3	10%	33.56	34.81	38.37	50.53
4	15%	34.96	35.41	42.15	53.55

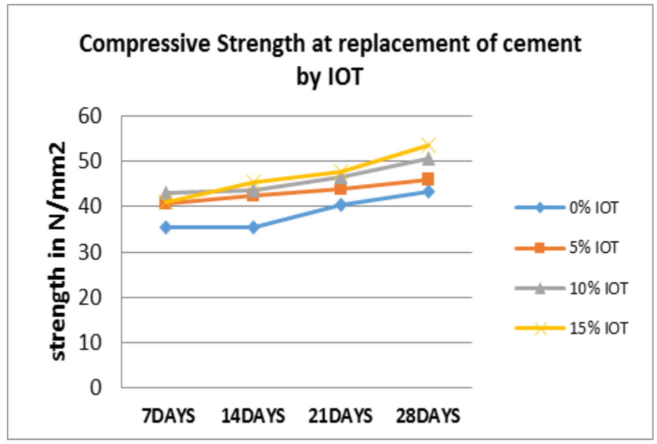

Fig 3 Graph showing Compressive Strength development with days

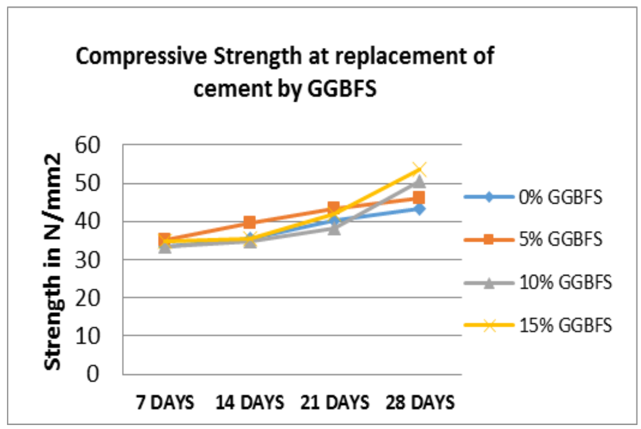

Fig 4. Graph showing Compressive Strength development with days

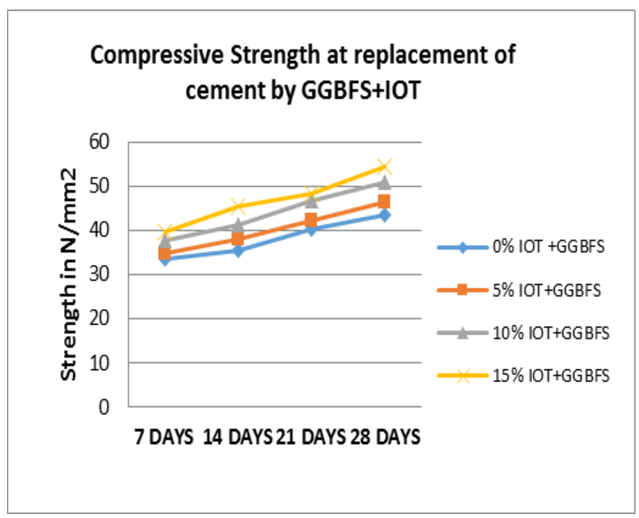

Fig 5.Graph showing Compressive Strength development with days

B. Flexural Strength

The specimens were tested in flexural testing machine as per IS codes and the flexural strength is calculated depending on the failure plane position from the supports. Different values obtained for concrete with different IOT and GGBFS replacement levels.

Table 6. Flexural Strength of concrete replaces cement by IOT

S.NO	IOT Content	Flexural Strength N/mm^2
		28days
1	0%	6.23
2	5%	6.76
3	10%	7.16
4	15%	7.45

Table 7. Flexural Strength of concrete replaces cement by GGBFS

S.NO	GGBFS Content	Flexural Strength N/mm^2
		28days
1	0%	6.23
2	5%	6.74
3	10%	6.90
4	15%	7.55

Table 8. Flexural Strength of concrete replaces cement by GGBFS +IOT

S.NO	IOT+GGBFS Content	Flexural Strength N/mm^2
		28days
1	0%	6.23
2	5%	6.79
3	10%	7.26
4	15%	7.62

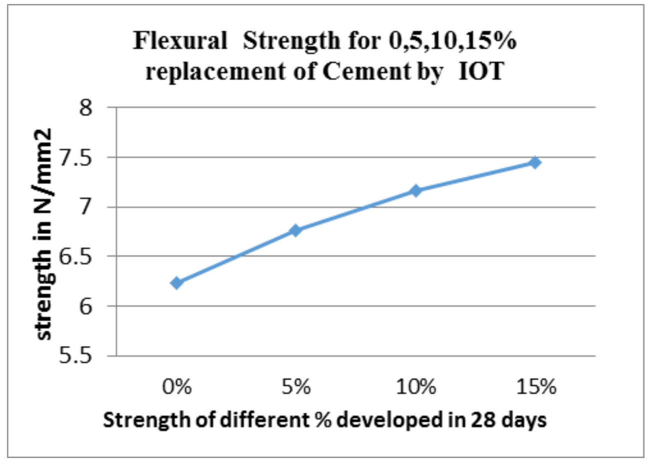

Fig 6. Graph showing Flexural Strength development in 28 days

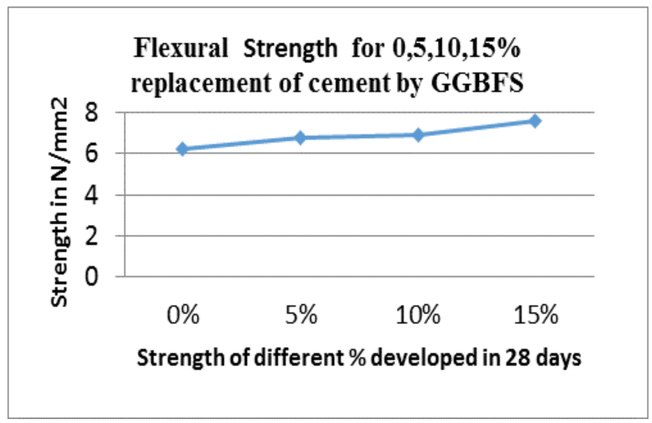

Fig 7. Graph showing Flexural Strength development in 28 days

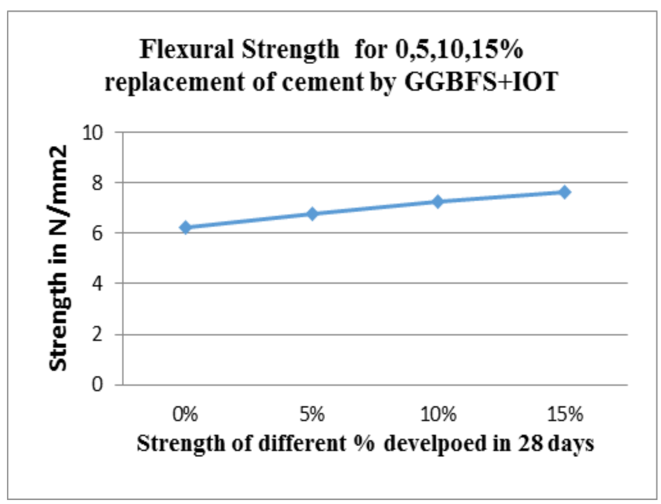

Fig 8. Graph showing Flexural Strength development in 28 days

5. CONCLUSION

The following conclusions are drawn based on the above experimental study.

1. As the iron ore tailing percentage increases the compressive and flexural strength increases.

2. As the Ground granulated blast furnace slag percentage increases the compressive and flexural strength increases.

3. Table no. 3, 4, 5 and Graph no. 3, 4, 5 shows that as IOT and GGBFS individually as well as together when replaced with cement Compressive strength increases than normal concrete of M35 grade

4. Similarly, Table no. 6, 7, 8 and Graph no. 6, 7, 8 shows that as IOT and GGBFS individually as well as together when replaced with cement Flexural strength increases than normal concrete of M35 grade.

5. Maximum strength achieved when replacement of IOT and GGBFS to cement is 15%.

6. Iron ore tailing as a replacement to the cement will solve two problems with one effort, namely, elimination of solid waste problem on one hand and provision of a needed construction material on other hand. The IOT and GGBFS reduce the cost production of concrete.

REFERENCES

[1] Ali Umara Shettima, Mohd. Warid Hussain, Yusuf Ahman, Jahangir Mirza - "Evaluation Of Iron Ore Tailings As Replacement For Fine Aggregate In Concrete".

[2] Jyolsna Jerin, R.K. Rath, Anil Kumar –"Partial Replacement of Sand and Cement by Iron Ore Slime for Concrete Building Material".ISSN:2249-8453, ISSN: 2321-6476, Volume 6, Issue2.

[3] Sahil Goyal,Keshav Singh,Ahmad Hussain, Priyanka Ramkripal Singh " Study On Partial Replacement Of Sand With Iron Ore Tailing On Compressive Strength Of Concrete". IJREAT, Vol 3,Issue 2.

[4] Kiran K. Shetty, Gopinatha Mayak, Vipul Vijayan –" Use Of Red Mud And Iron Tailings In Self Compaction Concrete". IJRET , ISSN: 2319-1163 .

[5] Rajesh Kr. Pandey, Abhishek Kumar, Mohd. Afaque Khan –" Effect Of Ground Granulated Blast Furnace Slag As Partial Replacement On Strength And Durability Of Concrete". IRJET, eISSN: 2395-0056, pISSN:2395-0072, Vol6,Issue 2.

[6] Francis Atta Kuranchie, Sanjay Kumar Shukla, Daryoush Habibi, Alireza Mohyeddin –"Utilization of Iron Ore Tailings as Aggregate In Concrete".

[7] P. Prasanthi, Dr. T. Suresh Babu, Praveen Kumar, Kv Manikanta "A Study On Replacement Of Portland Cement By Using Ggbfs, Flyash, Sodium Silicate And Sodium Hydroxide With Reference To Different Lab Test". IJETMAS, ISSN: 2349-4476, Vol. 3, Issue 6, june 2015.

[8] A. Patel, Dr. V.M Patel, Dr. M.A. Patel –"Review On Partial Replacement of Cement In Concrete".

[9] Sonali K. Gadpalliwar , R.S. Deotale, Abhijeet R. Narde –" To Study The Partial Replacement Of Cement By Ggbfs&Rha And Natural Sand By Qarry Sand In Concrete". IOSR –JMCE, e-ISSN: 2278-1684, p-ISSN: 2320-334X, Vol. 11, Issue 2.