Study on Utilization of Iron Ore Tailings as Fine Aggregates and GGBS as Partial Substitute in Concrete

Shwetha R A
Assistant professor,
Civil Engg, KNSIT, Karnataka, India

Abstract **- In this study, M20 grade of concrete was produced by complete replacing fine aggregate by Iron ore tailings, and GGBS as partial substitute to cement at 10%, 20%, 30% and 40%. The cubes were casted and their compressive strengths were evaluated at 7, 14 and 28 days. As the percentage increased the strength is also increased but only up to 30% further the strength is decreased. Replacing fine aggregate with mining waste will decrease the cost of concrete and using mining waste for different purposes in construction field will be a good impact on the environment.**

Keywords: Iron ore tailings, GGBS, compressive strength, conventional concrete.

1. INTRODUCTION

The use of aggregate for construction is one of the most important part of construction for its well added strength to the concrete. Finding a substitute for the aggregates used today is a task that is worth studying because the quarrying of aggregates from rivers and mountains harms the environment. If a substitute for aggregate can be obtained naturally and the source is abundant and can be regenerated, obtaining the aggregates would be depleting its source. The use of mining waste as fine aggregate in the concrete will result in decrease in the cost of the concrete and also the dumping problem of mining waste can be solved. It will be a very good impact on the environment if the mining waste is utilized for different purposes. In the case of Kudremukh, with an iron ore content of just 30%, the remaining 70% of waste iron ore tailing had to be dumped in the forested Lakya valley, across which a tailings dam was constructed. This dam now contains over 180 million tonnes of iron ore tailings.

1.1 Objectives

- Determining the physical and chemical properties of iron ore tailings.
- Determining the compressive strength of concrete using iron ore tailings as fine aggregate.
- Determining the compressive strength of concrete using iron ore tailings as fine aggregate with different proportions of GGBS (Ground Granulated Blast Furnace Slag) i.e. 10, 20, 30&40 percentages.

2. MATERIALS AND METHODOLOGY

2.1 Materials

2.1.1Cement

Ordinary Portland cement of grade 53(ultra tech) available in local market was used in the research. The properties of cement are as follows.

Table1: Properties of cement

Sl.No	Characteristics	Results	As per IS:12269-1987
1	Normal consistency (%)	30	-
2	Initial setting time(minutes)	105	Not less than 30
3	Final setting time(minutes)	185	Not more than 600
4	Specific gravity	2.83	3.15

2.1.2 Fine Aggregates

Clean River sand is used for present investigation as fine aggregates. Tests on sand as per IS specification are conducted and results are as shown in table2.

Table2: Physical properties of fine aggregates

Sl.No	Characteristics	Value
1	Specific gravity	2.5
2	Fineness modulus	3.06
3	Water absorption	0.88
4	Moisture content (%)	1.905
5	Grading zone	II

2.1.3 Coarse Aggregates

Coarse aggregates are those which are retained on IS sieve size 4.75mm.In the present study, aggregates of size 20mm&10mm from the local source were used as coarse aggregates.

- The specific gravity and bulk density were found to be 2.65&1595.4kg/m^3
- Water absorption=0.6%

2.1.4 Iron Ore Tailings

In Kudremukh iron ore tailing had to be dumped in the forested Lakya valley this was considered and tested .The specific gravity &Fineness modulus of iron ore tailing was found to be 2.67&2.54.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 06, June - 2017

2.1.5 GGBS

Granulated Blast Furnace Slag is obtained by rapidly chilling (quenching) the molten ash from the furnace with the help of water. During this process, the slag gets fragmented and transformed into amorphous granules (glass), meeting the requirement of IS 12089:1987 (manufacturing specification for granulated slag used in Portland Slag Cement).In this project JSW'S GGBS used in different proportions

3. Mix Proportions

The concrete mix is designed as per IS10262-2009,IS 456-2000 for the normal concrete. The grade of concrete which we adopted was M20 with the water cement ratio of 0.54.The mix proportions used for concrete are 1:1.6:2.73

Table3: Mix Proportions

Grade	Cement	Fine Aggregates	Coarse Aggregates	w/c ratio
M20	394kg/m^3	625.8 kg/m^3	1075.32 kg/m^3	0.54

4. TEST SPECIMEN

Cubes of size 150X150X150mm were prepared using the standard moulds .The samples were casted by complete replacement of fine aggregates by iron ore tailings &partial replacement of cement by GGBS (10%, 20%, 30%&40%).

5. COMPRESSIVE STRENGTH

The cube specimens were tested in compression testing machine after specified curing period in accordance with the IS specifications. The test results are given in the table.

Table4: compressive strength of conventional concrete

Sl. no	Age (days)	Maximum load	Compressive strength	Average
		KN	MPa	
1	7	370	16.44	16.53
	7	374	16.62	
2	14	492	23.87	23.92
	14	494	23.96	
3	28	631	32.04	32.02
	28	630	32.00	

Figure1: compressive strength vs. Age for conventional concrete

Table5: Compressive strength of concrete
(Iron Ore tailings replacing sand)

Sl. no	Age (days)	Maximum load	Compressive strength	Average
		KN	MPa	
1	7	417	18.53	18.51
	7	415	18.44	
2	14	582	25.87	22.93
	14	584	25.96	
3	28	745	33.11	33.15
	28	744	33.20	

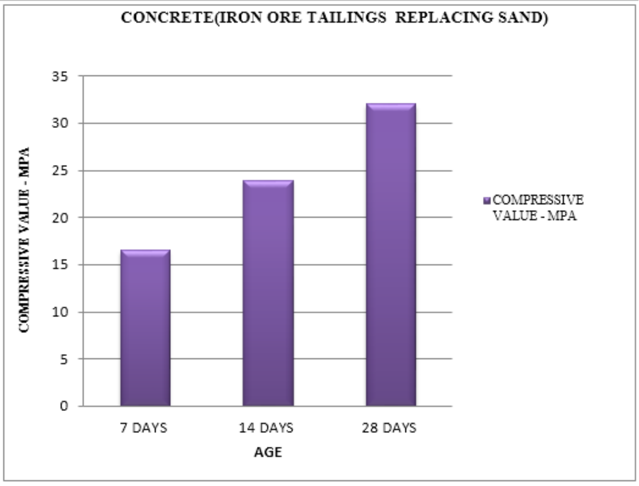

Figure2: compressive strength vs. Age for concrete
(Iron Ore tailings replacing sand)

Table6: Compressive strength of concrete
(Iron ore tailings as sand + 10% GGBS)

Sl. no	Age (days)	Maximum load	Compressive strength	Average
		KN	MPa	
1	7	474	21.06	21.17
	7	478	22.24	
2	14	656	29.15	29.21
	14	658	29.24	
3	28	827	36.75	36.68
	28	823	36.57	

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 06, June - 2017

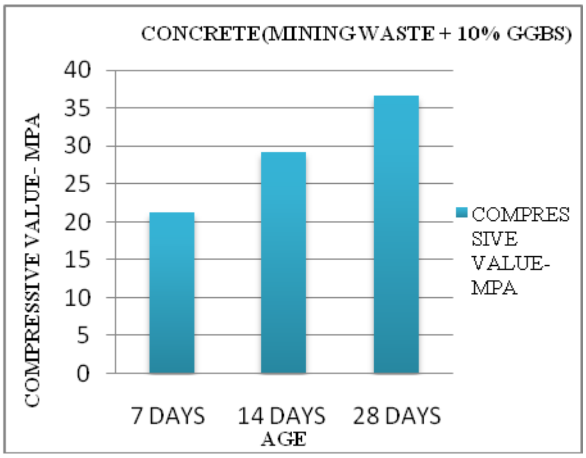

Figure3: compressive strength vs. Age for concrete
(Iron ore tailings as sand + 10% GGBS)

Table7: Compressive strength of concrete
(Iron ore tailings as sand + 20% GGBS)

Sl. no	Age (days)	Maximum load	Compressive strength	Average
		KN	MPa	
1	7	517	22.98	23.03
	7	519	23.07	
2	14	762	33.87	33.93
	14	764	33.96	
3	28	987	43.87	43.92
	28	989	43.96	

Table8: Compressive strength of concrete
(Iron ore tailings as sand + 30% GGBS)

Sl. no	Age (days)	Maximum load	Compressive strength	Average
		KN	MPa	
1	7	521	23.16	23.25
	7	524	23.29	
2	14	764	33.96	34.05
	14	768	34.13	
3	28	996	44.27	44.24
	28	994	44.18	

Table9: Compressive strength of concrete
(Iron ore tailings as sand + 40% GGBS)

Sl. no	Age (days)	Maximum load	Compressive strength	Average
		KN	MPa	
1	7	496	22.04	22.12
	7	499	22.17	
2	14	729	32.40	32.47
	14	731	32.48	
3	28	968	43.02	43.05
	28	969	43.06	

Table10: Compressive strength variations at 7, 14 &28 days for different proportions of GGBS

DAYS	Compressive strength (Mpa)			
	10% GGBS	20% GGBS	30% GGBS	40% GGBS
7	22.17	23.02	23.25	22.12
14	29.21	33.93	34.05	32.47
28	36.68	43.92	44.24	43.05

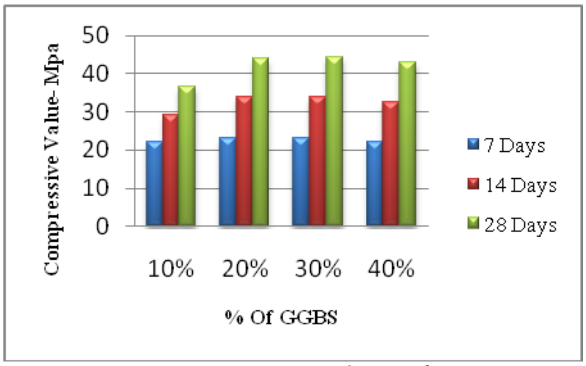

Figure4: Compressive strength vs. %of GGBS

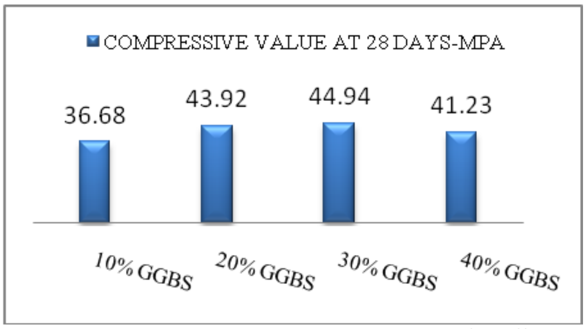

Figure5: Compressive strength variations at 28 days for different proportions of GGBS

6. Rate analysis

6.1 Rate analysis of conventional concrete:

S L. N O	MATERIAL	QTY	UNIT	RATE	AMOUNT
1	Cement	4	Bags	400	1600
2	Fine aggregate	0.38	M3	2000	760
3	Coarse aggregate	0.62	M3	900	550

Total=2910Rs
Add 2% water charges=58.00Rs
Grand Total= 2970Rs

6.2 Rate analysis of Iron ore tailings concrete:

SL.NO	MATERIAL	QTY	UNIT	RATE	AMOUNT
1	Cement	4	Bags	400	1600
2	Fine Aggregate (Iron ore tailings)	0.38	M3	0	0
3	Coarse aggregate	0.62	M3	900	550

Total= 2150Rs
Add 2% water charges= 43.00Rs
Add 2% for transportation of mining waste= 43.00Rs
Grand Total= 2240Rs

CONCLUSION

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

- Iron ore tailings can be efficiently used in place of fine aggregate to gain good strength in concrete.
- When GGBS added with different proportions, we got different compressive strength values. The strength is increasing as the amount of GGBS is increased but only up to 30% replacement.
- Concrete with 25-30% of GGBS and mining waste (Iron ore tailings) instead of sand can be used as high strength concrete as it is giving more strength than normal OPC concrete.
- Concrete with mining waste as fine aggregate and GGBS content up to 50-60% can be used to flooring purposes which results in high decrease in cost.
- By complete replacement of fine aggregate with mining waste it results in 20-25% decease in cost can be decreased when compared to normal M20 OPC concrete.

7. REFERENCES:

[1] B N Skanda Kumar, Suhas, SantoshUttamShet, J M Srishaila-"Utilization of Iron Ore Tailings as Replacement to Fine Aggregates in Cement Concrete Pavements", International Journal of Research in Engineering and Technology.eISSN: 2319-1163 / pISSN: 2321-7308.

[2] K.G.Hiraskar and ChetanPatil-"Use of Blast Furnace Slag Aggregate in Concrete', International Journal of Scientific & Engineering Research, Volume 4. Issue 5, May 2013/ISSN 2229-5518.

[3] SujingZhao, Junjiang Fan, Wei Sun - "Utilization of iron ore tailings as fine aggregate in ultra-high performance concrete", Construction and Building Materials 50, pp.540–548, (2014)

[4] Xiaoyan Huang: Ravi Ranade and Victor C. Li, F.ASCE - "Feasibility Study of Developing Green ECC Using Iron Ore Tailings Powder as Cement Replacement" Journal Of Materials In Civil Engineering 25:923-931(2013).

IS CODES

[5] IS 10262:1982, recommended guidelines for concrete mix design.

[6] IS 456:2000, Plain & Reinforced concrete Code of Practice.