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# "An Experiment on the Properties of Concrete Replacing Fine Aggregate Partially by Iron Ore Tailing (Iot) and Cement Partially by Groung Granulated Blast Furnace Slag (GGBS)"

**Abdul Qadeer, Brijbhushan S, Sharanamma**

***Abstract:*** ***The present project study is focuses on the behavior of iron ore tailing (IOT) and Ground granulated blast furnace slag (GGBS)Through partly replacing natural fine aggregate, at 10% 20%, 30% and cement at 5% 10% and 15% respectively. The (IOT) adopted for the project study is brought from kej minerals.The test was conducted on both fresh and hardened concrete in fresh state slump and compaction factor test is adopte d and compressive strength, split tensile strength, flexural strengt h, respectively is measured in hardened state, cubes, cylinder, prisms is prepared. Water absorption test was conducted for durability studies. At 20 percent IOT and 10 percent GGBS, the optimal replacement was found***

***Keywords*** **: *GGBS, Iron ore Tailing (IOT), Super plasticizer***

## I. INTRODUCTION

Building industry is India's second-largest industry after agri culture, accounting for about 11 percent of Indian GDP as it contributes significantly to the national economy and provides jobs for a large number of people Concrete production and application have a complex environmental impact. The main component of concrete is cement. Global cement production as on 2015 as on was 4.2 billion tones according IPCC for each tonne cement produce there was 1.25 tonnes of co2 emitted when multiplied by 4.2 billion by 1.25 tonne it accounted 5.2billion tonne of Co2 emissions from human resources amounted to 36 billion tons during the same year. The Government is challenged to grow the country with all security measures in place to protect the planet, without harming the environment. The construction and growth of a nation-construction industry plays an import ant role construction industry demands the use of natural resources like steel and ingredients of cement, sand regularly which affects the environment by using natural resources. A number of research studies in the branch of natural resource substitutes by industrial waste, such as iron ore tailing (IOT), substitute natural sand and granulated slag (GGBS) with concrete, so that it can repudiate the use of resources and preserve the environment..

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## II. AIMS AND OBJECTIVES

- Analysis of the properties and behaviour of IOT and GGB S with normal concrete.
- Sand is partly substituted by IOT and cement is replaced partially with GGBS.
- Upon replacement, the structural strength characteristics o f the concrete are determined.
- To assess the optimal percentage of IOT and GGBS mater ial to be added as a partial replacement of the respective F A and cement.
- analyzingworkability of concrete for FA and cement respe ctively while replacing IOT and GGBS.

## III. LITERATURE REVIEW

**BN Shanda Kumar** Studies have found that the rise in the percentage of IOT reduces the workability, hence super plasticizer is required, the concretes compressive strength is more than 40 percent IOT replacement than the reference mix.
**Naresh Kumar** In his analysis, it was found that the water absorption in the durability test optimum mix should be restricted to 10 percent in the concrete mix without superplasticizer, because replacement percent of IOT decrea ses workability, the superplasticizer at a different dose, for e very replacement increases workability,.
**Sujing Zhoa** In his analysis he found that the complete replacement of the NA for IOT has decreased workability considerably. And compressive strength of the concrete, as the replacement rate was less than 40%, compressive strength of IOT mix was reduced by less than 11%. flexural strength raised by upto 8% compared to regular mix.
**Naidu** He studied geopolymer concrete with the inclusion of GGBS in his study and found the increase in concrete capacity. When exposed to aggressive climate, GGBS concrete gives better quality than ordinary concrete.
**Reshna Rughooputh** It states that The desired combination was that with a GGBS substitution of 50 per cent and thus GGBS could be used in line with sustainable goals as a cement substitute material for structural concrete applications.

## IV. MATERIALS

**Cement** OPC 53 Grade is being used for the project as per As per IS:4031-1998 following test was performed

**Table 1:Physical Properties of cement**

| TEST | RESULTS |
|---|---|
| Specific gravity | 3.1 |
| Fineness | 3 % |
| Normal consistency | 30% |
| Initial setting time | 35 min |
| Final setting time | 270 min |
| Soundness | 1mm |

**Coarse aggregate**

20mm and 10mm from the local crusher test performed in ac cordance with IS:2386 are used, the proportion for gradation is 40:60 of 20mm and 10mm respectively selected for project

**Table No 2: Physical Properties of CA**

| TEST | RESULTS |
|---|---|
| CA shape | Angular |
| Specific gravity | 2.80 |
| Fineness modulas | 5.50 |
| Impact value | 12.75 |
| Water absoption | 0.71 |

**Fine aggregate**

For the project passing through 4.75 mm sieve. The natural sand of the local river is used, test adopted out as per IS:383-1970

**Table No. 3: Physical Properties of FA**

| TEST | RESULTS |
|---|---|
| Specific gravity | 2.65 |
| Fineness modulas | 2.75 |
| Water absoption | 1.98 |
| Silt content | Nil |

**Water** Portable water is used in concrete as an ingredient & for curing.

**Iron ore tailing (IOT)** Scrap content after the productive infusion of iron ore is called a tailing, the product has been obtained from kej minerals

**Table No 4:(A)Physical Properties of IOT**

| TEST | RESULTS |
|---|---|
| Colour | Reddish brown |
| Specific gravity | 2.65 |
| Fineness modulas | 3.95 |
| Water absorption | 14 % |

**Table No 4:(B) Chemical Composition of IOT**

| Mineral | Composition |
|---|---|
| Fe2O3 | 9 |
| SiO2 | 70.5 |
| Al2O3 | 8.5 |
| CaO | 4 |
| TiO | 2.1 |
| MgO | 3.9 |

**Ground granulated blast furnace slag (GGBS)** The GGBS is formed by purifying the molten iron slag from a blast furnace in water to make a glassy granular material, which subsequently ground to fine powder,.

**Table 5(A):Physical Properties of GGBS**

| TEST | RESULTS |
|---|---|
| Colour | Off white |
| Specific gravity | 2.95 |

**Table 5(B):Chemical Composition of GGBS**

| Mineral | Composition |
|---|---|
| SiO2 | 32.8 |
| Fe2O3 | 0.56 |
| Al2O3 | 14.2 |
| CaO | 40.6 |
| TiO | 0.38 |
| MgO | 7.65 |

## V. METHODOLGY

These steps are adopted

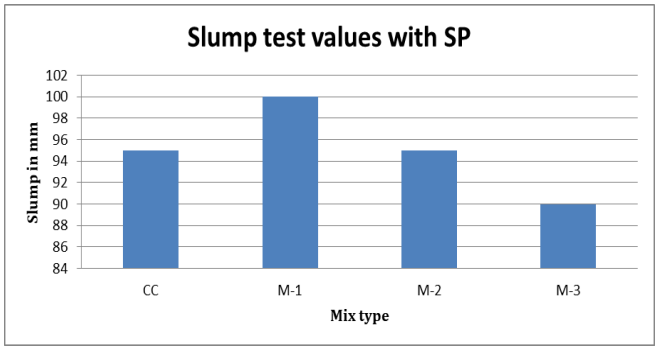
- The materials such as natural fine aggregate, coarse aggregate, iron ore tailings, cement ggbs are gathered.
- Fundamental tests are performed on the materials.
- Concrete mix design is performed as per IS-10262.
- Cement is replaced by GGBS at 0%,5%, 10%, 15%.
- Natural fine aggregate is replaced by iron ore tailing at 0%, 10%, 20%, 30%.

## VI. TESTS AND RESULTS

**Slump test** is done to assess consistency of freshly prepared concrete the most simple workability tests and widely adopted this test can be performed at site and in lab also

**Table 6: Slump test values with SP**

| SL NO | % replacement of GGBS by cement &IOT by FA | Dosage of Super plasticizer | Slump Value |
|---|---|---|---|
| 1 | CC | 0 % | 95 |
| 2 | Mix 1 | 0.15% | 100 |
| 3 | Mix 2 | 0.5% | 95 |
| 4 | Mix 3 | 1.0% | 90 |

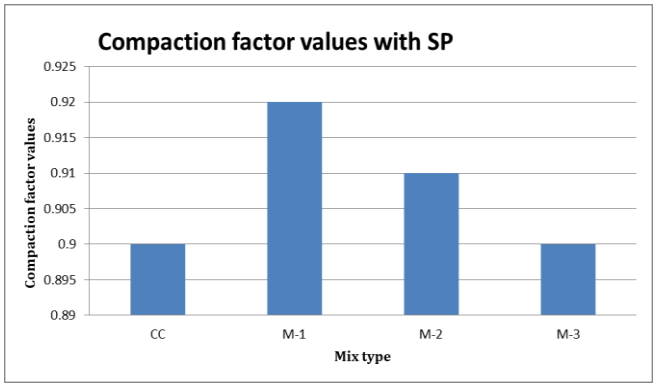



**Graph: 1 Slump test values with SP**

**Compaction Factor Test** is the laboratory workability test. The compaction factor is described as a ratio partly compacted concrete and fully compacted concrete which is used for concrete having low workability.

**Table7:Compaction factor values with.SP**

| SL NO | % replacement of GGBS by cement &IOT by FA | Dosage of Superplasticizer | Compaction factor values |
|---|---|---|---|
| 1 | CC | 0 % | 0.90 |
| 2 | Mix 1 | 0.15% | 0.92 |
| 3 | Mix 2 | 0.5% | 0.91 |
| 4 | Mix 3 | 1.0% | 0.90 |




**Graph: 2 Compaction factor values with SP**

**Compressive strength test** Concrete cubes of varying proportions of GGBS as binder and iron ore tailing as FA casted mould of 150 mm to 150mm sized was used for casting specimen. The concrete cubes were de-moulded after 48 hours of being casted and the same is tests in CTM or UTM of 2000KN capacity, least count of 10KN.

**Table 8(A): Types of Concrete Mix**

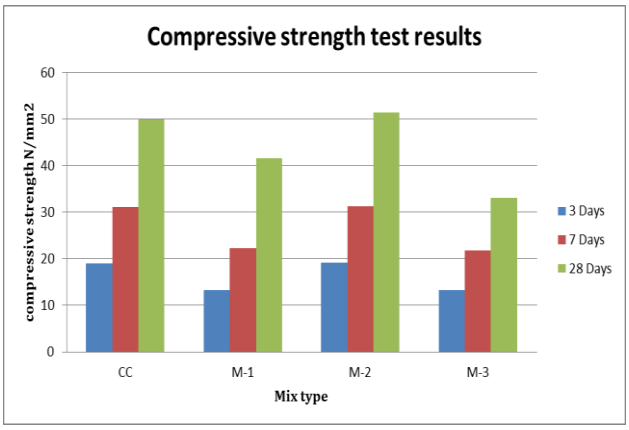
| SL NO | Concrete type | % IOT replaced with FA | % GGBS replaced with Cement |
|---|---|---|---|
| 1 | CC | 0% | 0% |
| 2 | Mix 1 | 10% | 5% |
| 3 | Mix 2 | 20% | 10% |
| 4 | Mix 3 | 30% | 15% |

**Table 8(B):Number of Cubs casted**

| SL NO | Concrete type | Total number of cubes |
|---|---|---|
| 1 | CC | 9 |
| 2 | Mix 1 | 9 |
| 3 | Mix 2 | 9 |
| 4 | Mix 3 | 9 |

**Table 9: Compressive Strength test results with SP**

| CONCRETE TYPE | NO.OF CUBES | CURING PERIOD | COMPREESIVE STRENGTH (N/mm2) | | | AVERAGE COMPRESSIVE STRENGTH (N/mm2) |
|---|---|---|---|---|---|---|
| | | | TRAIL 1 | TRAIL 2 | TRAIL 3 | |
| CC | 3 | 3 | 18.56 | 19.45 | 19.25 | 19.08 |
| | 3 | 7 | 30.25 | 31.55 | 31.75 | 31.18 |
| | 3 | 28 | 50.75 | 51.25 | 51.05 | 50.01 |
| MIX 1 | 3 | 3 | 13.25 | 12.95 | 13.75 | 13.31 |
| | 3 | 7 | 21.95 | 22.88 | 22.11 | 22.31 |
| | 3 | 28 | 42.45 | 41.44 | 41.05 | 41.64 |
| MIX 2 | 3 | 3 | 18.10 | 19.75 | 19.45 | 19.10 |
| | 3 | 7 | 31.44 | 31.50 | 30.95 | 31.29 |
| | 3 | 28 | 51.25 | 51.88 | 50.95 | 51.36 |
| MIX 3 | 3 | 3 | 13.22 | 13.88 | 12.95 | 13.35 |
| | 3 | 7 | 21.65 | 22.00 | 21.77 | 21.80 |
| | 3 | 28 | 32.50 | 33.65 | 32.88 | 33.01 |




**Graph: 3 CS test results**

**Split Tensile Strength test**

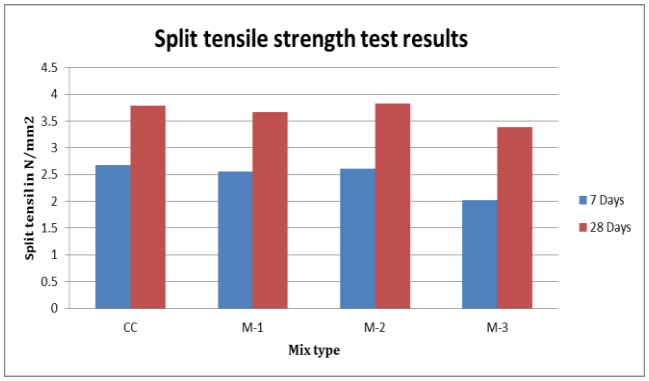
Tensile strength of concrete comes into play in the design of structural elements that are susceptible to shear forces, torsio n, shrinkage and temperature effects. The concrete has low tensile strength and it only have 10% of compressive strength, this test is done to see how iron ore tailing and ggbs as a replacements will perform under tension. The specimen is used in this test is a cylinder of diameter 150mm and 300mm long cured for 7 and 28 days by immersing in water .compression testing machine of capacity 2000KN is used for applying the load least count of which is 10KN placing In the test machine, the cylindrical sample should be such th at the upper plates are parallel to the lower plates. The operation should be shockless & continuously raised at a nominal rate The split tensile strength is determined by using the formula : fct = 2p/πLd

**Table No. 10(A):Number of Cylinder Casted**

| SL NO | Concrete type | Total number of Cylinder |
|---|---|---|
| 1 | CC | 6 |
| 2 | Mix 1 | 6 |
| 3 | Mix 2 | 6 |
| 4 | Mix 3 | 6 |

**Table No.10(B) Split tensile strength test results**

| CONCRETE TYPE | NO.OF CYLINDERS | CURING PERIOD | COMPREESIVE STRENGTH (N/mm2) | | | AVG SPLIT TENSIL STRENGTH (N/mm2) |
|---|---|---|---|---|---|---|
| | | | TRAIL 1 | TRAIL 2 | TRAIL 3 | |
| CC | - | 3 | - | - | - | - |
| | 3 | 7 | 2.7 | 2.65 | 2.68 | 2.67 |
| | 3 | 28 | 3.8 | 3.75 | 3.82 | 3.79 |
| MIX 1 | - | 3 | - | - | - | - |
| | 3 | 7 | 2.52 | 2.60 | 2.54 | 2.55 |
| | 3 | 28 | 3.66 | 3.76 | 3.60 | 3.67 |
| MIX 2 | - | 3 | - | - | - | - |
| | 3 | 7 | 2.68 | 2.62 | 2.58 | 2.61 |
| | 3 | 28 | 3.95 | 3.80 | 3.76 | 3.83 |
| MIX 3 | - | 3 | - | - | - | - |
| | 3 | 7 | 1.95 | 1.98 | 2.15 | 2.02 |
| | 3 | 28 | 3.25 | 3.38 | 3.55 | 3.39 |




**Graph: 4 Split tensile strength test results**

**Flexural strength of concrete** The test is conducted on a beam of size 50*50*300mm at 28 days ASTM C 78 (2 point load method) is used for conducting test. The sample specimen was prepared by filling in 3 layers the homogeneous concrete mixture in the beam mould being tamped 35 times by a tamping rod.

The flexural strength fb are found out by using the formula

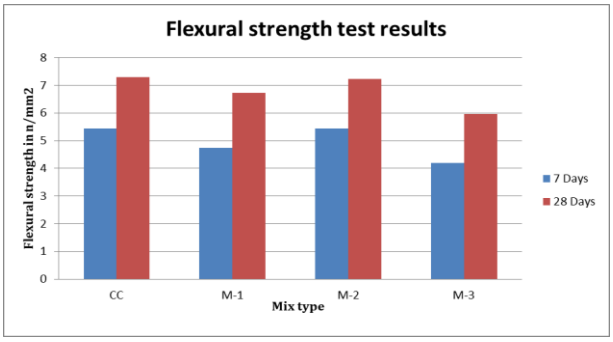
$$fb = \frac{Pl}{bd^2}$$

**Table No. 11: Number of Prism Casted**

| SL NO | Concrete type | Total number of Prism |
|---|---|---|
| 1 | CC | 9 |
| 2 | Mix 1 | 9 |
| 3 | Mix 2 | 9 |
| 4 | Mix 3 | 9 |

**Table No 12: Flexural Strength test results**

| CONCRETE TYPE | NO.OF CYLINDERS | CURING PERIOD | COMPREESIVE STRENGTH (N/mm2) | | | AVERAGE FLEXURAL STRENGTH (N/mm2) |
|---|---|---|---|---|---|---|
| | | | TRAIL 1 | TRAIL 2 | TRAIL 3 | |
| CC | - | 3 | - | - | - | - |
| | 3 | 7 | 5.2 | 5.5 | 5.6 | 5.44 |
| | 3 | 28 | 7.3 | 7.0 | 7.6 | 7.30 |
| MIX 1 | - | 3 | - | - | - | - |
| | 3 | 7 | 4.9 | 4.5 | 4.8 | 4.73 |
| | 3 | 28 | 6.8 | 6.3 | 7.1 | 6.73 |
| MIX 2 | - | 3 | - | - | - | - |
| | 3 | 7 | 5 | 5.5 | 5.8 | 5.43 |
| | 3 | 28 | 6.9 | 7.1 | 7.7 | 7.23 |
| MIX 3 | - | 3 | - | - | - | - |
| | 3 | 7 | 4.3 | 3.9 | 4.4 | 4.20 |
| | 3 | 28 | 6 | 5.7 | 6.2 | 5.96 |




**Graph: 5 Flexural strength test results**

**DURABILTY TEST** The durability of concrete is obtained by water absorption test this method is performed after the completion of 56 days curing To assess the percentage amount of water absorption more the voids more the water absorption

% water absorption =W2-W1/W1x100

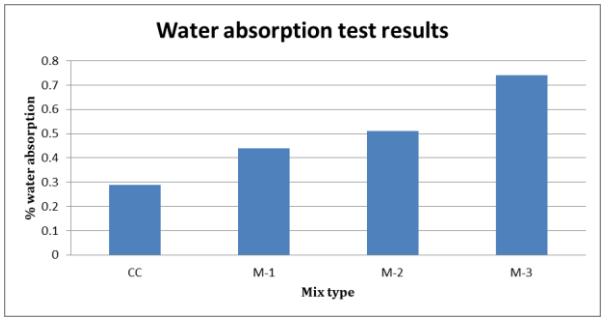
Where,

W1 is the oven-dried specimen weight

W2 is a sample of wet weight after water immersion.

**Table No.13:Water absorption test results**

| SL NO | Concrete type | DRY WEIGHT IN GRAMS (W1) | DRY WEIGHT IN GRAMS (W1) | % WATER ABSORPTION |
|---|---|---|---|---|
| 1 | CC | 8413.25 | 8437.5 | 0.29 |
| 2 | Mix 1 | 8510.95 | 8549.0 | 0.44 |
| 3 | Mix 2 | 8645.5 | 8690.25 | 0.51 |
| 4 | Mix 3 | 8720.75 | 8785.50 | 0.74 |




**Graph: 6 Water absorption test results**

## VII. CONCLUSION

- The study shows that proportion of replacement increases the decrease in the slump value, but superplasticizersare added at a different dose to increase h eir workability.
- Compaction Factor values decrease as the amount of substitute increases.
- The compressive strength and tensile-strength of the 20 percent IOT and 10 percent GGBS were found to be more than regular concrete, while the flexural strength of the CC was higher than all replacement percentages.
- Through substituting cement with GGBS and natural fine aggregate with IOT, the efficient percentage mix should b e limited to 10 percent and 20 percent respectively, with th e above analysis the mean target strength of M40 gra de concrete is achieved.
- In this study it is found that as the replacement percentage raises the water absorption also raises in the durability test.
- In this study it is found that sustainable and eco-friendly concrete can be produced by partially replacing cement by GGBS and FA by IOT.

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