

# PROPERTIES OF SFRC WITH PARTIAL REPLACEMENT OF CEMENT & SAND BY C.O.T & I.O.T

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## Abstract

Most important problem facing mankind today is how best to utilize natural resources to meet human needs and nurture economic growth without exhausting the resources and endangering the environmental integral on which life economic prosperity and our security depend. Due to rapid growth of construction activity concreting materials became scarcity such as sand and cement, so alternative material such as iron ore tailing and copper ore tailing which is a waste produced in production of steel and copper is used as partial replacement as cement and sand respectively, and hence to avoid the environmental pollution. This experimental work is taken up to study the effect of volume replacement on concrete strength of concrete with different percentage replacement levels.

This experimental investigation deals characterization of materials including iron ore tailing and copper ore tailing. The properties of materials are incorporated in concrete mix design and mix design as per procedure mentioned in IS 1026 – 2009. The fresh properties of the mixes and its hardened properties namely compressive strength for different curing periods of 3, 7 and 28 days, tensile strength for curing period of 7, 14 and 28days, and flexural strength for curing period of 28 and 56days are evaluated. Total eight different mixes viz 0%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5% and 30% of replacements for both cement and sand with COT and IOT respectively, with 0.6% of steel fibres, for M20 grade of concrete. Total 192 specimens had casted, out of which 72 cube specimens for compressive strength, 72 cylinder specimens for tensile strength and 48 beam specimens for flexural strength.

**Keywords:** COT- Copper ore tailing, IOT- Iron ore tailing, Material properties, compressive strength, split Tensile strength, flexural strength, SFRC-Steel Fibre Reinforced concrete

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## 1. INTRODUCION

The increasing demand for heavy construction material like steel and iron has resulted in the establishment of many iron ore mining companies. Iron Ore Tailing is a waste generated from the Iron Ore industry. It is a very fine aggregate residue resulting from the extraction of Iron from Iron Ore. The residue left after extraction is in the form of slurry. And copper ore tailing is residue resulted from the extraction of copper from copper ore and it shows some pozzolonic property with cement. Problems involved in the disposal of iron ore tailing and copper ore tailing are lack of space, technical problems, cost and environmental hazards. Usually the ore tailing is disposed of in the vicinity of plant as waste material over several hectares of valuable land leading to water and land pollution.

An attempt is made to use this copper ore tailing as an admixture in the preparation of fiber reinforced concrete by replacing the cement and sand by copper ore and iron ore tailing for sand in different percentages viz 15, 17.5, 20, 22.5, 25, 27.5 and 30 With 0.6% of steel fibres. The fundamental property like compressive strength, tensile strength and flexural strength is determined. To utilize the copper ore tailings and iron ore tailings as a replacement to

cement and sand respectively in steel fiber reinforced concrete and hence avoiding environmental pollution

## 2. MATERIALS

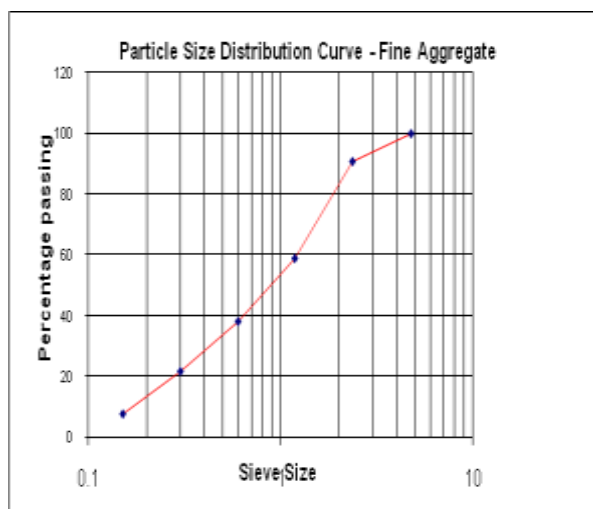
- **Cement** For the study the OPC 53 grade which satisfies the requirements IS 8112-1989 specifications is taken
- **Coarse Aggregate** The crushed stone aggregates from local quarry are used. The Coarse aggregates used are of 20mm and down size and the tests are done as per IS 383-1970 and 2386-1963 specifications
- **Fine Aggregate:** Locally available sand is used. The fundamental properties are tested and justified as per IS code 383-1970.
- **Curing period** (i) For Cubes - 3, 7 and 28 days. (ii) For cylinders – 7, 14 and 28days and (iii) beams -28, and 56days.
- **Steel Fibers** Crimped steel fibers are obtained from Majix steel fibers, Bombay (M & J international), with 140 aspect ratio.
- **Water** Ordinary portable water free from organic content, turbidity and salts is used.

- **Iron ore tailings** The iron ore tailings are collected from Kuduremukh iron Ore Company, Chikmagalur District.

And as per the standard procedure These sample is oven dried at  $100^{\circ}\text{C}$  and detailed study characterization is carried out as fine aggregate in concrete as per relevant IS Code of Practice. The physical and chemical properties are given in table below.

**Table -1:** Physical properties of IOT

1.	Particle shape	Spherical
2.	Density	14.5 KN/m <sup>3</sup>
3.	Specific gravity	3.21
4.	Colour	Dark tan (Brown)
5.	Maximum dry density	1.71 gm/cc
6.	Sieve analysis	
7.	Sieve Size	Percentage passing
	a)4.75mm	100
	b)2.36mm	90
	c)1.18mm	58.9
	d)600	38.2
	e)300µm	21.8
	f)150µm	7.8
	g)Pan	0.5
	Classification	<b>ZONE II</b>



**Chart -1:** Partical size distribution for IOT



**Fig -1:** Iron ore tailing

**Table -2:** Chemical composition of IOT

Constituent	Percentage
Iron (Fe)	19
Silicon dioxide (SiO <sub>2</sub> )	69
Aluminium trioxide (Al <sub>2</sub> O <sub>3</sub> )	3
Manganese oxide (MnO)	0.20
Phosphorus (P)	0.04
Sulphur (S)	0.08
Titanic dioxide (TiO <sub>2</sub> )	0.10
Calcium oxide (CaO)	0.10
Magnesium oxide (MgO)	0.16
Sodium oxide (Na <sub>2</sub> O)	0.06
Potassium oxide (K <sub>2</sub> O)	0.04
Copper (Cu)	0.003
Nickel (Ni)	0.002

- **Copper ore tailings** The copper ore tailings used in the experimental study was procured from Ingaldal copper mines, a unit of Hutti Gold Mines Company limited, Situated at a distance of 10 Km from Chitradurga, Karnataka, under dry mode of condition.



**Fig -2:** copper ore tailing.

characterization is done according to standard procedure characterization of material is given in Table below.

**Table -3:** Chemical and physical properties of cement and copper ore tailings.

Chemical composition (%)		
Component	Cement	Copper ore tailing
Silicon dioxide (SiO <sub>2</sub> )	29.15	11.20
Aluminium trioxide (Al <sub>2</sub> O <sub>3</sub> )	7.34	-
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> )	2.42	85.30
Calcium oxide (CaO)	50.04	-
Magnesium oxide (MgO)	3.99	-
SO <sub>3</sub>	1.97	-
Cl	0.01	-
Loss on ignition	1.65	-
Insoluble residue	0.27	-
Heavy metal content (mg/kg)	-	-
Cu	-	2284
Zn	-	402
Pb	-	60
Cr	-	12
Cd	-	0.86
Physical property		
Specific gravity	2.96	4.29
Blain specific surface area	3440	537
Absorption(%)	-	13.82

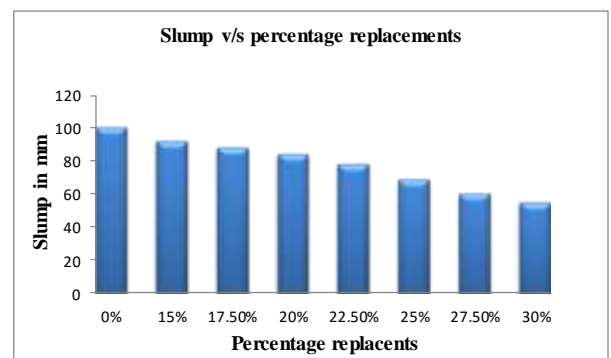
### 3. RESULTS AND DISCUSSION

This section introduces the aftereffects of the test examinations, in which aftereffects of droop test is exhibited first as new properties of cement took after by solidified properties of cement specifically compressive quality test, part pliable test and flexural test. The outcomes alongside the examination re accommodated every test independently.

### 3.1 Workability

**Table -4:** slump of different percentage replacement

Sl. No	Percentage Replacements	Water cement ratio	Slump in mm
1	0%	0.5	100
2	15%	0.5	92
3	17.5%	0.5	88
4	20%	0.5	84
5	22.5%	0.5	78
6	25%	0.5	69
7	27.5%	0.5	60
8	30%	0.5	55



**Chart -2:** workability

From the result of slump test on different replacement levels of cement and sand with copper ore tailing and iron ore tailing in concrete are compared with the conventional concrete. It shows that as percentage replacement increases the slump goes on decreasing, hence for the given slump, replacement level increases percentage of water addition is also increased.

### 3.2 Compressive strength

**Table -5:** Details of average compressive strength for 3, 7, and 28 days

Replacement levels (%)	Average compressive strength (N/mm <sup>2</sup> )		
	3 Days	7 Days	28 Days
0%	8.34	17.12	27.28
15%	8.08	16.50	27.20
17.5%	7.92	16.30	26.9
20%	7.71	16.07	27.0
22.5%	7.5	15.74	27.27
25%	7.24	15.377	27.5
27.5%	7.00	15.066	26.06
30%	6.65	14.814	25.06

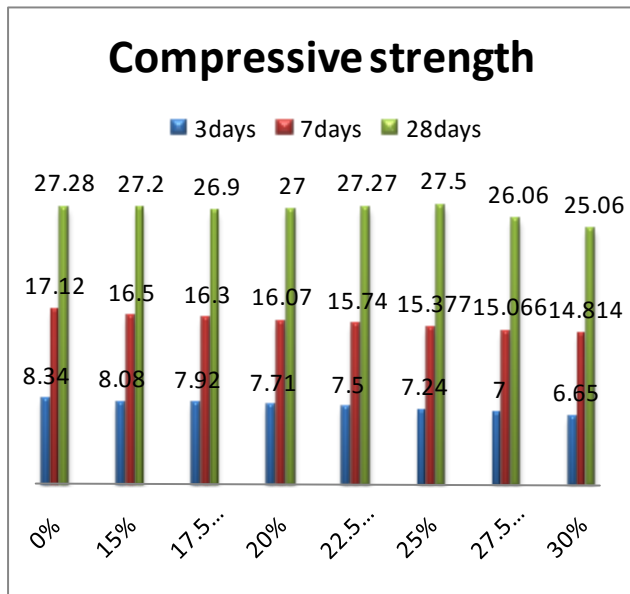


Chart -3: Compressive strength

Due to the low content of cement subsequently, it does not develop strength in the early stage, but shows almost equal reading of compressive strength for 28 days at a particular level of replacement. The above represented graph shows the maximum replacement levels as 25% for replacement of I.O.T and C.O.T.

### 3.4 Tensile Strength

**Table -6:** Details of average split tensile strength for 7, 14, and 28 days.

Replacement levels (%)	Average split tensile strength (N/mm <sup>2</sup> )		
	7 Days	14 Days	28 Days
0%	0.52	1.29	3.17
15%	0.49	1.25	3.19
17.5%	0.47	1.21	3.20
20%	0.45	1.18	3.26
22.5%	0.41	1.14	3.30
25%	0.36	1.11	3.21
27.5%	0.33	1.02	3.11
30%	0.30	0.99	3.01

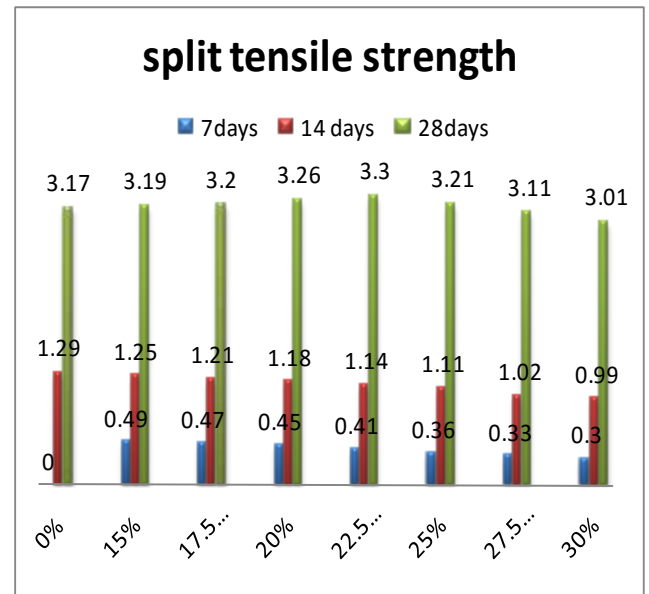


Chart -4: Tensile strength

Due to the low cement content subsequently, it does not develop strength in the early stage but it shows higher reading of tensile strength for 28 days at a particular level of replacement. The above represented graph shows maximum replacement level at 22.5% for replacement of I.O.T & C.O.T,

### 3.5 Flexural Strength

**Table -7:** Details of average flexural strength for 28 and 56 days

Replacement levels (%)	Average Flexural strength (N/mm <sup>2</sup> )	
	28 Days	56 Days
0%	27.59	32.994
15%	29.4	35.4
17.5%	31.994	36.2
20%	33.99	37.2
22.5%	34.81	40.8
25%	30.61	34.8
27.5%	26.2	31.8
30%	24	28.22

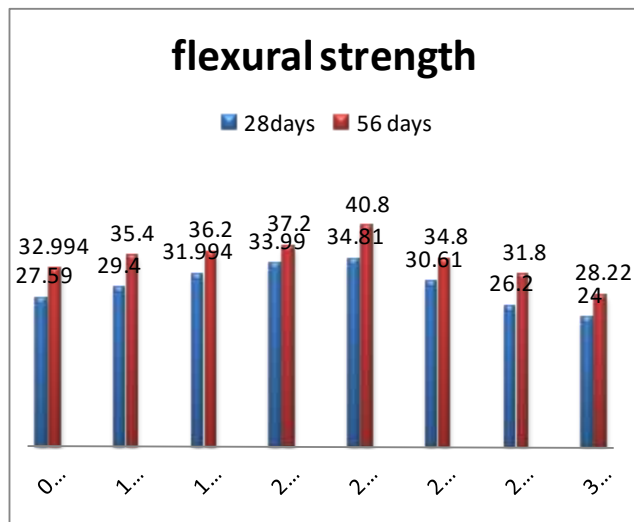


Chart -5: Flexural strength.

We can see the higher values of flexure with the increase of cement replacement by copper ore tailing and sand by iron ore tailing. Therefore the flexural strength is increased up to 22.5% replacement and after then it is decreased up to 30% replacement as Same as for 28days also.

So from graph 8.1, we getting the **optimum flexural strength of concrete beam are 40.8N/mm<sup>2</sup> at 22.5% replacement.**

Compare to 28days strength **56 Days strength has increased by 14% at 22.5%.**

#### 4. CONCLUSION

- An attempt is made to use this copper ore tailing as an admixture in the preparation of fiber reinforced concrete by replacing the cement and iron ore tailing for sand in different percentages viz., 15, 17.5, 20, 22.5, 25, 27.5, 30 with percentage of 0.6% Of steel fiber to the weight of cement. The fundamental property like compressive strength, tensile strength and flexural strength is determined.
- The workability of concrete containing copper ore tailing and iron ore tailing content increases which is due to the higher water demand of concrete compared to conventional concrete.
- Higher replacement of cement with copper ore tailing resulted in longer setting time of concrete mix.
- As the replacement has increased results in the less unit weight.
- The density of concrete decreases with increase in copper ore tailing content which lead to light weight concrete.
- The 7days and 14days strength of replaced concrete is less than conventional concrete but 28days strength is acceptably increased till 22.5%, above which strength had decreased.
- The results show that concrete has significantly higher strength up to 22.5% replacement in M20 concrete.
- Compressive strength, Tensile strength and flexural strength of the concrete has increased up to 22.5% with

addition of copper ore tailing and iron ore tailing and after that it will decreased.

- Addition of copper ore and iron ore tailing as pozzolanic material will enhance the property of concrete, reduces the cost of concrete production, and reduces the problem of its disposal and save the environment from the negative effects associated with the disposal of concrete.
- From economic point of view, the percentage of cement replacement saves money.
- The possibility of developing low cost concrete using cooper and iron ore tailing is feasible with lower grades of concrete.
- An attempt is made to use this copper ore tailing as an admixture in the preparation of fiber reinforced concrete by replacing the cement and iron ore tailing for sand in different percentages viz., 15, 17.5, 20, 22.5, 25, 27.5, 30 with percentage of 0.6% Of steel fiber to the weight of cement. The fundamental property like compressive strength, tensile strength and flexural strength is determined.
- The results show that concrete has significantly higher strength up to 22.5% replacement in M20 concrete a 28 days.

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## BIOGRAPHIES



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