COMPARISION OF STRENGTH BY REPLACING IRON ORE TAILINGS AND BOTTOM ASH AS REPLACEMENT TO FINE AGGREGATE

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Abstract— *In this study, bottom ash and iron ore tailing are employed to assess the cement concrete's strength. Fine aggregate has partially taken the position of bottom ash and iron ore tailing. For a single batch of M30 grade concrete, the Cubes and cylinders are subjected to compressive strength tests and split tensile strength tests. With a partial substitution of fine aggregate at 0%, 15%, 30%, 45%, and 60% utilizing bottom ash and iron ore tailing, respectively. The results show that adding more iron ore tailing and bottom ash to concrete mixes increases both the compressive and tensile strength. The ideal replacement levels of these materials were found to be 60% iron ore tailing, 15% bottom ash, and 25% fine aggregate.*

Keywords—Iron ore tailings(IOT) and Bottom ash(BA)

I. INTRODUCTION

The most often utilized building material worldwide is concrete. Essentially, it is made up of two parts: paste and aggregate. In contrast to the aggregate, which consists of sand, gravel, or crushed stone, the paste comprises cement, water, and occasionally other cementations materials and chemical admixtures. The aggregate is joined together by the paste. The aggregates, which make up 70% to 80% of the concrete, are relatively innocuous filler ingredients.

On the job, it is frequently the least expensive and most easily available material. One of its advantages is that since concrete requires no maintenance and does not corrode, has little surface preparation, and gets stronger with time. It is obvious that there would be a rising need for clean water; clean alternative was the safe and speedy transport of people and commodities, residential and industrial objects, and sources of energy the outcome of expanding population restriction, and globalization.

One of the world's largest producers and exporters of iron ore is India. Effective use of natural ore necessitates mining, yet mining generates a lot of waste. The need for effective waste management and disposal of this garbage needs to be implemented.

II. MATERIALS USED

1. Cement

Widely employed in building, cement is renowned for its powerful binding properties. It is a fine powder consisting primarily of limestone, clay, shells, and silica, which are heated in a kiln to an average temperature of 1450 degrees Celsius (2642 degrees Fahrenheit). This process, known as calcination, produces a substance called clinker.

The clinker is then ground into a fine powder, which is the cement we commonly refer to. Cement acts as a binder when mixed with water, forming a paste that hardens and binds other materials together. It is a key component During the creation of concrete, mortar, and other building materials.

Cement is an ingredient used to make concrete, which is the final product used in construction.

In this investigation OPC43 grade Ordinary Portland Cement used for all concrete mixes.

Table 1: Cement test results

Sl. No	Particulars	Result	Permissible value
1	Fineness of cement	7.2%	<10%
2	Cement's specific gravity test	3.14	3.1 to 3.16
3	Initial and final setting time of cement	25 minutes and 300 minutes	Min 30 minutes and max 600 minutes

Fig 1: ***Cement sample***

2. Fine aggregates (FA)

Fine aggregate, also referred to as fine sand or simply sand, is a type of granular material used in construction. It is typically composed of small particles, usually smaller than 5mm in size. Fine aggregate is often used in the manufacture of concrete and mortar. In construction, fine aggregate is mostly used to fill spaces between bigger coarse aggregates. Such as gravel or crushed stone, and to provide stability to the mixture. It makes the concrete or mortar mixture easier to work, making it easier to handle and shape.

In this experiment, sand was employed is ordinary rivers and. The sand confirms to grading zone-III

Table 2: Fine aggregates test results

Sl. No	Particulars	Result	Permissible value
1	Gradation test of FA	-	Confining to zone 3
2	Water absorption	1.5%	<3%
3	Specific weight of FA	2.6	To 2.7

Fig 2: ***Fine aggregates sample***

3. Coarse aggregates (CA)

Coarse aggregates are a key component of concrete and are commonly used in construction and civil engineering projects. They are large, granular materials typically consisting of crushed stone, gravel, or recycled concrete. Coarse aggregates are an essential part of concrete mixtures, providing strength, stability, and durability to the finished product.

20mm coarse aggregate was employed in the experiment.

Table 3: Coarse aggregates test results

Sl. No	Particulars	Result	Permissible value
1	Gradation test of CA	-	Confining to zone 2
2	Water absorption	1.6%	< 2%
3	Specific weight of CA	2.7	To 3.0

Fig 3: ***Coarse aggregates sample***

4. Iron ore tailings (IOT)

IOT are the waste materials that are produced during the extraction and beneficiation of iron ore. They are composed of a mixture of finely crushed rock, water, and small amounts of iron ore minerals.

Table 4: Iron ore tailings test results

Sl. No	Particulars	Result
1	Water absorption	5.25%
2	Specific weight of IOT	3.25

Fig 4: ***Iron ore tailings sample***

5. Bottom ash (BA)

Bottom ash is a particular kind of waste product that is generated during the combustion of coal or other solid fuels in power plants. When coal is burned, the incombustible components, such as rock and mineral impurities, remain as residue at the bottom of the combustion chamber. This residue is known as bottom ash.

Table 5: BA test results

Sl. No	Particulars	Result
1	Water absorption	8.62%
2	Specific weight of BA	2.56

Fig 5: ***bottom ash sample***

III. OBJECTIVES OF THE WORK

• To assess concrete's mechanical properties, such as strength in compression and split tensile

• To establish the perfect level of iron ore tailings are replaced and Bottom ash in Concrete.

• To learn about bottom ash and the iron ore tailings behaviour.

Constant parameters

- Concrete Grade of M-30.
- Cement-OPC 43 grade
- Msand-25%
- Coarse aggregate- A nominal size of 20 mm
- Cement to water ratio - 0.40-0.50
- Size of specimen

Cube specimen of size 150 x150x150mm

Cylinder specimen of size 300 x 150 mm

Variable Parameters

• Iron ore tailings – Iron ore tailings replace natural sand at 4 different replacement levels, namely 0, 15, 30, 45, and 60%

• Bottom Ash - Natural sand is replaced by bottom Ash in 4 different replacement levels 60,45,30,15 and 0%.

• Curing period - after 3, 7, and 28 days of cure, cube and cylinder specimens are subjected to split tensile and compressive strength tests, respectively.

IV. MIX DESIGN

M30 Grade Of ConcreteWas designed As Per IS:10262-2019.

V. EXPERIMENTAL RESULT AND DISCUSSION

TEST ON FRESH CONCRETE

A. Slump test:

Slump test determines how fluid new concrete is prior to hardening. Assessing freshly poured concrete is done to see whether it is usable and, therefore, if Concrete glides smoothly. It could serve as a batch indication.

Fig 6: Slump test setup

B. Vee Bee Test [IS 1199-1959]

The concrete slump test evaluates the fluidity of new concrete before it sets. It is done to assess the workability of freshly poured concrete and, subsequently, to see if the concrete flows easily. It might also be taken as evidence of faulty batch blending..

Fig 7: Vee Bee Test

TEST ON HARDENED CONCRETE

A. ***Compressive strength test:***

It is frequently done to carry out the test for compressive; the Strength of a material is measured by its ability to withstand a compressive load. It is particularly important in construction and engineering applications where materials need to withstand pressure without failure or deformation.

AS indicated by IS 516-1959, they are evaluated using a compression testing equipment with a 3000kN capacity. Equation F=P/A is used to determine compressive strength.

Where,

F- The specimen's compressive strength (in MPA).

P-Maximum load applied to the specimen (in N).

A- Sample's cross-sectional area (in mm^2)

Fig 8: Testing cubes under UTM machine

Table 6: Results of compressive strength

Sl. No.	Particulars	Average strength		
		3 days	7 days	28 days
1	Normal Concrete NC	15.03	22.25	36.82
2	15% IOT + 60%BA + 25% Msand (MIX 1)	10.48	17.5	28.05
3	30% IOT + 45%BA + 25% Msand (MIX 2)	11.22	19.05	31.25
4	45% IOT + 30% BA + 25% Msand (MIX 3)	13.39	21.02	34.05
5	60% IOT + 15% BA + 25% Msand (MIX 4)	15.01	22.5	37.25

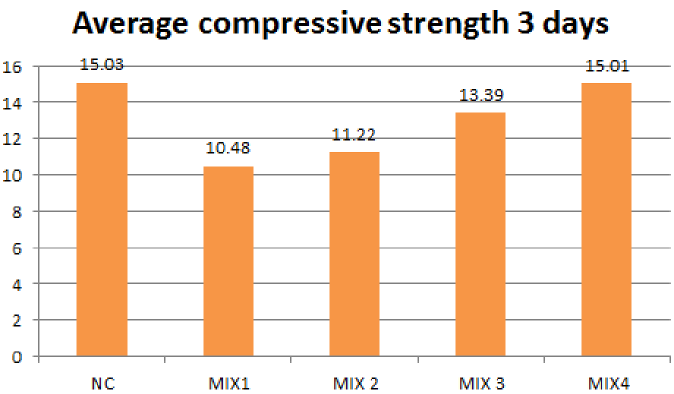

Chart 1: 3 days Graph

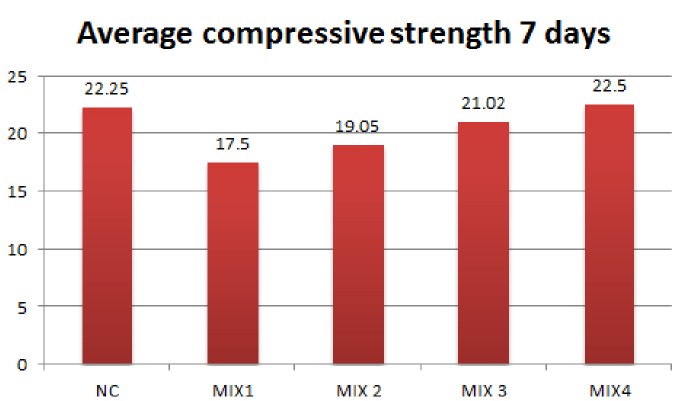

Chart 2: 7 days Graph

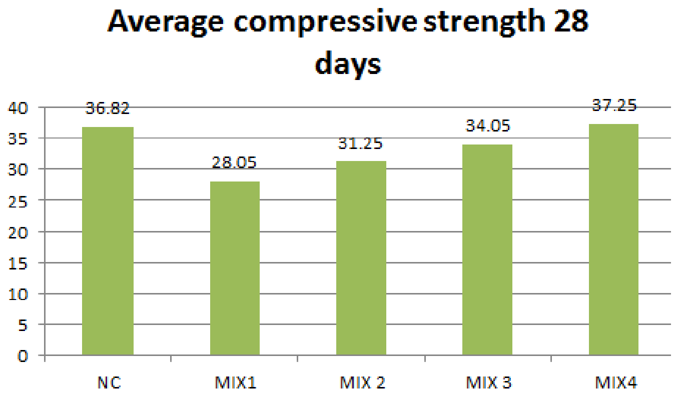

Chart 3: 28 days Graph

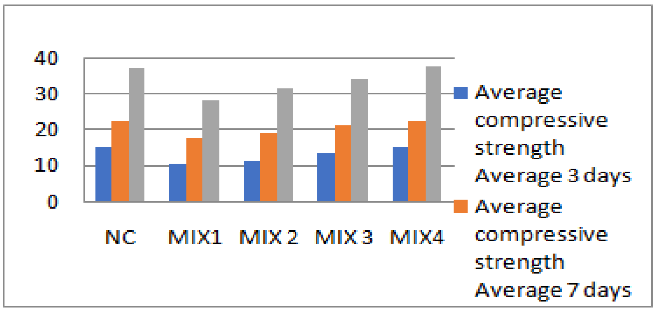

Chart 4: Comparison on Compressive strength Graph

B. Split tensile strength test:

The 300mm long by 150mm wide cylindrical specimens were created. According to IS 5816- 1999, a split tension test was performed on a compression testing apparatus with a 3000 KN capability. $F = 2P / (\pi D L)$ is used to compute the tensile strength.

Where,

P = Load at failure (in N)

D = Diameter of the cylindrical specimen (in mm)

L = Length of the cylindrical specimen (in mm).

F = Tensile strength of concrete (in MPa).

Fig 9: Testing cylinder's under UTM machine

Table 7: Test results for Split Tensile Strength

Sl. No.	Particulars	Average strength	
		7 days	28 days
1	Normal Concrete NC	2.1	3.8
2	15% IOT + 60%BA + 25% Msand (MIX 1)	1.62	2.9
3	30% IOT + 45%BA + 25% Msand (MIX 2)	1.24	3.1
4	45% IOT + 30% BA + 25% Msand (MIX 3)	1.81	3.43
5	60% IOT + 15% BA + 25% Msand (MIX 4)	1.9	3.75

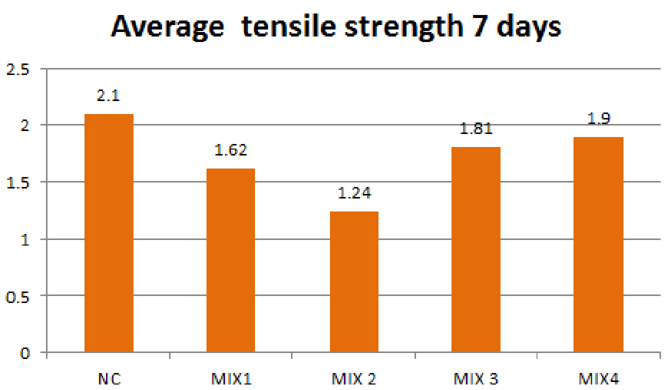

Chart 5: 7 days Graph

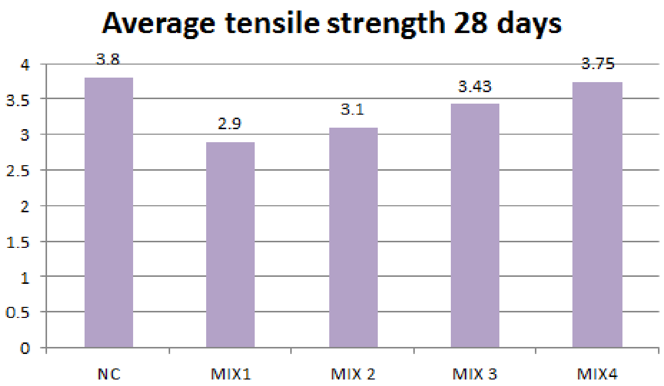

Chart 6: 28 days Graph

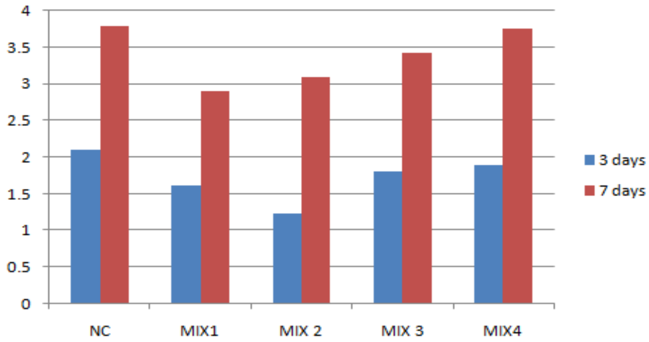

Chart 7: Comparison on split tensile strength Graph

CONCLUSIONS

Examination of new concrete's properties, such as split tensile strength and compressive strength, at various ages is an important aspect of concrete testing. Over time, concrete normally becomes stronger. as it undergoes hydration and gains maturity. The mixes were created. The next paragraphs provide an overview of the findings from these studies.

- Experimental research shows that adding bottom ash and concrete from iron ore tailings mixtures boosts the material's compressive and tensile strengths.
- Considering the test findings, it was discovered that adding more iron ore tailings and bottom ash as a partial substitute for M sand increased the strength of regular concrete.

In total, iron ore tailings can be used to partially prepare concrete instead of natural sand. It lessens the need for natural sand, resolves the issue of iron ore tailings causing environmental contamination, and encourages the development of green construction projects.

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