EFFECT OF INCORPORATION OF IRON BLAST FURNACE SLAG, BARYTES POWDER AS REPLACEMENT TO SAND AND CEMENT AND ADDITION OF GLASS FIBER ON THE MECHANICAL PROPERTIES OF M_{30} GRADE CONCRETE

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Abstract: *Cement concrete is the most widely used manmade construction material in the world. However, for the production of cement naturally available materials are required which should be used effectively and economically for sustainability. There are many waste products produced from various in industries whose safe disposal has become a challenge now a days.In order to make the waste into resource, one of the finest solution is to utilize them in cement concrete which is proved to be a wonderful material that can accept many waste industrial products without becoming detrimental to environment. Iron blast furnace slag is one of the waste materials that is produced from steel plants. About 120 million tones of iron blast furnace slag is produced annually in the country. Glass fiber is an easily available material. In the present study it is proposed to investigate the mechanical properties of the cement concrete using the iron blast furnace slag as fine aggregate duly replacing the sand at 20%, 40%, 60%, 80%and 100% in M30 grade concrete. Barytes is an inert material with high specific gravity About 90% of the country's reserves are available in the local mines in kadapa district. Barytes is used in high density concretes. It is also used in oil drilling industry, paints and other purposes. In the present investigation, barites powder up to 10% is used as replacement to cement for improving micro structure and durability of concrete. Finally, the iron blast furnace slag as fine aggregate, barites powder as partial replacement to cement and glass fiber are used in concrete of M30 grade and the mechanical properties are investigated. It is observed that the mechanical properties of glass fiber reinforced concrete are improved by the use of barytes powder and iron blast furnace slag.*

Keywords: Barites powder, Iron Blast Furnace Slag, Glass fiber Reinforced concrete

1. INTRODUCTION

Cement concrete is one of the most widely used construction material in the world. A study by the Indian institute of technology Bombay has estimated that the annual demand of sand in urban India is about 60Million metric tons[1].Blast furnace slag in India is used mainly in cement manufacture and other un organised works such as landfills and railway ballast. The price of Iron blast furnace slag vary from plant to plant [2]. Sustainability is important to the well-being of the society. There is an every need to use locally available materials with low energy cost, high durability and low maintenance requirements. Barytes or Barites in soft crystalline mineral form of barium sulphate($BaSO_4$) Mangampeta deposit in Kadapa district Of A.P, India is the single largest barytes deposit in the world [2] greater amount of chloride ion were fixed during the hydration c_3a synthesized the presence of $Baso_4$. Synthesized C_3A but also opc mortar can fix greater

amounts of chlorides in the presence of $BaSo_4$ [3].Many researchers have carried out investigations on the concrete with replacement of sand by iron blast furnace slag. There are a few studies made on finding the suitability of locally available(in Kadapa district) Iron blast furnace slag as replacement to sand and the effect of barites powder on the concrete with replacement of sand and also addition glass fibers. In the present study an attempt is made to find the effect of Iron Blast furnace slag fine aggregate as a partially replacement to sand with and without the partial replacement of cement by locally available barites powder on the mechanical properties of M30 grade concrete.

2. MATERIALS

The materials used in the present investigation are 1) Cement 2) river sand 3) Iron blast furnace slag 4) Barytes powder 5) Glass fiber and water. The properties of materials are furnished in table 3.1-3.7.

2.1Cement: 53 grade ordinary Portland cement confirming to IS- 12269-2013 is used in the investigation. The physical properties of cement are furnished in table 1.

Table 1. Properties of Cement

S. No	Properties	Numerical values
1	Specific gravity	3.15
2	Fineness	8.65%
3	Initial setting time	41min
4	Final setting time	468min

2.2Fine aggregate: Sand from local cheyyeru river confirming to zone II of IS 383-1970 is used in the investigation. The properties of sand are given in table 2.

Table 2. Fine Aggregates Properties

S. No	Particulars	Results
1	Type	Normal Sand
2	Specific gravity	2.72
3	Fineness modulus	3.14
4	Bulk density	1564 kg/m^3

2.3Coarse aggregate: The coarse aggregates used in the present investigation is obtained from local stone crushing unit. The properties of coarse aggregates are show in table 3.

Table 3. Coarse Aggregate's Physical Properties

SL.NO.	Properties	Value
1	Size of Aggregate	20mm down graded
2	Specific gravity	2.74
3	Bulk density	1662kg/m^3
4	Shape	Angular

2.4IRON BLAST FURNACE SLAG: The iron blast furnace slag used in the present investigation is brought from local mini steel manufacturing industry. The slag is crushed and made into fine particles. Then the material is sieved. The material confirming to zone II of IS 383-1970 is used in the concrete. The properties of the iron blast furnace slag are shown in the table 4.

Table 4. Physical Properties of Iron Blast Furnace Slag

S.No	Physical properties	Property of slag
1	Colour	Black
2	Specific gravity	3.15
3	Fineness	2.95
4	Bulk density	1044 kg/m^3
S.No	Physical properties	Property of slag

2.5 BARYTES: The barytes powder used in the present investigation is procured from barytes pulverizing mill located at kadapa. The properties of barytes powder are shown in table 5.

Table 5. Properties of Barite in the Present Investigation

S.NO	Property	Result
1	Colour	Light grey
2	Specific Gravity	4.30
3	Fineness	1.8%

2.6GLASS FIBER REINFORCED CONCRETE: The glass fiber used in the present investigation is procured from Bhuddha suppliers, Mumbai. The properties of glass fiber are shown in the table 6.

Table 6. Properties of Glass Fiber Reinforced Concrete

S.NO.	Particulars	Results
2	Diameter	14 microns
3	Length	12mm
4	Specific gravity	2.68

2.7 Water: The water used in the present investigation is fetched from the bore well in the college campus.

3 EXPERIMENTAL PROGRAMME

Mix proportions: M30 grade concrete is used in the present investigation. The mix proportions of M30 grade concrete are shown in table 7.

Table 7.

S. No	Material	Quantity
1	Cement	380kg/m^3
2	Sand	715kg/m^3
3	Coarse aggregate	1155kg/mm^3
4	Water	182lit

Concrete mixtures details:

Concrete Mixture CS: In this mix the sand is replaced by iron blast furnace slag at 20%, 40%, 60%, 80% and 100%, in M_{30} grade concrete.

Concrete Mix CSB: In this concrete mixture the sand is replaced by Iron blast furnace slag from 20% to 100% at an increase of 20% by weight of sand. And the cement is replaced by barytes powder at 5%, 7.5%, 10% in M_{30} grade controlled concrete mix.

Concrete Mix CSBG: In this mix the sand is replaced by iron blast furnace slag at 20%, 40%, 60%, 80% and 100%. The cement is replaced by Barytes powder at 5%, 7.5% and 10% and 1% (by weight of cement) glass fiber is used in M_{30} grade concrete.

The compressive strength of concrete cubes was tested as per the procedure given in IS-516-1959.

The splitting tensile strength of concrete cylinders (150mmdia and 300mm height) was tested as per the procedure laid down in IS-5816-1999

The flexural strength of concrete beams (150x150x700mm size) was tested as per the guide lines given in IS-516-1959.

4. RESULTS AND DISCUSSIONS

4.1 COMPRESSIVE STRENGTH:

The compressive strength of M30 grade concrete with different percentages of replacement of cement by barytes powder and sand by iron blast furnace slag and the compressive strength of concrete with 1% of glass fiber tested at 14 and 28 days as per the procedure given in IS-516-1959 and the results are furnished in the table 4.1-4.5.

4.1.1 COMPRESSIVE STRENGTH OF CONCRETE CUBES WITH SAND REPLACED BY IRON BLAST FURNACE SLAG:

Compressive strength of M30 grade conventional concrete and the concrete with replacement of sand by iron blast furnace slag at 20%, 40%, 60%, 80% and 100% are tested for at 14 and 28days and the compressive strength results with iron blast furnace slag and barytes powder are found at 14 and 28 days are furnished in table 8

Table 8. Compressive strength results of CS concrete cubes

Mix designation on	% Replacement		Compressive strength N/mm^2	
	Fine aggregate	Iron blast furnace Slag	14 days	28 days
$CS_{0\%}$	100	-	24.80	32.40
$CS_{20\%}$	80	20	24.55	31.82
$CS_{40\%}$	60	40	25.36	32.58
$CS_{60\%}$	40	60	27.61	34.80
$CS_{80\%}$	20	80	26.47	34.25
$CS_{100\%}$	-	100	24.13	32.83

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For the concrete cubes tested at 14 days, 28 days, the compressive strength is measured and the graphical representation of compressive strength of concrete cubes is shown in figure 1.

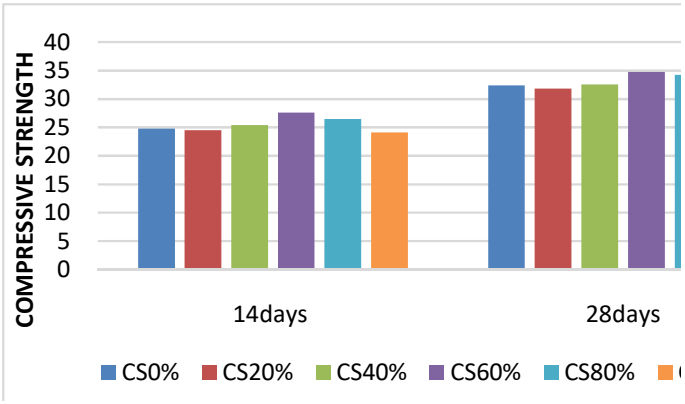

Figure 1 Compressive strength of concrete cubes

4.1.2 COMPRESSIVE STRENGTH OF CONCRETE CUBES WITH CEMENT REPLACED BY BARITES 5% AND SAND REPLACED BY IRON BLAST FURNACE SLAG:

The concrete cubes with replacement of sand by iron blast furnace slag at 20%, 40%, 60%, 80% and 100% and cement replaced by 5% barytes powder are the tested for compressive strength at 14 and 28 days and the results are furnished in table 9

Table 9. Compressive strength results of CSB5% concrete cubes

Mix designation on	% Replacement			Compressive strength N/mbm^2	
	Fine aggregate	Iron blast furnace Slag	Barytes	14 days	28 days
$CS_{0\%}B_{0\%}$	100	-	5%	24.80	32.40
$CS_{20\%}B_{5\%}$	80	20	5%	25.21	33.66
$CS_{40\%}B_{5\%}$	60	40	5%	26.44	34.20
$CS_{60\%}B_{5\%}$	40	60	5%	28.85	35.94
$CS_{80\%}B_{5\%}$	20	80	5%	28.04	35.13
$CS_{100\%}B_{5\%}$	-	100	5%	25.70	33.30

For the concrete cubes tested at 14 days, 28 days, the compressive strength is measured and the graphical representation of compressive strength of concrete cubes is shown in figure 2.

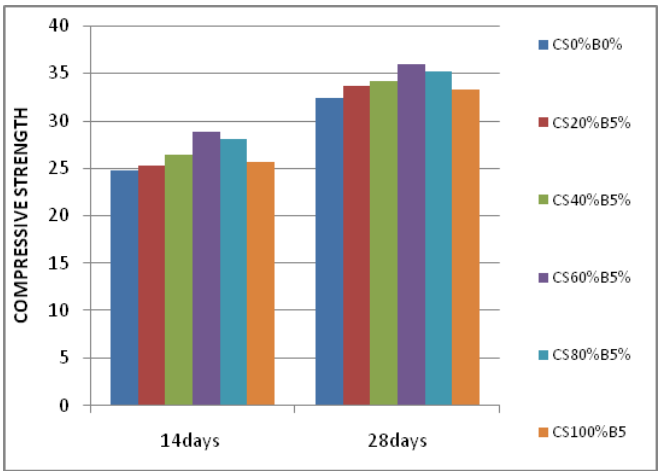

Figure 2 Compressive strength of concrete cubes

4.1.3 COMPRESSIVE STRENGTH OF CONCRETE CUBES WITH CEMENT REPLACED BY BARITES 7.5% AND SAND REPLACED BY IRON BLAST FURNACE SLAG:

The compressive strength of concrete cubes with 20%, 40%, 60%, 80% and 100% and cement replaced by 7.5% barytes powder the compressive strength results with iron blast furnace slag and barytes powder are found at 14 and 28 days are furnished in table 10.

Table 10. Compressive strength results of CSB7.5% concrete cubes

Mix designation on	% Replacement			Compressive strength N/mm²	
	Fine aggregate	Iron blast furnace Slag	Barytes	14 days	28 days
$CS_{0\%}B_{0\%}$	100	-	-	24.80	32.40
$CS_{20\%}B_{7.5\%}$	80	20	7.5%	26.13	34.02
$CS_{40\%}B_{7.5\%}$	60	40	7.5%	28.26	35.73
$CS_{60\%}B_{7.5\%}$	40	60	7.5%	29.85	37.04
$CS_{80\%}B_{7.5\%}$	20	80	7.5%	29.60	36.68
$CS_{100\%}B_{7.5\%}$	-	100	7.5%	27.61	34.30

For the concrete cubes tested at 14 days, 28 days, the compressive strength is measured and the graphical representation of compressive strength of concrete cubes is shown in figure 3.

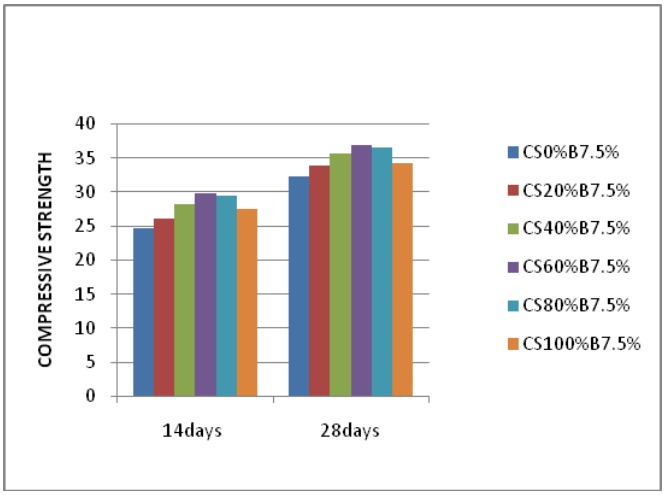

Figure 3 Compressive strength of concrete cubes

4.1.4 COMPRESSIVE STRENGTH OF CONCRETE CUBES WITH REOPLACEMENT OF CEMENT BY BARITES AT 10% AND SAND REPLACED BY IRON BLAST FURNACE SLAG: The compressive strength of concrete cubes with 20%, 40%, 60%, 80% and 100% and cement replaced by 10% barytes powder the compressive strength results with iron blast furnace slag and barytes powder are found at 14 and 28 days are furnished in table 11.

Table 11. Compressive strength results of CSB10% concrete cubes

Mix designation on	% Replacement			Compressive strength N/mm^2	
	Fine aggregate	Iron blast furnace Slag	Barytes	14 days	28 days
$CS_{0\%}B_{0\%}$	100	-	-	24.80	32.40
$CS_{20\%}B_{10\%}$	80	20	10	24.10	30.76
$CS_{40\%}B_{10\%}$	60	40	10	24.88	31.95
$CS_{60\%}B_{10\%}$	40	60	10	26.90	33.71
$CS_{80\%}B_{10\%}$	20	80	10	25.1	33.5
$CS_{100\%}B_{10\%}$	-	100	10	23.40	31.14

For the concrete cubes tested at 14 days, 28 days, the compressive strength is measured and the graphical representation of compressive strength of concrete cubes is shown in figure 4.

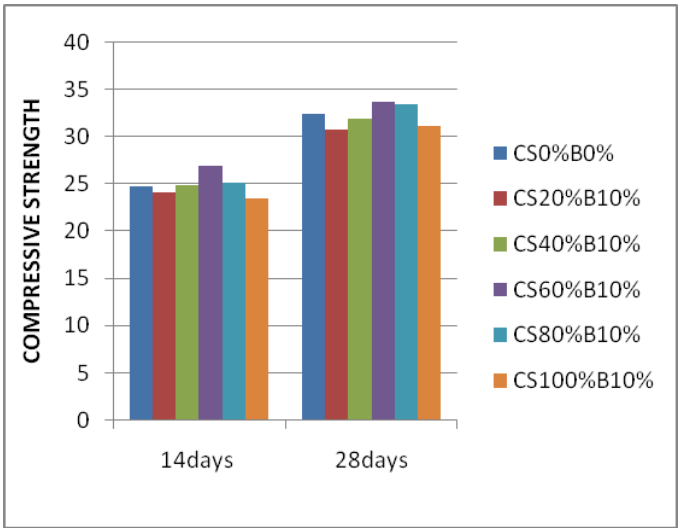

Figure 4 Compressive strength of concrete cubes

4.1.5 COMPRESSIVE STRENGTH OF CONCRETE CUBES WITH REPLACEMENT OF CEMENT BYBARITES AND SAND REPLACED BY IRON BLAST FURNACE SLAG AND GLASS FIBER: The compressive strength of concrete with addition of 1% glass fiber and replacement of sand with iron blast furnace slag and cement replaced by barytes powder are found at 14 and 28 days are furnished in table 12.

Table 12. Compressive strength results of CS concrete cubes

Mix designation on	% Replacement				Compressive strength N/mm^2	
	Fine aggregate	Iron blast furnace Slag	Barytes	Glass fiber	14 days	28 days
$CS_{0\%}B_{0\%}G_{0\%}$	100	-	-	-	24.80	32.40
$CS_{60\%}B_{0\%}$ $G_{0\%}$	40	60	0	1%	27.95	36.70
$CS_{60\%}B_{5\%}$ $G_{1\%}$	40	60	5	1%	28.44	37.53
$CS_{60\%}B_{7.5\%}$ $G_{1\%}$	40	60	7.5	1%	30.51	38.86
$CS_{60\%}B_{10\%}$ $G_{1\%}$	40	60	10	1%	26.28	35.10

For the concrete cubes tested at 14 days, 28 days, the compressive strength is measured and the graphical representation of compressive strength of concrete cubes is shown in figure 5.

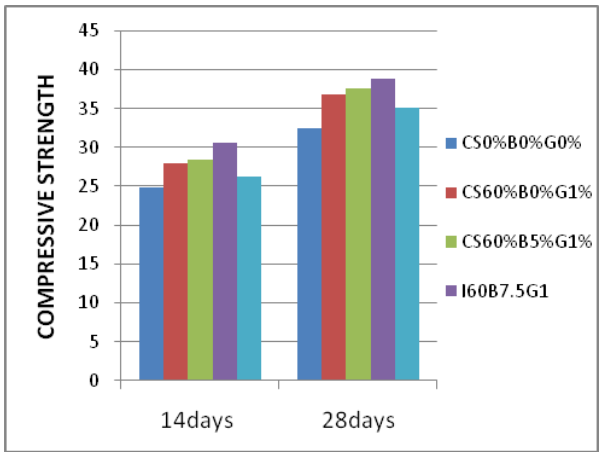

Figure 5 Compressive strength of concrete cubes

Khaled saidani et al have studied the mechanical properties of concrete with barytes powder as sand replacement. It was observed by them that the compressive strength of concrete with replacement of sand by barytes powder above 5% decreases the compressive strength upto 10% [5]. The compressive strength of M30 grade concrete increases with increase in replacement of sand by iron blast furnace slag from 20% to 60% at 14 days and days. The strength decreases with increases in the replacement of sand by iron blast furnace slag from 60% upto 100% at 14 and 28 days.

The compressive strength of concrete increases with the replacement of cement with barytes at 5% and 7.5% and the compressive strength decreases with 10% replacement of cement with barytes powder and the sand replaced by iron blast furnace slag.

The concrete with 60% replacement of sand by iron blast furnace slag has shown highest compressive strength at 14 and 28 days in concrete with iron blast furnace slag. The increase in strength is 11.33% and 7.16% higher than the control M30 grade concrete at 14 and 28 days respectively.

The concrete specimens with 60% replacement of sand by iron blast furnace slag and 5% replacement of cement by barytes powder have shown 16.33% and 10.93% increases in compressive strength at 14 and 28 days when compared to standard concrete mix.

The concrete cubes with 60% replacement of sand by iron blast furnace slag and 10% replacement of cement by barytes powder have shown 8.46% and 2.77% increases in compressive strength at 14 and 28 days when compared to M30 grade control concrete mix specimens.

The compressive strength of concrete cubes with replacement of sand by blast furnace slag at 60% and replacement of cement by barytes powder is increased with addition of 1% of glass fiber.

The addition of glass fiber has increased the compressive strength of M30 grade concrete by 12.70% and 13.27% at 14 and 28 days respectively.

The concrete with 60% replacement of sand with iron blast furnace slag 7.5% replacement of sand with iron blast furnace slag, 7.5% replacement of cement by barytes powder and 1% addition of glass fiber has given the highest compressive strength at 28 days. This strength is 19.94% more than the compressive strength of M30 grade opc concrete 28 days.

4.2 SPLIT TENSILE STRENGTH TEST

The split tensile strength of M30 grade concrete with different percentages of replacement of cement by barytes powder and sand by iron blast furnace slag and the compressive strength of concrete with 1% of glass fiber were tested at 14 and 28 days and the results are furnished

4.2.1 SPLIT TENSILE STRENGTH OF CONCRETE CYLINDERS WITH SAND REPLACED BY IRON BLAST FURNACE SLAG: By adding iron blast furnace slag for a substitute of fine aggregate in different amounts, i.e. 20 percent, 40 percent, 60 percent, 80 percent and 100 percent, the split tensile strength of M30 concrete mixes is investigated and the findings as per the procedure given in IS 516: 1959. The compressive strength results were shown in table 13

Table 13. Split tensile strength results for cylinders

Mix designation on	% Replacement		Split tensile strength N/mm²	
	Fine aggregate	Iron blast furnace Slag	14 days	28 days
$CS_{0\%}$	100	-	1.73	3.07
$CS_{20\%}$	80	20	2.2	3.11
$CS_{40\%}$	60	40	2.1	3.38
$CS_{60\%}$	40	60	2.4	4.81
$CS_{80\%}$	20	80	2.2	3.60
$CS_{100\%}$	-	100	2.1	3.13

For the concrete cylinders tested at 14 days, 28 days, the split tensile strength is measured and the graphical representation of Split tensile strength of concrete cylinders is shown in figure 6.

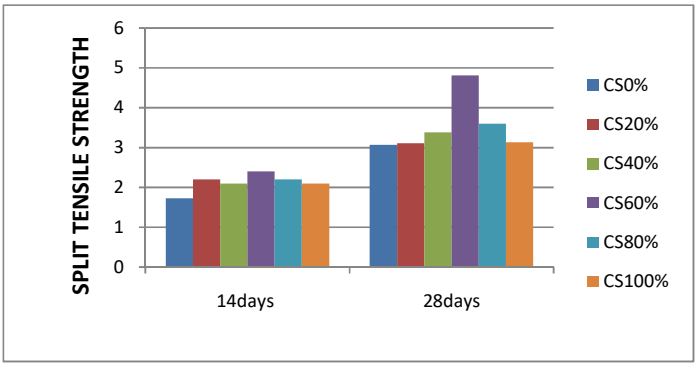

Figure 6 Split tensile strength of concrete cubes

4.2.2 SPLIT TENSILE STRENGTH OF CONCRETE CUBES WITH CEMENT REPLACED BY BARITES 5% AND SAND REPLACED BY IRON BLAST FURNACE SLAG:

Split tensile strength of M30 grade conventional concrete and the concrete with replacement of sand by iron blast furnace slag at 20%, 40%, 60%, 80% and 100% and cement replaced by 5% barytes powder the compressive strength results with iron blast furnace slag and barytes powder are found at 14 and 28 days are furnished in table 14.

Table 14. Split tensile strength results for cylinders

Mix designation on	% Replacement			Split tensile strength N/mm²	
	Fine aggregate	Iron blast furnace Slag	Barytes	14 days	28 days

$CS_{0\%}B_{0\%}$	100	-	5%	1.73	3.07
$CS_{20\%}B_{5\%}$	80	20	5%	2.16	3.22
$CS_{40\%}B_{5\%}$	60	40	5%	2.20	3.54
$CS_{60\%}B_{5\%}$	40	60	5%	2.56	3.96
$CS_{80\%}B_{5\%}$	20	80	5%	2.3	3.72
$CS_{100\%}B_{5\%}$	-	100	5%	2.16	3.25

For the concrete cylinders tested at 14 days, 28 days, the split tensile strength is measured and the graphical representation of Split tensile strength of concrete cylinders is shown in figure 7.

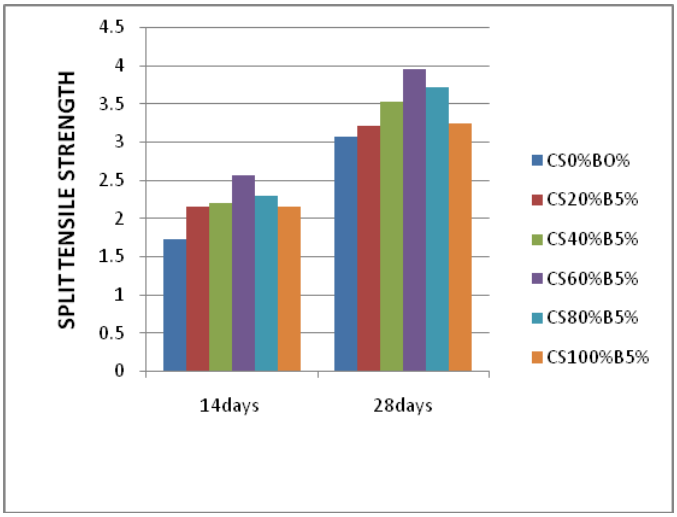

Figure 7 Split tensile strength of concrete cubes

4.2.3 SPLIT TENSILE STRENGTH OF CONCRETE CUBES WITH CEMENT REPLACED BY BARITES 7.5% AND SAND REPLACED BY IRON BLAST FURNACE SLAG: The compressive strength of concrete cubes with 20%, 40%, 60%, 80% and 100% and cement replaced by 7.5% barytes powder the compressive strength results with iron blast furnace slag and barytes powder are found at 14 and 28 days are furnished in table 15.

Table 15. Split tensile strength results for cylinders

Mix designation on	% Replacement			Split tensile strength N/mm²	
	Fine aggregate	Iron blast furnace Slag	Barytes	14 days	28 days
$CS_{0\%}B_{0\%}$	100	-	-	1.73	3.07
$CS_{20\%}B_{7.5\%}$	80	20	7.5%	2.03	3.51
$CS_{40\%}B_{7.5\%}$	60	40	7.5%	2.03	3.67
$CS_{60\%}B_{7.5\%}$	40	60	7.5%	2.4	4.10
$CS_{80\%}B_{7.5\%}$	20	80	7.5%	2.26	3.70
$CS_{100\%}B_{7.5\%}$	-	100	7.5%	2.1	3.38

For the concrete cylinders tested at 14 days, 28 days, the split tensile strength is measured and the graphical representation of Split tensile strength of concrete cylinders is shown in figure 8.

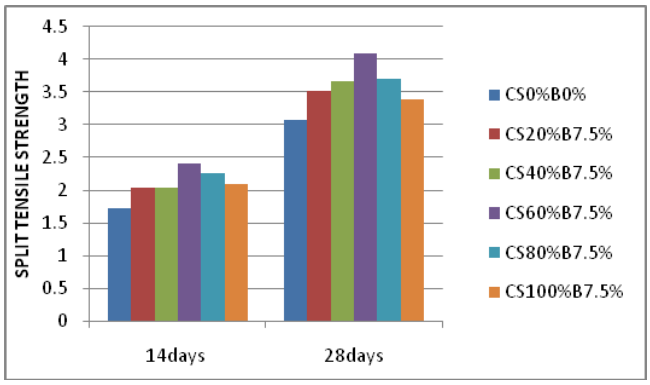

Figure 8 Split tensile strength of concrete cylinders

4.2.4 SPLIT TENSILE STRENGTH OF CONCRETE CUBES WITH CEMENT REPLACED BY BARITES 10% AND SAND REPLACED BY IRON BLAST FURNACE SLAG: The split tensile strength of concrete cubes with 20%, 40%, 60%, 80% and 100% and cement replaced by 10% barytes powder the compressive strength results with iron blast furnace slag and barytes powder are found at 14 and 28 days are furnished in table 16.

Table 16. Split tensile strength results for cylinders

Mix designation on	% Replacement			Split tensile strength N/mm²	
	Fine aggregate	Iron blast furnace Slag	Barytes	14 days	28 days
$CS_{0\%}B_{0\%}$	100	-	-	1.73	3.07
$CS_{20\%}B_{10\%}$	80	20	10	1.9	2.80
$CS_{40\%}B_{10\%}$	60	40	10	1.93	3.04
$CS_{60\%}B_{10\%}$	40	60	10	2.3	3.49
$CS_{80\%}B_{10\%}$	20	80	10	2.2	3.22
$CS_{100\%}B_{10\%}$	-	100	10	2.1	2.93

For the concrete cylinders tested at 14 days, 28 days, the split tensile strength is measured and the graphical representation of Split tensile strength of concrete cylinders is shown in figure 9.

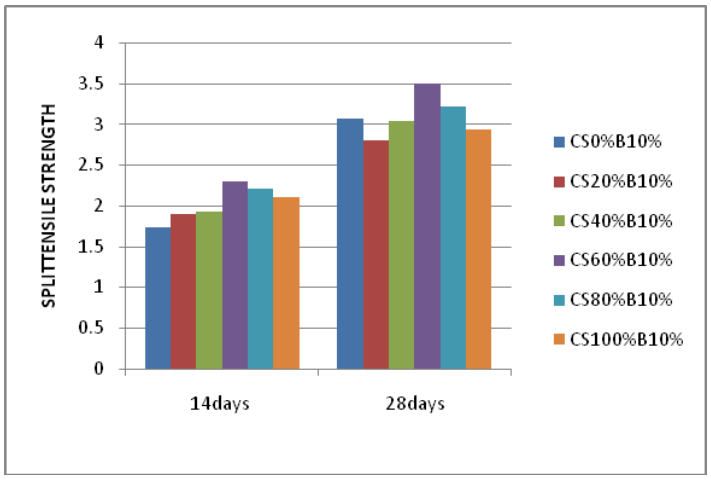

Figure 9 Split tensile strength of concrete cylinders

It is observed that from 5.10 that the compressive strength of M30 grade concrete increases with increase in replacement of sand by iron blast furnace slag from 20% to 60% at 14 days and days. The strength decreases with increases in the replacement of sand by iron blast furnace slag from 60% upto 100% at 14 and 28 days.

The split tensile strength of concrete increases with the replacement of cement with barytes at 5% and 7.5% and the compressive strength decreases with 10% replacement of cement with barytes powder and the sand replaced by iron blast furnace slag.

The concrete with 60% replacement of sand by iron blast furnace slag has shown highest split tensile strength at 14 and 28 days in concrete with iron blast furnace slag. The increase in strength is 11.33% and 7.16% higher than the control M30 grade concrete at 14 and 28 days respectively.

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The concrete cubes with 60% replacement of sand by iron blast furnace slag and 10% replacement of cement by barytes powder have shown 8.46% and 2.77% increases in split tensile strength at 14 and 28 days when compared to M30 grade control concrete mix specimens.

The split tensile strength of concrete cubes with replacement of sand by blast furnace slag at 60% and replacement of cement by barytes powder is increased with addition of 1% of glass fiber.

The addition of glass fiber has increased the split tensile strength of M30 grade concrete by 12.70% and 13.27% at 14 and 28 days respectively.

The concrete with 60% replacement of sand with iron blast furnace slag 7.5% replacement of sand with iron blast furnace slag, 7.5% replacement of cement by barytes powder and 1% addition of glass fiber has given the highest compressive strength at 28 days. This strength is 19.94% more than the split tensile strength of M30 grade opc concrete 28 days.

Navya Kiran et al have studied the effect of barytes powder on the tensile strength of M30 grade conventional concrete with addition of barytes powder upto 7.5% increases the split tensile strength of concrete [5].

4.3 FLEXURAL STRENGTH TEST: The flexural strength of concrete cubes increases with addition of glass fiber. The flexural strength values of concrete with 60% of sand replaced by iron blast furnace slag and cement replaced by barytes powder and addition of 1% glass fiber

4.3.1 FLEXURAL STRENGTH OF CONCRETE BEAMS WITH SAND REPLACED WITH IRON BLAST FURNACE SLAG, GLASS FIBER: Flexural strength of concrete with 60% replacement of sand by iron blast furnace slag cement replaced by barytes powder and addition of 1% glass fiber are given in table 17.

Table 17. Flexural strength test results

Mix designation on	% Replacement				Flexural strength test N/mm^2
	Fine aggregate	Iron blast furnace Slag	Barytes	Glass fiber	28 days
$CS_{0\%}B_{0\%}G_{0\%}$	100	-	-	-	3.81
$CS_{60\%}B_{0\%}$ $G_{0\%}$	40	60	0	1%	4.50
$CS_{60\%}B_{5\%}$ $G_{1\%}$	40	60	5	1%	4.64
$CS_{60\%}B_{7.5\%}$ $G_{1\%}$	40	60	7.5	1%	4.95
$CS_{60\%}B_{10\%}$ $G_{1\%}$	40	60	10	1%	4.32

For the concrete beams tested at 14 days, 28 days, the split tensile strength is measured and the graphical representation of Flexural strength of concrete is shown in figure 10.

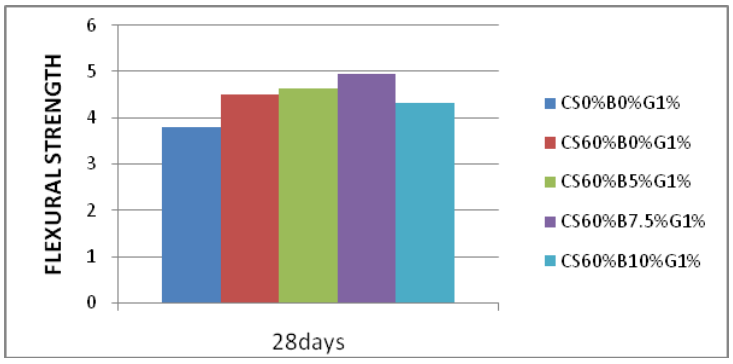

Figure 10 Flexural strength of concrete Beams

ShakshiGuptha et al have studied the mechanical properties of light weight concrete in which cement is replaced by fly ash and glass fiber. They found that the inclusion of glass fiber in the concrete did not improve the compressive and flexural strength of light weight concrete. The compressive strength of concrete with 2% of glass fiber at 28 days was comparable with the control concrete [7].

Komal chawala et al have studied the mechanical properties of glass fiber reinforced concrete composites and found that the 28 days compressive strength of various concrete composite were increases when compared to the compressive strength of control concrete [10].

Results of the present study show that the flexural strength of glass fiber concrete increases with increases in barytes powder upto 7.5%. Highest flexural strength is given by the concrete with 60% replacement of sand by iron blast furnace slag 7.5% cement replaced by barytes and addition of 1% glass fiber. This strength is 29.92% higher than the flexural strength of control of M30 grade concrete and 10% more than the M30 concrete with 1% glass fiber.

5. Conclusion

1. The investigation results that the replacement of sand with iron blast furnace slag improves the compressive strength split tensile strength, flexural strength of M30 grade concrete.

2. It can be concluded from the experimental results that the replacement of cement by barytes powder increases the mechanical properties of M30 grade concrete in which sand is replaced by iron blast furnace slag.

3. The addition of 1% glass fiber in M30 grade concrete with 60% of sand replaced by Iron blast furnace slag and cement replaced by 7.5% of barytes powder increases the mechanical properties of concrete.

4. The experimental results indicate that the M30 grade concrete with 60% replacement of sand by iron blast furnace slag and 7.5% of cement replaced by barytes powder improves the compressive strength upto 14.3% at 28days

5. It can be concluded that the compressive strength of M30 grade concrete with 1%addition of glass fiber and 60% of sand replaced by iron blast furnace slag and cement replaced by 7.5% of barytes powder improves the compressive strength upto 20% at 28days.

6. The addition of 1% glass fiber in M30 grade concrete with 60% of sand replaced by Iron blast furnace slag and cement replaced by 7.5% of barytes powder increases the mechanical properties of concrete.

7 The experimental results indicate that the M30 grade concrete with 60% replacement of sand by iron blast furnace slag and 7.5% of cement replaced by barytes powder improves the split tensile strength upto 35.18% at 28days compared to control concrete.

8. It can be concluded that the split tensile strength of M30 grade concrete with 1%addition of glass fiber and 60% of sand replaced by iron blast furnace slag and cement replaced by 7.5% of barytes powder improves the split tensile strength upto 29.92% at 28days.

9. Highest flexural strength isshown by the concrete with 60% replacement of sand by iron blast furnace slag 7.5% cement replaced by barytes and addition of 1% glass fiber. This strength is 29.92% higher than the flexural strength of control M30 grade of concrete and 10% more than the M30 concrete with 1% glass fiber.

6. Scope for future study

In the present study the mechanical properties of M30 grade concrete with replacement of sand by iron blast furnace slag confirm to zone II of IS 383-1970 and the replacement of cement by barytes powder and addition of 1% glass fiber were investigated.

The investigations may be carried out using iron blast furnace slag as fine aggregate with different fineness moduli. In the present study barytes powder used has fineness of 1.8%. Investigation may be done on mechanical properties of concrete using nano barytes powder.

In the present investigation 1% of glass fiber is used and the mechanical properties of m30 grade concrete were found. In future different percentages of glass fiber can be used

in different grades of concrete with replacement of cement by nano barytes powder and replacement of sand by iron blast furnace slag with different fineness moduli.
In the present investigation the mechanical properties namely the compressive strength, tensile strength and flexural strength at 14 and 28 days were found. Experiments may be done to find the above properties at late age ie., at 90 days, 120 days and 240 days and the elastic modulus of concretes durability of concrete can be studied.

REFERENCES

11.1. Journal Article

[1]Badri chatterjee (2019): Demand for sand in urban india- An article published in Hindusthantimes at 21st November 2019.

[2] Indian minerals year book 2017

[3] Noamitsutsuyukiet. Al. (2000)- Effect of barium salt on fixation of chloride ions in hardened motors – cement and concrete research 30(9), pp 1435-1442.

[4] Khaled saidani et al (2015): Baryte powder as sand substitution in concrete: effect on some mechanical properties- construction and building materials 95(2015)- pp 287-295.

[5] C.Navya Kiran et al (2018): Effect of barytes powder on mechanical and durability properties of M30 grade concrete- Journal of engineering technology and innovative research sep 2018, vol 5, issue 9, pp 493-506.

[6]SakshiGuptha" The Partial Replacement of Cement by fly ash ad Glass fiber in light weight fiber reinforced concrete", International Journal of Engineering Research & Technology, Vol. 6 Issue 07, July – 2017, pp. 24-27.

[7]IS:516-1959- Indian standard- Methods of tests for strength of concrete.

[8] IS:5819-1999- Indian standard- Splitting tensile strength of concrete- method of test.

[9] komalchawle and bhartitekwani "Studies of glass fiber reinforced concrete composite" International Journal of Structural and Civil Engineering Research vol-2, (aug-2013), pp.176-182.