PERFORMANCE EVALUATION OF SUSTAINABLE CONCRETE INCORPORATING GGBS AND WASTE FOUNDRY SAND

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ABSTRACT

Cement and high-quality aggregates are the main substances used in construction. growth within the demand for these materials lead to the skyrocketing price of the construction. due to this, the lower and middle earnings families aren't able to build their own houses. There had been research about the research establishments are searching out alternatives may be used for construction to reduce the construction price. In this affection an attempt has made to know the utilization of waste materials. In this project, GGBS and Waste Foundry Sand were used in concrete for the replacement of cement and fine aggregate individually.

The costliest concrete material is the binder (cement) and if such all-vital expensive material is partly changed with more natural, nearby and inexpensive material like GGBS will not simply contend with waste control but may even reduce the trouble of excessive price of concrete and housing. in this task, GGBS that is taken from the utilization in construction has attracted a lot of interest worldwide due to the large quantity consumptions and wide spread construction sites. Foundry sand is excessive satisfactory silica sand with uniform bodily traits. it is a of ferrous and nonferrous steel industries, in which sand has been used as a molding material. After the more than one usage the foundry sand it is used as land filling material.

This investigational was performed to estimate the strength properties of concrete in which cement and fine aggregates were partially exchanged with Ground Granulated Blast Furnace Slag (GGBS) and Waste Foundry Sand. Compression test, Split Tensile test, Flexural strength test and workability tests were conducted at the age of 28,56 and 90days by additional of river sand with different percentages (0%,10%,20%,30%,40%,50% and 60%) and also with 15% including with GGBS.

Keywords: GGBS, Waste Foundry Sand, Compressive Strength, Split Tensile Strength, Flexural Strength Test**.**

I. INTRODUCTION

Concrete, inside the broadest sense, is any product or mass made by the usage of a cementing medium. usually, this medium is the manufactured from reaction between hydraulic cement and water. For concrete to be good concrete it needs to be excellent in its hardened state and also in its clean state while being transported from the mixer and placed in the formwork. The requirements within the fresh nation are that the consistence of the combination is such that the concrete may be compacted and also that the mix is cohesive sufficient to be transported and placed without segregation.

As some distance because the hardened nation is considered, the usual requirement is a satisfactory compressive strength. Many properties of concrete are related to its compressive strength including density, impermeability, durability, resistance to abrasion, resistance to impact, tensile strength, and resistance to sulphates.

Waste Foundry Sand (WFS)

strong waste management has become one of the international environmental issues, as there is non-stop increase in industrial by way of-products and waste substances. because of loss of land filling area and its ever- increasing value, usage of waste fabric and by way of-products has become an attractive opportunity to disposal. Waste foundry sand (WFS) is certainly one of such industrial by-products.

Ferrous and non-ferrous metal casting industries produce several million tons of byby-product inside the global. In India, about 2 million lots of waste foundry sand is produced yearly. WFS is important by of steel casting industry and efficiently used as a land filling material for many years. however, use of waste foundry sand for land filling is becoming a problem because of fast increase in disposal cost. Foundry sand is high high- quality silica sand with uniform bodily characteristics. it is a ferrous and nonferrous metallic casting industries, in which sand has been used for centuries as a moulding material due to its thermal conductivity. it's miles a from the production of each ferrous and non-ferrous steel castings.

Ground Granulated Blast Furnace Slag (GGBS)

The ground Granulated Blast Furnace Slag is a of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace and molten slag floats above the molten iron at a temperature of approximately 15000C to 16000C as a resultant. The composition of molten slag about 30% to 40% SiO_2 and about 40% CaO, which is nearly same to the chemical composition of Portland cement. The molten slag, is water-quenched unexpectedly, after the molten iron is trapped off which results within the formation of a glassy granulate. The molten slag includes specifically siliceous and aluminous residue. This glassy granulate is dried and floor to the required duration, that is known as ground Granulated Blast Furnace Slag (GGBFS)The production of GGBFS requires greater strength in comparison with the strength needed for the production of Portland cement. through replacing the Portland cement with GGBFS will consequences in discount of carbon dioxide gas emission. it is consequently an environmentally pleasant construction fabric. GGBFS from modern thermal electricity plants generally does not require processing previous to being incorporated into concrete and is consequently considered to be an environmentally free input material. we can replace about 80% of the Portland cement by using the use of GGBFS in concrete.

GGBFS has characteristics of higher water permeability as well as advanced resistance to corrosion and sulphate attack. due to decrease heat hydration, it reduces the risk of thermal cracking. It has better durability, workability, reduces permeability to external organizations, which enables in making, placing and compaction less difficult. As a result, the service life of a structure is more desirable and the protection cost reduced.

II. MATERIALS & METHODOLOGY

The materials used in this experimental have a look at have been cement, fine aggregate, coarse aggregate, water, waste foundry sand, GGBS and super plasticizer.

Cement

Ordinary Portland cement (Ultra tech cement) of 53 grade confirmative to IS: 12269-1987 remained used. It was tested for its physical properties as per IS 4031 (part II)-1988.

S.No.	Property	Test Method	Test Result
1	Specific Gravity	Specific gravity bottle (IS 4031-Part 11)	3.14
2	Normal Consistency	Vicat apparatus (IS 4031-Part 4)	32 %
3	Initial Setting time	Vicat apparatus (IS 4031-Part 5)	40 min
4	Fineness	Sieve test on sieve no.9 (IS 4031-part 11)	7%

Aggregate

The size, shape and gradation of the aggregate play an important role in achieving a proper concrete. The flaky and elongated particles will lead to blocking problems in confined zones. The sizes of aggregates will depend upon the size of rebar spacing.

Fine Aggregate

The locally available river sand was used as fine aggregate in the present investigation. The sand was free from clayey matter, salt and organic impurities. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963. The fine aggregate was conforming to standard specifications.

S.No.	Property	Test Method	Test Results
1	Fineness modulus	Sieve analysis (IS 2386-1963 Part 2)	2.35
2	Specific gravity	Pycnometer (IS 2386-1963 Part 3)	2.53
3	Bulk density (kg/m3) - Loose Bulk density (kg/m3)-Dense	(IS 2386-1963 Part 3)	1520 1663

Coarse Aggregate

Machine crushed angular granite metal of 20mm nominal size from the local source was used as coarse aggregate. It was free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with IS 2386 - 1963.

Waste Foundry Sand

Waste foundry sand was obtained locally from Agarwal Rolling Mills, Shamshabad, and Hyderabad. WFS was used as a partial replacement of fine aggregate (natural river sand). Metal poured in the foundry is grey iron. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963.

S.No	Property	Test Method	Test Results
1	Fineness modulus	Sieve analysis (IS 2386-1963 Part 2)	1.66
2	Specific gravity	Pycnometer (IS 2386-1963 Part 3)	2.35
3	Bulk density (kg/m3) Bulk density (kg/m3)	(IS 2386-1963 Part 3)	1230 1350

Water

Locally available water used for mixing and curing which is potable and is free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

Ground Granulated Blast Furnace Slag

The Ground Granulated Blast Furnace Slag is a by-product of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace and molten slag floats above the molten iron at a temperature of about 15000C to 16000C as a resultant.

Super Plasticizer

Super plasticizer by trade name Conplast SP 430 manufactured by Fosroc Chemicals (India) limited obtained from S.V Enterprices, Habsiguda, Hyderabad was used as a water reducing agent to achieve the required workability. The dosage of super plasticizer was kept constant throughout the experimental program at 0.5% of the weight of the binder.

Workability

Each batch of concrete was tested for consistency immediately after mixing, by one of the methods described in IS: 1199-1959. Provided that care was taken to ensure that no water or other material was lost, the concrete used for the consistency tests was remixed with the remainder of batch before making the test specimens. The period of re-mixing was as short as possible yet sufficient to produce a homogeneous mass.

Compaction

The compaction was done on plane table vibrator and also by using the standard tamping bar for mortar cubes was used and the strokes of the bar were distributed in a uniform manner over the cross-section of the mould.

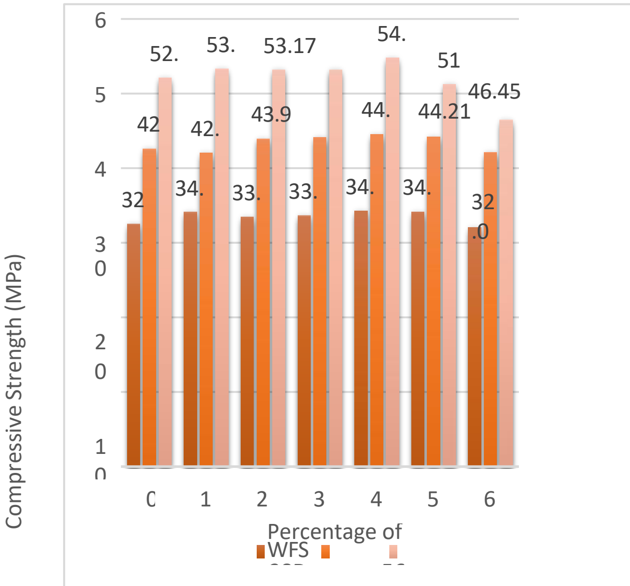
III. RESULTS AND DISCUSSION

Compressive Strength Test

Cube specimens were tested for compression and ultimate compressive strength was determined from failure load measured using compression testing machine. The average value of compressive strength of 3 specimens for each category at the age of 28 days,56 days ,90 days.

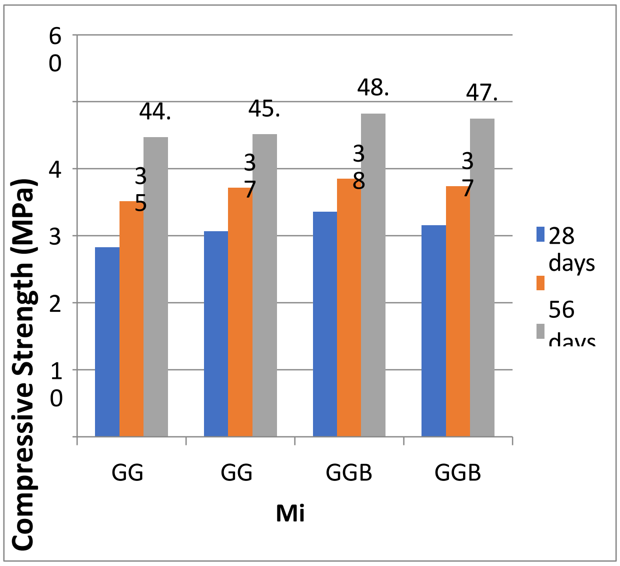
Compressive Strength of Various Concrete Mixes with Replacement of Fine Aggregate over Waste Foundry Sand at Different Ages

S.	Mix	Compressive		
		28 days	56 days	90 days
1	WF	32.5	42.6	52.08
2	WF	34.	42	53.
3	WF	33.	43	53.
4	WF	33.	44.	53.
5	WF	34.	44.	54.
6	WF	34.	44.	51.
7	WF	32.	42.	46.



Compressive Strength of Various Concrete Mixes with Different Percentage of GGBS at Different Ages

S.No.	Mix ID	Compressive Strength (MPa)		
		28 days	56 days	90 days
1	GGBS0	28.26	35.12	44.68
2	GGBS5	30.61	37.13	45.12
3	GGBS10	33.57	38.45	48.25
4	GGBS 15	31.52	37.34	47.49



Compressive Strength Test of Concrete Mixes with GGBS and Various Percentage of Waste Foundry Sand at Different Ages

Compressive strength of concrete at the age of 56 days and 90 days of curing with 10% GGBS and various percentage replacement of fine aggregate with waste foundry sand were tested.

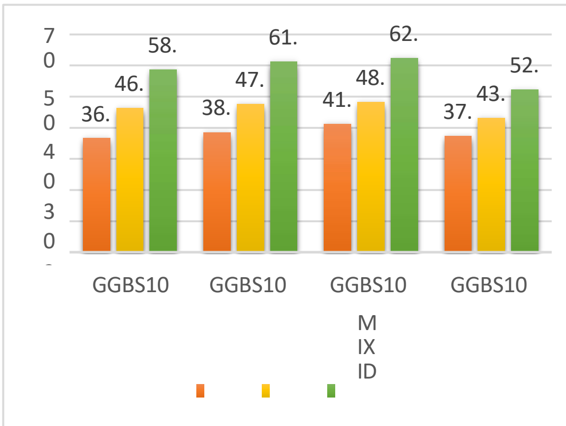
Compressive Strength of Concrete Mixes with GGBS and Various Percentage of Waste Foundry Sand at Different Ages

Split Tensile Strength Test

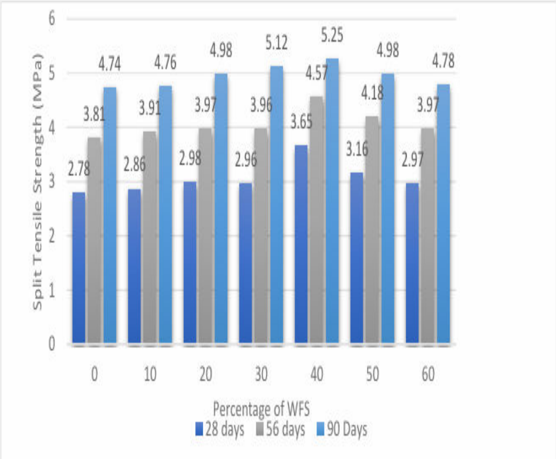
The graphical representation of variation of split tensile strength of plain concrete at 56 and 90 days.

Split Tensile Strength of Various Concrete Mixes with Replacement of Fine Aggregate over Waste Foundry Sand at Different Ages

S.	Mix	Compressive		
		28 days	56 days	90 days
1	GGBS10	36.61	46.31	58.65
2	GGBS10	38.	47.	61.
3	GGBS10	41.	48.	62.
4	GGBS10	37.	43.	

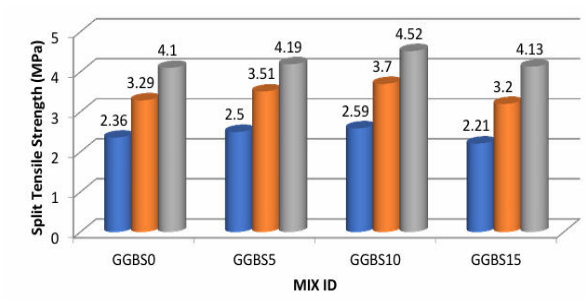


S.No.	Mix ID	Split Tensile Strength (MPa)		
		28 days	56 days	90 days
1	WFS0	2.78	3.81	4.74
2	WFS10	2.86	3.91	4.76
3	WFS20	2.98	3.97	4.98
4	WFS30	2.96	3.96	5.12
5	WFS40	3.65	4.57	5.25
6	WFS50	3.16	4.18	4.98
7	WFS60	2.97	3.97	4.78



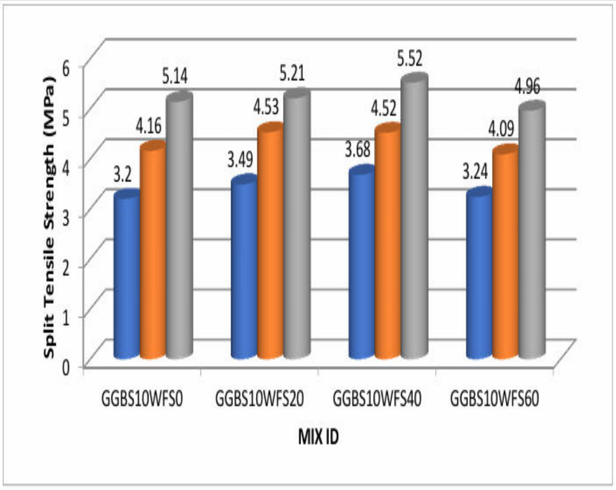
Split Tensile Strength of Various Concrete Mixes with GGBS and Different Percentages of Waste Foundry Sand

S.No.	Mix ID	Split Tensile Strength (MPa)		
		(28 days)	(56 days)	(90 days)
1	GGBS0	2.36	3.29	4.10
2	GGBS5	2.50	3.51	4.19
3	GGBS10	2.59	3.70	4.52
4	GGBS15	2.21	3.20	4.13



Split Tensile Strength of Various Concrete Mixes with GGBS and Different Percentages of Waste Foundry Sand

S.No.	Mix ID	Split Tensile Strength (MPa)		
		(28 days)	(56 days)	(90 days)
1	GGBS10WFS0	3.20	4.16	5.14
2	GGBS10WFS20	3.49	4.53	5.21
3	GGBS10WFS40	3.68	4.52	5.52
4	GGBS10WFS60	3.24	4.09	4.96

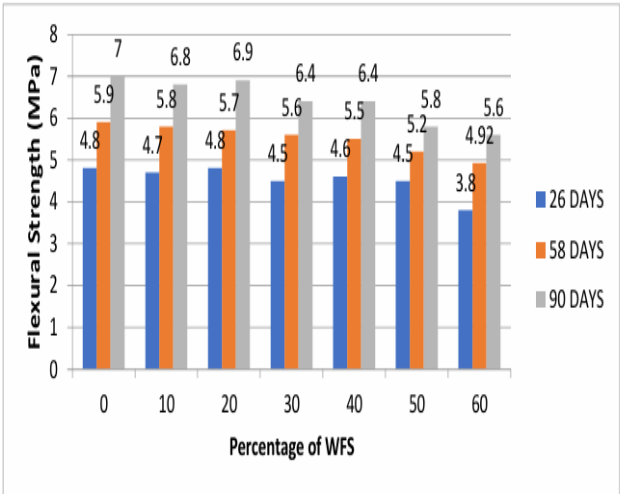


Flexural Strength Test

Beam specimens were tested for flexural strength. The tests were carried out confirming to IS 516-1959 the specimens were tested under two-point loading. The average value of 2 specimens for each category at the age of 90 days.

Flexural Strength of Various Concrete Mixes with Replacement of Fine Aggregate over Waste Foundry Sand

S. No.	Mix ID	Flexural Strength (MPa)		
		28 days	56 days	90 days
1	WFS0	4.8	5.9	7.0
2	WFS10	4.7	5.8	6.8
3	WFS20	4.8	5.7	6.9
4	WFS30	4.5	5.6	6.4
5	WFS40	4.6	5.5	6.3
6	WFS50	4.5	5.2	5.8
7	WFS60	3.8	4.92	5.6

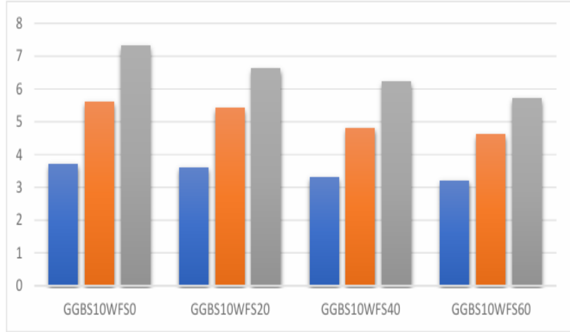


Flexural Strength Test

Flexural strength of concrete at 90 days of curing with 10% GGBS and various percentage replacement of fine aggregate with waste foundry sand were tested.

Flexural Strength of Various Concrete Mixes with GGBS and Different Percentage of Waste Foundry Sand

S.No.	Mix ID	Flexural Strength (MPa)		
		(28 days)	(56 days)	(90 days)
1	GGBS10WFS0	3.7	5.6	7.3
2	GGBS10WFS20	3.6	5.4	6.6
3	GGBS10WFS40	3.3	4.8	6.2
4	GGBS10WFS60	3.2	4.6	5.7



IV. CONCLUSION

- When percentage of waste foundry sand was increased beyond 40% the mix started losing its workability.
- When cement replaced with rice husk ash for mortar cubes strength increased up to 10 % replacement and then decreased. So, 10 % replacement is optimum here.
- Replacement of fine aggregate with waste foundry sand showed increase in the compressive strength of plain concrete of grade M40 up to 40% and then there was a considerable decrease in the strength. Maximum strength was achieved at 40%.
- For Plain Concrete mix at 60% replacement of fine aggregate strength of 46.43 MPa was achieved at 90 days which is less than the target strength.
- Flexural strength of concrete decreased with the inclusion and increase in the percentage of waste foundry sand for plain concrete.

- 10% replacement of cement with GGBS was found to be optimum for M40 grade of concrete.
- GGBS which is taken from bricks making kiln can be opted for replacement of cement for a considerable percentage (10 %) only.

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