Experimental Study on Strength Comparison of Concrete And Paver Blocks with Partial Replacement of Cement By GGBS

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Abstract- *Concrete is essential part of construction industry. Concrete is mixture of cement, aggregate, sand and water. Use of concrete increasing day by day in huge amount. Cement is main ingredient of concrete. Production of cement releases huge amount of greenhouse gases in environment which is very harmful for nature. Cement industry accounts for 5% of global co2 emission. 100 kg of co2 is approximately to be emitted in atmosphere during production of 100kg of cement. At present there is no any alternative for total replacement of cement so we have only one option of partial replacement of cement. The aim of this research to find out optimum use of GGBS which is by-product of steel industry as an eco-friendly and economical replacement. Cement has been replaced by GGBS to prepare concrete blocks, cylinder and prism in range of range 0%, 10%, 20%, 30%, 40%, 50% by weight of cement for M20, M30, M35, and M40. Paver blocks are also casted of M35 grade concrete.*

Keywords- GGBS, compressive strength, split tensile strength, flexural strength, and paver blocks.

I. INTRODUCTION

The most extensively used material in construction industry is concrete. Every year approximately six Billion tone of concrete being produced. This huge amount of concrete utilization affects environment In terms of damage due to extraction of raw material & emission of CO2 during cement manufacture. Due to above problem it is necessary to do research for partial replacement of cement by another material which may be naturally occurring, industrial waste or by-product. GGBS is by-product of steel industry. GGBS is obtained by quenching molten iron slag from blast furnace in water or steam to produce a glass, granular product that is then dried & ground into a fine powder. less additional energy required To produce GGBS compared to energy required to produce ordinary Portland cement. The replacement of cement by GGBS will help to reduction in Co2 gas emission therefore GGBS is environment friendly. SONA STEEL ALLOYS, a steel manufacturing company is situated near phaltan. This company produces huge amount of GGBS daily. To avoid the toxic waste and reprocess the waste material, this present study is carried out by partial replacement of cement by locally available GGBS. GGBS is used to prepare blocks, cylinder, prism and paver blocks then Tests are carried out on specimens

II. REVIEW OF LITERATURE

Partial Replacement of Cement with GGBS in Concrete has been studied by many researchers.

J.Vengadesh Marshall Raman1 and V.Murali Krishnan used GGBS for Self Compacting Concrete for Sustainable Construction. They replaced cement by GGBS accordingly in the range of 0%, 25%, 30%, 35%, and 40% by weight of cement for M-30mix. After iterative trial mixes the water/cement ratio (w/c) was selected as 0.40. Self-compacting Concrete mixtures produced, tested and compared in terms of compressive, split tensile strength and flexural strength with the conventional concrete for 28 days. Results shows that, 25% of GGBS can be replaced to get better strength.

P Lakshmaiah Chowdary, S Khaja Khutubuddin, B Vinayaka, D Saikiran, Y Induja, and Y Narasappa They representd the results of an experimental investigations carried out to find the suitability of GGBS in production of concrete. They have done experimental study on the effect of GGBS on strength. Concrete M20 was made using 43 Grade PPC and the other mixes were prepared by replacing part of PPC with GGBS. Cement were replaced by GGBS with 10%, 20%, 30%, and 40%by weight of cement. Test results indicate that use of replacement cement by GGBS in concrete has improved performance of concrete up to 10% to 30%.

Santosh Kumar Karri, G.V.Rama Rao, P.Markandeya Raju

In this research, M20 and M40 grade concrete specimens manufactured and tested by reserchers with partial replacement of cement with ground granulated blast furnace slag (GGBS) by 30%, 40% and 50%. The cubes, cylinders and prisms are tested for compressive strength, split tensile strength, flexural strength. Durability studies with sulphuric acid and hydrochloric acid were also conducted.

Sagar R. Raut P. P. Saklecha P. L. Nagtode In this work they studied the effects of GGBS on the compressive strength of the cements concrete by replacing cement with GGBS by 10%, 15%, 20%, and 40%. This project work also includes the benefits of using GGBS and its effects on the cement and concrete properties and its durability, and its sustainability.

Loknath Panigrahi and Sridhar P both researcher replaced cement with GGBS in range of 0% 10% 20% 30% 40% and 50% for preparing M35 concrete after casting and curing, concrete tested for of compressive ,split tensile strength and flexural strength.. It is found that, 20% of GGBS can be replaced.

This present study is carried out by partial replacement of cement by locally available GGBS. GGBS is used to prepare blocks, cylinder, prism and paver blocks then Tests are carried out on specimens.

III. METHODOLOGY

Following methodology used for our research work.

1. Collecting and study research papers, articles to get rough idea regarding proposed research work
2. Find properties of cement, aggregates, water, GGBS and sand
3. Obtain mix design proportion for M20, M30, M35 and M40 according to IS 10262:2009.
4. Prepare concrete specimen of M20, M30, M35 and M40 grade concrete and M35 for paver block for testing in lab with 0%, 10%, 20%, 30%, 40% and 50% replacement of cement by GGBS.
5. Cure the concrete specimen and paver block for 28 days.
6. Testing specimen for compressive, flexural and tensile strength and paver for compressive strength.
7. Compare the results with normal concrete and normal paver.
8. Based on comparison find the optimum % of GGBS to replace cement partially.

1V. MATERIAL USED

In this experimental study following material is used –

1. Locally available ordinary Portland cement of 53 grade of Ambuja cement brand
2. Ground granulated blast furnace slag (GGBS) From nearest SONA STEEL ALLOYS CO. LTD which is steel manufacturing company.
3. Naturally available river sand
4. Course aggregate taken from nearest stone crusher
5. crushed sand as an fine aggregate from nearest stone crusher for making paver
6. water

Properties of ingredients –

Natural sand –

1. Bulk density - 1.77 kg/lit
2. Specific gravity - 2.74
3. Fineness modulus – 3.74
4. Silt content – 5%
5. Bulkage – 15%

Coarse aggregate –

1. Bulk density - 1.39 kg/lit
2. Specific gravity – 2.70

Crushed sand –

1. Bulk density – 1.6 kg/lit
2. Specific gravity -2.70

Ground granulated blast furnace slag (GGBS) –

In this current research GGBS is used brought from nearest steel manufacturing company named SONA STEEL ALLOYS. Below physical and chemical properties are given by them

Physical properties-
Colour- off-white
Specific gravity- 2.9
Bulk density- 1200kg/m3
Fineness - >350m2/kg
Chemical composition-
Calcium oxide - 40%
Silica - 35%
Alumina -13%
Magnesia – 8%

Mix Design –

The mix design was carried out based on draft code IS: 10262

For M20 concrete – Mix Design for 1 cubic meter

Cement	sand	CA I (10MM)	CA II (20MM)	WATER	W/C RATIO
325	744	441	819	162	0.55

for M30 concrete – Mix Design for 1 cubic meter

Cement	sand	CA I (10MM)	CA II (20MM)	WATER	W/C RATIO
396	720	426	792	162	0.45

For M35 concrete – Mix Design for 1 cubic meter

Cement	sand	CA I (10MM)	CA II (20MM)	WATER	W/C RATIO
419	712	422	783	162	0.45

For M40 concrete – Mix Design for 1 cubic meter

Cement	sand	CA I (10MM)	CA II (20MM)	WATER	W/C RATIO
445	703	416	773	162	0.4

For M35 concrete (for paver) – Mix Design for 1 cubic meter

Cement	Crushed sand	CA I (10MM)	CA II (20MM)	WATER	W/C RATIO
439	718	417	775	162	0.45

V. CASTING AND CURING

The concrete specimens of standard cubes, standard cylinders and standard prisms was casted for M20, M30, M35, M40 concrete. In all specimens cement was replaced with GGBS by 0%, 10% , 20% ,30% ,40% ,50% .paver blocks are also casted of M35 grade concrete for checking its compressive strength with partial replacement of cement by GGBS BY 0%, 10%, 20% ,30% ,40% ,50%. After 24 hours of casting the test specimens, cubes, cylinders and prisms are de-moulded and immediately immersed in clean and fresh water tank and allow it for curing for 28 days.

VI. RESULTS AND DISCUSSION

Compressive strength of concrete-

Compressive strength of concrete is nothing but the maximum compressive stress that given solid material can sustain without fracture when load is applied gradually. Compressive strength is obtained by dividing the maximum load given by the cross-sectional area of concrete cube in a compression test

Split tensile strength -

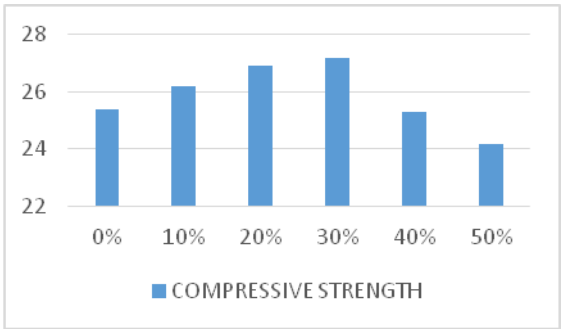
The tensile strength of concrete is very important basic property of concrete. tensile strength test on concrete cylinder is carried out to determine the tensile strength of concrete. due to its brittle nature concrete is very weak in tension and unable to resist the direct tension. when subjected to tensile forces concrete develops cracks.

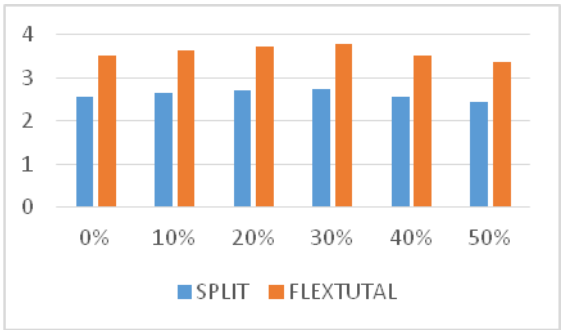
Flexural tensile strength –

Flexural strength is a measures of an unreinforced concrete beam or slab to resist failure in bending.The flexural strength is expressed as " Modulus of Rupture" (MR) in MPa. Flexural Strength is about 12 to 20% of compressive strength.
Test Results after 28 days of curing –

1. For M 20 concrete-

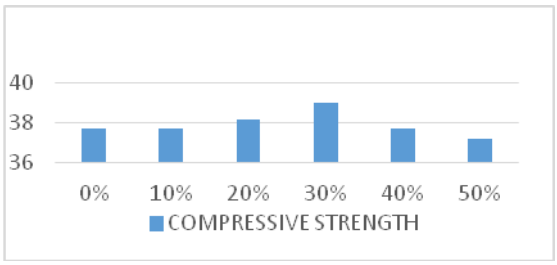
% Of GGBS	0%	10 %	20%	30%	40 %	50%
Compressive strength	25.38	26.22	26.90	27.20	25.28	24.18
Split tensile strength	2.56	2.65	2.72	2.75	2.55	2.44
flexural strength	3.52	3.64	3.73	3.78	3.51	3.36

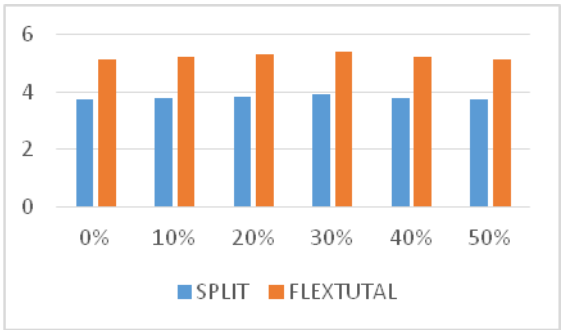




2. For M 30 concrete-

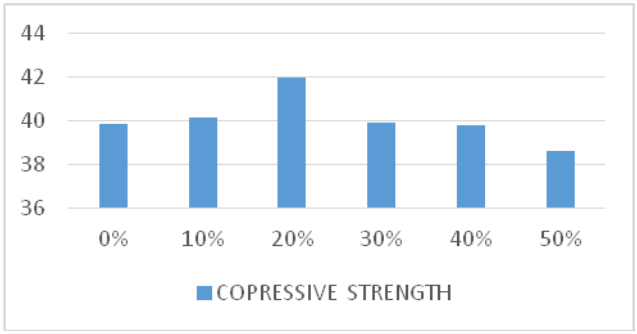
% Of GGBS	0%	10%	20%	30%	40%	50 %
Compressive strength	37.07	37.68	38.13	38.98	37.70	37.02
Split tensile strength	3.75	3.81	3.85	3.94	3.81	3.74
flexural strength	5.15	5.23	5.30	5.41	5.24	5.14

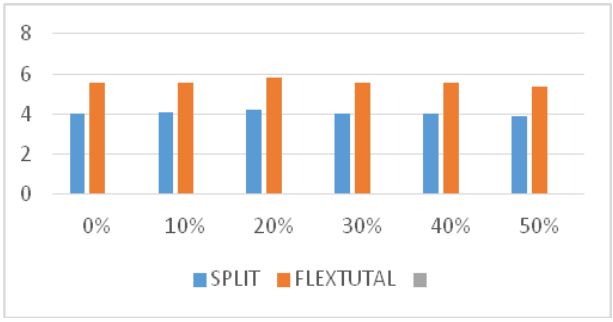




3. For M 35 concrete-

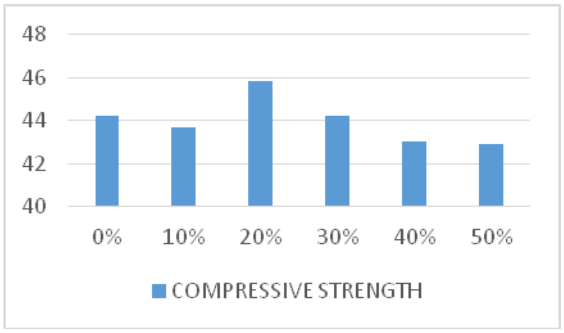
% Of GGBS	0%	10%	20%	30%	40%	50%
Compressive strength	39.87	40.18	41.97	39.93	39.81	38.61
Split tensile strength	4.03	4.06	4.24	4.04	4.02	3.90
flexural strength	5.54	5.58	5.83	5.55	5.53	5.36

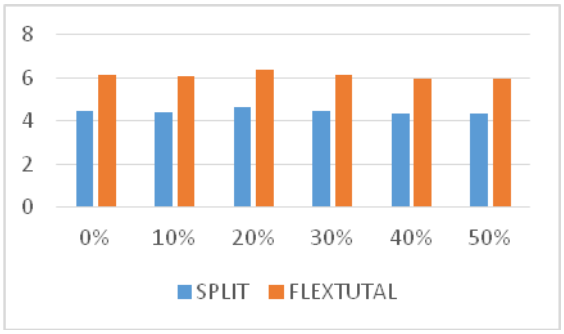




4. For M 40 concrete-

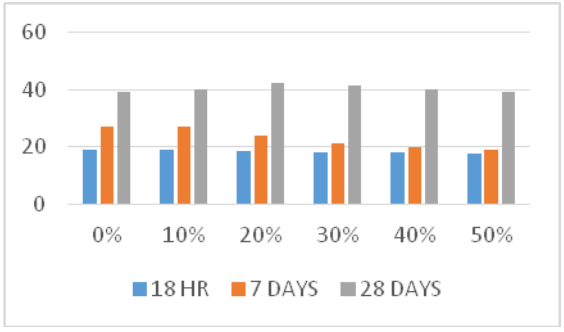
% Of GGBS	0%	10%	20%	30%	40%	50%
Compressive strength	44.21	43.67	45.81	44.24	43.03	42.90
Split tensile strength	4.47	4.41	4.63	4.47	4.35	4.33
flexural strength	6.14	6.07	6.36	6.14	5.98	5.96





5. Compressive strength of paver –

% of GGBS	0%	10%	20%	30%	40%	50%
18 hr	18.96	18.94	18.60	18.10	17.95	17.80
7 days	27.10	26.93	24.21	21.48	20.17	18.90
28 days	39.49	40.12	42.28	41.63	40.12	39.10



VII. CONCLUSION

When the GGBS is used for replacement of cement with varying percentage from 0% to 50% the following results can be drawn:

1. for M20 and M30 concrete, strengths at the end of 28 days decreases when the percentage of GGBS is increased beyond 30%.
2. For M35 and M40 concrete, strengths at the end of 28 days decreases when the percentage of GGBS is increased beyond 20%.
3. The presence of GGBS as cementation material did not affect the minimum early strength requirement that is 18MPA in 18 hrs. Of paver's up to 30% replacement of cement.
4. Compressive strength of paver is maximum at 20% replacement of cement by GGBS.
5. We can use GGBS effectively up to 30% replacement in M20 and M30 concrete, 20% in case of M35, M40 and for manufacturing paver blocks.

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