EXPERIMENTAL STUDY ON JUTE YARN REINFORCED CONCRETE WITH GROUND GRANULATED BLAST FURNACE SLAG AND SILICA SAND

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Abstract - *This paper highlights about the behavior of concrete when Ground Granulated Blast furnace Slag (GGBS), Silica Sand(SS) and Jute Yarn (JY) are added in concrete on the various strength properties of concrete by using the mix design of M30 grade. In the present work, GGBS and SS replacement for cement is 10%, 20%, 30%, 40% and 50% ; jute yarn is added 0.1% total volume of cube/cylinder. The compressive and split tensile strength is determined by casting cubes and cylinders. The tests are carried out after 7, 14 and 28 days. The results were compared to the conventional concrete specimen. GGBS and SS improved strength and durability properties and environmental benefits related to the disposal of waste material and to reduce carbon dioxide emission. The main objective of this work is to study the suitability of the GGBS as a pozzolanic material for cement & SS as a fine aggregate replacement in concrete.*

Key Words: Ground Granulated Blast furnace Slag, Silica Sand, Jute Yarn, etc…

1. INTRODUCTION

Concrete is always valuable product in construction industry. It is most widely used construction material for various types of structure due to its structural stability and strength. Concrete is basically made up of cementations material which have a property to bind them together, as well as with other material to form a solid mass. Now a day there is scarcity of concrete materials, so we are in need to find out the alternative materials to concrete. In this situation we should utilize the larger amount of waste products which is available. For example Ground Granulated Blast furnace Slag, Silica Sand, etc. Thus the possible use of these wastes will considerably reduce the cost of construction and as well as reduce or eliminate the environmental hazards caused by such wastes. Ground Granulated Blast furnaces Slag, Silica Sand with Jute Yarn are used as a partial replacement material to the cement concrete mix.

In this present study Granulated Blast furnace Slag is used as a cementations material and silica sand is used as aggregate and it is partially replaced in varying percentages to the cement and fine aggregate. The objective of this investigation is to evaluate the optimal level of Ground Granulated Blast furnaces Slag, Silica Sand with Jute Yarn replacement and strength properties of concrete.

1.1 AIM AND OBJECTIVE

The Aim of this paper is "To study on jute yarn reinforced concrete with Ground Granulated Blast furnaces Slag and Silica Sand

The objectives of this investigation are:

- To evaluate GGBS & SS as supplementary cementations material and fine aggregate.
- To make a comparative study of strength properties with partially replaced GGBS and silica sand, to cement and fine aggregate with varying proportions of 10% , 20%, 30%, 40% and 50%. Along with this jute yarn by total volume of cube/cylinder/beam.
- To study and identify the optimal level of Ground Granulated Blast furnace Slag and silica sand in concrete.
- To study the strength property of concrete blocks tested at the age of 7, 14 and 28 days.

2. MATERILS and METHDOLOGY

2.1GROUND GRANULATED BLAST FURNACE SLAG

GGBS which has high pozzolonic property and it is the by-product which is obtained during the manufacturing process of pig iron. It can increase the abilities to prevent water and chloride penetration. GGBS in the cementations material it gains the strength over a long period. Results in lower heat of hydration and lower temperature rises and makes avoiding cold joints easier, but may also affect construction schedules where quick setting is required. Use of GGBS significantly reduces the risk of damages caused by alkali-silica reaction (ARS), provide higher resistance to chloride ingress, reducing the risk of reinforcement corrosion and provides higher resistance to attacks by sulphate and other chemicals.

Table -1: CHEMICAL COMPOSTION OF GGBS

Composition	Percentage (%)
Calcium oxide (CaO)	30-45
Silicon dioxide (SiO_2)	17-38
Aluminum oxide (Al_2O_3)	15-25
Ferric oxide (Fe_2O_3)	0.5-2

Magnesium oxide (MgO)	4-17
Manganese oxide (MnO)	1-5
Glass	85-98

Fig -1: Ground Granulated Blast Furnace Slag

2. 2 SILICA SAND

Silica sand contains high purity silica with closely controlled sizing. Silica sand is preferred for construction materials due to its higher surface hardness and density. It will be widely used in metal casting industry mainly in glass making industry. Commonly different sizes of silica sand will be available, but we use 1.18mm passing and retained on 450 micron passing silica sand. It is very durable mineral resistant to heat and chemical attack so we can use in concrete. It contains 99% of silica and very less amount of impurities and silt content. Their micro-filling effects reduce the pores in concrete.

Table -1: CHEMICAL COMPOSTION OF SILICA SAND

Constituents	Values (%)
Silicon dioxide(SiO_2)	28.93
Calcium oxide (CaO)	37.33
Aluminum oxide (Al_2O_3)	2.00
Ferric oxide (Fe_2O_3)	0.76
Magnesium oxide (MgO)	0.53

Fig -2: SILICA SAND

2.3 JUTE YARN

The locally available jute fiber will be rolled up into thin wires. These thin wires will be called as jute yarn, these yarn can be used without any treatment in concrete. The jute yarn can ensure the post cracking resistance, high energy absorption features and increased fatigue resistance of cement based concrete. The high performances of jute yarn reinforced cement based composites are used to achieve the required strength however it may helpful in any partial replacement of concrete. The main advantage of jute yarn is to moderate moisture. The diameter of the jute yarn will be 0.2mm and length will be 15mm which is constant with percentage of 0.1% of total volume of cubes/cylinders.

Table -1: CHEMICAL COMPOSTION OF JUTE YARN

Constituents	Values (%)
Cellulose	65.2
Hemi- cellulose	22.2
lignin	10.8
Water soluble matter	1.5
Fat and wax	0.3-1.0

Fig -3: JUTE YARN

2.2 METHDOLOGY

- Conventional concrete specimens is prepared from a mixture of cement, fine aggregate, coarse aggregate and water.
- Cement is replaced by example Ground Granulated Blast furnace Slag and fine aggregate is replace by Silica Sand for 10%, 20%, 30%, 40% and 50% ; jute yarn is added to 0.1% by its total volume of Cubes/cylinders.
- These specimens are compared with the conventional specimens.
- The compressive strength and split tensile strength tests are carried out.

3.0 MIX DESGIN

Concrete mix design of M_{30} grade in this experiment was designed as per the guidelines specified in IS 10262-2009.

Design stipulations

1. Characteristic compressive strength = 30 N/mm^2 (Required in the field at 28 days)
2. Maximum size of aggregate = 20 mm

3. workability = 50 - 75mm(slump)

4. Degree of quality control = Good

5. Type of exposure = Normal

Test Data for Materials

1. Specific gravity of cement = 3.15
2. Specific gravity of coarse aggregate = 2.7
3. Specific gravity of fine aggregate = 2.62
4. Water absorption : coarse aggregate = 0.5%
5. Water absorption : fine aggregate = 1%
6. Sieve analysis of fine aggregate = Conforming to grading Zone-1 of Table-4 IS 383-1970
7. Sieve analysis of Coarse aggregate = Conforming to Table-2 IS 383-1970.

Table -1: Mix proportioning

Water	Cement	Fine aggregate	Coarse aggregate
191.52ml	456kg	685.4kg	1086.4kg
0.42	1	1.5	2.38

4. Casting, Curing and Testing of specimens

4.1 Casting of the specimens

Cement, Granulated Blast furnace Slag, Silica Sand, Jute Yarn, coarse aggregate and Fine aggregate were taken mix proportion 1:1.5:2.38 which correspond to M_{30} grade of concrete .Cement is replaced with Granulated Blast furnace Slag and fine aggregate is replaced with Silica Sand 10%,20%,30%,40% , 50%, jute yarn is added to 0.1%by its total volume of cubes/cylinders. Water is added in the ratio 0.42 .wet mixes concrete are mixed homogeneously. The wet concrete is poured into moulds and cylinders is compacted through hand compaction in 3 layers and kept into vibrator compaction. After the compaction top surface of smooth finish .After 24hrs specimens will be de moulded.

4.2 Curing of the specimens

The de mould specimen placed in to curing tank .water is important ingredients of concrete as it actively participates in the chemical reaction with cement, particularly hydration process .Some of the specification also accept for making concrete if the PH value water lies between 6-8 and is free from organic matter. In the present investigation potable water is used. We are allowing to curing for 7, 14 days and 28 days.

4.2 Testing of the specimens

The test specimens for compressive strength test were made of cube having size 150X150X150mm cast iron mould. For each mix proportion 3cubes were casted and tested for 7 days 14days and 28 days. The test specimens for split tensile strength test were made of cylinders having size 150 mm diameters, 300mm high cast iron cylinder. For each mix proportion 3cubes were casted and tested for 7 days, 14daysand 28 days

4.2.1 Compressive strength Test

The cube mould of size 150X150X150mm as per IS 516-1959,The specimens of conventional cement concrete block and Granulated Blast furnace Slag and Silica Sand with jute yarn block with varying proportions of 10%, 20%, 30%, 40%,&50% as partial replacement. Along with this jute yarn is added to 0.1% total volume of cubes. The compressive strength of concrete is calculated by using equation.

$$F=P/A$$

F= Compressive stress in N/mm^2

P= Maximum load in N

A= Cross section Area cube specimen mm^2

Fig -4: Compressive strength test set-up

Table -5: Compressive strength comparison of GGBS, SS and JY Added concrete.

Percentage replacement of GGBS+SILICA SAND	Avg. compressive strength at 7 days in N/mm^2	Avg. compressive strength at 14 days in N/mm^2	Avg. compressive strength at 28 days in N/mm^2
10%	25.2	31.2	37.1
20%	26.7	32.4	38.02
30%	27	33.2	39.2
40%	28.21	34.1	41.3
50%	24.2	29.2	35.2

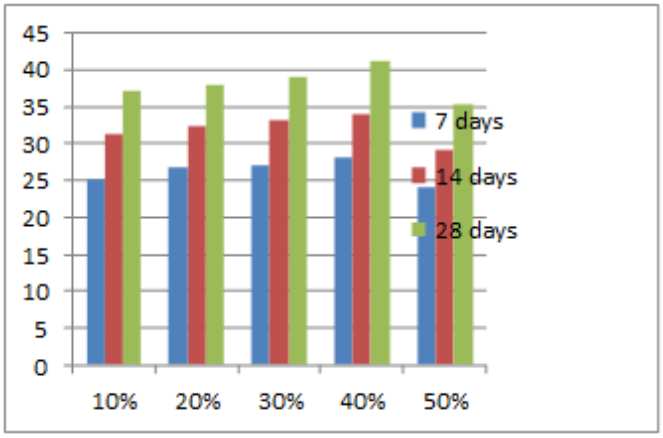

Fig -5: Compressive strength comparison of GGBS, SS and JY Added concrete

4.2.2 Split tensile strength Test

The tensile strength is one of the basic and an important property of the concrete .The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. The test specimens for split tensile strength test were made of cylinders having size 150 mm diameters, 300 mm high cast iron cylinder. The specimens of conventional cement concrete block and Granulated Blast furnace Slag and Silica Sand with varying proportions of 10%, 20%, 30%, 40%,&50% as partial replacement, along with this jute yarn is added to 0.1% total volume of cylinder. The split tensile strength of concrete is calculated by using equation.

$$F=2P/(\Pi \times D \times L)$$

F= Split tensile stress in N/mm^2

P= Maximum load in N

D= Dia of cylindrical specimen in mm

L= Length of cylindrical specimen in mm

Fig -6: split tensile strength test set-up

Table -6: split tensile strength comparison of GGBS, SS and JY Added concrete.

Percentage replacement of GGBS+SILICA SAND	Avg. Split tensile strength at 7 days in N/mm^2	Avg. Split tensile strength at 14 days in N/mm^2	Avg. Split tensile strength at 28 days in N/mm^2
10%	2.9	3.30	3.8
20%	3.02	3.58	3.96
30%	3.31	3.49	3.61
40%	3.39	4.14	4.52
50%	2.49	2.93	3.30

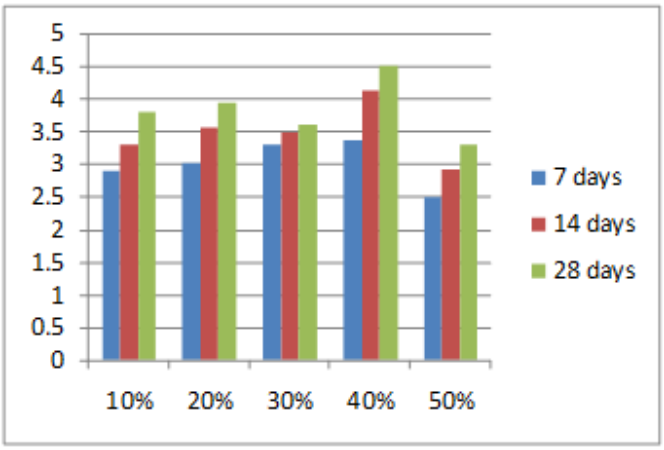

Fig -6: Split tensile strength comparison of GGBS, SS and JY Added concrete.

5. CONCLUSION

- Compressive strength of concrete cubes give optimum result with 40% Replacement of cement by GGBS and fine aggregate by Silica Sand at 7, 14 and 28 days.
- Split tensile strength of concrete cylinder give optimum result with 40% Replacement of cement by GGBS and fine aggregate by Silica Sand at 7, 14 and 28 days.
- Compare to conventional concrete block ,jute yarn incorporated block give higher compressive and tensile strength.
- The strength achieved more in the use of GGBS and Silica Sand in concrete.
- There is reduction in cost of construction when using GGBS and SS, along with jute yarn.

FUTURE SCOPE OF WORK

- The same experimental work can be carried out on other higher grades of concrete.
- Shear and torsional strengths can be computes.
- Behaviour of strengths for different aspect ratio can be studied.
- We can replace silica sand partially up to 80% ,but slump value will be decreased.

REFERENCES

1) IS CODE 10262:2009 For concrete mix proportion page number 4-7.

2) IS383:1970 for conforming zone-1 table 4.

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CODE BOOK

- IS CODE 10262:2009 For Concrete Mix Proportioning Page No 4-7.
- IS 383:1970 For Conforming zone-1 table 4.