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REINFORCEMENT OF CONCRETE WITH COCONUT FIBRE AND PARTIAL REPLACEMENT OF CEMENT WITH GGBS

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Abstract – *Concrete is one of the basic ingredients in the construction field which has a wide range of importance. But it requires large amount of natural resources which is drawback of using concrete for construction. Due to the usage of natural resources, it creates environmental imbalance. Ground Granulated Blast Slag and Coconut fibre are the industrial waste and natural resources used in the mix design. In this experimental work the effects of replacing cement partially by Ground Granulated Blast Slag and coconut fibre as reinforcement is studied. In this present study a concrete mix design is made for M30 and is taken as normal concrete. The cement is replaced by Ground Granulated Blast Slag and Coconut fibre accordingly in the range of 0% (without Ground Granulated Blast Slag), 5%, 10%, 15%, 20% by weight of cement and coconut fibre is added to the concrete mix accordingly in the range of 0% (without fibre), 1.0%, 1.5%, 2%, 2.5% by weight. Concrete test results like compressive strength at the age of 7 days, 14 days and 28 days was obtained. The test results indicate that GGBS and coconut fibre improves strength of concrete.*

Key Words: **Ground Granulated Blast Slag (GGBS), Coconut Fibres, Compressive Strength, Ordinary Portland Cement (OPC), Conventional Concrete and Fibre Reinforced Concrete.**

1. INTRODUCTION

Concrete is the most popular construction material across the world because of its high structural strength and stability. One of the major challengesof our present society is the protection of environment. Some of the important elements in this respect are reduction of the consumption of energy and raw materials. The use of different waste materials is showing prospective application in the construction industry as an alternative to conventional materials.

Ground granulated blast furnace slag is a waste product from iron and steel manufacturing industries, which may be used as partial replacement of cement in concrete due to its inherent cementing properties. Substantial energy & energy savings can result when industrial by products are used as partial replacements for energy-intensive Portland cement. This will not only reduce the emission of greenhouse gases but also will be the substantial way of management of waste.

Coconut fibre is available in abundance, which makes it quite viable as a reinforcement material in concrete. Further, it acts as a new source of income for the coconut producer who gets the benefits of the new demand generated by the construction industry. In addition to this, it is an effective method for the disposal of coir mattress waste which will reduce the demand for additional waste disposal infrastructure and decrease the load on existing landfills and incinerators. The problem of high rate of water absorption of the fibre could be reduced by coating the fibres with oil.

1.1 Need of the work

- To utilize industrial wastes like coconut fibre and GGBS as the dumping of industrial wastes in open lands are creating a huge environmental pollution and hence there is a need to explore the possibility of utilization of industrial waste materials like coconut fibre, GGBS etc.
- To protect aquifers and surface bodies of fresh water via the elimination of disposal sites.
- To conserve hundreds of thousands of acres currently used for disposal of industrial waste products.

2. LITERATURE REVIEW

Chalamcharla Venu Gopal et al (2017) in this present construction era concrete is the most used construction material in the world. Concrete is consumed widely that it is second most consumed material after the water in terms of per-capita consumption. As the pollution is increasing and the environmental sustainability is affected, researchers are seeking for other materials to reduce the consumption of cement. GGBS is one of these supplementary materials used to replace with cement to reduce the consumption of the cement.

Navaratnarajah Sathiparan et al (2017) this study was to investigate the effect of coconut coir on the strength and durability properties of cement-lime surface plaster mortar. The purpose of adding coconut coir into the mortar was due to coconut coir had a capacity in controlling cracking in the mortar.

Uma Shankar et al (2016) this paper describes the feasibility of using waste in concrete production as a partial

replacement of cement with GGBS and addition of coconut fibres. The cement has been replaced by GGBS in the range of 30% and 40% by weight of cement, Coconut fibres in the range of 1.5%, 2.0% and 2.5% by weight of binder for M20 grade mix and compare with plain cement concrete.

3. MATERIALS

3.1 Cement [IS: 12269-2013]

Ordinary Portland Cement available in the local market of the standard brand was used in the investigation. Care has been taken to see that the procurement made from a single batch is stored in airtight containers to prevent it from being affected by the atmospheric and monsoon moisture and humidity.

3.2 Fine Aggregates [IS: 383-1970]

Fine aggregates can be natural or manufactured. The fine aggregate used is natural sand obtained from the river Godavari confirming to grading zone-II of table 3 of IS 10262: 2009. The results of various tests on fine aggregate are given in table.

Table 1: Physical properties of fine aggregates

S.No.	Property	Values
1.	Fine Modulus	2.75
2.	Specific Gravity	2.64
3.	Bulk Modulus a) Loose b) Compacted	 16.20 kg/m^3 17.20 kg/m^3
4.	Grading	Zone II

3.3 Coarse Aggregates [IS: 383-1970]

Aggregates should be of uniform quality with respect to shape & grading and free from impurities like dust, clay particles and organic matter etc. In total mass of coarse aggregates we used 70% of 20 mm aggregates, 20% of 10 mm aggregates and 10% of 6 mm aggregates.

3.4 Water

This is the least expensive but most important ingredient of concrete.

3.5 Ground Granulated Blast Furnace

GGBS means the Ground Granulated Blast Slag Furnace Slag is a byproduct of the manufacturing of pig iron, Iron ore, coke, and lime stone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of 1500^{0}C to 1600^{0}C. This glassy granulate is dried and ground to the required size, which is known as ground granulated blast slag (GGBS). It is suitable for mass concreting as well as sea water construction.

Fig.1: GGBS

3.6 Coconut Fibres

They are properly washed and drawn into strands before use. Treatment of fibres removes dust and other residual particles left on the fibre so as to augment the surface of contact between the fibre and mix resulting in better binding between the reinforcement and concrete.

Fig.2: Coconut Fibres

4. CASTING OF CUBES

The moulds are cleaned and apply oil on all sides of the moulds. The moulds are placed on a level platform. The well-mixed concrete is filled into the moulds by vibrating machine.

Excess concrete was removed with a trowel and the top surface is finished smooth. If the slump value satisfied, cast the sample into cubes and vibrate well for not obtaining the voids in them. After casting them leave for 24 hours and then keep in curing tank for 7, 14 and 28 days.

Fig.3: Casting of Cubes

5. MIXING AND CASTING OF CONCRETE

Mixing of ingredients is done in concrete mixer of required capacity. The cementitious materials thoroughly blended and then the aggregate is added and followed by the gradual addition of water and mixing. Wet mixing is done until a mixture of uniform color and consistency is achieved which is then ready for casting.

The moulds are cleaned and apply oil on all sides of the moulds. The moulds are placed on a level platform. The well-mixed concrete is filled into the moulds by vibrating machine.

Excess concrete was removed with a trowel and the top surface is finished smooth. If the slump value satisfied, cast the sample into cubes, beams, and cylinders and damp well for not obtaining the voids in them. After casting them leave for 24 hours and then keep in curing tank for 7, 14, 28 days.

6. TESTING PROCEDURE FOR COMPRESSIVE STRENGTH

Compressive strength of the concrete specimens (100 mm * 100 mm * 100 mm) was determined according to the IS 516:1959. The bearing surfaces of the testing machine were wiped clean and the concrete cube specimen was placed in the machine in such a manner that the load applied on the opposite sides of the cubes as cast, and not on the top and bottom faces. The axis of the specimens was carefully aligned with the centre of thrust of the spherically seated platen. The load was applied without any shock or vibration and increased continuously at a rate of 14 N/mm^2/min (approximately) until the specimen failed. The failure load was recorded. The compressive strength of specimen was calculated by dividing the failure load to cross-sectional area of the specimen. Average values should be noted. The compressive strength of the cubes was determined at curing periods of 7, 14 and 28 days.

Fig.4: Compressive Strength Testing Machine

7. RESULTS

The values obtained from the experiments conducted on the cube specimens for 7, 14 & 28 days curing calculated and the results discussed below:

Table 2: Results of Compressive Strength test on Cubes in MPa

S.No.	GGBS %	Coir %	7 days	14 days	28 days
1.	0	0	28	32	37
2.	5	1	36	42	44
3.	10	1.5	38	43	48
4.	15	2	35	41	45
5.	20	2.5	33	39	43

The above table shows that the compressive strength of the concrete increased gradually up to the combination of 10% GGBS and additional 1.5% coconut fibre at all ages. After that with the increase of combination of GGBS and addition of coconut fibres, compressive strength values decreases.

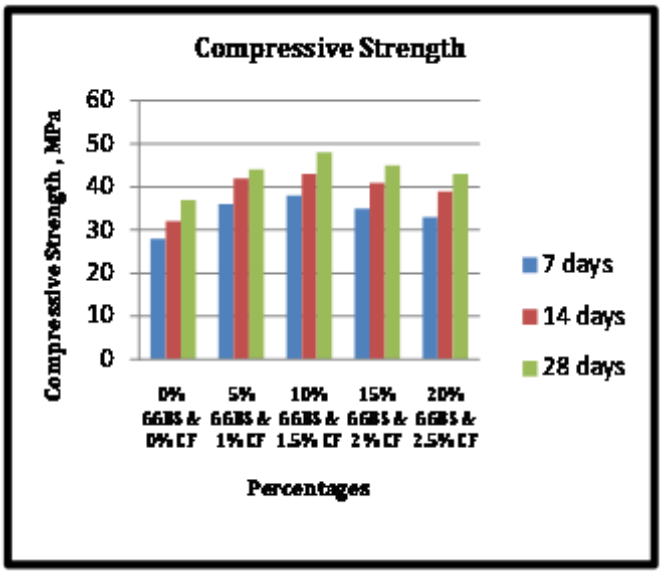

Fig .5: Bar chart Representation of Compressive strength

8. CONCLUSIONS

Based on the study of G.G.B.S. & coconut fibre in Fibre reinforced concrete in comparison with conventional concrete of M30 mix, the following conclusions were drawn:

1. By the addition of GGBS and Coconut fibres in Fibre Reinforced concrete shows better performance than the conventional concrete.

2. The maximum Compressive strength was obtained with the combination of 10% GGBS and 1.5% coconut fibres at all ages.

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