Effects of Graphene Oxide With Ground Granulated Blast Furnace Slag As A Partial Replacement of Cement In Concrete

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Abstract- *This paper represents the use of Graphene oxide and Ground Granulated Blast Furnace Slag (GGBS) in partial replacement of cement. Portland cement production is highly energy intensive process, and emits carbondioxide during calcinations which has a crucial effect on global warming. The production of one tone of OPC releases approximately one tone of carbondioxide to the atmosphere. This requirement is drawn the attention of Investigators to explore new replacements of ingredients of concrete. The present technical report focuses on Investigating characteristics of concrete with partial replacement of cement with Ground Granulated Blast Furnance slag (GGBS) and Graphene oxide. The topic deals with the usage of GGBS(15%, 30%, 45%, 60%)and Graphene oxide(0.05%, 0.1%, 0.15%, 0.2%) to study the compressive and split tensile strength is carried out for 3,7,28 days respectively.One of the most Interesting Nanomaterials which still require detailed investigation is grapheme and grapheme oxide India*

Keywords- Fine aggregate, coarse aggregate, graphene and ground granulated blast furnace slag , compressive strength, workability.

I. INTRODUCTION

Concrete is the most widely used construction material in the world. It is composed of cement paste, aggregates and pores. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problems are among the solid wastes generated by industry. Substantial energy and cost savings can result when industrial by-products are used as partial replacements for the energy intensive Portland cement. The nanomaterials presents invaluable opportunities to further raise the performance bar with the inclusion nanomaterials in cementitious composites. There have been many recent studies on newly produced nanomaterials in cement composites such as nanosilica, nanotitanium oxide, carbon nanotubes (CNT's), graphene oxide, GGBFS etc., In the past years, graphene and its derivatives have been investigated extensively, The superlative properties of graphene oxide has a promising future when combined with ordinary Portland cement (OPC), forming a nanocomposite. research have been done by scientist as well as by the civil engineers and is still ongoing. Now a days we are preferring a blended materials such as fly ash, silica fume, fibre, rice husk ash, and other materials which possessing a good cementicious properties for replacing cement, and other waste by products and materials

Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. jute is one of the most affordable natural fibres, and second only to cotton in the amount produced and variety of uses. Jute fibres are composed primarily of the plant materials cellulose and lignin. It falls into the bast fibre category along with kenaf, industrial hemp, flax (linen), ramie, etc. The industrial term for jute fibre is raw jute. The fibres are off-white to brown, and 1–4 metres (3–13 feet) long.

Fly ash also known as pulverised fuel ash in the United Kingdom, is a coal combustion product that is composed of the particulates that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash.

II. MATERIALS AND SPECIMEN

2.1Ordinary Portland Cement

IS: 8112-1989 for 53 Grade. The properties of cement tested were Fineness (90μSieve) = 6%, Normal consistency = 27.5%, Initial & Final setting time = 30 minute & 600 minute and Specific gravity of 3.1.

1.2 Fine Aggregate

Locally available river sand passing through 4.75 mm IS sieve, conforming to grading zone-II of IS: 383-1970 was used. The physical Properties of sand like Fineness Modulus, Specific Gravity, water absorption and Moisture Content were 2.473, 2.60, and 1.5% and 0.8%.

2.3 Coarse Aggregate

Crushed natural rock stone aggregate of maximum nominal size up to 20mm and aggregate passing 10mm were used. The combined specific gravity, Bulk Density and water absorption of 20mm & 10mm were 2.91, 2492 kg/m3, 1.0% and 1.5% at 24hrs.Fineness modulus of 20mm & 10mm aggregate were 2.810.

2.4 Water

Water conforming to as per IS: 456-2000[19] was used for mixing as well as curing of Concrete specimens.

2.5. Preparation of Specimen

Preparation of test specimen includes following procedure

2.6 Batching

There are two types of batching available namely, weight batching and volume batching. We followed weight batching because it gives accurate proportion of concrete. The quantity of ingredients was arrived by conducting proper weigh batching and stored separately for mixing. We used balance of accuracy 0.01g.

2.7 Mixing of Concrete

Proper mixing of concrete was carried out manually in a good way. Initially, the ingredients are mixed well in dry state. Then water is added little by little and mixed well to a workable state.

2.8 Placing

Mixed concrete is placed in a mould in such away that there is no chance of segregation. Proper compaction was done by using tamping rod.

2.9 Demoulding and curing

After one day the moulds are removed and the specimen was subjected to curing.

2.10 REPLACED MATERIALS:

2.10.1 GRAPHENE OXIDE:

Graphene is defined as a single layer of carbon atoms arranged in a hexagonal lattice. Graphene , a " wonder material" is the world's thinnest, strongest and stiffest material. It is the basic building block of other important allotropes . Graphene is considered as the fundamental building block for graphitic materials of all other dimensions.

2.10.2 GGBFS (or) GGBS

It is obtained by quenching molten iron slag (a by-product of iron and steel- making) from a blast furnace in water (or) steam , to produce a glassy, granular product that is then dried and ground into a fine powder.

III. EXPERIMENTAL INVESTIGATION

3.1 SPECIFIC GRAVITY TEST

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Stones having low specific gravity are generally weaker than those with higher specific gravity values.

`Specific gravity of a material may be defined as the ratio of density of the material to the density of water at a specified temperature.

3.2 SIEVE ANALYSIS TEST

The grain size analysis is widely used in classification of soils. The data obtained from grain size distribution curves is used in the design of filters for earth dams and to determine suitability of soil for road construction, air field etc. Information obtained from grain size analysis can be used to predict soil water movement although permeability tests are more generally used.

3.3 FINENESS MODULUS TEST

To find the fineness modulus of fine aggregate and The Standard grain size analysis test determines the relative proportions of different grain sizes as they are distributed among certain size ranges.

3.4. TEST FOR CONCRETE

3.4.1 General

This chapter deals with the mix design of M25 concrete and also batching, mixing and preparation of cubes and the test is done on the fresh concrete to determine the workability of that mix and the compression test is done on the hardened concrete at the 7th day and 28th day of the curing period to determine its compressive strength of the concrete.

3.5 Mix Design

The design of concrete mix is not a simple task on account of the widely varying properties of the constituent material, the conditions prevail at the site of work, in particular the exposure conditions, and the conditions that are demanded for a particular work for which the mix is designed. Design of concrete mix requires complete knowledge of the various properties of these constituent materials, the implication in case of change on these conditions at the site, the impact of the properties of plastic concrete on the hardened concrete and the complicated interrelationships between the variables. All these make the task of mix design more complex and difficult.

3.5.3 Workability

Workability is the ease with which fresh concrete can be mixed, transported, placed and compacted in the moulds or forms. Some forms can be large and some may be very thin. Some may have high reinforcement and some may have how. Concrete should have good flow until it completely fills up the mould, surrounding the reinforcements without voids.

3.5.4 Water content

Cement requires about 38% of water by its weight for complete chemical reaction and occupies the space with gel pores. But with this quality of water the concrete is very stiff and cannot be poured and compacted. So more water is added to concrete to make it workable.

III. RESULTS

3.1 Compression Test on Concrete Cube

Compression test is the most common test conducted on hardened concrete, partly because is an easy test to perform, and partly becomes most of the desirable characteristic properties of concrete are qualitatively related to is compressive strength. The compression test is carried out on specimens cubical or cylindrical in shape. The cube specimen should be in the size 150 × 150 × 150 mm.

Table 3.1 Compressive Strength For Graphene Oxide

Percentage of Graphene Oxide (%)	3 Days	7 days	28 days
0%	15.46	18.32	30
0.05%	17.41	20.20	32.1
0.1%	19.62	22.45	34.76
0.15%	16.34	18.32	29.9
0.2%	14.93	16.26	26.3

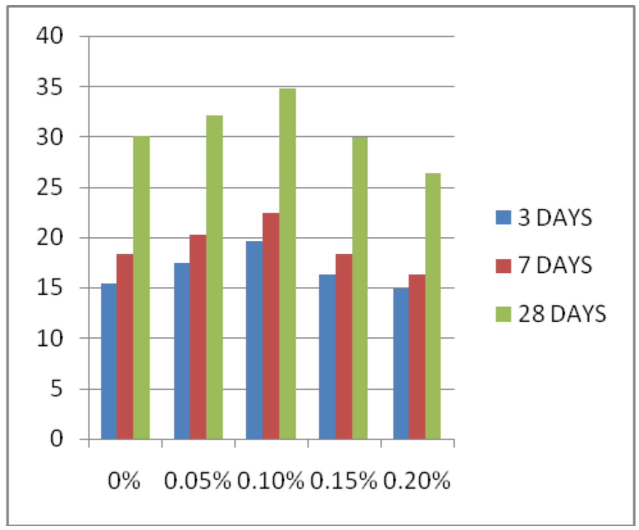

Fig 3.1 Compressive strength graph for Graphene Oxide

Table 3.2 Compressive strength of GGBS

Percentage of GGBS (%)	3 days	7 Days	28 Days
0%	12.68	18.43	29.67
15%	4.79	20.49	31.57
30%	17.7	23.44	34.1
45%	20.28	25.85	35.50
60%	19.32	21.45	31.83

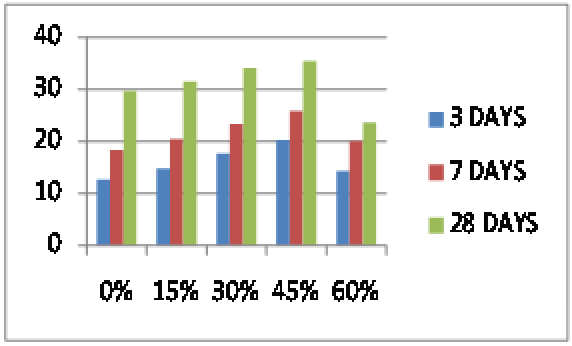

Fig 3.2 Compressive strength graph for GGBS

3.2 SPLIT TENSILE STRENGTH

The cylindrical specimen shall have diameter not less than four times the maximum size of the coarse aggregate and not less than 150 mm. The length of the specimens shall not be less than the diameter and not more than twice the diameter. For routine testing and comparison of results, unless otherwise specified the specimens shall be cylinder 150 mm in diameter and 300 mm long. Split tensile strength of concrete made with 15cm diameter and 30cm long

Table 3.3 Split tensile strength Graphene Oxide

Percentage of jute fibre (%)	3 days	7 days	28 days
0%	2.4	2.8	3.12
0.05%	2.6	3.04	3.54
0.1%	2.8	3.07	3.7
0.15%	2.45	2.76	3.1
0.2%	2.35	2.41	2.98

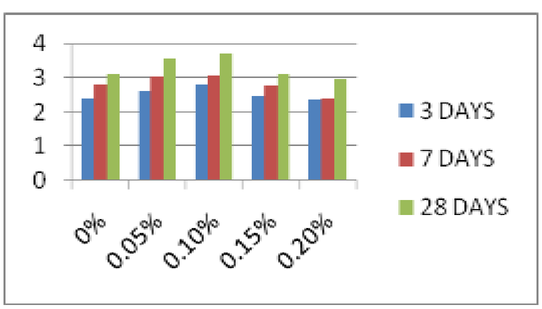

Fig 3.3 Split tensile strength graph for Grapheme oxide

3.3 TEST FOR COMBINATION CUBE

The test where conducted separately for fly ash and jute fibre concrete and after the results of the test the best percentage of jute fibre and fly ash is chosed then the combination cube is casted with that percentage and tested for compressive and tensile strength.

Table 3.4 Compressive strength of combination cube

S.NO	MIX %	DAYS	COMPRESSIVE STRENGTH IN Mpa
1.	45% GGBS + 0.1% GRAPHENE	3	19.95
2.		7	24.15
3.		28	35.13

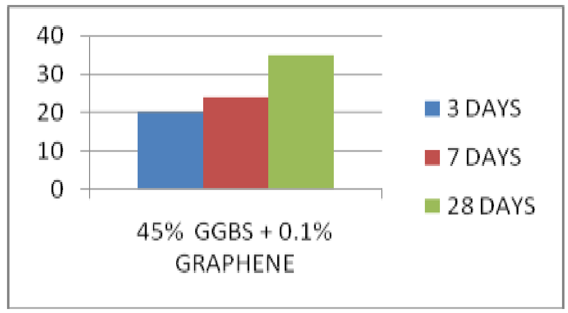

Fig 3.4 Compressive strength graph for combination cube

Table 3.5 Split tensile strength of combination cube

S.NO	MIX %	DAYS	SPLIT STRENGTH IN Mpa
1.	45% GGBS + 0.1% GRAPHENE	3	2.83
2.		7	3.02
3.		28	3.42

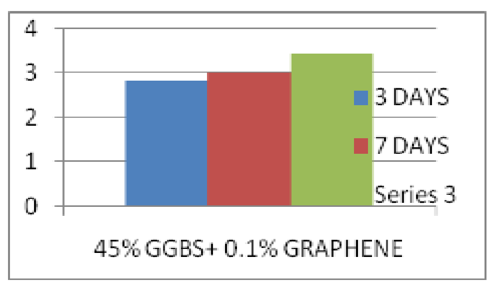

Fig 3.5 Split tensile strength graph for combination cube

IV. CONCLUSIONS

The aim of the project is to control the manufacturing and usage of conventional building materials in construction work and enlarge the usage of waste materials which can replace these conventional building materials, by having more (or) less similar physical and chemical propertie. By using graphene in cement means it reduces the voids and cracks in building. By the test results of replacement in cement, we have analyzed that graphene can be effectively increase the compressive strength of concrete with replaced for upto 0.1% of cement and GGBS replaced for upto 45% of cement to increase the compressive strength of concrete, hence the optimum percentages of strength achieved for these percentages. And finally graphene and GGBS concrete produced by replacing 0.1% of cement and graphene and GGBS replaced by 45% of cement in a same concrete mix, and strength achieved for 3,7 and 28 days for compressive and split tensile strength respectively.

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