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EXPERIMENTAL INVESTIGATION ON STRENGTH PROPERTIES OF CONCRETE BY USING GRAPHENE

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Abstract: This Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the plant. It is obtained by mixing cementing materials, water and aggregates, and sometimes admixtures, in required proportions. The mixture when placed in forms and allowed to cure hardens into a rock-like mass known as concrete. Concrete is composed principally of aggregates, Portland cement, and water, and many contain other cementitious materials and/or chemical admixtures. It will contain some amount of entrapped air and may also contain purposely entrained air obtained by use of admixture or air- entraining cement. Chemical admixtures are frequently used to accelerate, retard, improve workability, reduce mixing water requirements, increase strength, or alter other properties of the concrete. In this work the graphene was used with different proportions.

Index Terms **– Compressive Strength, Split Tensile Strength, Graphene**

I. INTRODUCTION

The selection of concrete proportions involves a balance between economy and requirements of placeability, strength, durability, density, and appearance. Concrete proportions must be selected to provide workability, consistency, density, strength, and durability, for the particular application. The general types of mineral admixtures are Fly ash (FA), Ground Granulated Blast Furnace Slag (GGBS), Silica Fume (SF), Rice Husk ash (RHA), Pozzolanic ash. The graphene is an allotrope of carbon consisting of a single layer of Graphite (pure crystalline carbon) arranged in a hexagonal lattice. A modern material with unique physical properties that could reshape our future. While not a new building material, graphene has been impractical to use in construction since its discovery. In theory, it is an excellent material, as it is incredibly lightweight while being stronger and stiffer than both steel and carbon fiber. potentially, it could be combined with more traditional materials to create stronger beams and cables, allowing for more impressive structures. However, graphene is so difficult to produce that builders have rarely been 9 able to use more than a few flakes of its per project. Until now, that is, as the US' Oak Ridge National Laboratory has developed a new way of producing it using a technique known as chemical vapour deposition.

II. LITERATURE REVIEW

Minzhen Cai, Daniel Thorpe, Douglas H. Adamson and Hannes C. Schniepp, September 2012, "Methods of graphite exfoliation". In this paper, graphene produced by physical and chemical exfoliation of bulk graphite. They produce the bulk production of graphene oxide and graphene via exfoliation, focusing on the exfoliation techniques and yields. successful exfoliation techniques that they categorize into three major classes: mechanical exfoliation, thermal exfoliation, and other methods(Electrochemical exfoliation, Supercritical fluid exfoliation). Wencheng Du, Xiaoqing Jiang and Lihua Zhub, July 2013, "Direct liquidphase exfoliation of graphite to produce single and few layered pristine graphene", Journal of Materials Chemistry

A, DOI: 10.1039/c3ta12212c, pg.no: 10592-10606. The direct liquid-phase exfoliation of graphite to produce graphene is a convenient method for generating ideal graphene samples in large quantities. A large number of liquids have been employed as exfoliation media and show a range of exfoliation efficiencies. The recent progress made on the exfoliation of bulky graphite powders or flakes into single- and few-layered graphene sheets in various liquids, including organic solvents, ionic liquids, and water/surfactant solutions. The qualities and yields of the exfoliated graphene samples, as well as their use in various applications, are also reviewed. 15 M. Devasena and J. Karthikeyan, February 2015, "Investigation on Strength Properties of Graphene Oxide Concrete". In this they aimed to find out the optimum quantity of graphene oxide required to achieve maximum compressive, tensile and flexural strength of concrete. Graphene oxide was added to the concrete in three mix proportions. Graphene oxide content were varied by 0.05%, 0.1%, 0.2% of cement content. The compressive strength increases in the range of 10.2% to 19.9% than the normal mortar respectively. Use of an optimal percentage (1.5wt %) of GO nanoplatelets caused a 48% increase in the tensile strength of the cement mortar specimens. Virginie Wiktor conducted laboratory tests to show that only 0.05% of GO is needed to improve flexural strength of an OPC matrix from between 41% to 59% and compressive strength from between 15% to 33%. Kai Gong, Zhu Pan, Asghar H. Korayem, Ling Qiu, Dan Li, Frank Collins, Chien Ming Wang and Wen Hui Duan, February 2015, "Reinforcing Effects of Graphene Oxide on Portland Cement Paste". In this experimental study, the reinforcing effects of graphene oxide (GO) on Portland cement paste are investigated. It is discovered that the introduction of 0.03% by weight GO sheets into the cement paste can increase the compressive strength and tensile strength of the cement composite by more than 40% due to the reduction of the pore structure of the cement paste. The overall results indicate that GO could be promising nanofillers for reinforcing the engineering properties of Portland cement paste. At the age of 28 days, the compressive strength of the plain cement sample is 43 MPa. This value is increased by as much as 46% to approximately 63 MPa by having 0.03% by weight GO sheets. The 28-day tensile strength results obtained from the tensile 16 splitting tests. It was observed that the tensile strength of the samples reinforced with GO is approximately 50% higher than that of the plain cement sample.

III. SCOPE OF THE STUDY

The scope of the project is to study the behaviour of strength properties of the admixtures. The high strength of these admixtures is to be studied from experimental tests by conducting a comparative study on the performance of conventional concrete and concrete with admixture.

IV. OBJECTIVE OF THE STUDY

- To cast specimens according to the standards.
- To cast specimens for the test of Strength properties of concrete .
- To identify the correct proportion of high strength mix.
- To determine the cube compressive strength by Compressive strength test.
- To determine the flexural strength by Flexural strength test.

V. MATERIAL PROPERTIES

1. Cement

Portland Pozzolana Cement (Fly ash based) confirming to IS:1489- 1991(Part I) was used. It should be free from lumps. The physical properties of cement as shown below

Table 1:Physical Properties of Cement

CHARACTERISTICS	VALUE
Specific gravity	2.9
Consistency	32%
Initial setting time	35 minutes
Final setting time	600 minutes

2. **Fine Aggregate (M - Sand)**

Fine aggregate is an important and essential ingredient of concrete. The M sand product from plant is of a consistent high quality and has good equi dimensional shape. The crusher sand used for the experimental programmed was locally procured and conformed to grading zone II. The fine aggregates were tested per Indian Standard Specifications IS: 383-2016.

Table 2: Physical Properties of Fine Aggregate

CHARACTERISTICS	VALUE
Type	Crushed (M - Sand)
Maximum size	4.75mm
Specific gravity	2.61
Finess modulus	2.68

3. Coarse Aggregate

Coarse aggregate are produced by disintegration of rocks and by crushing rocks. These are available in different sizes. Coarse aggregate are usually those particles which are restrained on IS 4.75mm sieve. Coarse aggregate used in this study were 20 mm nominal size and tested as per Indian standard specification IS:383 – 2016.

Table 3: Physical Properties of Coarse Aggregate

CHARACTERISTICS	VALUE
Type	Crushed
Maximum size	20 mm
Specific gravity	2.74
Finess modulus	7.26
Impact value	21.4%

4. Graphene

Table 4: Physical Properties of Graphene

CHARACTERISTICS	APPROXIMATE VALUE
Purity	99%
Thickness	2 – 5nm
Surface area	380 m^2/g
Number of layers	2 – 4
Concentration	0.5%
Physical state	Liquid
Color	Black
Odor	Odorless
Taste	Tasteless
Molecular weight	12.01

5. Water

The water, which is used for making concrete, should be clean and free from harmful impurities such as oil, alkali, acid, etc., Locally available potable tapwater is used for casting.

V. MIX PROPORTION

Table 5: Mix proportions of Concrete

MIX	M0	M1	M2	M3
% of Graphene	-	1	2.5	3
Graphene in (litre/m³)	-	4.24	10.61	12.74
Cement Kg/m³	424.5	424.5	424.5	424.5
FA	640	640	640	640
CA	1144	1144	1144	1144
W/C	0.45	0.45	0.45	0.45
Water in (litre/m³)	191	186.76	180.39	178.26

VI. EXPERIMENTAL INVESTIGATION:

1. Casting and Curing of Specimen

Concrete mixing done as per the requirement of IS standards (IS 516 : 1959). Hand mixing were employed here for mixing concrete. The concrete batch shall be mixed on a watertight, non-absorbent platform with a shovel or trowel. The cement and fine aggregate shall be mixed dry until the mixture is thoroughly blended and is uniform in color. The coarse aggregate shall then be added and mixed with the cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch, the water shall then be added and the entire batch mixed until the concrete appears to be homogeneous and has the desired consistency.

Figure 1: Mixing and Casting of Specimen

Before starting the casting works moulds must be oiled properly so that itis easy to remove the concrete after hardened. After oil applied, mould is allowed to dry for few minutes, then the fresh concrete is placed in respective moulds in three layers and each layer is compacted for 35 strokes by 16mm diameter rod of length 0.6m. compacting the concrete is very important since it plays a major role in increasing the strength of the concrete. After the good compaction, concrete should be finished well on the top side. It should be left for hardening for about 24hours. After 24 hours, concrete is removed from the mould and it should be marked for identification and left under the water for curing.

2. Compressive Strength Test

Compressive strength is the capacity of a material to withstand axially directed pushing forces. When the limit of compressive strength is reached, brittle materials are crushed. The compressive strength is used to determine the hardness of cubical and cylindrical specimens of concrete. The compressive strength of concrete was carried out as per IS 516:1959. After the curing period was over, the cubes were tested in the compression testing machine (CTM) of capacity 300 tonne, at the rate of 140 kg/cm²/minute. The ultimate load at which the cube failedwere taken. The test were carried out on three specimens and average compressivestrength were recorded.

Figure 2: Compression Test on Cube

3. Split Tensile Test

A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete. In direct tensile strength test it is impossible to apply true axial load. There will be always some eccentricity present, another problem is that stresses induced due to grips. Due to grips there is a tendency for specimen to break at its end. The load shall be applied without shock and increase continuously at a nominal rate within the range 1.2 N/mm²/min to 2.4 N/mm²/min.Record the maximum applied load indicated by the test machine at failure.

Figure 3: Split Tensile Test on Cylinder

VII. Results and Discussion:

1. Compression Strength Test

S No	Mix	7Days	14 Days	28Days
1.	M0	17.44	24.27	26.58
2.	M1	19.32	26.21	29.73
3.	M2	21.07	30.65	35.60
4.	M3	21.94	32.25	39.68

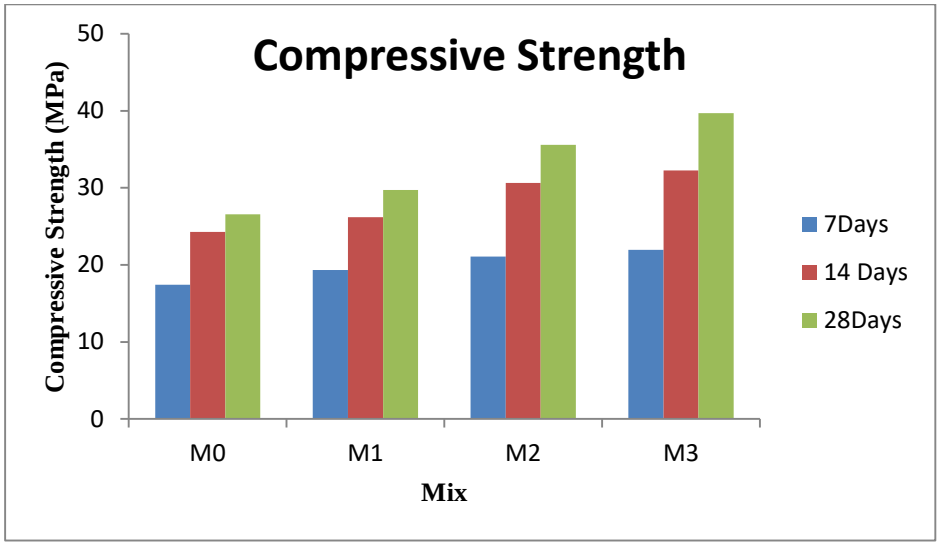

Figure 4: Test Results on Compressive Strength

The above table shows the results on Compressive strength test. M3 denotes the maximum compressive strength. For M2 the percentage of Increase in compressive strength than conventional is 10.8 and for M3 the percentage of Increase is 43.9 than conventional concrete.

2. Split Tensile Strength

S.No	Mix	28 Days
1.	M0	2.45
2.	M1	2.52
3.	M2	2.63
4.	M3	2.86

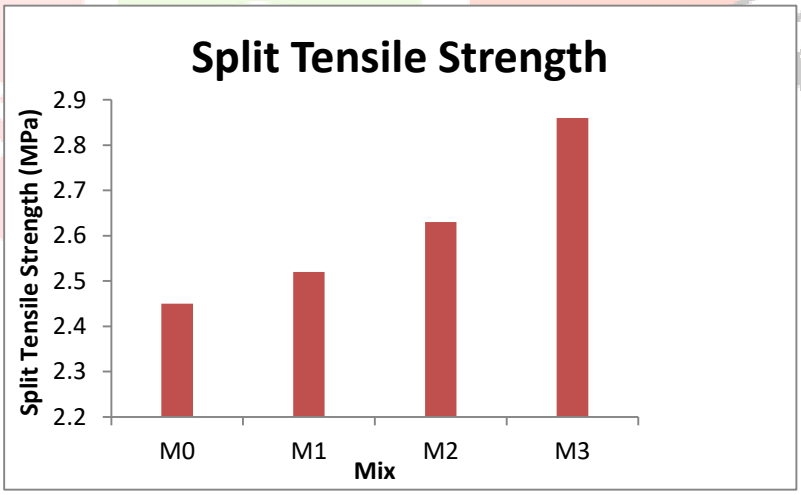

Figure 5: Test Results on Split Tensile Strength

The above table shows the results on Split tensile strength. M3 denotes the maximum compressive strength.

VIII. CONCLUSION

From this thesis it is observed that the usage of Graphene as an admixturein the concrete greatly increases the strength of the concrete. It is important to know the specifications of the graphene to be used. Since, it defines the percentage of the graphene to be used. Based on the percentage of Graphene, strength of the concrete differs. For these specifications of graphene, to find the optimum percentage of graphene five trial mixes 1%, 2.5%, 3% were done. The strength of the concrete increases to the maximum at 3% of graphene to the weight of cement and also the strength of the concrete increases at 2.5% to the weight of cement which is nearer to strength of 3% graphene . So, the graphene percentage in this project is finalized

as 2.5% and 3%. These two percentages and the conventional concrete are casted as cube, cylinder to find out the compression, split tension respectively. The optimum percentage of graphene is found as 3% of graphene to the weight of the cement.

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