

Investigational Study of Physical Properties of Concrete with Graphene Oxide

Namrata N Chavan¹ Prof. M. S. Karriappa²

¹M.Tech Student ²Professor

^{1,2}Department of Civil Engineering

^{1,2}M.S.Bidve Engineering College, Latur, Affiliated to Dr.Babasaheb Ambedkar Technological

University, Lonere, Approved by AICITE, Accredited by NAAC, Maharashtra, India

Abstract— Cement-based concrete is a widely used material for a great variety of constructions. Although, cement has great properties and high performance, its intrinsic brittleness is a weakness that requires further investigation for improvement. Graphene demonstrates a number of excellent properties, such as high flexibility, 1TPa Young's Modulus, 130 GPa tensile strength, high electrical and thermal conductivity. This study is on the feasibility of implementing graphene into the concrete matrix for improving its compressive and tensile or flexural strength. A careful study and understanding of the performance of graphene cement concrete, and also compare the compressive and split tensile strengths of M30 concrete by replacing cement with 0.25% , 0.50% and 0.75% graphene oxide.

Keywords: Graphene Oxide, M Sand, Workability, Compressive Strength, Tensile Strength

I. INTRODUCTION

Cement-based concrete is the most commonly used material in civil infrastructure. Although cementitious materials have shown great properties, they are brittle materials with very low tensile strength and reduced strain capacity. Concrete is widely used construction material for various types of structures due to its structural stability and strength. All the materials required for producing such huge quantities of concrete come from earth's crust.

Graphene oxide (GO) is the product of chemical exfoliation of graphite. Due to its good dispersibility in water, high aspect ratio and excellent mechanical properties, GO is a potential candidate for use as Nano reinforcements in cement based materials. When GO is included in OPC compositions, the matrix materials produced exhibit significantly improved mechanical and physical properties compositions can be produced by adding GO at the time of mixing the cementitious material, liquid, aggregate and other conventional additives. The addition of GO also improves the ductility and reduces the likelihood of sudden failure of concrete and improves the degree of hydration of the cement paste and increases the density of the cement matrix, creating a more durable product.

A. Scope of Project:

Graphene oxide used as a partial replacement of cement and shows economical, technical and energy saving benefits. To check its properties for concrete which is to be used for construction, a study of all strength such as compressive strength, tensile strength.

1) Scope

The project aim is to compare the strength of conventional concrete and replaced concrete. By conducting compressive strength test, Tensile strength, thus comparing the results

obtained with normal conventional concrete using M30 grade of concrete.

- A much more extensive study on the properties and behaviour of concrete with Graphene oxide.
- Study may be done for higher grades of Concrete because of their properties.

II. METHODOLOGY

A. Materials Collection and Properties

1) Cement

The making process of PPC Cement is done by burning calcareous and argillaceous materials by partial fusion at a high temperature of about 1450°C. The Portland Pozzolana Cement has been used. Brand used is Ultratech PPC Cement and it was conforming to IS:1489-1991.

Here PPC is used because it makes concrete more impermeable, denser, as compared to OPC. The strength for long term is more in PPC compared to OPC.

Sr. no	Test Conducted	Results Obtained	Requirement as per IS
1	Specific Gravity	3.15	-
2	Normal	31%	-
3	Consistency Setting Time	initial 150 final 210	Min 30 Max 600
4	Fineness(kg/m ³)	342	300
5	Soundness(mm)	1.00	10.0mm max

Table 2.1.1: Physical Properties of PPC Cement

S.No.	Characteristic	Required Value
1	Total loss on ignition (%by mass)	Not more than 5.0
2	Magnesia (%by mass)	Not more than 6.0
3	Insoluble residue (%by mass)	Not more than $\frac{x+4(1000-x)}{100}$
4	Sulphuric anhydride	Not more than 3.5%
5	Total chloride content	Not more than 0.10%

Table 2.1.2: Chemical Properties of PPC Cement

#Fine aggregate (M sand)

SR NO	PROPERTY	RESULT
1	Specific Gravity	2.72
2	Fineness modulus	2.68
3	Gravity zone	II

Table 2: Physical properties of fine aggregate

Coarse aggregate

SR NO	PROPERTIES	RESULT
1	Size	12 mm
2	Specific gravity	2.68
3	Total water absorption	0.70%
4	Fineness modulus	7.20

Table 3: Physical properties of coarse aggregate

#Graphene oxide

Charge carrier mobility	~200 000cm ² /V.s
Thermal conductivity	~5000W/m.k
Transparency	~97.4%
Specific surface area	~2630m ² /g
Young's modulus	~1GPa
Tensile strength	~1100GPa
Band gap	0

Table 4: Physical properties of Graphene oxide

B. Workability of Concrete

Workability of concrete is the property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, consolidated and finished.

C. Compressive Strength

Compressive strength test is the most common test conduct on concrete because it is easy to perform and most of the desirable characteristics properties of concrete qua related to its compressive strength. Compressive strength is determined by using compression testing machine (CTM) of capacity 2000KN. The load apply ay uniform rate. The wooden cubes having size (150mm x 150mm)

$$\text{Formula} = \frac{P}{A^2}$$

D. Tensile Strength Test:

Knowledge of tensile strength of concrete is of great importance. Tensile strength is the basic and important properties of concrete. Tensile strength is determine byusing filling ability. It can be used at site. The test also indicates the resistance to segregation .compression testing machine. The tensile strength of concrete is tested by using test specimens 150 x 150 x 150 mm. They are allowed for curing tank for 7 and 28 days. The test is carry out by placing a specimen between the loading surface of a CTM and the load is applied at uniform rate until the failure of the specimen. The tensile strength measure for each test condition and average value is considered.

E. Slump Test:

The slump test is done to assess the horizontal flow of concrete in the

1) L Box Test:

The test assesses the flow of concrete also the extent to which concrete is subjected to blocking by reinforcement.

2) U Box Test:

The test is used to measure the filling ability concrete. The apparatus consist of a vessel that is divided by a middle wall into two compartments

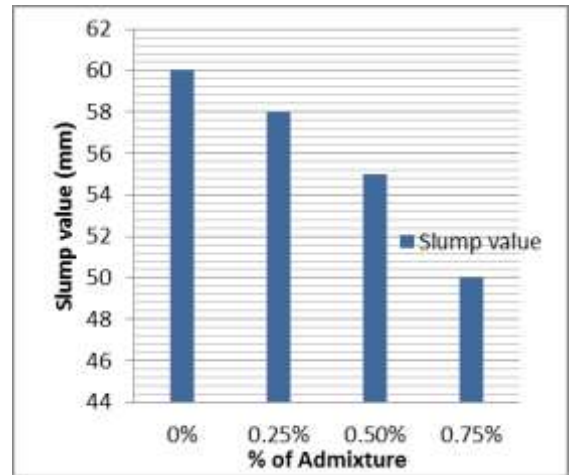
III. RESULT

A. Fresh concrete test results

1) Slump Test

S1 No.	Mix	Graphene Oxide %	Slump Value in mm
1	MIX1	0	56
2	MIX2	0.25	67
3	MIX3	0.50	84
4	MIX4	0.25	40

Table 5: test results of slump test

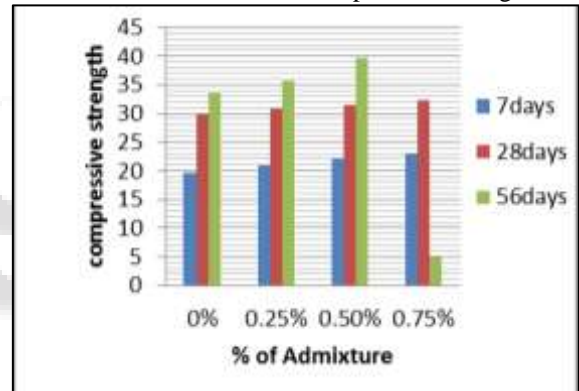


Graph 1: slump cone test result

B. Compressive strength

% of mix	7days	28 days	56 days
0	19.68	30.09	33.69
0.25	21.02	30.94	35.71
0.50	22.15	31.50	39.80
0.75	22.95	32.35	41.12

Table 6: test results of compressive strength

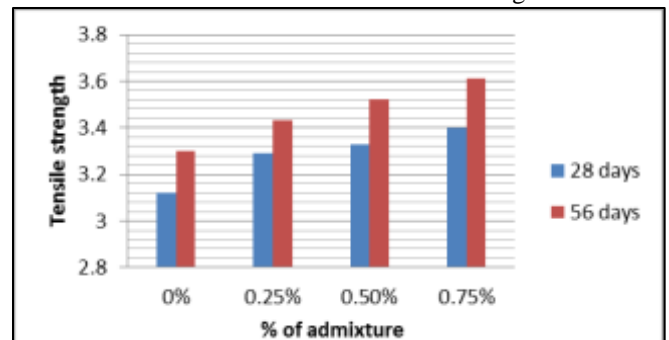


Graph 2: compressive strength test result

C. Tensile strength

% of mix	28 days	56 days
0	3.12	3.30
0.25	3.29	3.43
0.50	3.33	3.52
0.75	3.40	3.61

Table 7: Test results of Tensile strength



Graph 3: tensile strength test result

IV. CONCLUSION

- 1) It is observe that with increase in percentage of admixture workability decreases.
- 2) Nanoparticles of graphene oxide improves the physical properties of the concrete, both compression and tensile strength, when, concrete samples were tested with Graphene Oxide (GO) in percentage of 0.25% ,0.50 & 0.75% by weight of cement to obtain high strength, it is carried out for M30 grade of concrete
- 3) For 0% MIX, when compared with 28days strength, the compressive strength of concrete increases to 11.94% at 56days.
- 4) For 0.25% MIX, when compared with 28days strength, the compressive strength of concrete increases to 15.41% at 56days
- 5) For 0.50% MIX, when compared with 28days strength, the compressive strength of concrete increases to 26.34% at 56days.
- 6) For 0.75% MIX, when compared with 28days strength, the compressive strength of concrete increases to 27.10% at 56days.
- 7) For 0% MIX, when compared with 28days strength, the Tensile strength of concrete increases to 5.76% at 56days.
- 8) For 0.25% MIX, when compared with 28days strength, the Tensile strength of concrete increases to 4.25% at 56days.
- 9) For 0.50% MIX, when compared with 28days strength, the Tensile strength of concrete increases to 5.70% at 56days
- 10) For 0.75% MIX, when compared with 28days strength, the Tensile strength of concrete increases to 6.17% at 56days

REFERENCES

- [1] ShanghaisLv, Sun Ting, Jingjing Liu, and Qingfang Z. (2014), "Use of graphene oxide nanosheets to regulate the microstructure of hardened cement paste to increase its strength and toughness. *CrystEngComm*", 16(36):8508–8516.
- [2] Ye Qing, Zhang Zenan, Kong Deyu, and Chen Rongshen, (2007) "Influence of nano-sio2 addition on properties of hardened cement paste as compared with silica fume. *Construction and Building Materials*", 21(3):539–545.
- [3] Shiho Kawashima, PengkunHou, David J. Corr, and Surendra P. Shah. (2013), "Modification of cement-based materials with nanoparticles. *Cement and Concrete Composites*", 36:8–15, Special issue: Nanotechnology in Construction.
- [4] Samuel Chuah, Zhu Pan, Jay G Sanjayan, Chien Ming Wang, and Wen Hui Duan, (2014), "Nano reinforced cement and concrete composites and new perspective from graphene oxide", *Construction and Building Materials*, 73:113–124.
- [5] Beaudoin J, Feldman R. Dependence of degree of silica polymerization and intrinsic mechanical properties of C–S–H on C/S ratio. In: 8th international Conference on the chemistry of cement, Rio de Janeiro; 1986. p. 33742.