International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 05 | May 2024 www.irjet.net p-ISSN: 2395-0072

Study on the effect of mechanical performance of Graphene Oxide blended cement concrete

Krishna Bhadran P S [1], Nandan K V[2], Sreeranjini Sreekumar[3], Seetha Pisharikkel[4]

[1,2,3] *B Tech Students, Dept. of Civil engineering, Vidya Academy of Science and Technology, Thrissur, Kerala, India*
[3]*Assistant Professor, Dept. of Civil Engineering,* Vidya Academy of Science and Technology, Thrissur, Kerala, India

---

Abstract – *Cement concrete is the most widely used construction material due to its low cost, easy availability of constituents along with high strength and durability. The global use of cement contributes to the carbon emissions. Cement production releases CO2 during its production process. Also, disadvantages such as low tensile and flexural strength coupled with brittleness promotes the addition of nanomaterials like graphene oxide. Graphene demonstrates a number of properties such as high flexibility, high tensile strength. This study investigates the feasibility of implementing graphene into the concrete matrix for improving its compressive and tensile or flexural strength.*

The aim of this research is to study the performance of graphene oxide blended cement concrete, and also compare the compressive and split tensile strengths of M25 concrete by adding graphene oxide at various percentages. This paper investigates on the incorporation of graphene oxide in cement to improve its mechanical properties and thereby contributing to an alternative and sustainable practice in the field of construction.

The positive outcomes of graphene oxide blended cement concrete suggest promising applications in the field of construction that results in enhanced performance and reduced environmental impact. The findings underscore the potential of graphene oxide as a key additive in cementitious materials towards a more resilient and sustainable built environment.

***Key Words*: cement concrete, graphene oxide(GO), workability, compressive strength, tensile strength**

1.INTRODUCTION

Cementitious materials are the most common construction materials used worldwide. They are generally brittle and have very low tensile strength and strain capacity. Recently, Graphene oxide has attracted attention from many concrete researchers due to their exceptional mechanical, chemical, thermal, and electrical properties, and good performance as polymeric reinforcement materials. Graphene is a single layer sp_2-bonded carbon sheet forming a honeycomb crystal lattice. Use of graphene oxide could open up many new applications such as high tensile strength and high compressive strength.

2. OBJECTIVES

The main objectives of this study are as follows:

- To study the behavior of concrete with Graphene oxide.
- To study the workability of Graphene oxide blended cement concrete.
- To determine the compressive strength and tensile strength of Graphene oxide concrete.
- To find out the optimum quantity of Graphene Oxide required to achieve maximum compressive and tensile strength of concrete.

3.SCOPE OF THE STUDY

The conventional concrete mix has many drawbacks like less tensile strength, brittleness and causes great carbon emissions. By using graphene oxide as an additive in concrete, the mechanical performance and durability can be improved in a sustainable manner, ecofriendly and economical manner. The positive outcomes of graphene oxide blended cement concrete suggest promising applications in the field of construction that results in enhanced performance and reduced environmental impact. The findings underscore the potential of graphene oxide as a key additive in cementitious materials towards a more resilient and sustainable built environment.

4.MATERIALS

4.1 Cement

Cement ordinary Portland cement of 53 grade conforming to IS:12269-1987 was used throughout the experiment. The Specific gravity of cement is 3.15 and the fineness modulus of cement is 4.65%.

4.2 Fine aggregate

Locally available fine aggregate passing through 4.75mm IS Sieve having Specific gravity of 2.65 is used. It was dried in sun light before it is used for standard design mix concrete.

4.3 Coarse aggregate

20mm down size natural crushed stone having specific gravity of 2.71 and water absorption of 0.2% was used.

4.4 Water

Locally available potable and filtered water is used. Water is important ingredient for strength and durability characteristics of concrete.

4.5 Graphene Oxide

Graphene oxide (GO) is a compound derived from graphene, which is a single layer of carbon atoms arranged in a two-dimensional honeycomb lattice. It easily disperses with concrete. Physically it is dark in color and viscous in nature.

5.METHODOLOGY

5.1Mix design

In this experimental work, M25 grade concrete with w/c ratio of 0.45 was used. in this experimental study, totally 30 numbers of cube specimen (size 150*150*150mm) and 15 numbers of cylinder specimens (size 300mm height and 150mm diameter) were casted. The GO was added to the concrete by percentage weight of cement. Table shows the arrived values of mix ratio of conventional concrete.

Cement	Fine aggregate	Coarse aggregate	Water
1	1.6	2.8	0.47

5.2 Mixing, casting and curing of specimens

Mixing is done in the normal method i.e., First the cement, sand and coarse aggregate is taken according to their weight and mixed uniformly. Then required quantity of water mixed with GO is added to the dry mix and the mixture is mixed until it is homogeneously mixed. The moulds are cleaned properly and the inner surface of the mould is properly oiled. Then the concrete is filled inside of the by three layers of 25 blows. Once the moulds are filled with concrete mix the excess concrete is removed and the top surface is levelled properly. Then the concrete specimens are allowed to set for 24 hours and are removed from mould. Curing of the specimens is done for 7 and 28 days.

6. WORKABILITY OF FRESH CONCRETE

The workability of fresh concrete mixes was found out using slump test. It was found that the workability of the mix reduces with addition of GO.

Table -1: Slump test strength results

S.no	Sample description	Slump value in mm
1	Normal concrete	150
2	0.01% GO	130
3	0.02% GO	75
4	0.03% GO	65
5	0.04% GO	50

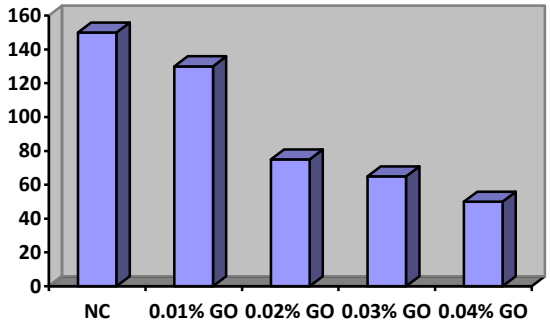

Chart -1: Workability of fresh concrete

7. EXPERIMENTAL TESTS

7.2 Compressive strength test

IS Code 516:1959 was used for method of tests for compressive strength of concrete. Cube specimen of size 150x150x150mm is used for compression test. Oil is applied uniformly to the inside of the moulds on all the surfaces. Concrete is filled in three layers with tamping of 25 blows for each layer. After 24 hours they are taken out of the moulds and immersed in water tank for 7 and 28 days for curing. The cubes are tested with the application of gradual loading.

Compressive strength in N/mm^2 = P/ A

where, P=load at failure in Newton

A=area of cross section in mm^2

7.3 Split tensile strength test

IS Code 5816:1999 was used for method of test split tensile strength of concrete. Cylinder specimen of size 300 mm (length) x 150mm(diameter) is used for the test. The specimens were tested after 28 days curing. Cylindrical concrete specimen is placed between the platens of testing machine, keeping the two plywood strips one at the bottom and the other at the top. The whole assembly is arranged at the center of plates of testing machine. The load is applied gradually at a rate of 1.4 to

2.1N/mm2/minute until the failure. The maximum load applied to the specimen is noted.

Split tensile strength in $N/mm^2 = 2P/\pi dl$

where, P=load in Newton

d=diameter of cylinder in mm

l=length of cylinder in mm

8. RESULTS AND DISCUSSION

8.1 Compressive test

The compressive strength of concrete was increased with addition of GO. The maximum strength obtained was 38.03 N/mm^2 and was observed at 0.02% addition of GO and decreased at 0.03% addition of GO.

Table -1: Compressive strength results

S.No.	Sample description	Compressive strength in N/mm^2	
		7 days	28 days
1	Normal concrete	22.91	32.65
2	0.01% GO	25.04	36.27
3	0.02% GO	26.30	38.03
4	0.03% GO	26.07	37.95
5	0.04% GO	25.15	37.69

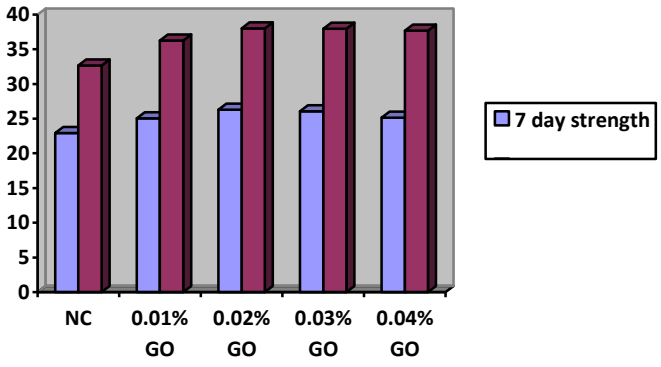

Chart -2: Compressive strength of concrete

8.2 Split tensile strength

The split tensile strength value is increased with addition of GO. The maximum strength was 8.40 N/mm^2 and was observed at 0.02% addition of GO. The strength decreased at 0.03% addition of GO.

Table -1: Tensile strength results

S.no	Sample Description	Tensile strength in N/mm^2
1	Normal concrete	5.55
2	0.01% GO	6.13
3	0.02% GO	8.40
4	0.03% GO	7.08
5	0.04% GO	6.86

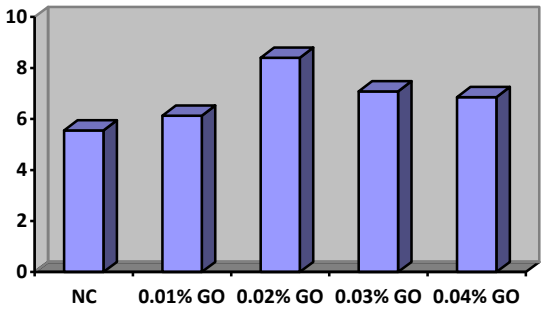

Chart -3: Tensile strength of concrete

9. CONCLUSIONS

The addition of GO was found to effectively improve the properties of concrete.

- The percentage increase of 28 days' compressive strength of GO blended concrete compared with conventional concrete mix is observed from 10 to 15%.
- The percentage increase of split tensile strength of GO blended concrete compared with conventional concrete mix is observed from 11 to 15%.
- The maximum compressive and tensile strength were achieved with the addition of 0.02% GO into the concrete mix.
- A reduction in the workability of concrete is observed by addition of GO in the concrete mixes.

ACKNOWLEDGEMENT

We extend our heartfelt thankyou to the Department of Construction Materials, Kerala Engineering Research Institute(KERI), Peechi, Kerala for providing their guidance and laboratory facility for this study.

REFERENCES

[1] Text Book of Concrete Technology- MS Shetty.

[2] Prof. Dimitra Dimove and others, Advanced Science News Journal, www.afm Journal., Exeter University, UK

[3] M. Krystek, Dr. M. Gorski" Cement graphene composite", Silesian University, Poland, in Advance Science Journal.

[4] Prof. Sardar Kashif Ur Rahman and others", A sustainable graphene based cement composite" Dept of Civil Engg., University of Malaya, Malaysia.

[5] Yuxia Suo, Rongxin Guo, Haiting Xia, Yang Yang, Bin Zhou, Zhiman Zhao Journal of Building Engineering- Volume 53, 1 August 2022

[6] Seungyeon Han, Mohammad Shakhawat Hossain, Taeho Ha and Kyong Ku Yun (2022)- Nanotechnology Reviews 2022

[7] Luca Lavagna, Andrea Santagati, Mattia Bartoli, Daniel Suarez-Riera and Matteo Pavese (2023)- National Centre for Biotechnology Information