



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 11, November 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

An Investigation on Strength Characteristics of Concrete Enhanced with Graphene

MD Sohel Ahmed¹, K. Prathap Reddy¹

¹Assistant Professor, Department of Civil Engineering, School of Engineering, Guru Nanak Institutions Technical Campus, Hyderabad, Telangana, India

ABSTRACT: In the realm of construction engineering, there is an imperative need to explore materials that exhibit a multitude of engineering properties. These materials should not only possess improved physical, chemical, and mechanical characteristics but also offer the versatility to be applied across various facets of civil engineering construction. Concrete, as the predominant construction material in civil engineering, warrants a refinement of its physical and mechanical attributes by delving into the realm of nanoscale research. These advancements are attainable through the utilization of nanomaterials. The incorporation of nanomaterials into concrete paves the way for a novel approach to augment the load-bearing capacity of concrete structures. This study centers its attention on a relatively recent nanomaterial, namely Graphene, which exhibits the potential to enhance concrete properties. The investigation revolves around evaluating the impact of adding 0.5 to 1.5 grams of Graphene into the concrete mixture on its strength. The research findings indicate a significant and swift increase in the flexural, compressive, and tensile strength of cement when combined with Graphene oxide. As such, the overall results suggest that Graphene holds promise as a valuable nanomaterial filler for elevating the engineering properties of concrete mixtures.

KEYWORDS: Cement, Nanocomposite, Graphene, Characteristic compressive strength, Tensile strength.

I. INTRODUCTION

Concrete, serving as the cornerstone in civil engineering, plays a pivotal role in construction. Comprising a mixture of cement, sand, and gravels, it has been a longstanding material of choice. However, the construction industry is currently seeking alternative materials to replace or enhance concrete, as it is recognized as a composite material with potential room for improvement. The integration of nanomaterials holds promise for augmenting the performance of concrete. Recent studies have yielded compelling results, suggesting that nanomaterials such as carbon nanotubes, nano silica, and graphene oxide can be employed effectively as composite additives in concrete. Notably, graphene and its derivatives have garnered significant attention from researchers in recent years due to their exceptional properties that make them ideal candidates for synergistic exploration with cement in the realm of research

II. MATERIALS

2.1 Cement

Ordinary Portland Cement (53 Grade) in accordance with IS:12269-1987 was used and it should not have any kind of lump. The physical properties of cement are shown in Table 1.

Table-1: Physical Properties of Cement

Characteristics	Values
Setting time (Initial)	30 mins
Setting time (Final)	600 mins
Fineness	225 m ² /Kg
Specific gravity	3.15
Consistency	31.5%

2.2 Coarse Aggregates

Coarse aggregates used in the study as per the local availability and those were in different sizes. To get the uniform size of aggregates, sieve analysis was performed and those which was retained on 4.75mm sieve and passed through 20mm sieve was used and tests were performed in accordance to IS:383 – 1970.

Table-2: Physical Properties of Coarse aggregates

Characteristics	Values
Type	Crushed
Max. size	20 mm
Sp. gravity	2.68
Fineness modulus	7.07

2.3 Fine Aggregates

Fine aggregates are the crushed materials which are generally obtained in form of river sand. In this study, locally available sand is used and tests were performed in accordance to IS:383 – 1970.

Table-3: Physical Properties of Fine aggregate

Characteristics	Values
Type	Crushed
Max. size	4.75 mm
Sp. gravity	2.65
Fineness modulus	2.68

2.4 Graphene

Graphene is a carbon allotrope in two dimensional arranged in hexa-gonal pattern. Graphene, a “wonder material” is one of the most light weight nano material. In this study two types of graphene are used. One is having low surface area i.e. 180 m²/gm and the second is high surface area i.e. 400m²/gm. These types were bought from a graphene.

Table-4: Physical Properties of Graphene

Characteristics	Values
Physical state	Powder
Colour	Black
Surface area	180 m ² /gm & 400 m ² /gm
Average thickness	3-8 nm
Weight	0.02/m ²

2.5 Water

The water used in the concrete mixing should be free from impurities such as acidic, alkaline substances, etc. Regular water is taken for mixing.

III. MIX DESIGN

Mix proportion of M 30 grade which should be relevant to specifications of IS 10262-2009 was used in the study. The detail of various proportions of ingredients used in mix design are as per following table.

Table-5: Mix Proportions

All qty. is in Kg/m ³	Control Mix	LSA/HAS Graphene Trial-1	LSA/HAS Graphene Trial-2	LSA/HAS Graphene Trial-3
Graphene	0	0.5 gm/mould	1.0 gm/mould	1.5 gm/mould
Cement	566.80	566.80	566.80	566.80
FA	425.10	425.10	425.10	425.10
CA	850.20	850.20	850.20	850.20
W/C	0.45	0.45	0.45	0.45
Water	255.06	255.06	255.06	255.06

IV. EXPERIMENTAL RESULTS

In this study, we observe the hardened properties of concrete for addition of 0.5, 1.0 and 1.5 grams of graphene are determined.

4.1 Hardened Properties

To get the variations in the properties of concrete i.e mechanical, Characteristic compressive strength and split tensile strength, cube (100 x 100 x 100 mm) and cylinder (100 mm diameter x 200 mm height) specimens were casted for getting the strength for seven days and twenty-eight days respectively. For each strength results, three samples were tested. The results of tests obtained are followed by the respective tables.

4.2 Characteristic Compressive Strength

Based on the results obtained from the concrete mixes incorporating varying amounts of graphene, it is evident that graphene's introduction has a notable impact on the compressive strength of the concrete at both 7 and 28 days.

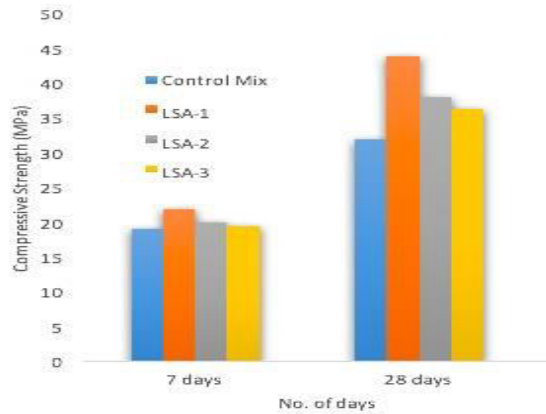


Fig. 1. Graphical representation of compressive strength of concrete with low surface graphite

In the case of the control mix, without graphene, the compressive strength at 7 days is measured at 19.13 MPa, which improves to 32.03 MPa at 28 days. However, when 0.5 grams of graphene (LSA-1) is added to the mix, the compressive strength at 7 days increases significantly to 22.05 MPa, and this enhancement is even more pronounced at 28 days, reaching 43.95 MPa. For the LSA-2 mix with 1.0 gram of graphene, the compressive strength at 7 days registers at 20.13 MPa, with a further increase to 38.20 MPa at 28 days. Similarly, the LSA-3 mix incorporating 1.5 grams of graphene exhibits a 7-day compressive strength of 19.60 MPa, and this strength continues to improve, reaching 36.48 MPa at 28 days. These findings clearly indicate that the addition of graphene, particularly at the 0.5-gram dosage (LSA-1), has a substantial positive impact on the compressive strength of the concrete. The observed increase in compressive strength over time suggests that graphene may be a promising nanomaterial for enhancing the mechanical properties of concrete, thereby holding significant potential for applications in the construction industry. Further research and development in this direction are warranted to explore the full range of benefits and practical implications of graphene-enhanced concrete.

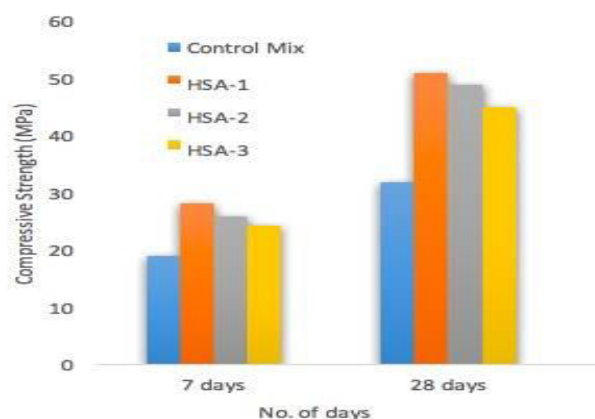


Fig. 2. Graphical representation of compressive strength of concrete with high surface graphite

In the control mix, which does not include graphene, the compressive strength at 7 days is 19.13 MPa, and it increases to 32.03 MPa at 28 days. However, when 0.5 grams of graphene (HSA-1) is added to the mix, the compressive strength at 7 days experiences a substantial improvement, reaching 28.15 MPa, and this enhancement is further pronounced at 28 days, with a compressive strength of 51.10 MPa. For the HSA-2 mix, which contains 1.0 gram of graphene, the compressive strength at 7 days is measured at 26.03 MPa, and it further increases to 48.96 MPa at 28 days. Similarly, the HSA-3 mix, with 1.5 grams of graphene, exhibits a 7-day compressive strength of 24.40 MPa, and

this strength continues to improve, reaching 45.08 MPa at 28 days. These findings clearly demonstrate that the addition of graphene, especially at the 0.5-gram dosage (HSA-1), has a substantial and positive impact on the compressive strength of the concrete. The notable increase in compressive strength over time suggests that graphene has the potential to be a valuable nanomaterial for enhancing the mechanical properties of concrete. This holds promise for applications within the construction industry. Further research and development in this area are warranted to explore the full range of benefits and practical implications of using graphene to enhance concrete strength.

4.3 Split Tensile Strength

Based on the data obtained from the concrete mixes with varying graphene content, it is clear that the inclusion of graphene has a noticeable impact on the split tensile strength of the concrete at both 7 days and 28 days.

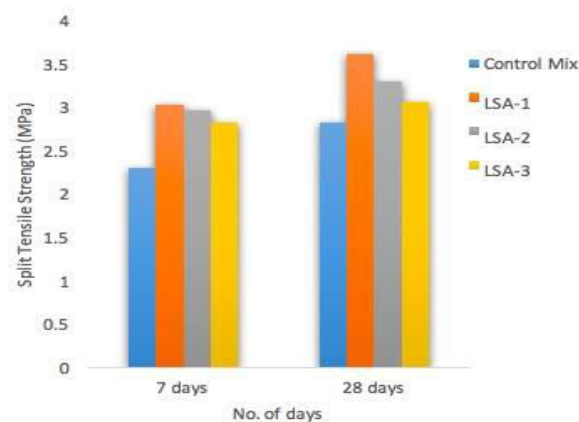


Fig. 3. Graphical representation of split strength of concrete with low surface graphite

In the control mix, where graphene is absent, the split tensile strength at 7 days is recorded at 2.30 MPa, and it increases to 2.83 MPa at 28 days. However, when 0.5 grams of graphene (LSA-1) is added to the mix, there is a substantial improvement in split tensile strength at 7 days, reaching 3.04 MPa, and this enhancement is even more pronounced at 28 days, with a split tensile strength of 3.62 MPa. For the LSA-2 mix, which incorporates 1.0 gram of graphene, the split tensile strength at 7 days is measured at 2.97 MPa, and it further increases to 3.31 MPa at 28 days. Similarly, the LSA-3 mix, containing 1.5 grams of graphene, exhibits a 7-day split tensile strength of 2.83 MPa, which continues to improve, reaching 3.07 MPa at 28 days. These findings clearly indicate that the addition of graphene, particularly at the 0.5-gram dosage (LSA-1), has a substantial positive impact on the split tensile strength of the concrete. The increase in split tensile strength over time suggests that graphene has the potential to enhance the concrete's resistance to tensile forces. This has important implications for improving the structural integrity of concrete elements, making it a promising nanomaterial for concrete applications in the construction industry. Further research and development in this direction are essential to fully understand and harness the advantages of graphene in enhancing split tensile strength in concrete.

In the control mix, which does not include graphene, the split tensile strength at 7 days is 2.30 MPa, and it increases to 2.83 MPa at 28 days. However, when 0.5 grams of graphene (HSA-1) is added to the mix, there is a significant improvement in split tensile strength at 7 days, reaching 3.15 MPa, and this enhancement is even more pronounced at 28 days, with a split tensile strength of 3.80 MPa. For the HSA-2 mix, which incorporates 1.0 gram of graphene, the split tensile strength at 7 days is measured at 3.11 MPa, and it further increases to 3.57 MPa at 28 days.

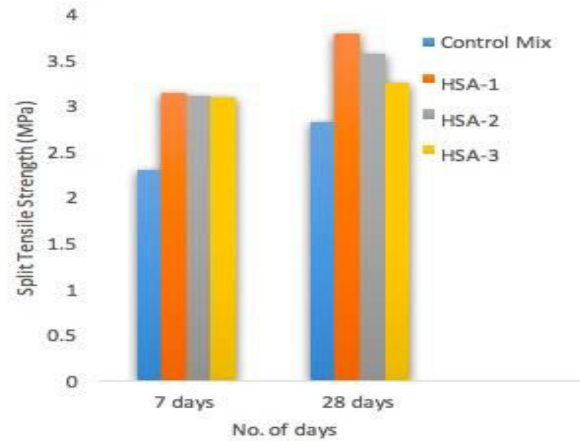


Fig. 3. Graphical representation of split strength of concrete with high surface graphite

Similarly, the HSA-3 mix, containing 1.5 grams of graphene, exhibits a 7-day split tensile strength of 3.09 MPa, which continues to improve, reaching 3.26 MPa at 28 days. These results clearly demonstrate that the addition of graphene, particularly at the 0.5-gram dosage (HSA-1), has a substantial and positive impact on the split tensile strength of the concrete. The increase in split tensile strength over time suggests that graphene has the potential to enhance the concrete's ability to resist tensile forces. This improvement has significant implications for enhancing the structural integrity of concrete elements, making graphene a promising nanomaterial for applications within the construction industry. Further research and development in this area are crucial to fully explore and harness the benefits of graphene in improving split tensile strength in concrete.

V. CONCLUSION

When graphene is added in cement concrete its strength increased and decreased both as per the used quantity of graphene. High surface area graphene provides more strength than low surface area graphene. The result of study shows that there is a downfall in strength with further increase in the quantity of graphene over 0.5 grams. Since it is a nano material, it requires more precise study to get the better use of this so called "Wonder Material".

REFERENCES

- [1] A. N. Reddy and D. Ramesh, "Studies on Impact Strength of Concrete with Nano-Materials at Elevated Temperatures," vol.25, no.15, 2015.
- [2] A. N. Reddy and T. Meena, "Acid Resistance of Ternary Blended Nanosilica Concrete Incorporating Fly Ash and Alccofine," pores, vol. 26, p. 27, 2021.
- [3] S.Nandhini and I.Padmanaban, "Experimental Investigation on Graphene oxide Composites with Fly Ash Concrete", International Journal of Earth Sciences and Engineering, vol. 09, no. 03, 2016.
- [4] A. N. Reddy and T. Meena, "The Effect of Alccofine on Blended Concrete Under Compression," in Emerging Technologies for Agriculture and Environment: Select Proceedings of ITsFEW 2018, Springer Singapore, 2020, pp. 27-37.
- [5] A. N. Reddy, "Properties of Green Cement Concrete with Alternative Cementitious Binders," International Journal of Engineering Sciences & Research Technology, vol. 3, no. 8, 2014.
- [6] A. N. Reddy and T. Meena, "A Study on Influence of Nano Silica on Mechanical Properties of Blended Concrete," Journal of Computational and Theoretical Nanoscience, vol. 16, no. 5-6, pp. 2006-2011, 2019.
- [7] T.Subramani and K.S.Ramesh "Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement Of Sand With M sand" International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 4, Issue 5, 2015.
- [8] IS 383: 1970, "Specification for coarse and fine aggregates from natural sources for concrete", Bureau of Indian Standards.
- [9] I.S: 516-1959, "Methods of Tests for Strength of Concrete", Bureau of Indian Standards, New Delhi.
- [10] IS: 456-2000 (reaffirmed 2005) "Plain and Reinforced Concrete – Code of Practice", Fourth Revision, pp.14
- [11] IS: 12269-1987, "Specification for 53 Grade ordinary Portland cement", Bureau of Indian Standards, New Delhi.

- [12] IS: 10262-2009, “Concrete mix proportioning- Guidelines”, Bureau of Indian Standards, New Delhi.
- [13] A. N. Reddy and T. Meena, “A Study on the Effect of Colloidal Nano-Silica on Blended Concrete Containing Fly Ash and Alccofine,” *Revista Romana de Materiale*, vol. 49, no. 2, pp. 217-224, 2019.
- [14] A. N. Reddy and U. V. Tilak, “Drying Shrinkage and Durability Studies on Alkali Activated Slag Concrete Using Different Activators,” *Int. J. Innovative Res. Sci. Eng. Technol.*, vol. 4, no. 11, pp. 11483-11492, 2015.
- [15] U. V. Tilak and A. N. Reddy, “Effect of Different Percentage Replacement of Weathered Aggregate in Place of Normal Aggregate on Young’s Modulus of Concrete to Produce High Strength and Flexible/Ductile Concrete for Use in Railway Concrete Sleepers,” *SSRG International Journal of Civil Engineering*, vol. 2, no. 11, pp. 24-29, 2015.
- [16] A. N. Reddy and T. Meena, “A Comprehensive Overview on Performance of Alccofine Concrete,” *International Journal of Pharmacy & Technology*, vol. 9, no. 1, 2017.
- [17] A. N. Reddy and T. Meena, “An Experimental Study to Find the Optimum Dosage of Admixtures in Blended Concrete,” *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 7, no. 2, pp. 1062-5, 2019.
- [18] A. N. Reddy, S. Priyanka, and P. Mounika, “The Effect of Nanosilica on Mechanical Properties of Concrete,” *Int. Res. J. Appl. Sci.*, vol. 1, no. 1, pp. 36-40, 2019.
- [19] A. N. Reddy and T. Meena, “Study on Effect of Colloidal Nano Silica Blended Concrete Under Compression,” *Int. J. Eng. Technol.*, vol. 7, no. 10, 2018.
- [20] A. N. Reddy, P. Mounika, and R. Moulika, “Study on Effect of Alccofine and Nano Silica on Properties of Concrete-A Review,” *International Journal of Civil Engineering and Technology (IJCIET)*, vol. 9, no. 13, pp. 559-565, 2018.
- [21] N. Reddy, K. Naveen, and N. S. Rani, “Use the Treated Domestic Wastewater as a Mixing Water in Cement Mortar,” *International Journal of Engg. Science Invention*, pp. 23-31, 2015.



SJIF Scientific Journal Impact Factor

Impact Factor: 8.423



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details