PHYSICAL AND BIOLOGICAL CHARACTERIZATION OF GRAPHENE OXIDE ADMIXED CONCRETE EXPOSED TO SEA ENVIRONMENT.

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Abstract

This paper presents a comprehensive review of graphene-induced concrete and its performance in marine environments. With the increasing demand for durable and sustainable construction materials, graphene has emerged as a promising additive due to its exceptional mechanical, electrical, and barrier properties. In this review, we discuss the synthesis methods of graphene and its incorporation into concrete matrices. The effects of graphene on the mechanical properties, durability, and resistance to seawater corrosion of concrete are examined. Additionally, the role of graphene in improving the impermeability, chloride ion penetration resistance, and carbonation resistance of concrete in marine environments is discussed. Furthermore, the challenges and opportunities for the widespread adoption of graphene-enhanced concrete in coastal and offshore structures are addressed. Overall, this review highlights the potential of graphene-induced concrete as a durable and sustainable solution for marine construction applications.

Key Words: GRAPHENE OXIDE, EXPOSURE, SEA ENVIRONMENT, STRENGTH, SUSTAINABLITY

1.INTRODUCTION

In the realm of civil engineering, ordinary Portland cement (OPC) continues to be the material of choice for construction. Cement is produced more than 3.6 billion tons worldwide, satisfying the world's need for infrastructure and building construction as a result of urbanization, particularly in rapidly emerging nations like China and India. But concrete's main drawback is that it's brittle, which is caused by its low tensile strength, strain capacity, and poor resistance to fracture formation. The tensile strength of concrete ranges from 2 to 8 Mpa, depending on the mix proportions of aggregates, cement, and water. High-performance and intelligent cementitious materials are needed to produce safer, more resilient, and more cost-effective infrastructure systems in light of the building industry's rapid advancement. However, these conventional fibers' impacts on cement paste are naturally restricted at the macro and meso scales because their sizes are often at or above the millimeter scale. Excellent nanomaterial, graphene oxide, is available thanks to recent advances in materials science and nanotechnology and can be used as a nano-sized additive for cementitious materials. When comparing graphene to other nanomaterials, it exhibits a distinct atom-thick sp2 bonded 2D structure. Due to the oxygen functions present, graphene oxide has the benefit of being easily soluble in a variety of matrixes and organic solvents, including water.

2. LITERATURE REVIEW

S.C. Devi, R.A. Khan studied Graphene oxide (GO) has the potential to significantly alter the building sector soon. It exhibits greater dispersibility qualities than any other graphene-derived material due to the oxygenated functions connected to the aromatic structure. Many scholars have expressed their opinions on the impact of GO on mechanical and durability qualities in ceramic matrices. GO was included in five mixtures (0%, 0.02%, 0.04%, 0.06%, and 0.08% by weight of cement). Mechanical and water permeability properties were examined. The mix containing 0.08% GO had a higher compressive and tensile strength than the other mixes. The sorptivity and permeability of nano-reinforced concrete mixes containing GO were found to decrease as the GO content in the concrete increased, as compared to the control mix. The synthesized GO was structurally studied by FE-SEM/EDX, FT-IR, and XRD. SEM/EDX was used to perform microstructural analysis on 90-day-old concrete mixes, and the quality of the concrete mixes was assessed using the UPV test.

A. Mohammed , J.G. Sanjayan , W.H. Duan , A. Nazari investigated the transport properties of graphene oxide-reinforced cement composites and how they can be used in concrete with similar ingredients. Transportation parameters determine the long-term longevity of concrete constructions. Water sorptivity, chloride penetration, and mercury intrusion porosimetry were used to investigate the influence of graphene oxide addition on the cement matrix and its transport parameters. Graphene oxide was disseminated into cement mortar to create graphene oxide cement composite by adding 0.01%, 0.03%, and 0.06% by weight of cement. Experimental results show that incorporating a very small fraction of graphene oxide (0.01%) can effectively inhibit the entry of chloride ions. In addition, introducing graphene oxide at a moderate proportion of 0.03% improves sorptivity substantially. It can be inferred that the addition of graphene oxide to the cement matrix can significantly improve the cement matrix's transport capabilities, hence increasing its durability.

Wang et al. investigated the impact of different dispersion techniques on the mechanical properties of graphene-reinforced concrete, highlighting the importance of achieving uniform dispersion for optimal performance. Efficient dispersion of graphene within concrete matrices is crucial for realizing its potential benefits. Various dispersion methods have been explored, including mechanical mixing, sonication, and chemical treatments.

H. Luo, Y. Shen, and Z. Li conducted experiments to assess the effect of graphene oxide Nano platelets on the compressive and flexural strength of cement mortar. They observed improvements in both strength parameters with the addition of graphene oxide, attributing the enhancements to the reinforcement provided by graphene sheets.

Similarly, **Yang et al** explored the mechanical and electrical properties of graphene/cement composites. Their research demonstrated that improved dispersion of graphene in the cement matrix led to significant enhancements in compressive strength, flexural strength, and electrical conductivity. The study highlighted the importance of achieving uniform dispersion for maximizing the mechanical performance of graphene enhanced concrete.

Studies have also examined the microstructural changes induced by the incorporation of graphene in concrete. **M. Ma, Y. Liu, and X. Chen** utilized advanced microscopy techniques to investigate the dispersion and interfacial interactions of graphene in cementitious matrices. They observed a uniform distribution of graphene and strong interfacial bonding between graphene sheets and cementitious phases, which contributed to the enhanced mechanical properties of the composites.

Another area of interest is the influence of graphene incorporation on the thermal and electrical conductivity of concrete. Studies by **Chen et al and Wang et al**. explored the thermal conductivity of graphene-modified concrete and its potential applications in energy-efficient construction. Additionally, graphene incorporation has been investigated for imparting electrical conductivity to concrete, enabling applications in smart infrastructure systems and sensing technologies.

2.2 CHALLENGES AND DISADVANTAGES:

Despite the promising results, challenges remain in the widespread adoption of graphene modified concrete. Issues such as cost-effectiveness, scalability of production, and long-term performance need to be addressed.

- Production of Graphene may pollute the environment.
- Waste disposal after its lifetime.
- Dispersion and Agglomeration
- Compatibility with Cementitious Materials
- Dosage Optimization
- Cost and Availability
- Scale-Up and Production Techniques
- Long-Term Durability and Performance
- Health and Safety Concerns

2.3 RESEARCH GAP:

Future research directions may focus on developing cost-effective production methods and evaluating the environmental impacts of graphene incorporation in concrete. No paper has mentioned about:

• anti-microbial properties.

• Exposure to chemicals.

• Corrosion resistance properties.

• The addition of another admixture will enhance concrete properties.

Agglomeration of nanomaterials hinders their potential to improve the properties of concrete. In this regard, the dispersion mechanism of nanomaterials is yet to be developed. Although GO appears to be well-dispersed in water, there is no such guarantee of good dispersion in the cement matrix. Admixtures play an important role to preserve the cement workability when nanomaterials are added. However, detailed studies on the role of nanomaterials on the hydration and interaction with the various phases of cement, including admixtures require attention. The durability aspect of cement and mortar containing nanomaterials provides an interesting avenue for research. The behavior of such composite under degradation such as carbonation, acid resistance, and sulphate resistance should be analyzed.

3. CONCLUSIONS

The main drawback of producing concrete by traditional methods is the rise in carbon emissions. Graphene has many remarkable features such as an eco-friendly concrete material, high elasticity; Elastic modulus (E) of around 425GPa, and tensile strength is around 1.3TPa so designated as a 21st-century material. Finally, research on graphene incorporated concrete shows that graphene has a great deal of potential to improve the characteristics and functionality of concrete materials. Concrete's mechanical strength, durability, and other important attributes can be improved by adding graphene, whether in the form of graphene oxide (GO), graphene Nano platelets (GNPs), or other graphene based materials, even if laboratory trials have shown encouraging results, there are still issues and gaps that need to be fixed before graphene-incorporated concrete is extensively used in real-world applications. These encompass concerns about dispersion methods, scalability, long-term robustness, economy, standardization, health and safety issues, and investigation of new uses. Among all the Nano fillers, GO appears to be an ideal candidate to enhance the properties of cement-based composite. The excellent intrinsic properties of the 2D Nano sheet can strengthen the brittle cement matrix, similar to CNT. Furthermore, the oxygen-bearing functional groups are desirable for homogeneous dispersion in cement, nucleation of C–S–H and densify the microstructure.

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