Graphene Oxide-Modified Epoxy Coatings for Mitigating Corrosion in Concrete Sewers

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Concrete sewer systems are highly vulnerable to microbial-induced corrosion, resulting in severe structural deterioration and high maintenance costs. Developing durable, chemically resistant coatings is essential to mitigate this deterioration. Inorganic-organic composite coatings, particularly enhanced with nanomaterials, offer promising solutions for improving corrosion resistance and long-term performance. This study aims to develop a novel graphene oxide (GO)-epoxy composite coating with enhanced adhesion, chemical stability, and barrier properties. It evaluates the effectiveness of GO as a filler in improving corrosion resistance, reducing water absorption, and increasing coating durability under simulated sewer conditions. GO was synthesized from Sri Lankan vein graphite obtained from Bogala Lanka Mines using the Hummers method. A composite coating was prepared by incorporating 1 wt% GO into an epoxy matrix to improve dispersion and interfacial interaction. Coated and uncoated mortar specimens were subjected to cyclic immersion in 0.2% sulfuric acid (pH 1.39). The test consisted of two 5-day cycles, with acid replacement between cycles to simulate sewer conditions. Performance was evaluated through pH variation, mass loss, and visual appearance. Water absorption and contact angle measurements were also conducted to assess the water resistance of coatings. Fourier transform infrared spectroscopy confirmed the successful synthesis of GO, while scanning electron microscopy verified its uniform dispersion within the epoxy matrix. Uncoated specimens exhibited severe degradation, with mass loss increasing from ~11% to ~14% over two cycles. Epoxy-coated samples showed significantly lower mass loss (~2%) after the first cycle. A slight negative mass change (~ –1%), was observed after the second cycle, possibly due to acid entrapment or surface deposition. GO-epoxy coatings performed best, with minimal mass loss (~1.5%) and stable behavior thereafter, demonstrating strong resistance to acid penetration. Water absorption decreased from 9.95% (uncoated) to 0.09% (epoxy) and 0.02% (GO-epoxy), while the contact angle increased from 47.30° to 66.95° and 78.65°, respectively indicating enhanced water resistance with GO incorporation. GO enhances the protective performance of epoxy coatings by improving barrier properties, reducing water ingress, and increasing resistance to acidic environments. These findings highlight the potential of GO-epoxy composites as durable, cost-effective solutions for extending the service life of concrete sewer infrastructure.

Keywords: composite coating, corrosion resistance, epoxy, graphene oxide, sewer

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