Numerical homogenization of irregular and inhomogeneous three-layered composites based on polyurea (polyurethane-urea) and rigid polyurethane

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ABSTRACT

Numerical homogenization is a crucial technique for analyzing composite materials [1], enabling the accurate modeling and prediction of their effective mechanical properties through the finite element method (FEM). This study focuses on applying this technique to a specific type of composites used for the renovation and protection of wells and tanks exposed to aggressive sulphate environments. The composite package combines two layers of polyurea as a protective coating for the renovation of corroded concrete structures with an inner layer of rigid polyurethane to fill voids and serve as a quasi-load-bearing reinforcement layer. Given the irregularity and inhomogeneity of the corrosion-induced voids in concrete, the homogenization process in this study not only incorporates these features to predict the composite's behavior accurately but also analyzes the potential delamination between layers and its impact on the effective properties of the composite.

The methodology is based on the strain energy equivalence approach between the detailed 3D model of the corrugated structure and its simplified Reissner-Mindlin plate representation [2,3]. By leveraging the FEM [4] for numerical homogenization, the study aims to provide a comprehensive understanding of the composite's mechanical performance, including the effects of potential delamination, ensuring the effective restoration and strengthening of the damaged structures. This nuanced approach promises significant implications for the durability and longevity of infrastructure in sulfate-rich environments, offering a novel solution for structural engineers and materials scientists by ensuring that both the integrity and performance of the composite under such conditions are thoroughly understood and optimized.

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