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Application of Gene Expression Programming Model to Present a New Model for Bond Strength of Fiber Reinforced Polymer and Concrete

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ABSTRACT

In this paper, the gene expression-programming model was applied to present a novel model for the bond strength of concrete and fiber-reinforced polymer estimation. In order to do this, collected data were divided into the trained and tested ones by gene expression programming (GEP) means. The input parameters are the width of fiber-reinforced polymer, the width of concrete, thickness of fiber-reinforced polymer, the elastic modulus of fiber-reinforced polymer (FRP), concrete cylinder compressive strength, and bond length. The output parameters are the bond strength of concrete and FRP. Finally, a novel relationship was derived using the GEP to predict the bond strength of FRP -to-concrete composite joints. Results showed that the presented relationship was more convenient than the other models and that it was a powerful tool to predict the bond strength values of the FRP -to-concrete composite. For example, R-square (R2) of the present work is 0.92 compared to that (< 0.82) reported for other models. Among the models presented by other researchers, that of Dai et al. is more accurate than the other ones, and the model offered by Khalifa et al. has the lowest accuracy.

Keywords: Fiber Reinforced Polymers; Bond Strength; Gene Expression Programming; Concrete.

1. INTRODUCTION

Fiber-reinforced polymer (FRP) is built of a polymer matrix reinforced with fibers. The application of FRP is an effective method to ensure load path continuity between concrete surface and FRP. It is also used to increase the bond strength of concrete structures. Because of high strength-to-weight ratios and high corrosion resistance of FRPs, they are used to strengthen concrete structures [1-6]. For example, Singh [7] presented a new equation to estimate FRP-to-FRP bond capacity. They experimentally studied on bonded FRP-to-FRP lap joints and suggested models to calculate the bond capacity. Castillo et al. [8] presented a review of the design models of reinforced concrete structures strengthened with FRP composites. In another study, Castillo et al. [9] experimentally studied on bent FRP anchor specimens to characterize their behavior upon the occurrence of the fiber rupture failure mode. Properly designed FRP anchors can fully develop the strength of FRP strips. However, the comprehensive impact of some