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ORIGINAL PAPER

Modeling for torsional strength prediction of strengthened RC beams

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Abstract
This study investigates three models to predict the torsional strength of FRP-strengthened reinforced concrete (RC) structural beams: artificial neural network (ANN), nonlinear regression model (NLR), and linear regression model (LR). The researchers examined data from over 96 tested FRP-strengthened beams to develop these prediction models. The models account for 10 distinct variables (input parameters), such as the RC beam's width and height, the FRP sheet's thickness and elastic modulus, the yield stress of the longitudinal and transverse steels, the compressive strength of the concrete, the effective width of the FRP strips along the beam's length, the center-to-center spacing of the FRP strips, the angle of wrapping, and the number of FRP layers. The beam's torsional strength is an appropriate parameter. Several statistical measures, including correlation coefficient (R^2), root mean squared error (RMSE), mean absolute error (MAE), Scatter Index (SI), and objective (OBJ) values, were employed to assess the efficiency of the presented models. With R^2, RMSE, MAE, OBJ, and SI values of 0.99, 3.07 kN m, 2.41, 2.63, and 0.17 kN m, respectively, the results demonstrated that the ANN model outperformed the other models in predicting the ultimate torsional strength of strengthened RC beams. This study provides an important database that may be used as a benchmark for future predicts of the torsional strength of strengthened RC beams. The influence of each parameter on the torsional strength of these beams was further studied using sensitivity analysis. The results showed a highly accurate prediction of the torsional strength of FRP-strengthened RC beams.

Keywords RC · Torsional strengthening · ANN · FRP

1 Introduction

It is a challenging and vital task to determine the torsional behavior of reinforced concrete beams, especially when they are strengthened with FRP. However, there has been little investigation on the torsional behavior of these beams, even though there have been many studies and experiments on their bending behavior within specific environmental conditions.

A difficult characteristic of structural behavior is twisting. Torsional stresses develop when shear stresses are not applied through the shear center. The performance of beams reinforced with FRP under torsional loading has been the subject of numerous investigations, with some remarkable laboratory findings.

Standard techniques for calculating Tu may not be compatible with strengthened RC beams. This parameter may be changing, according to ongoing study. To predict the results of experiments, engineers need to use less complicated techniques and mathematical formulas. This demand results from Tu's depending on several variables. Soft computing techniques might be regarded as an acceptable response. These methods may be used to generate alternatives and solutions for both linear and nonlinear problems when mathematical models are unable to sufficiently explain how the main features of the problem are connected.

Artificial intelligence systems for evaluating and predicting the torsional strength of strengthened RC beams are

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