Damage identification of RC beams using Feed-Forward Back Propagation Neural Network Approach (FFBPN)

Kjarol A. Oroz*, Vladimir Ramos*, Joan R. Casas† and Rick M. Delgadillo*†

* Department of Civil Engineering, Universidad Peruana de Ciencias Aplicadas (UPC), Prolongación Primavera 2390, Monterrico Santiago de Surco, Lima, Peru - web page: https://www.upc.edu.pe/
e-mail: u201714025@upc.edu.pe, u201615839@upc.edu.pe, *†Correspondence: pccirdel@upc.edu.pe

† Department of Civil and Environmental Engineering, Technical University of Catalonia (BarcelonaTech), Catalonia, Spain.
Campus Nord, C1 building. Jordi Girona, 1-3, 08034, Barcelona, Spain
e-mail : joan.ramon.casas@upc.edu - web page: https://www.upc.edu/es

Key Words: Damage Detection, RC Beams, Artificial Neural Network (ANN), Natural Frequency, Artificial Intelligence (AI), Feed-Forward Back Propagation Neural Network Approach (FFBPN), Structural Health Monitoring (SHM).

ABSTRACT

Reinforced concrete (RC) beams are constantly exposed to environmental factors, overloads and aging, which is a challenging problem because they increase the risk of structural failure. In this sense, the detection of structural damage through modal parameters and artificial intelligence (AI) tools makes it possible to establish a comprehensive and precise vibration-based methodology within the field of Structural Health Monitoring (SHM). In this article, the variation of vibration frequencies is used in combination with Machine Learning (ML) techniques through the use of Feed-Forward Back Propagation Network (FFBPN) for structural damage detection in reinforced concrete beams (RC). The proposed methodology considers three steps: (i) the vibration frequencies of the beam are obtained using the ANSYS software for twenty-six structural damage scenarios, of which twenty are for code training and six are test for accuracy validation (ii) the training data and the data set values are used to study the performance of an FFBPN (iii) The FFBPN trained with the natural frequency data is able to detect and assess the severity of transverse cracks in the beam. Finally, the proposed methodology shows an accuracy greater than 91.5% for damage detection and its severity in the reinforced concrete beam for the six test scenarios proposed. Besides, these results serve to evaluate the structural conditions in beams of real constructions such as buildings, hospitals, schools.