A FRAMEWORK FOR DAMAGE DETECTION IN TRUSS STRUCTURES USING THE FINITE ELEMENT METHOD AND ARTIFICIAL INTELLIGENCE

Abstract. *This study presents a numerical procedure developed for assessing structural damage in frame structures. The analysis focuses on a spatial frame consisting of 58 beams. Finite element calculations are conducted based on static analyses. The numerical results are used to create a database considering various damage scenarios, simulated by the removal of specific beams from the structure. For each damage condition, data on strains in particular beams are recorded in the database. The selection of these beams is based on the evaluation of a parameter named strain delta, which quantifies the sensitivity of each beam to damage to a certain damage scenario faced by the structure. The built database is then used to train an artificial neural network (Random Forest Classifier) designed to detect damage scenarios from given structural information, specifically strains obtained through the finite element method. The prototype numerical framework is intended for future application in detecting vandalism in electric transmission towers. The trained artificial neural network is expected to estimate the probability of beams' removal from the frame, particularly from sections near the ground, simulating vandalism, based on specific structural inputs measured by strain gauges attached to the frame. The results obtained confirm the effectiveness of the methodology developed in this study when both the training and input data provided to the neural network are of the same nature (either both numerical or experimental). Additionally, it was found that the neural network is capable of detecting structural damage even when trained with numerical data and tested with experimental inputs. However, precise identification of the specific removed beam was not achieved. The Random Forest Classifier algorithm, combined with the numerical analysis performed, demonstrated its capability to identify different structural damage scenarios, providing reliable results based on strain measurements, even when the specific removed beam could not be determined.*

Keywords: *Damage Detection, Frame Structures, Finite Element Analysis, Artificial Neural Networks.*