World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:12, No:12, 2018

Bridge Damage Detection and Stiffness Reduction Using Vibration Data: Experimental Investigation on a Small Scale Steel Bridge

Authors : Mirco Tarozzi, Giacomo Pignagnoli, Andrea Benedetti

Abstract : The design of planning maintenance of civil structures often requires the evaluation of their level of safety in order to be able to choose which structure, and in which measure, it needs a structural retrofit. This work deals with the evaluation of the stiffness reduction of a scaled steel deck due to the presence of localized damages. The dynamic tests performed on it have shown the variability of its main frequencies linked to the gradual reduction of its rigidity. This deck consists in a steel grillage of four secondary beams and three main beams linked to a concrete slab. This steel deck is 6 m long and 3 m wide and it rests on two abutments made of concrete. By processing the signals of the accelerations due to a random excitation of the deck, the main natural frequencies of this bridge have been extracted. In order to assign more reliable parameters to the numerical model of the deck, some load tests have been performed and the mechanical property of the materials and the supports have been obtained. The two external beams have been cut at one third of their length and the structural strength has been restored by the design of a bolted plate. The gradual loss of the bolts and the plates removal have made the simulation of localized damage possible. In order to define the relationship between frequency variation and loss in stiffness, the identification of its natural frequencies has been performed, before and after the occurrence of the damage, corresponding to each step. The study of the relationship between stiffness losses and frequency shifts has been reported in this paper: the square of the frequency variation due to the presence of the damage is proportional to the ratio between the rigidities. This relationship can be used to quantify the loss in stiffness of a real scale bridge in an efficient way.

Keywords : damage detection, dynamic test, frequency shifts, operational modal analysis, steel bridge
Conference Title : ICSHMST 2018 : International Conference on Structural Health Monitoring Systems and Technologies
Conference Location : Rome, Italy
Conference Dates : December 13-14, 2018