On situ vibration based structural health monitoring of a railway steel truss bridge: a preliminary numerical study.

Lorenzo Bernardini[1*], Claudio Somaschini[2] and Andrea Collina[2]

[1*] Mechanical Engineering Department, Politecnico di Milano, Via G. La Masa 1, 20156, Milano.
lorenzo.bernardini@polimi.it

[2] Mechanical Engineering Department, Politecnico di Milano, Via G. La Masa 1, 20156, Milano,
claudio.somaschini@polimi.it, andrea.collina@polimi.it

Key Words: *Steel truss bridge, railway bridge, structural health monitoring, direct monitoring, vibration-based monitoring.*

Viaducts and bridges enable daily transportation of goods and passengers throughout the entire country. Railway network is subject to increasing travelling loads and traffic frequency. In addition, most of the bridges were built in the last century: they are subject to ageing and degradation [1], as an unavoidable phenomenon. It is therefore necessary to develop proper structural health monitoring systems that can support periodical visual inspections. That is why infrastructure managers are always looking for new technologies to assess in an almost continuous way the health status of their network components. Direct monitoring systems consist of mounting a set of different sensors on the structure under analysis, whose measurements are then used in order to assess structure mechanical performances and status. Given the nature of the bridge/viaduct to monitor and the kind of damage to detect, it is important to choose the proper typologies of sensing devices. Moreover, the following step is represented by the choice of an adequate damage-sensitive index (or set of them), that is able to capture and reflect eventual changes in structure performances during time. This paper is the result of a numerical study performed on a 3D FE model based on an existing structure: the studied bridge is a Warren truss railway bridge, located in Northern Italy, built few year after the second world war. The authors investigated the performances of different vibration-based methods [2]-[3], namely two modal-parameters based approaches and a non-modal ones. The former, based on the use of modal parameters (natural frequencies and mode shapes) as damage-sensitive indexes, was shown to be slightly sensitive to damage, also applying important flaw intensities. Instead, the latter, that do not imply the computation of any modal parameter, showed better results, both in terms of damage identification and localization. In particular, exploiting the RMS values of the signals recorded by a mesh of velocimeters placed along the span can represent a possibility to detect damage presence and its approximate location. This analysis has been performed for a set of different damage scenarios, suggested by the infrastructure managers. The simulations were run adopting a complete multi-body train model. Furthermore, in the attempt to get closer to real operating conditions, the actual track profile featuring the considered line portion was inserted in the simulation program.

REFERENCES

[1] Jongbing Won, Jong-Woong Park, Soojin Jang, Kyohoon Jin and Youngbin Kim, Automated Structural Damage Identification Using Data Normalization and 1-Dimensional Convolutional Neural Network, Applied Science 2021, 11, 2610. DOI: https://doi.org/10.3390/app11062610

[2] Fan, W., Qiao, P.: Vibration-based damage identification methods: A review and comparative study. Struct. Health Monit. 10(1), 83-111 (2011).

[3] Casas, J.R.; Moughty, J.J. Bridge damage detection based on vibration data: Past and new developments. JFiBE 2017, 3, 4.