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FONDAZIONE

MS20 - Bridge Dynamics

R. Betti, Y. Fujino, H. Xia

MS20.I - Tuesday 12 September, 14:30-16:30

A theoretical and experimental evaluation of the modal properties of a cable-stayed footbridge

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In the paper the experimental and numerical estimation of dynamic characteristics, i.e. natural frequencies and modes of vibrations, of cable-stayed footbridge is presented. The investigation was performed for an existing pedestrian bridge located in Pcim, Southern Poland. The primary purpose of the structure is to carry pedestrians and cyclists across the Raba river. It is a part of the road junction situated within 300 m of the national expressway S7. The suspended structure consists of three spans: the middle one is 60.00 m long, whereas two extreme are 25.50 m long. The total theoretical length is 120 m. The footbridge's deck made of steel-concrete composite is connected to the two steel pylons by cables. The structure is equipped with elastomeric bearings as linking elements between the deck and the abutments. The aim of the investigation was to evaluate the dynamic characteristics, i.e. natural frequencies, modes of vibrations and damping ratio of the footbridge. For the numerical analysis a 3D model of the footbridge was prepared with the ABAQUS software. For the experimental investigation the procedure of the in situ tests was prepared. Three types of excitation were used during experimental tests: ambient vibration, shock excitation and slow sine sweep testing. In the last stage of the study authors make the validation of the obtained results. For this purpose the Modal Assurance Criterion theory was used. The modal analysis revealed that the lowest natural frequency of the footbridge equaled 1.9 Hz, so it coincides with the frequency of pedestrian steps while walking or running.

Dynamics of the scissors-type mobile bridge

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The paper presents a new type of emergency bridge, which can be quickly constructed in case of damages after a natural disaster. The concept of the bridge is based on the application of scissor-type mechanism, which provides its rapid deployment. Up to now several experimental Mobile Bridges of different size were constructed and tested. The current model MB4.0 has the span of about 20m and the height of 2m. Main structural members of the bridge are made of extruded aluminium alloy while the frame of the hydraulic deployment system is constructed of steel SS400. The main scissor elements of the MB4.0 allow for a static load of approximately 120kN, however the structure of the deck limits it to 30kN. In case of deployable structures apart from static analysis of different configurations of expansion, it is very important to investigate the dynamic behaviour of the system. High compliance and flexibility of the scissors-type bridge may influence user's comfort and safety in case of heavy dynamic loads such as human induced impacts, wind gusts or earthquakes. The presented research reviews fundamental numerical and experimental results for the MB4.0. Experimental testing included strain and acceleration measurements in free and forced loading conditions. From these results, it was possible to estimate basic dynamic characteristics of the bridge. In order to provide a basis for development of new methods for structural reinforcement and suppression of vibrations, various numerical models were created. The conducted research allows for a better and safer design of the structure of the Mobile Bridge.

Estimation of the dynamic response in a slender suspension bridge using measured acceleration data

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