footbridge madrid2020 creatingexperience

Conference 23-25.09.2020 Madrid

Contact author: Elsa Caetano, ecaetano@fe.up.pt

DYNAMIC DESIGN LOADS AND PERFORMANCE OF A GFRP-SFRSCC HYBRID FOOTBRIDGE PROTOTYPE

Authors: Vítor DACOL[1], Elsa CAETANO[2], João R. CORREIA[3]

Affiliation: [1] Postdoc Researcher, CONSTRUCT, Faculty of Engineering (FEUP), Univ. of Porto, Portugal

[2] Associate Professor, CONSTRUCT, Faculty of Engineering (FEUP), Univ. of Porto, Portugal

[3] Full Professor, CERIS, DECivil, Instituto Superior Técnico (IST), University of Lisbon, Lisbon

Keywords: Composite structures, GFRP, Steel, Dynamic behaviour, Vibrations, pedestrian loads, damping.

This paper presents an experimental and numerical study of the dynamic behaviour of a hybrid footbridge made of pultruded GFRP profiles and an SFRSCC deck, installed in northern Portugal and in operation since 2015. The study comprised the identification of the resonant frequencies, damping ratios and mode shapes of the footbridge based on ambient and forced excitation and the assessment of the response to pedestrian loads. To evaluate the damping performance of polymer-based composite materials, namely GFRP, numerical simulations of pedestrian effects were conducted both on the numerical model of the GFRP-SFRSCC footbridge and an alternative steel-based footbridge design using damping ratios identified on the GFRP-based prototype and reported in the literature for a similar structure, in the case of the steel-based model, in average five times lower than the former.

It is observed that the fundamental frequencies of the GFRP and steel-based structures are very similar, with the first frequency of the GFRP prototype being 8.62 Hz. A maximum vertical acceleration measured of 0.936 m/s^2 for a pedestrian density of 0.82 (person/m^2) would lead to a classification of this footbridge, according to HIVOSS, in a medium category comfort class.

To simulate the crowd response, a simplified probabilistic approach is followed to represent the effects of a non-synchronised number of pedestrians acting on the footbridge deck. The results indicate the enormous importance of considering the fourth harmonic load component in the modal analysis to accurately reproduce the dynamic behaviour of a short-span footbridge.

It is also concluded that the GFRP-based structure has a better performance than a steel-based structure whenever the pedestrian loads act in the vicinity of a structural frequency. Although the studies conducted are specific to one structure, this better performance of polymer-based composite materials than steel material under resonant vibrations is expected for short span footbridges.

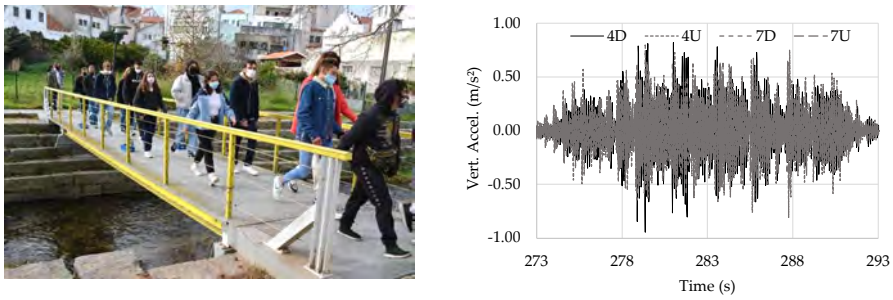

Fig. 5. Crossing footbridge by 18 pedestrians during ambient vibration test. General view and time records

https://doi.org/10.24904/footbridge2022.283