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PROPOSED METHOD FOR ESTIMATION OF DAMPING RATIO OF A STRUCTURE USING CONTINUOUS WAVELET TRANSFORMATION METHOD

K.K. Wijesundara

Department of Civil and Infrastructure Engineering,
South Asian Institute of Technology and Medicine, Malabe, Sri Lanka
kushan.saitm@gmail.com

Currently, ambient vibration measurements are commonly used in the assessment and structural health monitoring of civil engineering structures such as buildings, bridges, dams and towers. Because the ambient vibration testing is cheap and fast, no elaborate excitation equipment are required, no boundary condition simulations are required, and modal properties of the whole system can be estimated using a modal extraction technique. Furthermore, the extracted modal parameters such as natural periods, mode shapes and damping ratios can also be used for verifying the design characteristics of a civil engineering structure and validating the numerical model that can be used to predict the response of a structure under an extreme loading condition. Out of the three modal properties, the estimation of the damping ratio of a structure from an ambient vibration measurement using the Random Decrement (RD) method itself may be inaccurate due to the presence of higher mode amplifications in the response. Therefore, this study proposed a novel method called two-step procedure for the estimation of the damping ratio of a structure from an ambient vibration measurement by combining the RD method with the Continuous Wavelet Transformation (CWT) method.

The two step method was validated through a numerical simulation of a structure. For these purposes, two dimensional numerical model of a five storey concrete frame was analyzed elastically for 50 real earthquakes. The vibration at the top storey induced by each earthquake can be considered to be an ambient vibration for very short duration. The damping ratio of the structure was estimated by analyzing each vibration measurement at the top storey using the two step procedure and subsequently, the resultant damping ratios were compared with the numerical damping ratio of 5% assigned to all the modes of vibration of the numerical model. Based on the results of numerical application in five storey frame building, it can be concluded that the two step method can estimate the damping ratio quite accurately even when a response is non-stationary and lasts for relatively short duration. However, the maximum error of 26% was observed when the two steps procedure is used.