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Development of Residual Seismic Capacity Evaluation System with IT Kyoshin seismometer

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Authors have been developing the real-time residual seismic capacity evaluation system, which needs only few relatively cheap accelerometers. The developed system is, however, the system only for the building of which first mode is predominant such as low-rise buildings. High-rise buildings of which higher mode effect is not negligible, and eccentric buildings, which show three-dimensional response such as torsion have more than one predominant vibration mode.

In order to enable the system to be used for the high-rise building, a technique for analysis of dynamic structural response is developed based on the Wavelet Transform Method (WTM). This technique extends an earlier methodology for structures with a predominant fundamental mode, to multi-degree of freedom situations. The structural behavior is evaluated in the form of a performance curve of the predominant response, as a relationship between the equivalent force and equivalent displacement. This curve, scaled by its corresponding mass ratio may be directly compared to a seismic demand curve for the purpose of condition assessment.

In this paper, the decomposition procedure of dynamic structural response using the WTM is presented. Validity of the procedure is illustrated based on an analysis of a two degree of freedom system. Thereafter, actual dynamic response data from the Vincent Thomas Bridge (VTB) during the 1987 Whittier earthquake, the 1994 Northridge earthquake, and two ambient vibration events in 2004 are studied.

The main findings of this study are,

The developed WTM can efficiently decompose the dynamic response into its primary response frequency bands. The resulting predominant resonance agreed very well with the eigenvalue analysis result.

In the investigated cases, the predominant performance curves of the VTB in the longitudinal directions were successfully extracted. Their estimated equivalent mass ratios were found to be almost constant at all deformation levels. Therefore, the performance curve can be divided by this constant value to be compared with the demand curve.

A reduction in the longitudinal stiffness of the VTB is documented during the large cycles of dynamic response. Stiffness in the longitudinal direction has not changed due to the imparted earthquake excitations during the last 20 years.

The same system is applied for a building in Yokohama national University. More than 10 earthquake responses are recorded from February 2008 to July 2008. The responses showed availability of the system although the building remains elastic.