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Joint application of non-invasive techniques to characterize the dynamic behaviuor of engineering structures

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The systematic monitoring of strategic civil infrastructures such as bridges, large dams or high-rise buildings in order to ensure their structural stability is a strategic issue particularly in earthquake-prone regions. Nevertheless, in areas less exposed to seismic hazard, the monitoring is also an important tool for civil engineers, for instance if they have to deal with structures exposed to heavy operational demands for extended periods of time and whose structural integrity might be in question or at risk. A continuous monitoring of such structures allows the identification of their fundamental response characteristics and the changes of these over time, the latter representing indicators for potential structural degradation. The aim of this paper is the estimation of fundamental dynamic parameters of some civil infrastructures by the joint application of fast executable, non-invasive techniques such as the Ambient Noise Standard Spectral Ratio, and Ground-Based microwave Radar Interferometer techniques. The joint approach combine conventional, non-conventional and innovative techniques in order to set up a non destructive evaluation procedure allowing for a multi-sensing monitoring at a multi-scale and multi-depth levels (i.e. with different degrees of spatial resolution and different subsurface depths). In particular, techniques based on ambient vibration recordings have become a popular tool for characterizing the seismic response and state-of-health of strategic civil infrastructure. The primary advantage of these approaches lies in the fact that no transient earthquake signals or even active excitation of the structure under investigation are required. The microwave interferometry radar technology, it has proven to be a powerful remote sensing tool for vibration measurement of structures, such as bridge, heritage architectural structures, vibrating stay cables, and engineering structures. The main advantage of this radar technique is the possibility to perform a dynamic monitoring of several points of a structure without any contact between the sensor and the investigated target.
The comparison of the results obtained by the simultaneous application of such techniques on engineering structures shows an excellent agreement:
• to estimate dynamic parameters of the civil structure and cultural heritages (main vibrational modes in two orthogonal direction and relative dampings, modal shape);
• to follow the dynamic parameters variation due to damage and structural degradation.