



## **Analysis of structural seismic behaviour: from non stationary to non linear effects**

Felice Carlo Ponzo, Rocco Ditommaso, and Lisa Monaco  
University of Basilicata, DiSGG, Potenza, Italy (felice.ponzo@unibas.it)

The change in fundamental frequency of a building is considered the simplest way to detect the onset of damage. Several authors in the past proposed that the difference in periods that can be observed among ambient noise, earthquake weak-motion measurements can be attributed to transient non-linearity due to reversible modification of the building characteristic (e.g. the degree of coupling between frame and infill in reinforced concrete buildings).

The necessity of effective and efficient seismic protection of vast and aging structures and infrastructure has increased markedly the interest in the development of structural monitoring techniques. Damage to any structure alters its dynamic properties and for that dynamic monitoring techniques enable the identification of damage by comparing pre and post seismic excitation characteristic. The principle parameters usually monitored are: fundamental period, damping factors and modal shapes. Several damage identification and localization techniques are based on variations in these parameters (see, e.g Ponzo et al. 2010 and reference therein).

Non Destructive Evaluation (NDE) methods can be rank on four different levels with the higher levels requiring increased quality and quantity of available information. The most common methods are therefore related to Level 1, due to their simplified and economic implementation. These methods are based mainly upon the variation of vibration frequencies and/or variations in Equivalent Viscous Damping associated with these vibration modes. It is important to underline however that although the presence of damage will lead to alterations in vibration modes the opposite does not necessarily hold true. Two types of frequency variation can be distinguished; long time period variations (due to variations in temperature, foundation soil moisture content etc.) and short period variations (for example due to a seismic event). For short period variations, changes in frequency can be attributed to either non-linearity (i.e. Damage) or non-stationary phenomenon (the particular combination of input and response). This fact may lead to erroneous conclusions attributing the frequency variations to the structural damage instead that to non-stationary phenomena.

This article deals with the theoretical foundation of the analysis of non-stationary behaviour of structures, and then provides experimental evidence in order to distinguish non-linearity from simple non-stationary phenomena. Further work must be performed in order to fully validate this kind of approach and to completely define these threshold for various structural forms and building typologies.

### REFERENCES

Ponzo F. C., Ditommaso R., Auletta G., Mossucca A. (2010). A Fast Method for Structural Health Monitoring of Italian Strategic Reinforced Concrete Buildings. *Bulletin of Earthquake Engineering*. Volume 8, Number 6, pp. 1421-1434. DOI: 10.1007/s10518-010-9194-6.