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Evaluating seismic retrofitting efficiency through ambient vibration tests and analytical models

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Abstract

Economic and environmental imperatives lead to an ever growing need to extend the service life of the existing building stock without putting the users at risk. In zones prone to moderate seismic hazard, many buildings were built without considering seismic actions. The design and assessment of efficient seismic retrofitting rely on physical models of the buildings. However, model errors resulting from simplifications and other assumptions might lead to a biased and thus unreliable diagnosis. Therefore, structural measurements are interpreted to reduce the uncertainty related to the ambiguous task of inferring the real structural response of existing buildings, even in the linear elastic range.

This contribution includes the assessment of the retrofitting of an existing masonry building through ambient vibration field measurements. Measured frequencies and mode shapes are interpreted using an error-domain model-falsification framework that allows explicit representation of uncertainties related to modelling and measurement errors. A simple continuous Timoshenko cantilever beam, characterizing the linear elastic dynamic response of the building, is used to model the building. It is concluded that such interpretation of ambient vibration data is useful to assess the efficiency of seismic retrofitting.

Keywords: structural identification, model falsification, ambient vibrations, seismic retrofitting, Timoshenko beam, multiple model reasoning

1 Introduction

Large parts of the building stock in regions that are prone to moderate seismic hazard were built without considering seismic actions at the design stage. If important infrastructure fails to satisfy minimum seismic capacity demands that have been established by recent codes and regulations, seismic retrofitting is needed.

Dynamic properties of a structure depend on the ratio of mass to stiffness, therefore strengthening has to be carefully designed and performed in order to meet the desired objectives of retrofitting. However, the behaviour of existing structures is subjected to important uncertainties that are related to aspects such as material properties, boundary conditions and the nature of connections between structural elements. These uncertainties may result in unreliable models and therefore, in these situations the use of structural measurements may be useful.

Ambient vibration measurements have been found to carry valuable information on the linear elastic range of dynamic response [1]. Therefore, ambient vibrations constitute an effective source of structural data to assess the efficiency of seismic retrofitting of buildings [2]. In addition, ambient vibration measurements are an attractive

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