DEVELOPMENT OF EARTHQUAKE RESISTANT DESIGNS, METHODOLOGIES AND CONSTRUCTION TECHNOLOGIES FOR MASONRY BUILDINGS IN SRI LANKA

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Abstract

Earthquakes are natural hazards under which disasters are mainly caused by damage to or collapse of buildings and other man-made structures. Earthquake damage depends on many parameters, including intensity, duration and frequency content of ground motion, geological and soil condition, quality of construction, etc. Building design must be such as to ensure that the building has adequate strength, high ductility, and will remain as one unit, even when subjected to very large deformation.

Although Sri Lanka is considered to be located away from a region of high seismic activity, researches have given evidence that there is possibility for seismic hazards in the South Asian region in the near future that can affect structures built in Sri Lanka. The effects of earthquakes are commonly considered for structures designed by engineers while domestic buildings constructed without professional guidance lack the provision for earthquake resistance. Therefore, it would be useful to analyze the behaviour of the masonry structures and take adequate precautions to minimize damage from earthquakes.

Many references have been made in this research to identify various existing masonry construction methods in the world that can be adopted to minimize the effects of earthquakes on residential buildings. Apart from literature survey, two economical methods of earthquake -'resistant methods have been proposed using hollow cement stabilized soil interlocking blocks as the masonry element. One method is to use steel as reinforcing material and the second method is to use bamboo as the reinforcing material. In both the options the walls have been designed as load bearing walls for gravity loads and also as shear walls for lateral seismic loads, to safely withstand the effects of earthquakes. The structural system of construction is the same as a shear wall - diaphragm concept, which gives three-dimensional structural integrity for the buildings. Both these methods , especially safeguard the openings, by avoiding cracks around them in the case of seismic loading.

In order to observe the actual performance of the masonry walls under seismic loadings, masonry walls constructed out of hollow cement stabilized soil interlocking blocks both reinforced and un-reinforced with steel reinforcement have been modeled and tested to determine their in-plane cyclic performance. From these experimental studies, the relative performance of each masonry construction system in resisting the in-plane lateral loads under a constant superimposed vertical load was assessed. The reinforced cement stabilized soil interlocking system that was tested showed that the system was more ductile when subjected to cyclic loads than the non reinforced system.

A suitable methodology to verify the seismic resistance of masonry structures has been developed. The methodology is based on a method specified in the Eurocode 6 and the Australian seismic code. The method was applied for the typical house that has been analyzed throughout the paper. A design criteria is presented, with specific attention to the definition of behaviour factors to be used in the analysis and more generally on methods for the seismic performance verification of masonry buildings. Necessary and possible developments of design/assessment procedures and code provisions are presented. A cost comparison of various masonry technologies has been presented and the two proposed earthquake resistance technologies have been found to be very economical.

DECLARATION

I, V.Ratnam, hereby declare that the content of this thesis is the original work carried out by me. Whenever others' work is included in this thesis, it is appropriately acknowledged as a reference.

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