DEVELOPMENT OF DISASTER RESISTANT BUILT ENVIRONMENTS WITH COMMONLY USED BUILDING MATERIALS IN SRI LANKA

by

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ABSTRACT

At present, sustainable building construction practices are actively promoted. One of the key strategies that can enhance the degree of sustainability is creating built environments that can last a very long time when very high level of disaster resistance is achieved with commonly available building materials in a very cost effective way. These strength enhancement methods should cover multitudes of disasters like cyclones, floods and earthquake tremors.

Masonry is a very good material for carrying compressive stresses due to gravity loads consisting of self weight and live loads. However, alternative building materials such as Compressed Stabilized Earth (CSE) bricks and blocks and rammed earth can also demonstrate a behaviour comparable to conventional masonry such as burnt clay bricks and cement sand blocks.

Lateral loads are the dominant of all forces acting in a disastrous situation. Therefore, flexural strengths of the building materials are of very importance. These lateral forces are static or dynamic in nature. In most instances, it may be possible to find equivalent quasi-static forces for dynamic forces. This means, an accurate assessment of the lateral load carrying capacity of masonry walls and also strategies available for improving the lateral load carrying capacities will be of importance.

It is shown that for experimental determination of flexural strength parallel and perpendicular to bed joints, testing of panels with low degree of pre-compression can give reasonable results with acceptable level of scatter. This method has been used to determine the flexural strength parameters for both conventional and alternative materials.

It is also shown that the presence of continuous tie beams at plinth level, window sill level and lintel level can create a situation where wall panels behave almost as vertically spanning. Since tie beams can control the deflection in lateral direction while applying some pre-compression, it was possible to present a theoretical concept for determining the lateral load resistance with the enhancements possible with tie beams. This method relies on the compressive strength of masonry. Once this theoretical method is used with adequate partial factors of safety, a reasonable estimate of lateral load resistance can be obtained. This method can be used even with masonry having very low flexural tensile strength parallel to bed joints.

The above method has to rely on the restraint offered by the continuous tie beam. This means that the tie beam should be adequately restrained. The ideal restraint can be the return walls that would generally occur at 3.0 - 4.0 m intervals in houses. It would also be advisable to have the tie beam extended at least 300 to 600 mm into the partition walls since it can provide better load transfer. This means that some of the plan layout may need some adjustments. Such an integrated approach could provide a house where the masonry walls are adequately tied at various levels and hence capable of transferring loads from one element to the other thus mobilizing various load resisting systems like that can be possible with shear walls.

Even a well constructed house with these disaster resistant features can still suffer if the foundation fails. Thus, adequate soil improvements where sandy soil is mixed

with laterite soil and re-compacted in both foundation and also around the house would be essential.

Three-dimensional finite element modelling with commercial software became a reality only recently. The use of such software like SAP 2000 to identify the likely behaviour under lateral loads was presented. A similar attempt was made to obtain the influence of the nearby houses under wind conditions using ANSYS software.

With all these disaster resistant features, it would now be possible to create a robust single storey house with potential to last as long as possible. The same techniques can be adopted for multi-storey houses as well. Therefore it can be stated with confidence that the research presented in this thesis led to a development of an integrated approach for creating disaster resistant houses. Once such robust built environments are coupled with passive techniques already successfully used for adequate indoor thermal comfort, it would be possible to have robust houses that will need very low energy for day to day operations.

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DECLARATION

This thesis is a report of research work carried out in the department of Civil Engineering, University of Moratuwa, between September 2005 and August 2009. Except where the references are made to the other work, the contents of this thesis are original. The work has not been submitted in part or in whole to any other university.

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