SEISMIC EVALUATION OF EXSISTING STUCTURES AND PROPOSED RETROFITTING METHODS

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Introduction

Earthquake is a form of devastating natural disaster causing lot of damages to people and to infrastructures. Absence of adequate lateral load resisting system in structures is the major reason for damage. Geological studies predict there will be greater chance to occur earthquakes in Sri Lanka in future than past due to formation of new plate boundary. Retrofitting is necessary to improve their capacity to resist such action if they are not capable of facing such activity.

The objective of the research is to make seismic evaluation of the structures in selected area and arriving at potential retrofitting methods. Basic evaluation was done by using rapid visual screening procedure. Two storey masonry building was selected as most vulnerable building and detail analysis was carried out. Modeling of masonry structure in finite element program to simulate it's actual behavior is very complicated and time consuming since it consist of thin layers of two different materials. Two retrofitting methods were introduced and performance of the structure was evaluated.

Methodology

Rapid screening guidelines given by Federal Emergency Management Agency (FEMA) (1) was used to identify most vulnerable building among 15 buildings in a Kingswood college Kandy. FEMA method assigns basic score according to building type (concrete, masonry, timber etc.) and modified scores to each building according to their features which can be good or bad during seismic activity. Finite element model (Fig 2) was prepared by using shell elements and homogeneous material properties.(3). In detail evaluation, linear time history analysis was carried out. Newmark time integration method was used and 0.5, 0.25 were used for gamma and beta values. Koyna dam earthquake was selected for the analysis and 0.3g horizontal ground acceleration was considered. (2) Performance was evaluated after introducing two retrofitting techniques.

i. Bracings (Fig. 3.)
ii. Reducing sizes of openings (Fig. 4.)

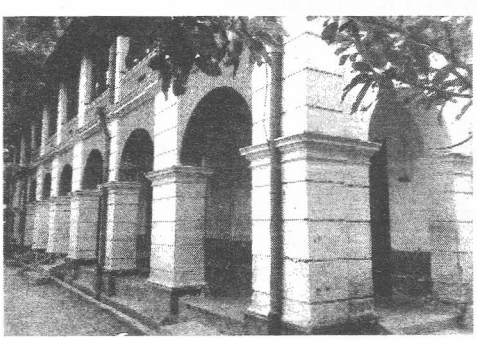

Fig. 1. School hostel building

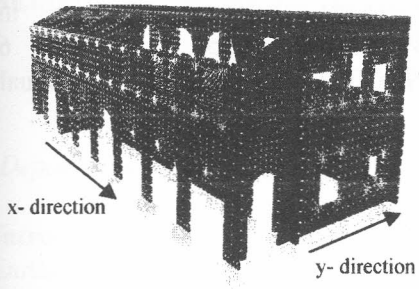

Fig. 1. Finite element model

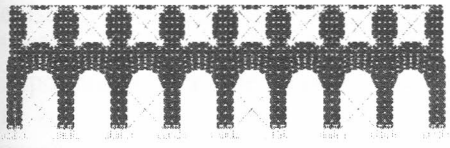

Fig. 2. Braced model

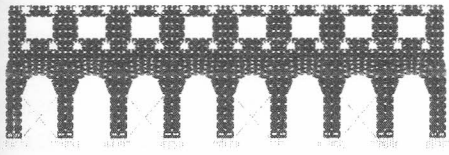

Fig. 3. Bracing with reduced openings

Results and Discussion

According to the Rapid Visual Screening sheet a school hostel fig 1 which is a two storey masonry structures was selected as the most vulnerable building having received a score of -2.1 marks.

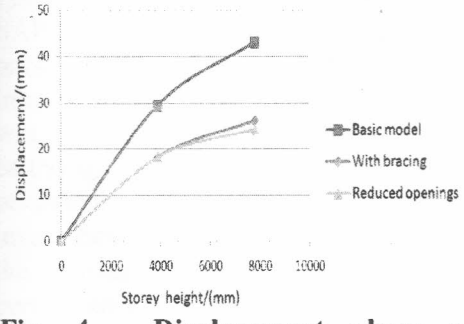

Fig. 4. Displacement along x direction

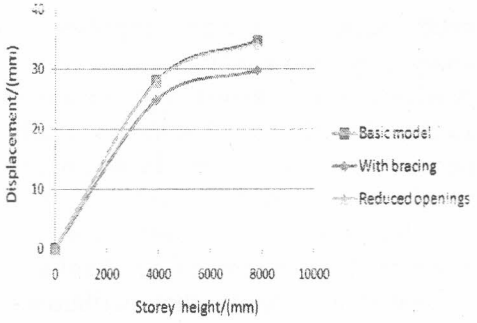

Fig. 4. Displacement along y direction

In this research aim was to identify behavior of two storey unreinforced masonry structure during an earthquake and apply retrofitting techniques for reduce damage to the building. After retrofitting displacements were reduced in both directions. (fig 5, fig 6)

Direct application of FEMA method for a country like Sri Lanka is not a good practice. Because the types of the building and condition of the building in Sri Lanka are not as the same as those in United States America. So there should be some significant modifications need to be done to existing procedure for matching it more appropriate in Sri Lankan context.

Detail analysis was carried out for two storey masonry structure. In this particular case, homogeneous material properties were used in SAP2000. One of major failure mode of masonry structures, when subjected to lateral load by shear failure in brick-mortar interface. Shear failure of masonry cannot be simulated in SAP 2000. Results can be improved by modeling brick and mortar layer separately (3). (Heterogeneous modeling) But this method is very time consuming and

need super computer capacity to analyze by such model.

Analysis was carried out expected earthquake for Sri Lanka in return period with 300 years. Peak ground acceleration used for analysis is 0.3g

(2) Reliability of results can be enhance if seismicity of Sri Lanka is estimated and apply that earthquake loading to building. To obtain more reliable results more advance finite element packages such as Abacus can be used. Using those packages it is possible to take account material discontinuity and shear failure of masonry.

Conclusions

FEMA guidelines were used to identify most hazardous building for detailed analysis. It is suggested that modifications to the FEMA procedure in order to adopt it to Sri Lankan conditions. Then it can be use as rapid procedure for identifying hazardous buildings during an earthquake for Sri Lanka. Both retrofitting techniques give nearly same reduction of displacements in x direction. But if there are not enough openings that method is not effective.

References

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