SEISMIC VULNERABILITY ASSESMENT OF REINFORCED CONCRETE FRAMED BUILDINGS IN SRI LANKA: A CASE STUDY

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Degree of Master of Engineering in Structural Engineering Design

Department of Civil Engineering

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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S.K.A.Gunaratne

ABSTRACT

Earthquakes are one of nature's greatest hazards to life. Sri Lanka is considered to be in an aseismic zone away from major plate boundaries or any active faults. However, the first Earthquake hazard recorded on 14th April 1615 in Colombo with 2000 deaths and destroying 200 houses. Since then, there have been many seismic events in Sri Lanka and neighbouring areas which are small to moderate in magnitude of which the trimmers were felt by the people in some of the regions in Sri Lanka. In addition, geologists suspect that there is a formation of a new plate boundary dividing Indo-Australian plate. Moreover, there is a possibility of occurrence of an intra-plate type earthquake within Indo-Australian plate (Eg. Maharashtra earthquake in 1993).

Considering the above facts, there is a risk of occurrence of a small to moderate type earthquake in the vicinity of Sri Lanka. Hence, it is high time to commence not only the design and detailing of the buildings for seismic resistance but also the seismic assessment and retrofitting of the existing public buildings , because almost all of the existing buildings in Sri Lanka have not been designed or detailed for earthquake resistance.

However, detailed seismic performance assessments are new to Sri Lanka though most of the earthquakes proven countries have already been reaping the benefits of such assessments considering in-situ conditions of the buildings.

Therefore, it is intended to study the seismic performance of a medium rise building which is a reinforced concrete framed building situated in Colombo, Sri Lanka. Pushover procedure given in ATC 40 and the hinge parameters given in FEMA 356 guidelines were used to carry out the performance assessment.

One of the outcomes expected from this study is to check the applicability and importance of pushover analysis for seismic assessments of a medium rise building having a large floor area incorporating all As-built details and found that it is applicable and realistic results can be obtained.

As per UBC world seismic zoning, Sri Lanka is situated in seismic zone 0. However, considering the future seismic risk, the building was assessed for seismic Zone 1 and 2A.

It was found from the study that the building performs at Immediate Occupancy performance level for serviceability earthquake in seismic zone 1(C_A=0.06, C_V=0.09).But not perform well for serviceability earthquake in seismic zone 2A(C_A=0.12, C_V=0.18).In addition found that the building can safely withstand a maximum ground motion having acceleration coefficients of C_A=0.11 and C_V=0.17 performing at Immediate Occupancy performance level.

Furthermore, it was observed that seismic performance of the building considered, can be improved significantly in shorter direction than in longer direction by strengthening some of the critical elements. The building performs well in shorter direction than in longer.

It was also found that pushover analysis helps to enhance the seismic resistance of a structure significantly by identifying and strengthening the critical elements with a small amount of additional cost.

Finally, this analysis gives an indication of the integral seismic resistance of a reinforced concrete framed structure although specifically not designed for seismic loading. The recommendations were also made for proper seismic assessment and resistance verified from the study.

This study is to be continued to find out the significance of a 3D analysis compared to a 2D analysis with respect to the accuracy of analysis results and time taken for the evaluation. Furthermore, the seismic performance assessment of this building can be carried out with other software such as PERFORM 3D to verify the analysis results obtained from SAP 2000.

Key words: Seismic assessment, Seismic evaluation, Performance based design, Non linear static analysis and Pushover analysis.

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B_{eff}	Effective damping ratio
C_A , C_V	Acceleration coefficients
T_{eff}	Effective period of vibration
S_a	Spectral acceleration
S_d	Spectral displacement
ATC	Applied Technology Council
FEMA	Federal Emergency Management Agency
V	Base shear
D	Displacement at the top of the building
I/O	Immediate occupancy performance level
L/S	Life safety performance level
C/P	Collapse prevention performance level
SP	Structural performance level
NP	Non structural performance level