A REVIEW ON PERFORMANCE EVALUATION OF RC MOMENT RESISTING IRREGULAR FRAMES USING NONLINEAR DYNAMIC ANALYSIS

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Abstract: ***Engineering structures are very complex and difficult to analyze for their dynamic, or vibrational, behavior. With the incidental loss of life and property witnessed in the last couple of decades alone in India, due to failure of structures caused by earthquakes, now attention is given to neglect the adequacy of strength in RC framed structures to resist strong ground motions. To determine structural response beyond yield point, out of two types of nonlinearity material and geometrical, material nonlinearity is considered in present paper. As such, nonlinear analysis can play an important role in the analysis and design of new and existing buildings.***

In the present paper, RC Moment Resisting Irregular Frames (T&L Shape) of 5, 9,12 and 15 Story are analyzed for seismic Zone IV and designed as per IS code provisions, considering both seismic and gravity loads. Further, performance evaluation of above frames is done using Non Linear Time History Analysis (NLTHA) in Seismostruct software.

I. INTRODUCTION

Building codes require that structures should be designed to withstand a certain intensity of ground acceleration, with the intensity of the ground motion depending on the seismic hazard. Because of the high forces imparted to the structure by the earthquake, the structures are usually designed to have some yielding. The goal of earthquake engineering is to minimize loss of life due to the collapse of the yielding structure. However, the costs involved in replacing and rehabilitating structures damaged by the relatively moderate earthquakes have proven that the "Life-Safe" building design approaches are economically inefficient. As a result, the principle of "Performance Based Earthquake Engineering" (PBEE), which promotes the idea of designing structures with higher levels of performance standards across multiple limit states, has been proposed. In association with PBEE principles, a new analysis approach, called Incremental Dynamic Analysis (IDA), has been developed to assist the engineer in evaluating the performance of structures.

In performance based design, the response of structure is considered beyond elastic limit. Static and dynamic non-linear analysis are the analysis techniques used for performance based design. Elastic analysis gives a good indication of the elastic capacity of the overall structure and indicates where first yielding occur. It can't predict failure mechanisms and account for redistribution of forces during progressive yielding. Inelastic analysis procedures help to understand that how the building really works by identifying modes of failure & the potential of progressive collapse.

The capacity of structural members to undergo inelastic deformations governs the structural behavior and damageability of multi-storey buildings during earthquake ground motions. From this point of view, the evaluation and design of buildings should be based on the inelastic deformations demanded by earthquakes, besides the stresses induced by the equivalent static forces as specified in several seismic regulations and codes. In general, the study of the inelastic seismic responses of buildings is not only useful to improve the guidelines and code provisions for minimizing the potential damage of buildings, but also important to provide economical design by making use of the reserved strength of the building as it experiences inelastic deformations.

Nonlinear time history analysis is the most accurate method used to predict seismic responses of structures subjected to ground motions. Development of computer software causes to use this method widely in design new buildings and evaluating building performances during the past decade. To perform nonlinear time history analysis, ground motions directly applied to the model and it needs a suitable ground motions. Selecting ground motions is major issue in nonlinear time history analysis. There are two methods to obtain dynamic responses of a structural model, which are direct time integration and modal superposition. The nonlinear time history analysis presented herein belong to the direct integration method which is a second order differential equation

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The equation of motion for a structural system represented by MDOF model is shown in Equation 2.1:

$$M\ddot{U}+C\dot{U}+KU= -MI\ddot{u}_g \qquad \text{……Eq 2.1}$$

Where,

M = the mass matrix
C = the damping matrix
K= the stiffness matrix
$\ddot{u}_g$=earthquake ground acceleration
U =displacement calculated

SeismoStruct, one of the Seismosoft's collection available online, is a finite element software which is capable of determining large displacement responses for both two and three dimensional models subjected to dynamic and static loadings. SeismoStruct considers both geometric nonlinearity and material inelasticity while analysing buildings. In addition, it has a 3D element library with different cross-sectional configurations for concrete, steel and composite structural members. To obtain a realistic model of a prototype building, Seismosoft's uses spread inelasticity distribution along cross-sectional and members' length.

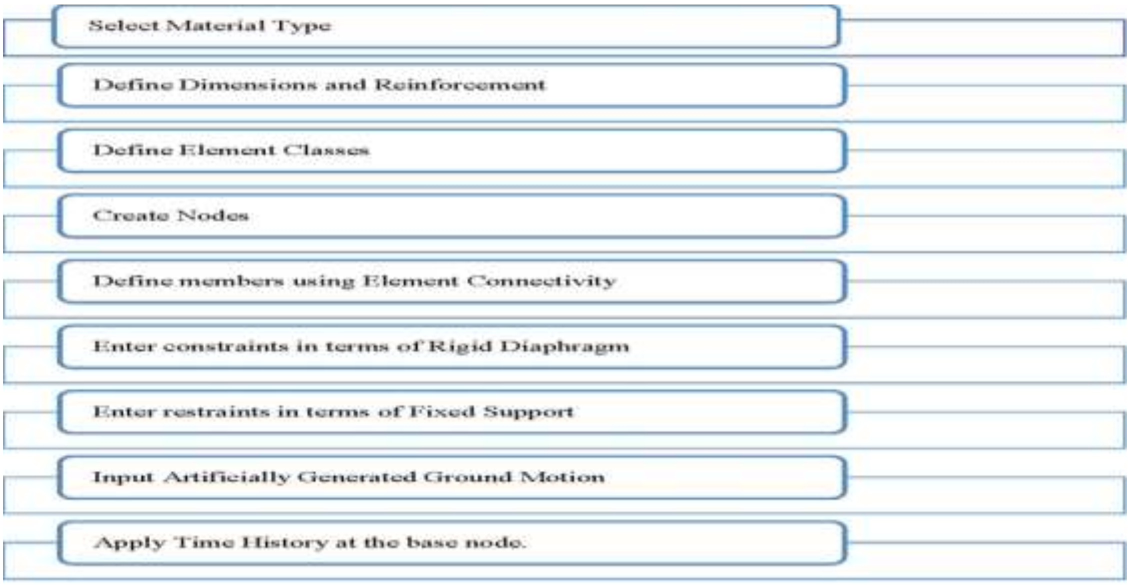
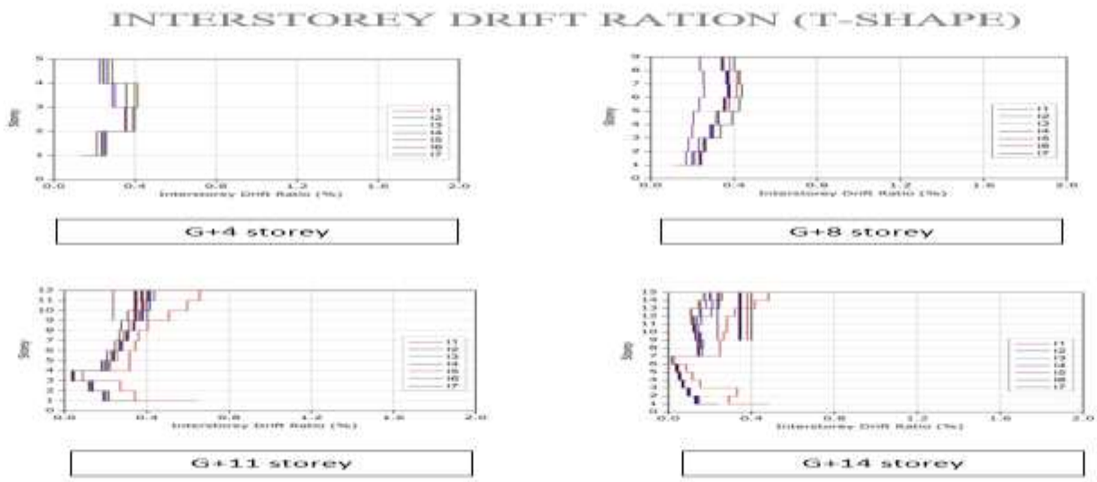
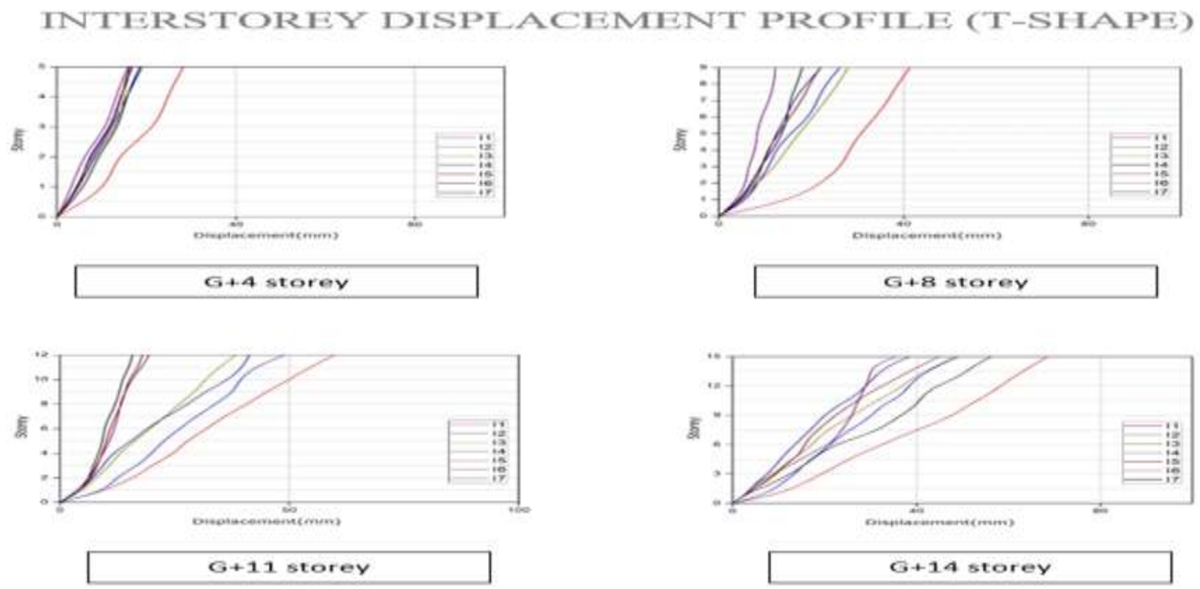


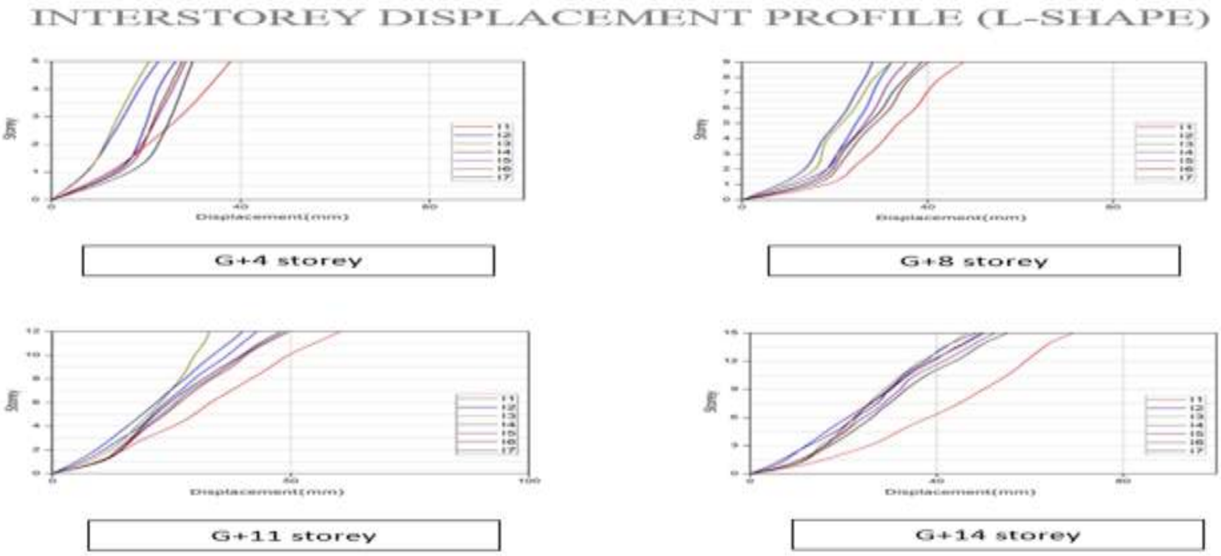
Figure 1Flowchart to simulate nonlinear model in seismostruct

II. RESULTS AND DISCUSSION

Results obtained from NLTHA for set of 7 Indian ground motions are plotted in terms of Interstorey Drift Ratio Profile & Interstorey Displacement Profile.







In this study, RC Moment Resisting Irregular Frames (L and T Shape) of 5, 9, 12 and 15 Storey are analyzedusing STAAD Pro V8i and designed as per IS Code provisions for lateral forces of Zone IV. Performance evaluation is done by nonlinear dynamic methods viz. nonlinear time history analysis. The following conclusions have been drawn from this study:

As seen from Nonlinear Dynamic Analysis,

1) The buildings considered in the present work are designed for lateral forces of Zone IV. As seen from nonlinear time history analysis, the capacity of building meets the demands imposed on it.

2) The linear drift limit as per IS: 1893 (Part 1): 2002 is 0.4% and frames were designed with response reduction factor of 5. The target drift limit for frames comes out to be 2% as per IS: 1893(Part1):2002. It is observed from the plots that target inter-storey drift limit of 2% is not crossed in any of the frames when evaluated by Indian ground motions. Hence it can be said that frames show satisfactory performance under dynamic loading.

3) As per IS: 456 (Part 1): 2000 displacement limit is (L/250). It is observed from the plots that displacement limit of (L/250) is not crossed in any of the frames when evaluated by Indian ground motions. Hence it can be said that frames show satisfactory performance under dynamic loading.

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All my efforts are result of cosmic system named GOD. Thank you lord for everything.

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