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DAMAGE INDICES FOR MULTISTOREY BUILDING WITH AND WITHOUT MASONRY INFILL

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Abstract - *Many researchers have studied the performance of RC structures in seismic environment. Damage indices are proposed to quantify local and global structural damage of buildings, subject to base excitations on a scale ranging from zero to unity; where zero represents undamaged state and unity represents collapse injury state of the building.*

Infill wall can reduce the structural response during seismic excitations due to its strength and stiffness. In the present work, a RC building of ten storeys has been taken and its performance is evaluated under the ground motions. For the initial study two basic models are being considered. First is simple three storey model with masonry infill and another is simple three storey model without masonry infill. The building is being analyzed by means of nonlinear time history analysis for seismic sequences using FE software SAP 2000NL.

***Key Words*: Damage index, nonlinear time history, pushover analysis, stick model, hysteresis energy.**

1. INTRODUCTION

Since the early 1970's, there has been significant research on the damage assessment of the RCC buildings. As proposed by several researchers (Park et al 1984, Chung et al 1987, Williams, Sexsmith 1995, Fajfar, Vidic 1994) damage indices can be classified as local damage indices and global damage indices. A local damage index is a sign of damage for a part of structure such as an element, frame or a story while a global index is an indicator of damage to the whole structure. Till now lot of research is carried out to estimate the damage of reinforced concrete structures in terms of its components. A harm model was developed by Park and Air National Guard (1985),to review the unstable harm ofconcrete member supported AN experi mental information.The damage is taken as a linear combina- tion of the maximum deformation and the absorbed hyster- etic energy.

1.1 Effects of damage on a structure:

The effects of damage on structure can be classified as linear or nonlinear. A linear damage state is defined as the case when the initially linear elastic structure remains linear elastic after the damage. The change in modal properties are a result of changes in the geometry and / or the material properties of the structure, but the structural response can still be modelled using a linear equation of motion. Non-linear damage is defined as the case when the initially linear-elastic structure behaves in a non-linear manner after the damage has been introduced.

2.STRUCTURE:

In order to investigate the effect of masonry infill on the building against seismic activity, the following three dimensional RC building is taken for analysis.

2.1 Structure details:

In the present study a G+9 reinforced cement concrete special moment resisting frame is considered for the analysis in accordance with IS 1893 (part 1): 2016 provisions. The storey height is 3.0 m. The load per unit space of the ground, consisting of the ground block, finishes, etc. is 4 kN/m^2. The intensity of live load on each floor is 3 kN/m^2. The soil below foundation is hard and the building is located in Delhi. Required suitable data is assumed. Plan dimensions are as shown in figure 1. (All dimensions in m) Assumed data is as follows:

Beam size for 5 m span – 230 X 450 mm, Beam size for 6.5 m span – 230 X 550 mm,

Column size for initial G+2 model – 300 X 450 mm, Column size for G+9 model – 450 X 750 mm, Specific weight of infill – 20 kN/m^3, block thickness – two hundred millimetre, Wall thickness – 230 millimetre.

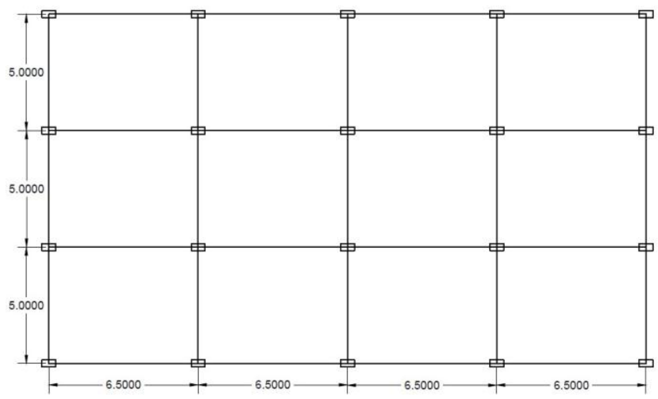

Fig 1. Line Plan

2.2 Earthquakes and their dynamic characteristics:

Four earthquake records are considered to perform the time history analysis. The Peak Ground Acceleration (PGA) values of the records varies from 0.316g to 0.856g. The dynamic characteristics of earthquake records are shown in table 1 and the acceleration time history of the records are shown in figure 2

Table 1. Details of Earthquakes

Earthquake Name	Location	Year	PGA(g)
Elcentro	Lomaprieta, California, USA	1989	0.316
Northridge	Northridge, California, USA	1994	0.611
Bhuj	Bhuj, Gujarath, India	2001	0.326
Santa monica	California, USA	1994	0.856

Pushover analysis:

Simplified analysis method to determine the displacement demand enforced on a building expected to deform inelastically is pushover analysis. It develops the relationship between base shear, Vb, and roof displacement, Δ. In the present study, the Seismic damage of the regular structure is evaluated using information obtained from structural response under monotonic loading (pushover analysis).

A accumulative dissipated energy operate is employed to estimate the condition of injury of a high-rise concrete take a look at structure. Based on the capacity curve, at any displacement the damage state of the structure is estimated.

3-D pushover analysis is performed on test structure in SAP, and the capacity curve is plotted by Vb –Δ relation from static nonlinear analysis as shown in figure3.the realm underneath this curve offers the entire energy dissipated until the collapse of the structure. To signify the damage state of the structure at each displacement, a damage scale is proposed. At ultimate displacement the damage scale is normalised to one. The damage scale at any displacement is given by the ratio of the energy dissipated upto that displacement excluding the energy dissipated due to the yield displacement to the total energy degenerated at collapse stage during the pushover analysis. The table 2 shows the values of yield displacement, yield strength and ultimate displacement of both building (with and without wall) in X and Y direction.

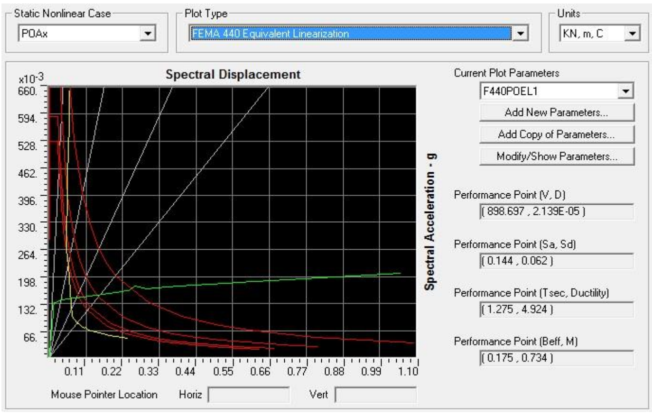

Fig 2. Pushover curve of 3D building without infill wall in X direction.

Time history analysis:

The non-linear inelastic storey wise building is very difficult to be consider in three dimensions, so therefore the real 3D building is converted into 1D inelastic (elasto-plastic) stick system. Which gives the storey wise hysteresis plot and time history displacement plot very easily. Which could be used for calculating the damage indices in excel format. Figure 4 shows the inelastic stick system.

Modified Park and Ang model represented by the equation 1 is used to get the structural damage index for four ground motions.

$$D = \frac{Xm-Xy}{Xu-Xy} + \beta \frac{\int dE}{QyXu} \quad (1)$$

The parameters in the damage model considered as Xm is the maximum displacement of each cycle of the hysteresis, Xy is the yield displacement of the structure, Xu is the ultimate displacement of the structure under monotonic loading, the value of β depends on the characteristics of the earthquakes, for present study it's value is taken as 0.4, dE is the total cumulative energy dissipated in hysteresis where the damage should be calculated, Qy is the yield strength of the structure corresponding to the yield displacement. The sample of displacement time history of joint 4 of 3D building without infill wall in X direction for Bhuj earthquake is as shown in figure 5 and hysteresis energy of 3D building without infill wall in X direction for Bhuj earthquake is as shown in figure 6. Damage investigations as per the corresponding results are shown in table 3.

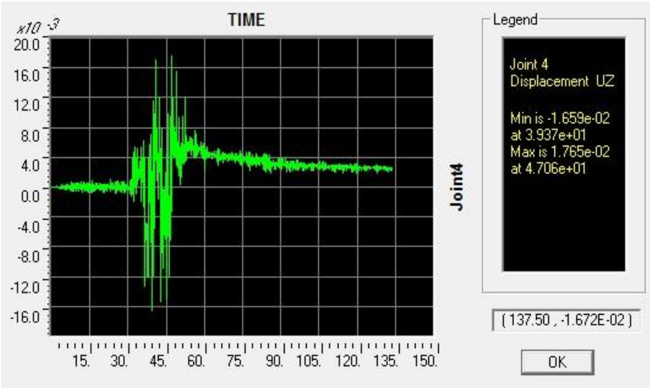

Fig 3. Displacement time history of joint 4 of 3D building without infill wall in X direction for Bhuj earthquake.

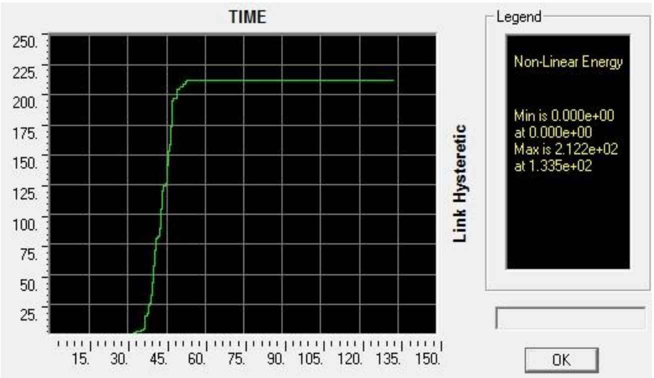

Fig 4. Hysteresis energy of 3D building without infill wall in X direction for Bhuj earthquake.

3. CONCLUSIONS

The paper has carried out a critical analysis of seismic damage indices to calculate damage due to base excitations. With regards to Modified Park and Ang damage index, it is examined that the damage in 3D multistory building without masonry infill is significantly higher than the damage in building with masonry infill subjected to four seismic motions. In the present study, the damage indices in building without masonry infill are 88% more for Elcentro earthquake, 91% more for Northridge earthquake, 90% more for Bhuj earthquake and 31% more for Santa monica earthquake as compared to the damage indices in building with masonry infill. As the storey level increases there is increase in damage index. A procedure to assess the seismic damage index of a regular multistory structure is proposed.

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REFERENCES

[1] Konstantinos Morfidis, et al. "The role of masonry infills on the damage response of RC buildings subjected to seismic sequences", Journal of Engineering Structures, (2016) 1-18.

[2] George S. Kamaris, et al. "Seismic damage estimation of in-plane regular steel/concrete composite moment resisting frames", Journal of Engineering Structures, Vol. (2016) 115, 67–77.

[3] R. Junemann, et al. "A statistical analysis of reinforced concrete wall buildings damaged during the 2010, Chile earthquake", Journal of Engineering Structures, Vol. (2014) 82, 168–185.

[4] R. Sinha & S. R. Shiradhonkar "Seismic Damage Index for Classification of Structural Damage – Closing the Loop", 15th World Conference on Earthquake Engineering, Lisboa, (2012) 1-10.

[5] Z.R. Lu, S.S. Law "Differentiating damage effects in a structural component from the time response", Journal of Mechanical Systems and Signal Processing, Vol. 24, (2010) 2914–2928.

[6] Oliver R. de Lautour, et al. "Damage classification and estimation in experimental structures using time series analysis and pattern recognition", Journal of Mechanical Systems and Signal Processing, Vol. (2009) 24, 1556-1569.