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Fragility Analysis of RCC Frame Structure

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ABSTRACT:In recent years, number of studies have been carried out for the evaluation of behavior of structure during seismic events. Fragility analysis is one of the important probabilistic approach to estimate the damage data at different damage state during seismic events. The G+10 Reinforced Concrete frame structure is considered for analysis. The structure is analysed in ETABS by Non-linear Static Analysis(Pushover Analysis). Fragility curve developed for Non-linear Static analysis(Pushover Analysis) from results obtained by capacity spectrum method for different damage states. The fragility curves are derived from analytical method. The fragility points for different damage states are derived from analytical formula. Fragility curve is plotted for probability in Y-axis and spectral displacement in X-axis for 4 different damage states from Non-linear static analysis(Pushover Analysis).

KEYWORDS: Non Linear Static analysis (Push Over Analysis), Damage State.

I. INTRODUCTION

Earthquakes are distinct from other disasters because they bring destruction through the collapse of man-made structures Which may lead to direct loss of life. Buildings are the major structures that are exposed to damage when earthquakes are triggered. Earthquakes cause economic losses as well as loss of lives. In past earthquake events, such as the Latur earthquake 1993, buildings and infrastructures were severely damaged and collapsed. During these events, the worst damages were often recorded. For example, many people were killed and many people get injured by falling building debris. Therefore, building damage is the main source of seismic losses during earthquakes. To overcome or solve this problem, fragility curves were introduced by researchers to serve as one of main tool in assessing damage and loss during earthquakes. Fragility curves are defined as the probability of reaching or exceeding a specific damage state under earthquake excitation. The general equation to develop fragility or conditional probability is expressed $Fragility = P[LS|IM = y]$ Equation (1.1) where, LS is the limit state or damage state (DS), IM is the intensity measure (ground motion), and Y is the realized condition of ground motion IM. Various equations were derived from this research. However, all the equations are based on above equation, which is a general equation for generating a fragility curve. Although most of these studies used different equations to generate their versions of the seismic fragility curves. Structural Types Fragility curves were discussed based on three types of structures, namely, steel, reinforced concrete, and timber. The fragility curves for buildings are categorized into three types. These types are low-, mid-, and high-rise buildings based on the number of story's. The important factors of vulnerability, which are also available for large databases, include a number of storeys, age of construction, regularity in plan and elevation, infill regularity, and building position in the block. Thus, classifying buildings is one of the significant factors that must be considered in developing fragility curve. Differences in materials, height, and number of bays also result in different shapes of vulnerability curves.

II. LITERATURE SURVEY

Variability functions and fragility curves observed by considering the ground motion and records and structural modelling uncertainties for low-, mid- and high-rise RC buildings in Patna, India, which is a region of high seismicity by Kumar [1]. For modelling uncertainties, they considered the material, geometrical, and design as random parameters. In this study, they selected the random parameters were purely based on the investigation of buildings in the Patna

region. The buildings were modelled and analysed using nonlinear static (NLS) pushover analysis. The monotonic load in a triangular pattern was applied for NLS analysis to get pushover curves. The pushover curves were subsequently converted into capacity curves considering the dynamic characteristic of the first mode of vibration. The obtained capacity curves were utilized to derive the variability in the capacity spectrum for different categories of RC buildings.

By calculating for both the uncertainties, lognormal variability functions were determined, and seismic fragility assessment was performed for different building categories in Patna, India. Fragility curves established by Murat [2] for mid-rise RC frame buildings located in Istanbul and investigated the effect due to the number of stories of the building on fragility constraints. To study these effect buildings with 3, 5 and 7 story were designed according to the Turkish seismic design code. IDA using twelve artificial ground motions were applied to these sample building and fragility curves were developed considering a lognormal distribution for the IDA result. Also, the regression analysis was carried out between fragility parameters and the number of stories of the building. It was found that fragility parameters change widely due to the number of stories of the building. Finally, the maximum allowable inter-story drift ratio and spectral displacement values that satisfy the immediate occupancy and collapse prevention performance level requirements were estimated using obtained fragility curves and statistical method. The variability in seismic fragility functions for frames of different heights for the most vulnerable condition of structure using nonlinear time history analysis studied by Apu [3]. They analyzed the total of 4, 8 and 20 stories RC moment resisting two-dimensional frames. The ground motions (GM) were selected as per the conditional mean spectrum and these were conditioned on a target spectral acceleration at the concern time period. RC frames were designed and detailed as per Indian standards. A concentrated plasticity approach was adopted for non-linear analytical modelling of the RC frames. Fragility functions derived following a lognormal distribution from incremental dynamic analysis curves and maximum estimation of the response is obtained for fitting curves with observed fragility. The fragility functions of the three structures showed that under critical or extreme conditions of GM the taller buildings had higher fragility than the shorter buildings for each level of limit states even though both were designed to meet their code-level design forces. The advancement in computational methodologies and large database of existing buildings, fragility analysis can be implemented for precise vulnerability assessment of buildings was studied by Tarannum Yasmin et al. [4]. The vulnerability curves can be categorized into three groups-empirical, analytical and hybrid. Empirical approach includes Damage Probability Matrices and Vulnerability Functions, which depend on the damage motion relationship statistics observed after an earthquake. Analytical curves adopted damage distributions simulated from the analyzed structural models. Hybrid curves overcome the deficiencies of the above two approaches by combining post-earthquake damage statistics with simulation techniques. They reviewed the importance of fragility analysis using existing methodologies. The methodologies focused on their key features highlighting limitations and suggests the way forward for selection of appropriate assessment method for seismic vulnerability assessment of existing buildings and the incorporation of experimental vibration-based methods

III. METHODOLOGY

The following method is adopted for the analysis of RC frame building,

- A literature review is carried out, based on the objectives of the study.
- ETABS 2016 software is used for modelling of the RC frame structure.
- Analyse the model using pushover analysis as per IS 1893-2002.
- Material used is M20 and Fe-415
- The column size is Column 1 is 230 mm x 600 mm, Column 2 is 230 mm x 680 mm and Column 3 is 230mm x 750mm.
- Beam size is 230 mm x 600 mm and slab thicknesses are S1-150mm, S2-125mm, S3-140mm, S4-100mm
- Finally, the conclusions are drawn based on the obtained results

IV. MODELLING

This chapter involves in modelling of RC frame system of G+10 with a storey height of 3m. The grade of concrete used M20 and rebar used Fe 415.

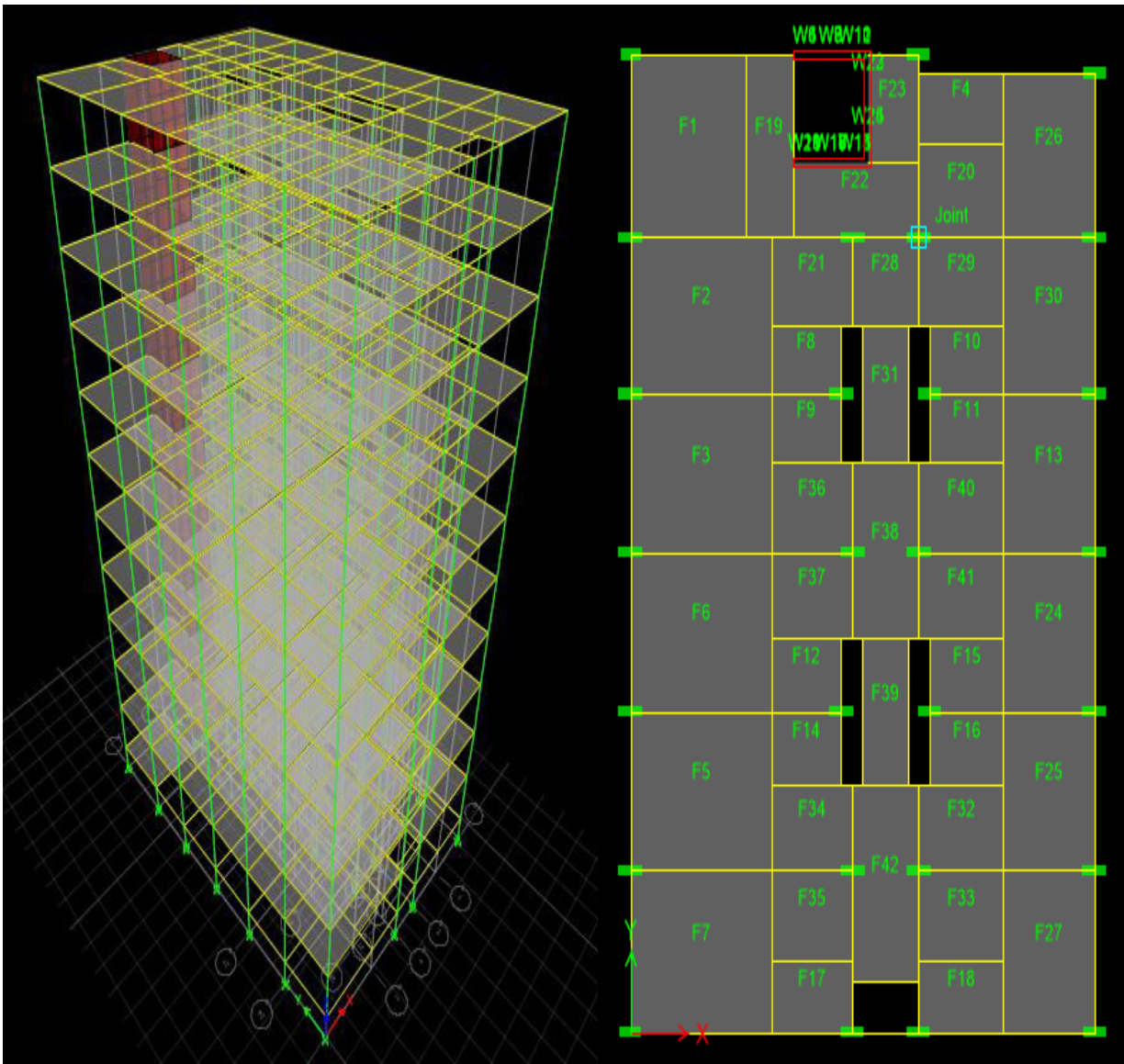


Figure 1 Model of G+10 Figure 2 Plan of Structure of Typical Storey

V. RESULTS AND DISCUSSIONS

1) Development of Fragility Curve from Pushover Analysis by Capacity Spectrum Method

Fragility curves can be obtained in a simplified way starting from the bilinear representation of the capacity curves. Table 1 show how the thresholds S_d are obtained in this case in function of the yielding displacement D_y and the ultimate displacement D_u of the structure.

Sr. No	Spectral Displacement	Median Spectral Displacement (S_d)	Damage State Threshold
1	$0.71 D_y = 0.51$	S_{d1}	Slight
2	$D_y = 0.69$	S_{d2}	Moderate
3	$D_y + 0.25(D_u - D_y) = 1.255$	S_{d3}	Severe
4	$D_u = 2.85$	S_{d4}	Complete

The Non-linear Static analysis (pushover analysis) is done and from the results the fragility curve developed for different damage states. From the pushover analysis the target displacement is 442.527mm and roof displacement is 111. 286mm. Spectral displacement at yield and spectral displacement at ultimate is calculated from the above results. Figure 3 shows the pushover curve for the base shear vs displacement.

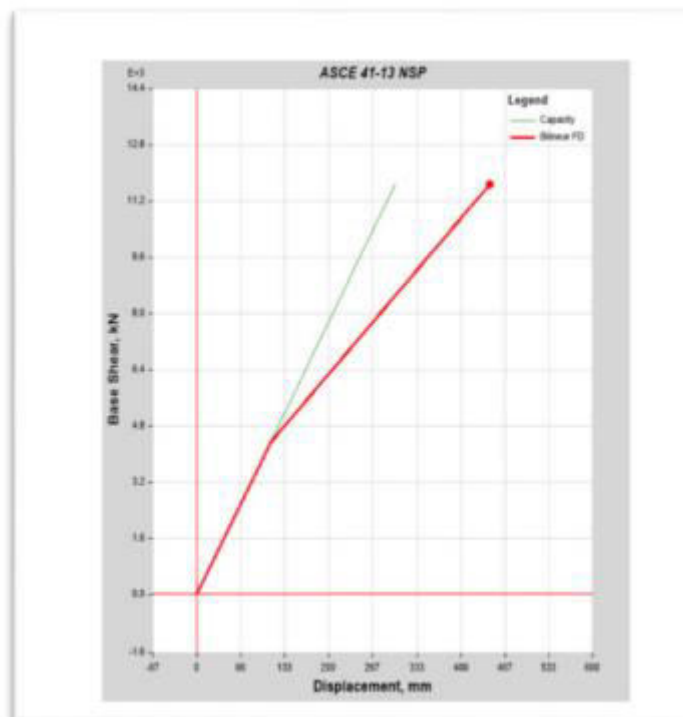


Figure 3 Pushover Curve

The total fragility functions corresponding to the different damage states are computed and the curve is plotted. The maximum probability in the slight damage (SD) state is 85% at maximum spectral displacement. The probability of the structure in complete damage (CD) state is low as compare to slight damage state. Figure 4 shows the fragility curve for probability vs spectral displacement.

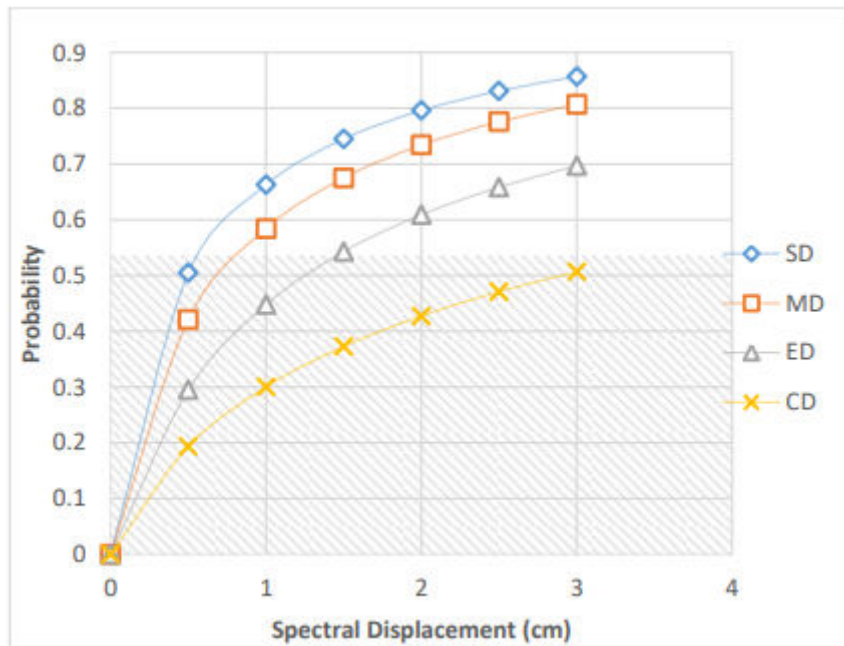


Figure 4 Fragility Curve

VI. CONCLUSION

Fragility curve of the structure from seismic analysis is plotted to study the damage probability for different damage state in the building. From the fragility analysis the following conclusions are drawn below,

For Pushover Analysis Based Curve,

1. The maximum probability for slight damage is 80% and for complete damage is 50% at maximum spectral displacement 30mm
2. The structure is safe for spectral displacement at yield and ultimate spectral displacement because in slight damage at 100% probability no damage occurs and for complete damage it requires 100% probability.
3. In the damage state of moderate and severe the maximum probability is 69% and 80% at maximum spectral displacement 30mm.
4. Hence, the structure requires the repairs because at 100% of probability at moderate and severe damage the cracks occur in the structure.

VII. RECOMMENDATION

For increasing the performance of the structure in Non Linear static analysis (pushover analysis) in the state of moderate and severe damage shear wall can be used.

REFERENCES

1. Pratyush Kumar, Avik Samant, Seismic Fragility Assessment Of Existing Reinforced Concrete Buildings In Patna, India, Elsevier Structures 27 (2020) 54-69.
2. Murat Sedar Kircil, Zekariya Polat, Fragility Analysis Of Mid-Rise Rc Frame Buildings, Elsevier Engineering Structures 28 (2006) 1335–1345.
3. Kartik J., Dr.B. Shivakumara Swamy, Fragility Analysis Of Rc Framed Structure For Different Seismic Zone, International Research Journal Of Engineering And Technology (Irjet) Issn: 2395-0056, Volume5, Issue-7, July 2018.
4. Vazurkar U. Y And Chaudhari, D. J, Development Of Fragility Curves For Rc Buildings, International Journal Of Engineering Research, Vol 5, Pp. 591- 594, February 2016.
5. Nibas Apu, Ravi Sinha, Seismic Fragility Assessment Of Ductile Reinforced Concrete Building Frames, International Journal Of Disaster Resilience In The Built Environment (Ijdrbe) October 2020.
6. Tarannum Yasmin, Ajay Chourasia, S.K. Bhattachryya, Jalaj Parashar, Fragility Analysis For Seismic Vulnerability Assessment Of Building: A Review, International Research Journal Of Engineering And Technology (Irjet) Issn: 2395-0056, Volume-2, Issue-6, September 2015.
7. Carlo Del Gaudio, Marco Di Ludovico, Maria Polese, Gaetano Manfredi Andrea Prota, Paolo Ricci, Gerardo M. Verderame, Seismic Fragility For Italian Rc Buildings Based On Damage Data Of The Last 50 Years, Springer Nature Bulletin Of Earthquake Engineering November 2019.
8. Swarup Ghosh, Shyamal Ghosh, Subrata Chakraborty, Seismic Fragility Analysis In The Probabilistic Performance-Based Earthquake Engineering Framework: An Overview, Springer Nature 2019.
9. Alex H. Barbet, Luis G. Pujades, Nieves Lantada, Seismic Damage Evaluation In Urban Areas Using The Capacity Spectrum Method: Application To Barcelona, Elsevier Soil Dynamics And Earthquake Engineering 28 (2008) 851–865, October 2007.
10. Mahesh N. Patil, Yogesh N. Sonawane, Seismic Analysis Of Multi-Storied Building, Internet



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