FRAGILITY ANALYSIS OF RC FRAMED STRUCTURE FOR DIFFERENT SEISMIC ZONES

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Abstract - *The life of a building is generally taken as 100 years. The life of the building can be checked by various methods. One such method for finding the probability of failure is fragility analysis. Fragility analysis is done to check the probability of failure of a structure. It is a stochastic method of analysis, which provides an approximate result to estimate the probability of failure. The building chosen is a commercial complex of G+5 storeys, situated in Yadagiri, Karnataka, India. The building is analyzed by SAP2000 by Non linear Pushover analysis for different Zones such as (ZONE II, ZONE III, ZONE IV, ZONE V) and also for different soil conditions such as (TYPE I, TYPE II, TYPE III). The results are obtained from capacity spectrum and FEMA 356 co-efficient method, the target shear force is obtained from the software itself and by manually calculating the value of base shear, target shear force and calculated base shear for different Zones and different soil conditions is compared. The fragility curves are derived from both analytical and theoretical method. Finally, after deriving the fragility curves by method, fragility points are also derived using an analytical formula. A curve is plotted for probability in Y axis and Spectral acceleration is X axis. The probability of failure is within the limit for Zone II for all soil conditions, Zone III it is within the limit for Type II and Type III soil conditions. Also, the probability of failure is exceeding the limit for Zone IV and Zone V for all soil conditions.*

Key Words: **Fragility, Stochastic, Pushover, Fragility Curve, Seismic Zones, Soil Conditions**

1.INTRODUCTION

Human kind is dependent upon civil engineering for its existence. Civil engineering being a vast field. It mainly deals with the design and maintenance of structure like residential buildings, commercial buildings, industrial structure, infrastructure projects, important service and community buildings etc. Concrete is a versatile material, which stands in second place regarding per capita consumption in the world.

1.1 FRAGILITY:

Fragility curves is a stochastic tool representing the probability of exceeding a given damage state (or performance) as a function of an engineering demand parameter that represents the ground motion (preferably spectral displacement/ spectral acceleration for a given frequency).

1.2 OBJECTIVES

The basic objectives of the study is to find the probability of failure of an RC building is given below,

- To analyse the building frames by Fragility Analysis.
- To determine fragility curves for different Zones and different soil conditions.
- Suggesting minimal structural changes for the building floor plan to attain good and efficient structure.
- Overall to check the efficiency of the software itself.

1.3 METHODOLOGY

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

1. A detailed literature review is carried out, based on the objectives of study.
2. SAP 2000 software is used for the modelling of the commercial complex for different Zones and different soil conditions.
3. Analyse the model using dynamic analysis as per IS:1893-2002.
4. Material used is: M20 Grade concrete and Fe-415, Fe-500 steel.
5. The beam and column sizes are taken as per beam column layout.
6. Finally, the conclusion is drawn based on the results obtained.

2. MODELLING

This chapter involves in modelling of RC frame system of G+5 with a storey height of 3m. The frame is beam-column system. Therefore, the load is distributed from the slab to beam and from beam to column. The grade of concrete used is M-20 and rebars used is Fe-415 and Fe-500

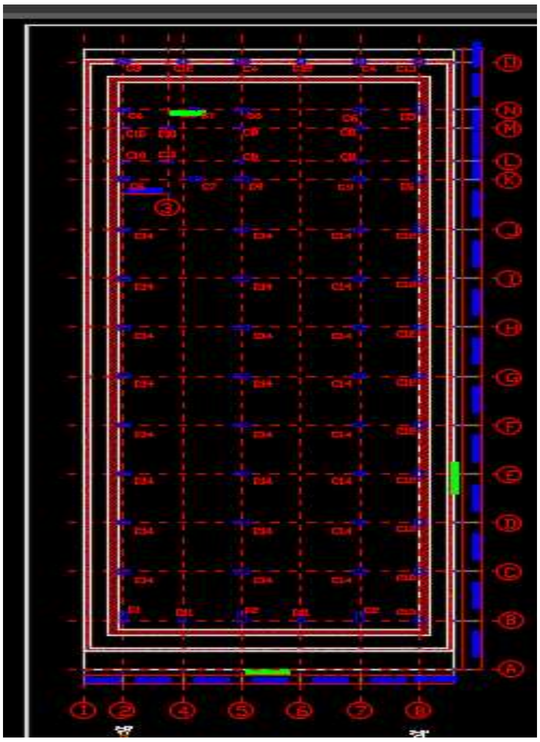

Fig -1: Beam Column Layout

Figure 1 shows the beam column layout of the commercial building, i.e., the position of beams and columns to be fixed.

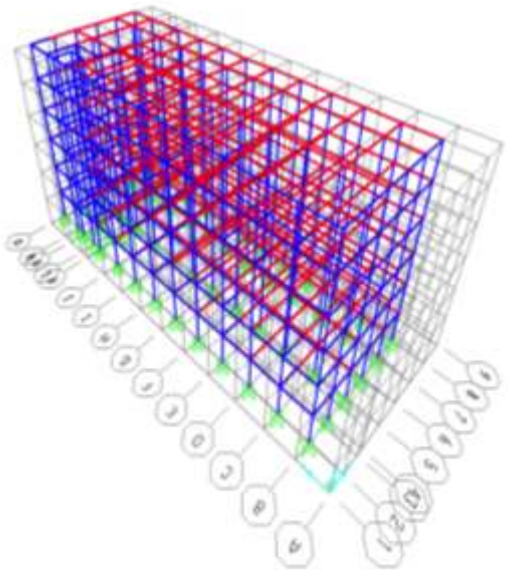

Fig -2: Model of G+5

Figure 2 shows the 3D view of the G+5, commercial building with a storey height of 3m. the total height of the building is 18m, situated in Yadagiri, Karnataka, India.

3. ANALYSIS

The commercial building is analyzed for by Non Linear Pushover analysis. The dynamic analysis is performed for Zone II, Zone III, Zone IV and Zone V and different soil conditions. Procedure is as follows,

1. To Create / import the beam column layout from auto cad in the usual manner by graphical interface software SAP 2000.

2. Define the material properties, such as characteristic strength of concrete, rebar properties, etc.

3. Define the sectional properties, such as dimensions of beam, column and slab.

4. Assign the sectional properties as per the beam column layout.

5. Define the loads, such as dead load, live load, floor finish, wall load.

6. Now, assign the loads respectively.

7. Now for doing pushover analysis, define load combinations and pushover.

8. Provide hinges for both beam and column as per ATC – 40.

9. Provide meshing to the slabs as cookie cut.

10. Analyze the model, and obtain the pushover capacity curve for different soil conditions.

4. RESULTS AND DISCUSSIONS

The Non Linear Pushover analysis, is done to obtain the static pushover curve such as capacity spectrum curve, FEMA-356 Co-efficient method curve. Also, the fragility curves and fragility points are derived for BHUJ and ELCENTRO earthquake.

Table -1: Seismic Co-Efficients

Seismic coefficients, C_A				
Soil	Zone II	Zone III	Zone IV	Zone V
	0.1	0.16	0.24	0.36
Type I	0.05	0.08	0.12	0.18
Type II	0.05	0.08	0.12	0.18
Type III	0.05	0.08	0.12	0.18
Seismic coefficients, C_V				
Type I	0.05	0.08	0.12	0.18
Type II	0.07	0.11	0.17	0.25
Type III	0.08	0.13	0.2	0.3

Table -1 shows the seismic co-efficients for different Zones and for different soil conditions which is used for performing analysis.

Table -2: Target Shear Vs Shear Actual For Different Zones

	SOIL TYPE	TARGET SHEAR	SHEAR ACTUAL	RESULT
ZONE II	TYPE I	1032	937	SAFE
	TYPE II	1393	1484	SAFE
	TYPE III	2301	1718	SAFE
ZONE III	SOIL TYPE	TARGET SHEAR	SHEAR ACTUAL	RESULT
	TYPE I	1280	1562	UNSAFE
	TYPE II	1815	1874	SAFE
	TYPE III	3137	2500	SAFE
ZONE IV	SOIL TYPE	TARGET SHEAR	SHEAR ACTUAL	RESULT
	TYPE I	1606	2062	UNSAFE
	TYPE II	2457	2811	UNSAFE
	TYPE III	3800	3936	UNSAFE
ZONE V	SOIL TYPE	TARGET SHEAR	SHEAR ACTUAL	RESULT
	TYPE I	2116	2811	UNSAFE
	TYPE II	3081	4217	UNSAFE
	4112	4780	UNSAFE	4112

Table -2 shows the value of shear force obtained from the software and actual shear obtained from manual calculations and the results are obtained. As it is clearly seen, for Zone II, Zone III almost for all types of soil the building is safe. But, only in the case of Zone IV and Zone V the structure is totally unsafe for all types of soil.

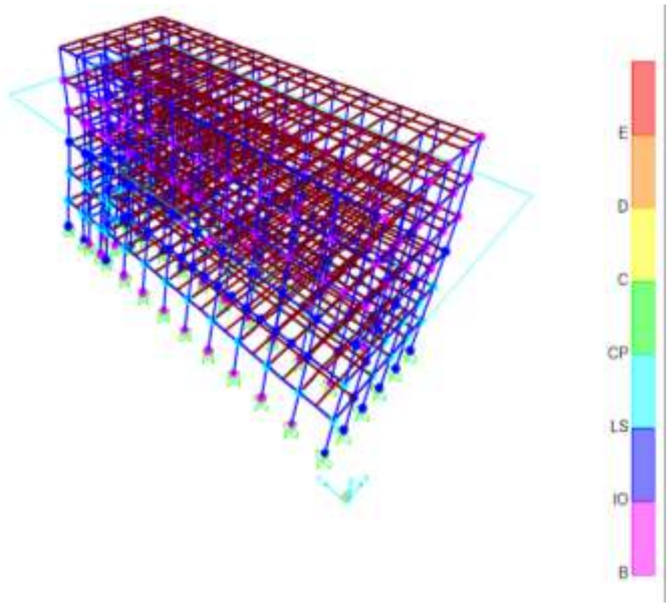

Fig -3: Analyzed Model

From figure -3, we can see the behaviour of the commercial building under dynamic load and also find the state of damage of the structure

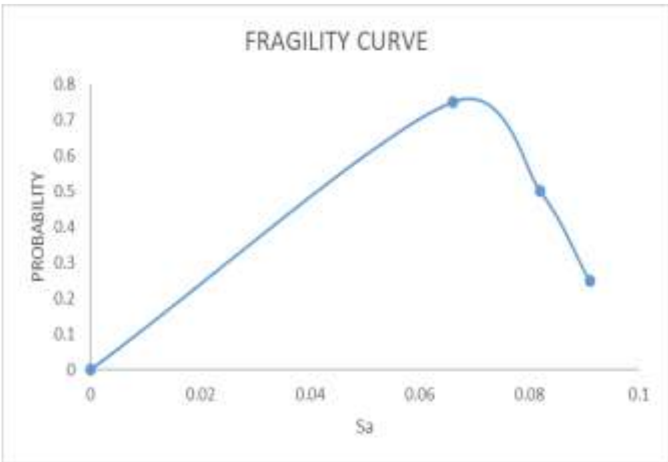

Fig -4: Fragility Curve

Figure -4, represents the fragility curve for Zone II. From the curve it is prominent that the peak point on the curve is at 0.7 and hence we can conclude that the structure is safe in Zone II.

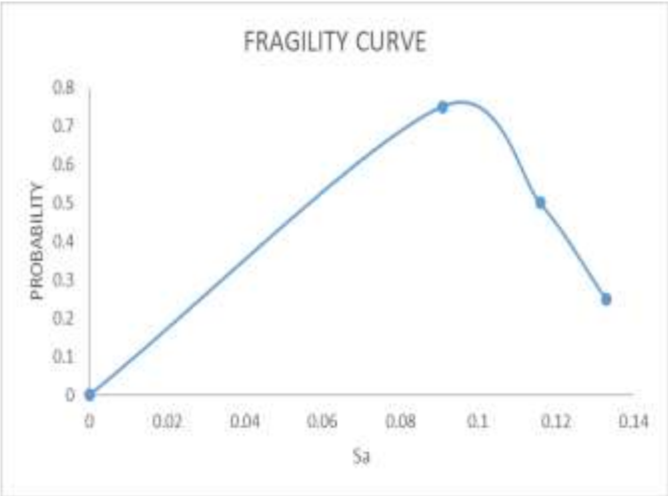

Fig -5: Fragility Curve

Figure -5, represents the fragility curve for Zone III. From the curve it is prominent that the peak point on the curve is at 0.75 and hence we can conclude that the structure is safe in Zone II.

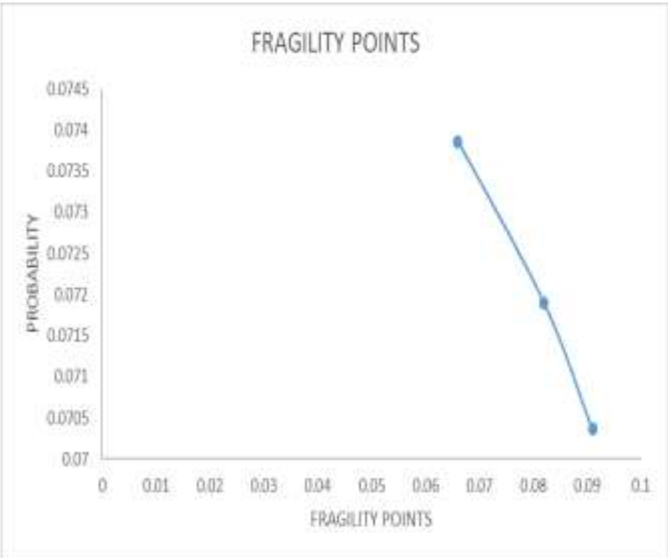

Fig -6: Fragility Point

Figure -6, represents the fragility point for Zone II. This has been calculated using the formula for different earthquakes.

From the curve it is seen that the fragility points lie below the fragility curve, also from this it is suggested that the building is safe in Zone II.

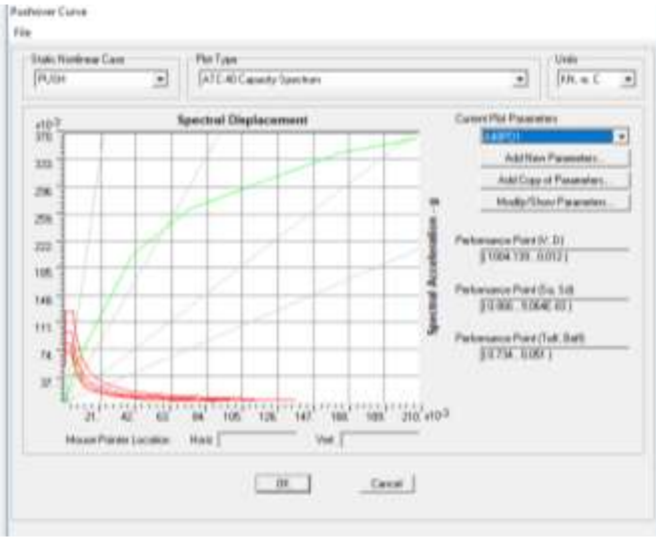

Fig -7: Capacity Spectrum Curve

From figure -7, the static pushover capacity spectrum curve, at performance point, the value of target shear, displacement , spectral acceleration, spectral displacement and effective time period.

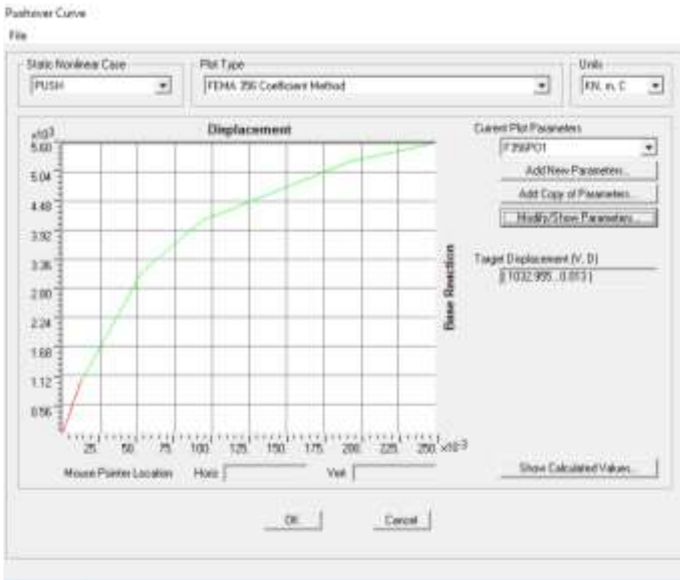

Fig -8: Capacity Spectrum Curve

From figure -8, FEMA -356 co-efficient method, the value of shear force for different Zones and different soil conditions is obtained.

4. CONCLUSIONS

The target shear force is obtained from the software itself for different Zones and different soil conditions. The value of base shear is calculated as per IS 1893 :2002. Base shear values is calculated for different Zones and different soil conditions. The following points is incurred,

- In Zone II, for all soil conditions the building is safe.
- In Zone III, the building is safe only for type II and type III soil conditions.
- For Zone IV and Zone V the building will fail for all types of soil conditions.
- It is concluded that the building is safe in Zone II and Zone III so the building is safe.
- In Zone IV and Zone V, for structures to withstand any damage due to lateral forces the structures should be designed as earthquake resistant structures, by providing bracings, ductile detailing, etc.
- If the fragility points lie under the fragility curve, then the structure constructed in that particular soil type and in that particular Zone is said to be safe.
- If the fragility points lie above the fragility curves, then the structure constructed in that particular soil type and that particular Zone is said to be Un- safe.

FUTURE SCOPE OF STUDY:

- This method can also be used for analysis of tall buildings.
- By changing the material and sectional properties, research work can be carried out.
- Research on improving the methodology can be done.

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