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IMPACT OF BHUJ EARTHQUAKE ON G+7 BUILDING BY TIME HISTORY ANALYSIS AND COMPARE ITS RESULTS TO RESPONSE SPECTRUM METHOD

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ABSTRACT

Severe damage has been caused by medium intensities earthquakes and therefore the need of earthquake resistant design of structures. The seismic analysis can be performed by linear static analysis, nonlinear static analysis, linear dynamic analysis and nonlinear dynamic analysis. In present research, the linear dynamic response spectrum and time history analysis is adopted to evaluate the response of G+7 multi-storeyed building with open storey and infill walls. The structure is been modelled and analysed utilizing STAAD-PRO-V8i and various seismic responses of the building are being calculated and being plotted to compare the results

Keywords*: Seismic Analysis, Soft Storey, Infill walls ,multi-storey, SMRF , Dynamic Analysis, Storey Deflection, Storey Displacement, Response Spectrum Analysis, Time History, Lateral Force, Story Drift, Story Stiffness.*

I. INTRODUCTION

Many earthquakes of severe to medium intensities occur in the Indian subcontinent almost once a decade. This earthquake causes severe damage to properties in general and multi-storeyed building in particular. Hence all the building constructed in Indian subcontinents and particularly situated in earthquake prone zones should be designed for loads and stresses, resulting out of earthquakes.

For the determination of seismic responses there is necessary to carry out seismic analysis of structure. The analysis can be performed on the basis of external action, the behaviour of structure or structural materials, and the type of structural model selected. Based on the type of external action and behaviour of structure, the analysis can be further classified as: (1) Linear Static Analysis, (2) Nonlinear Static Analysis, (3) Linear Dynamic Analysis; and (4) Nonlinear Dynamic Analysis.

Response spectrum method is the linear dynamic analysis method. In that method the peak response of structure during an earthquake is obtained directly from the earthquake response, but this is quite accurate for structural design applications.

Time history analysis is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear. To perform such an analysis, a representative earthquake time history is required for a structure being evaluated. Time history analysis is a step-by step analysis of the dynamic response of a structure to a specified loading that may vary with time. Time history analysis is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

We need to confirm to the safety against the dynamic force like earthquake force that are affecting the structures, and determine seismic responses of such building.

In present research, the linear dynamic response spectrum and time history analysis is adopted to evaluate the

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response of G+7 multi-storeyed building with open storey and infill walls. The structure is been modelled and analysed utilizing STAAD-PRO-V8i and various seismic responses of the building are being calculated and being plotted to compare the results.

II. DESIGN PARAMETERS

Analysis is being done for G+7 multi- storey building(rigid joint frame) using STAAD PRO using the preliminary data as follows:-

Table 1: List of design parameters

Sn.	Specifications	Details
1.	Type of Structure	High Rise RC frame structure (SMRF)
2.	No. of Storeys	G+7, 7 stories
3.	Seismic Zone	V
4.	Time History Data	Bhuj/Kutchchh Earthquake IIT R station Ahmedabad Hypo-central distance 239 Km
5.	Floor height	3.0 m
6.	Building height	25.5 m
7.	Plan size	30 m *20 m
8.	Total area	600 m2
9.	Size of columns	0.60 m* 0.35 m
10.	Size of beams	0.65m * 0.30m
11.	Thickness of external wall	230mm
12.	Thickness of internal wall	115mm
13.	Thickness of slab	150mm
14.	UDL due to external walls	6.75KN/m
15.	UDL due to internal walls	4.75 KN/m
16.	UDL due to parapet	2.25 KN/m
17.	LL for all floors except roof	2 KN/m2
18.	LL for roof	1.5KN/m2
19.	Material used	Concrete M-30KN/m2 and Reinforcement Fe-415(HYSD)
20.	Earthquake load	As per IS- 1893-2002
21.	Type of soil	Medium soil as per IS-1893
22.	Ec	5000√fck N/ mm2 (Ec is modulus of elasticity in N/mm2)
23.	Dynamic analysis	Response Spectrum and Time History Method
24.	Software used	STAAD-Pro
25.	Zone factor Z	0.36(as per IS 1893: 2002 for Zone V)

III. MODELLING

The G+7 multi-storeyed building is framed as a 3D space frame with rigid joints using STAAD PRO software for simulation of behaviour under DL, LL, Seismic, Response and Time History Loading. The support conditions are considered as fully fixed. The plan of the building is as follows:-

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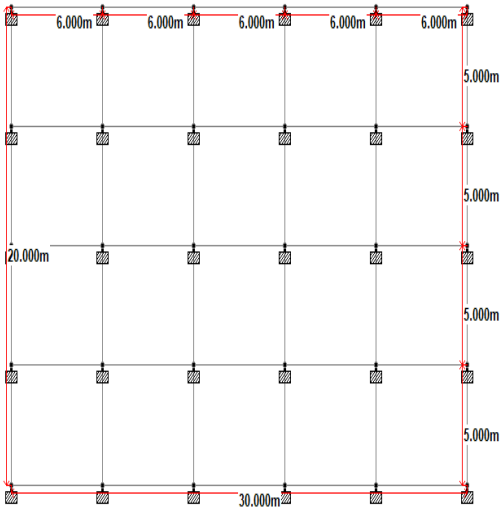

Figure 1:- Plan of G+7 multi-storeyed building

The G+7 multi-storeyed building is being analysed for 2 cases viz, (i) G+7 multi-storeyed building with soft storey and with infill walls by Time History method (ii) G+7 multi-storeyed building with soft storey and with infill walls by Response Spectrum method

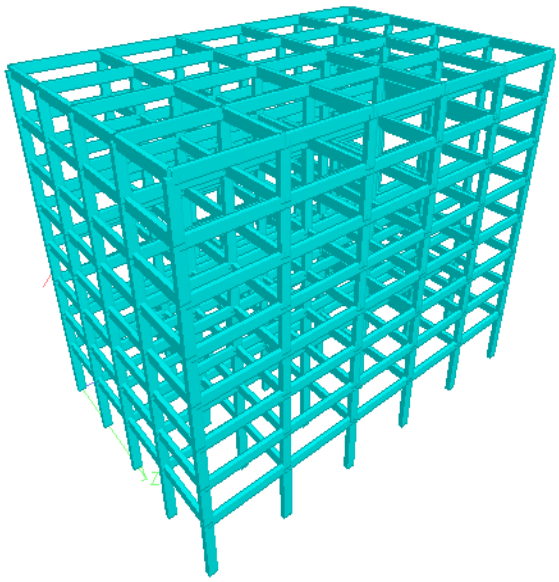

Figure 2:- 3D Model of G+7 multi-storeyed building with soft storey & with and without infill walls Loading and Load Combinations

Different types of loads being applied on the G+7 multi-storeyed building model are Dead loads which includes self-weight of the structure comprising of the weight of the beams, columns, slabs, finishing, water proofing etc. Uniform loading due to external walls, internal walls and parapet also comes under dead load taken in the analysis. All the dead loads being considered is as per the dimensions of the building under consideration and as per IS 875 Part 1: 2016.Live loads on the slabs and on the roof are as per IS 875 Part 2.Seismic forces in X and Z dir. considering zone V with zone factor 0.36 as per IS 1893: 2002 are used. Time history loading is also used in X dir.

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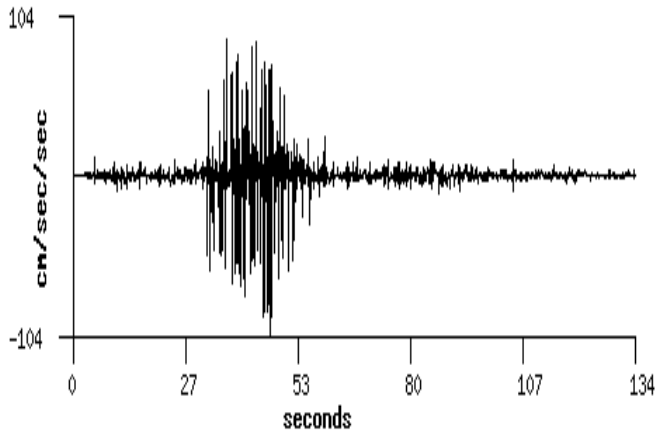
In the time history analysis, a typical time history for the BhujEarthquake of January 26, 2001 at 08:46:42.9 I.S.T. Magnitude: 7.0 mb, 7.6Ms recorded at Ahmedabad Station having Latitude and Longitude as23 02 N, 72 38 E Component: N 78 E is used. Accelerogram Band pass filtered between 0.07 Hz and 27.0 Hz having an Initial Velocity of -0.1411E-02 m/s, Initial Displacement = 3.970 mm and Peak Acceleration = -1.0382 m/s/s at 46.940 sec is utilized.



Load Combinations

Various load combinations being considered in the analysis of the G+7 multi-storeyed building are as follows:-

Table 2: List of various load combinations

Time History Method	**Response Spectrum Method**
Dead load including self-weight, wall loading, parapet loading, slab thickness, finishing and waterproofing etc.(DL)	Dead load including self-weight, wall loading, parapet loading, slab thickness, finishing and waterproofing etc.(DL)
Live load(LL)	Live load(LL)
Time History Loading in X dir.(THx)	Response Spectrum Loading in X dir.(RSx)
1.5(DL+LL)	Response Spectrum Loading in Z dir.(RSz)
1.2(DL+LL)	1.5(DL+LL)
1.2(DL+LL±THx)	1.2(DL+LL)
1.5 DL	1.2(DL+LL±RSx)
1.5(DL±THx)	1.2(DL+LL±RSz)
0.9 DL ± 1.5 THx	1.5 DL
	1.5(DL±RSx)
	1.5(DL ±RSz)
	0.9 DL ± 1.5 RSx
	0.9 DL ± 1.5 RSz

IV. ANALYSIS AND RESULTS

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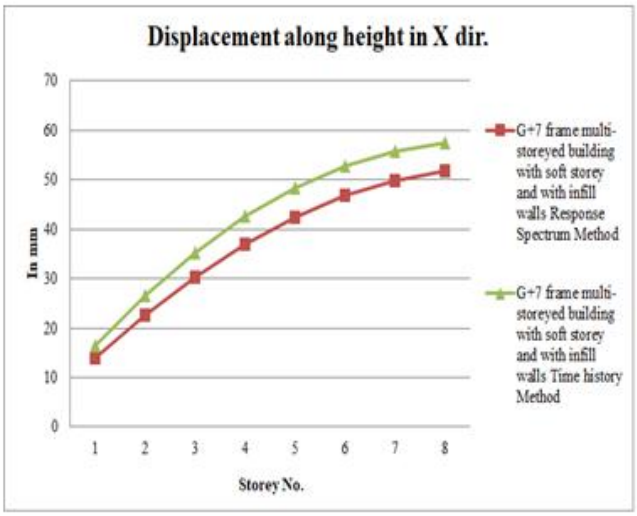
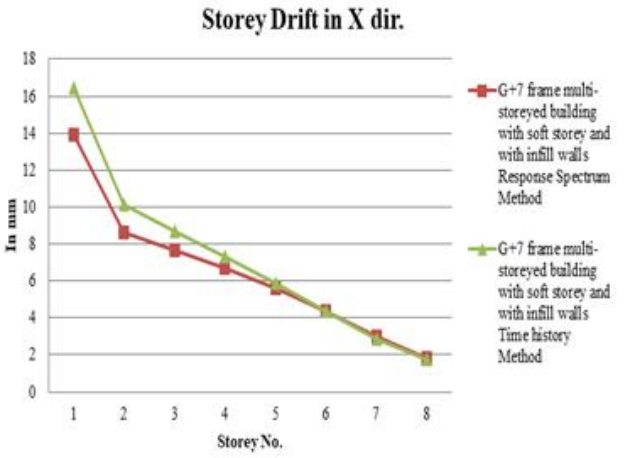
(i) Displacement along the height in X dir. :-

Displacement along the height in X dir.(in mm)		
Storeys	G+7 frame multi-storeyed building with soft storey and with infill walls Response Spectrum Method	G+7 frame multi-storeyed building with soft storey and with infill walls Time history Method
1	13.925	16.44
2	22.562	26.544
3	30.198	35.251
4	36.888	42.594
5	42.494	48.454
6	46.872	52.804
7	49.869	55.673
8	51.7	57.417



(ii) Storey Drift in X dir.:-

Storey drift in X dir.(in mm)		
Storeys	G+7 frame multi-storeyed building with soft storey and with infill walls Response Spectrum Method	G+7 frame multi-storeyed building with soft storey and with infill walls Time history Method
1	13.925	16.44
2	8.637	10.104
3	7.636	8.707
4	6.69	7.343
5	5.606	5.86
6	4.378	4.35
7	2.997	2.869
8	1.831	1.744



(iii) Maximum Lateral Reaction in X dir. :-

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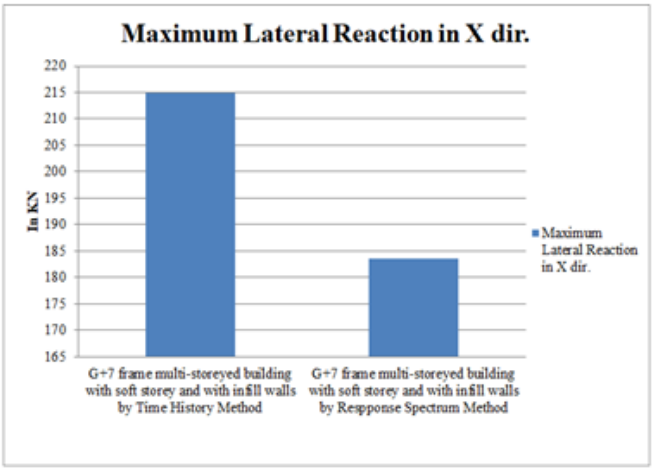
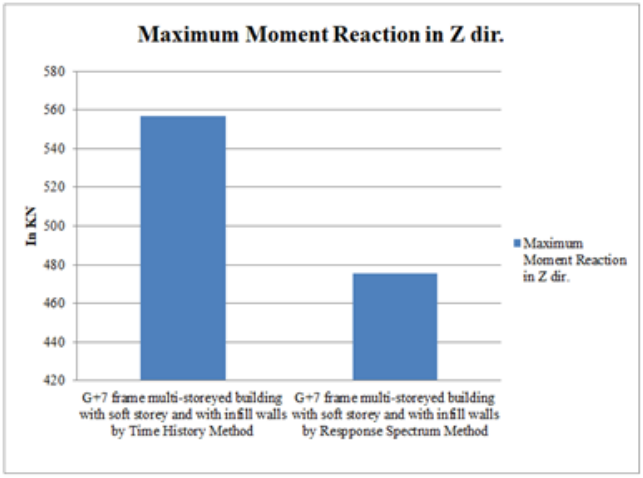
	Maximum Lateral Reaction in X dir.
G+7 frame multi-storeyed building with soft storey and with infill walls by Time History Method	214.818
G+7 frame multi-storeyed building with soft storey and with infill walls by Response Spectrum Method	183.591



(iv). Maximum Moment Reaction in Z dir. :-

	Maximum Moment Reaction in Z dir.
G+7 frame multi-storeyed building with soft storey and with infill walls by Time History Method	556.632
G+7 frame multi-storeyed building with soft storey and with infill walls by Response Spectrum Method	475.401



V. CONCLUSION

The seismic performance of the reinforced concrete G+7 multi-storeyed building for Frame with infill wall and open ground story is being studied. The seismic performances were estimated through the comparison between different response like storey displacements, story drift etc. by Response Spectrum method of analysis and Time history Method of analysis. In the present study, an attempt has been made to compare the seismic behaviour of high rise buildings with complexities for both these methods and the following conclusions are drawn.

(i) Displacement along the height in X dir. for G+7 model with soft storey and infill walls for Time history method is 14.66% more on an average than Response Spectrum Method.

(ii) The increase in the displacement along the height in X dir. decreases as the height increases with the maximum increase in displacement for ground story.

(iii) The drift in X dir. is marginally higher about 6.71% on an average for G+7 model with soft storey and infill walls in Time History method than Response Spectrum method.

(iv) The increase in drift is maximum for ground floor and reduces with height. The higher floors have in-fact lesser drift in Time History method than Response Spectrum Method.

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(v) Maximum Lateral reaction in X dir. is a little higher about 17% on an average in the model analysed by Time history method than by Response Spectrum method.

(vi) Maximum Moment reaction in Z dir. is 17.09% higher on an average for model analysed by time history method than by Response Spectrum method.

Time history method gives higher values of various seismic parameters and so the building designed by Time history method is safer than a building designed by Response Spectrum method. Hence to analyse and design a building in an earthquake prone region like Zone 5 Time history method should be preferred over Response Spectrum Method.

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