Comparative Response Spectrum and Time History Analysis of G+17 RC Frame on Zone III in India

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Abstract: ***Seismic resistant deign is a matter of interest for structural engineers these days hence becoming popular in the field of structural engineering. Since there are a number of earth quakes were faced in the society, there is a very much need of this subject to emerge. Many government and some private building owners today require that new buildings be designed to resist the effects of Earthquakes and other incidents that could cause tremendous local damage. In this discussion it may be possible to design buildings to resist such attacks without severe damage, the loading effects associated with these hazards and so intense that design measures necessary to provide such performance would result in both unacceptably high costs as well as impose unacceptable limitations on architectural design of such buildings. Response spectrum is one of the useful tools of earthquake engineering for analyzing the performance of structures especially in earthquakes, since many systems behave as single degree of freedom systems. Thus, if you can find out the natural frequency of the structure, then the peak response of the building can be estimated by reading the value from the ground response spectrum for the appropriate frequency. In most building codes in seismic regions, this value forms the basis for calculating the forces that a structure must be designed to resist (seismic analysis). A response spectrum is a plot of the maximum response amplitude (displacement, velocity or acceleration) versus time period of many linear single degree of freedom oscillators to a give component ground motion. For this purpose response spectrum case of analysis have been performed according to IS 1893. In the Present Study Analysis is carried out for the proposed plan of G+17 building in both Response spectrum and Time history analysis considering Zone-III for Response Spectrum and Bhuj Earthquake 2001 (Gujarat) data gathered from Virtual Data Centre for Time History Analysis and the Results are compared between Response Spectrum and Time history cases which compares Theoretical and Practical data of same zone.***

Keywords: Response Spectrum, Time History, Structural Displacements, Base Shear

1. Introduction

Since there are a number of earth quakes were faced in the society, there is a very much need of this subject to emerge. Many government and some private building owners today require that new buildings be designed to resist the effects of Earthquakes and other incidents that could cause tremendous local damage.

In this discussion it may be possible to design buildings to resist such attacks without severe damage, the loading effects associated with these hazards and so intense that design measures necessary to provide such performance would result in both unacceptably high costs as well as impose unacceptable limitations on architectural design of such buildings.

Fortunately, the probability that any single building will actually be subjected to such hazards is quite low. As a result, a performance based approach to design has evolved. The most regular performance goals are to permit severe and even tremendous damage effect a structure, but avoid huge loss of life Often, design to resist earthquakes, impact and other unusual loads must be thought of in the content of life safety, not in terms of serviceability or lifecycle performance. The serviceability and reuse may be required for test facilities, but most commercial office and industrial facilities will not have to perform to these levels.

Structures designed to resist the effects of earthquakes are permitted to contribute all of their resistance, both material linear (elastic) and material non-linear (inelastic), to absorb damage locally, so as not to compromise the integrity of entire structure. It is likely that local failure can and may be designed to occur, due to uncertainty associated with such Seismic-loads.

Time History Analysis of Structures is carried out when the input is in the form of specified time history of ground. Time History Analysis is performed using Direct Integration Methods or by using Fourier Transformation Technique and in the Direct Integration Method, there are many integration schemes; two most popular among them are-

1) Duhamel Integration
2) Newmark's B Method

For both of the above two methods, a recursive relationship is derived to find responses at **k+1**th time station for a given **k**th time station value

2. Plan and Configurations

A G+17 reinforced concrete building is modelled, analysed and studied. The examine is completed in all of the seismic zones of India and conclusions are drawn. The input statistics required for the layout of G+17 building are supplied within the tables below. table 1 show the building details which includes plan length, overall top of the constructing, ground peak and place details which include region, soil type and so on. The elements together with significance element, reaction discount aspect values are taken from IS 1893 (element 1): 2002. table 2 indicates the material properties and segment houses. Table 3 suggests the loading information at the building for designing.

The building for the present work is G+17 residential building consisting of 30' in Z-direction and 40' in X-direction. The typical storey height is 3.2m and overall height of the building is 19.2m from the ground level. The following are the specifications of G+17 building in preliminary design.

Height of floor	: Plinth level – 1.5 m
	: Remaining floors – 3.0 m each.
Slab thickness	: 125mm
Thickness of wall	: 230mm (outer)
	: 115mm (inner)
Beam sizes	: 230mmX300mm
Column sizes	: 230mmX450mm Grade of Steel
	: FE 500
Grade of concrete	: M25
Density on concrete	: 25 kN/m^3
LL on floors	: 2 kN/m^2 as per IS:875 part-2
LL on roof	: 1.5 kN/m^2 as per IS:875 part-2
Dead load	: 12.0 kN/m^2 for outer walls
	: 6.0 kN/m^2 for inner walls
	: 4.6 kN/m^2 for slab dead load including floor finishes
Density of wall	: 20 kN/m^3
Combination load	: 1.5 (Dead load + Live load)
	: 1.2 (Dead load + Live load)

Plan of building

The plan for the present study is G+17 storied building and preliminary design is done by doing static analysis i.e., only dead and live loads of the building are considered for analysis.

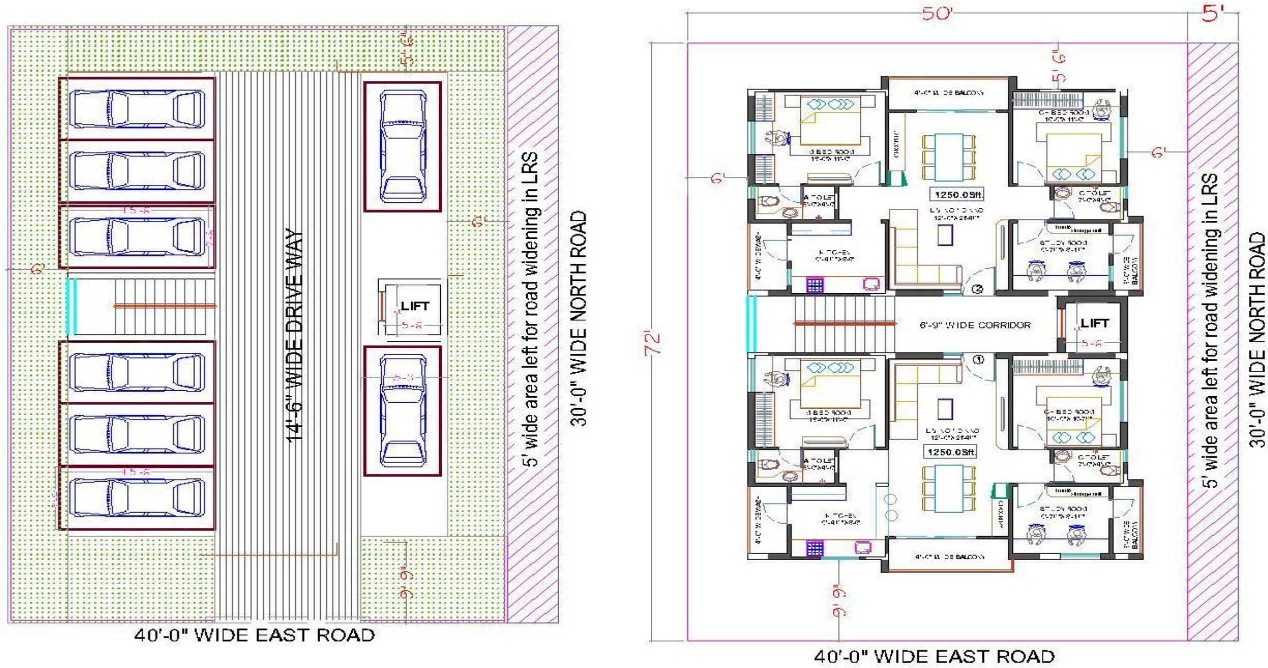

Figure 1: Proposed Plan of the Building

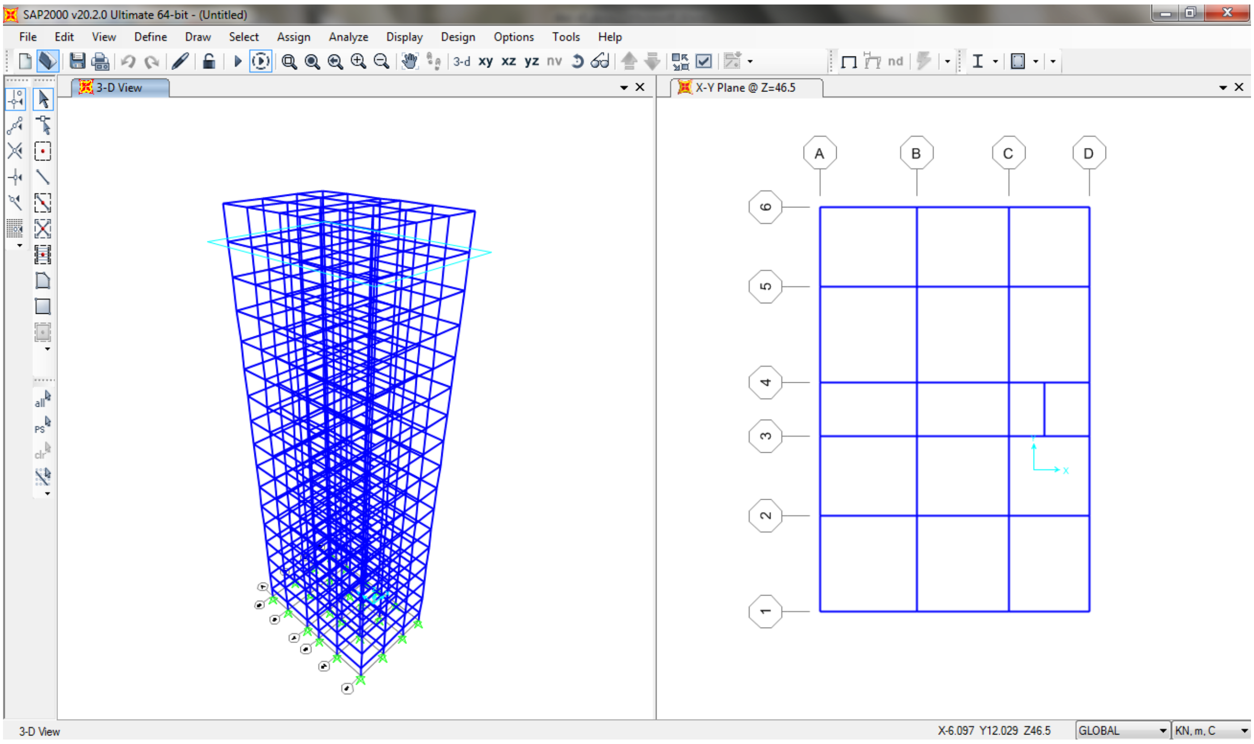

Figure 2: Modelling of Building in SAP2000

3. Methodology

Create model in SAP 2000 for the plan shown in fig.1 by considering beam and column frames shown in Fig.2 and perform analysis for static load cases such as Dead load, Live load which are mentioned above. Fix the Dimensions of structural members so that the building is resisted for all the static and Pseudo static load combinations, Now define the Response Spectrum load case considering Zone II for the present study, performing analysis and comparing the results between static and Dynamic Load cases.

4. Summary and Results

The Maximum Shear force and Bending Moment diagrams of all the load cases are shown aside after performing analysis, which are used for finding main and transverse reinforcement in beams and columns.

The maximum Deflection among all the load cases observed at storey level 17 as 6.9 mm and 5.8 mm at corners of Building and maximum permissible of column's as per IS:1893-2002 is 0.004*clear storey Height = 12.8mm

The building is safe against Torsional Irregularity as (D max/D ave) < 1.2

The building is safe against stiffness irregularity as all the storeys have equal stiffness

The modal mass participation factor must be greater than 90% as per IS:1893-2002 and the no of mode shapes taken in the present study is 51 so that modal mass ratios are satisfying the criteria below as specified in code .

MODAL	Mode	49	0.086565	1.85E-05	1.957E-07	8.378E-07	0.9763	0.97709
MODAL	Mode	50	0.085092	7.369E-05	1.117E-09	0.00015	0.97637	0.97709
MODAL	Mode	51	0.083777	0.00016	7.402E-10	0.00013	0.97653	0.97709

Figure 3: Table Showing Modal participating mass ratios

Base Reactions

Units: As Noted

OutputCase	CaseType Text	StepType Text	GlobalFX KN	GlobalFY KN	GlobalFZ KN	GlobalMX KN-m	GlobalMY KN-m	GlobalMZ KN-m	GlobalX m	GlobalY m
RES	LinRespSpec	Max	1459.227	1519.789	10.705	53074.1349	51971.9997	6518.03	0	
TIME HISTO...	LinDirHist	Max	2533.292	13.001	194.388	589.7474	28718.8924	6120.8791	0	
TIME HISTO...	LinDirHist	Min	-2062.052	-16.356	-164.734	-390.919	-29384.4102	-8009.6049	0	

Figure 4: Table Showing Base Reactions in Response Spectrum and Time History Load Case

The maximum Displacement in Response spectrum load case is observed as 0.056 m at joint 884 and 0.095 m at joint 904. Maximum reinforcement in beams and column's is limited to <= 2.5% of area of concrete in the present study. The width to depth ratio is maintained >= 0.4 as per IS:13920 for beams and column's. Results show that Acceleration and Velocities of masses due ground is high in Time History case which means actual moment of inertia is more than Theoretical case.

5. Conclusions

In the present study a five storey R.C.C symmetric building was analyzed for seismic load. Seismic load is calculated from IS1893-2002 and Response spectrum analysis is carried out on SAP2000 software. After dynamic analysis of building subjected to seismic load, following conclusions were drawn.

1) Seismic resistant design refers to improving structural reliability of structure instead of complete collapse of building when it subjected to earthquake phenomenon. The present study on G+17 Residential building prove

that increase in stiffness of structural members by increasing in size prove better results which also oppose the uplift force on footings by increasing in dead weights.
2) Regular building which is symmetric about both the axis proves to perform well for load transformation of loads to ground during seismic conditions than irregular buildings and also avoids Torsional irregularity.
3) Effects of seismic load can be decreased by providing lateral moment resisting frames like shear wall thereby diminishing the effect of lateral loads which also reduce damage and increase structural integrity of the building.
4) Deviation of displacement is Non-Uniform along the height of building.
5) For the significant structures, seismic analysis needs to carry out by keeping in view the earthquake activities in today's circumstances.

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