

RESPONSE SPECTRUM ANALYSIS OF G+9 BUILDING

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Abstract

The principle objective of this project is to analyse and design a g+9 storied building using ETABS 2015. The design involves load calculations manually and analyzing the whole structure by ETABS2015. The design methods used in ETABS2015 analysis is a dynamic analysis using response spectrum method conforming to Indian Standard Code of Practice. This features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, ETABS2015 is the professional's choice. A building model is designed and analyzed and the time period, stiffness, base shear, storey drifts and top-storey deflection of the building is observed. The wind load values were generated by ETABS2015 considering the given wind intensities at different heights and strictly abiding by the s of IS 875. Seismic load calculations were done following IS 1893-2000. Complicated and high-rise structure need very time taking and cumbersome calculations using convectional manual methods. ETABS2015 provides us a fast, efficient, easy to use and accurate platform for analyzing and designing structure.

Key Words. Base Shear, Storey Drifts, Deflections, Time Period

INTRODUCTION

The term earthquake can be used to describe any kind of seismic event which may be either natural or initiated by humans, which generates seismic waves. Earthquakes are caused commonly by rupture of geological faults; but they can also be triggered by other events like volcanic activity, mine blasts, landslides and nuclear tests. An abrupt release of energy in the Earth's crust which creates

seismic waves results in what is called an earthquake, which is also known as a tremor, a quake or a temblor). The frequency, type and magnitude of earthquakes experienced over a period of time defines the seismicity (seismic activity) of that area. The observations from a seismometer are used to measure earthquake. Earthquakes greater than approximately 5 are mostly reported on the scale of moment magnitude. Those smaller than magnitude 5, which are more in number, as reported by the national seismological observatories are mostly measured on the local magnitude scale, which is also known as the Richter scale. There are many buildings that have primary structural system, which do not meet the current seismic requirements and suffer extensive damage during the earthquake.. At present time the methods for seismic evaluation of seismically deficient or earthquake damaged structures are not yet fully developed. The buildings which do not fulfill the requirements of seismic design, may suffer extensive damage or collapse if shaken by a severe ground motion. The seismic evaluation reflects the seismic capacity of earthquake vulnerable buildings for the future use. According to the Seismic Zoning Map of IS: 1893-2002, India is divided into four zones on the basis of seismic activities. They are Zone II, Zone III, Zone IV and Zone V.

Response Spectra

Response spectra are curves plotted

between maximum response of SDOF system subjected to specified earthquake ground motion and its time period (or frequency). Response spectrum can be interpreted as the locus of maximum response of a SDOF system for given damping ratio. Response spectra thus helps in obtaining the peak structural responses under linear range, which can be used for obtaining lateral forces developed in structure due to earthquake thus facilitates in earthquake-resistant design of structures. Usually response of a SDOF system is determined by time domain or frequency domain analysis, and for a given time period of system, maximum response is picked. This process is continued for all range of possible time periods of SDOF system. Final plot with system time period on x-axis and response quantity on y-axis is the required response spectra 103 pertaining to specified damping ratio and input ground motion. Same process is carried out with different damping ratios to obtain overall response spectra

- VI) Damping in the system
- VII) Time period of the system

Design Parameters

We are focusing on the behavior of RCC structure when loads including seismic loads including wind load act on. We are analytically investigating the behavior RCMRF during the earthquakes (Zone V) and observing maximum story displacement, story drift, rebar percentage. Response spectrum method is considered to analyze the structure by using ETABS software. . The wind load values were generated by ETABS2015 considering the given wind intensities at different heights and strictly abiding by the s of IS 875. Seismic load calculations were done following IS 1893-2000.

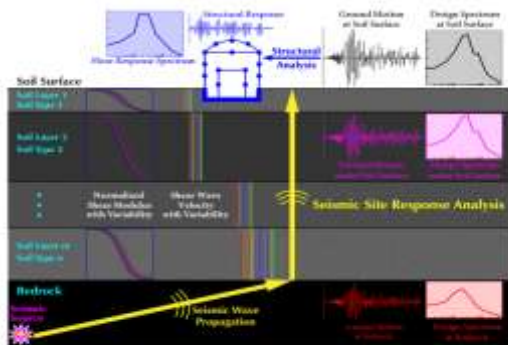


Figure 1.1 Design response spectra in earthquake engineering

Factor Influencing Response Spectra

The response spectral values depends upon the following parameters,

- I) Energy release mechanism
- II) Epicentral distance
- III) Focal depth
- IV) Soil condition
- V) Richter magnitude

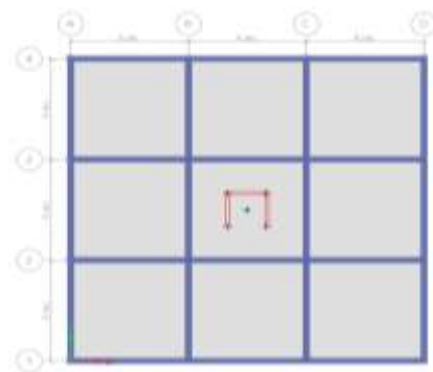


Fig.2.Plan in ETABS



Fig.3.3D view of model in ETABS

Table 1. Story Data

Name	Height	Elevation	Master	Similar	Splice
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	mm	mm	Story	To	Story
Story11	3000	34000	Yes	None	No
Story10	3000	31000	Yes	None	No
Story9	3000	28000	No	Story10	No
Story8	3000	25000	No	Story10	No
Story7	3000	22000	Yes	None	No
Story6	3000	19000	No	Story7	No
Story5	3000	16000	No	Story7	No
Story4	3000	13000	No	Story7	No
Story3	3000	10000	No	Story7	No
Story2	3000	7000	No	Story7	No
Story1	4000	4000	No	Story7	No
Base	0	0	No	None	No

Response Spectrum Parameters

Response-spectrum analysis is useful for decision making to select structural type, before designing a structure. It gives the dynamic performance of a structure. Structures of shorter period experience greater acceleration, whereas those of longer period experience greater displacement. The number of modes to be considered in analysis should be such that the sum of total of model mass of all the modes considered is not less than 90% of total seismic mass of structure. By considering 12 modes mass participation

of RCMRF building is achieved up to 92.28% (Model1) and 93.38% (Model2). Therefore 12 modes are considered for all models. Center of mass & centre of rigidity coincides, due to regularity in the plan, mass and stiffness of the building. So providing shear walls at all corners symmetrically may not affect center of mass and center of rigidity.

Load Patterns Table 2. Load Patterns

Name	Type	Self-WeightMultiplier	Auto Load
Dead	Dead	1	
Live	Reducible Live	0	
windX	Wind	0	Indian IS875:1987
windY	Wind	0	Indian IS875:1987
EQXA	Seismic	0	IS1893 2002
EQXB	Seismic	0	IS1893 2002
EQYA	Seismic	0	IS1893 2002
EQYB	Seismic	0	IS1893 2002

Indian IS875:1987 Auto Wind Load Calculation

Auto Wind Load

This calculation presents the automatically generated lateral wind loads for load pattern windX according to Indian IS875:1987, as calculated by ETABS.

Exposure Parameters

Exposure From = Diaphragms
 Structure Class = Class B
 Terrain Category = Category 2
 Wind Direction = 0;90 degrees
 Basic Wind Speed, V_b [IS Fig. 1]

Windward Coefficient, $C_{p,wind}$
 Leeward Coefficient, $C_{p,lee}$
 Top Story = Story10
 Bottom Story = Base
 Include Parapet = No

Factors and Coefficients

Risk Coefficient, k_1 [IS 5.3.1] $k_1 = 1$
 Topography Factor, k_3 [IS 5.3.3] $k_3 = 1$

Lateral Loading

Design Wind Speed, V_z [IS 5.3] $V_z = V_b k_1 k_2 k_3$
 Design Wind Pressure, p_z [IS 5.4] $p_z = 0.6 V_z^2$

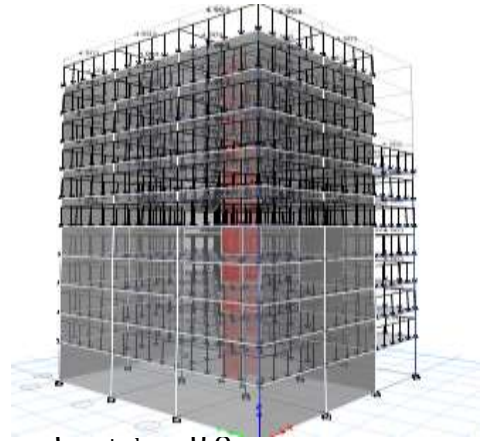


Fig.4. Frame span loads
 $C_{p,wind} = 0.0$
 $C_{p,lee} = 0.5$ (dead)

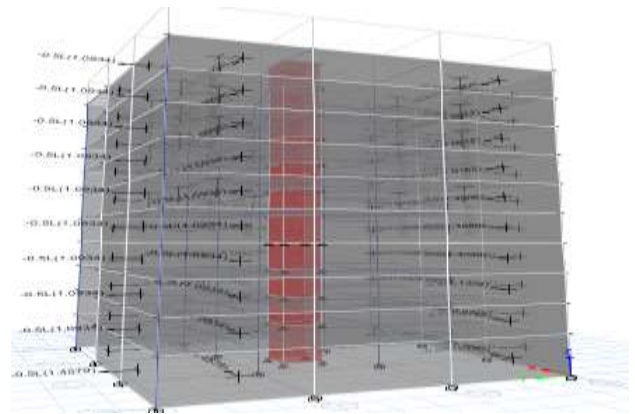


Fig.5. Wind pressure coefficient windy

Design Results

Table 1. Mass Source

Name	Include Elements	Include Added Mass	Include Loads	Include Lateral	Include Vertical	Lump at Stories	Is Default	Load Pattern	Multiplier
MsSrc1	No	Yes	Yes	Yes	No	Yes	Yes	Dead	1
MsSrc1	No	Yes	Yes	Yes	No	Yes	Yes	Live	0.25

Table 2. Centers of Mass and Rigidity

Story	Diaphragm	Mass X kg	Mass Y kg	XCM m	YCM m	Cumulative X kg	Cumulative Y kg	XCCM m	YCCM m	XCR m	YCR m
Story10	D1	348666.49	348666.49	8.2929	9.7101	348666.49	348666.49	8.2929	9.7101		
Story9	D1	356269.01	356269.01	8.2952	9.7077	704935.5	704935.5	8.294	9.7089		
Story8	D1	356269.01	356269.01	8.2952	9.7077	1061204.5	1061204.5	8.2944	9.7085		
Story7	D1	395498.61	395498.61	8.9885	9.0188	1456703.11	1456703.11	8.4828	9.5212		
Story6	D1	396005.44	396005.44	9	9.0073	1852708.56	1852708.56	8.5934	9.4114		
Story5	D1	396005.44	396005.44	9	9.0073	2248714	2248714	8.665	9.3402		
Story4	D1	396005.44	396005.44	9	9.0073	2644719.44	2644719.44	8.7152	9.2904		
Story3	D1	396005.44	396005.44	9	9.0073	3040724.89	3040724.89	8.7522	9.2535		
Story2	D1	396005.44	396005.44	9	9.0073	3436730.33	3436730.33	8.7808	9.2251		
Story1	D1	400150.22	400150.22	9	9.0084	3836880.55	3836880.55	8.8037	9.2025		

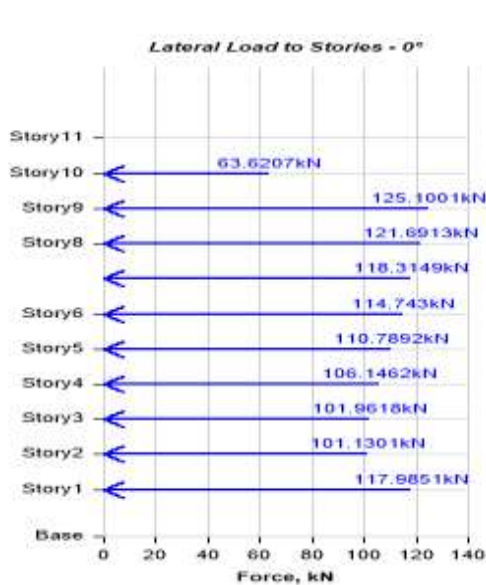


Fig.6. Applied Story Forces in Zero Degree Direction

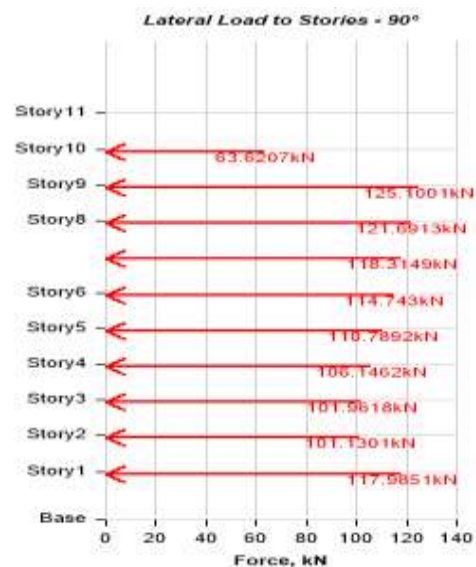


Fig.7. Applied Story Forces in Ninety Degree Direction

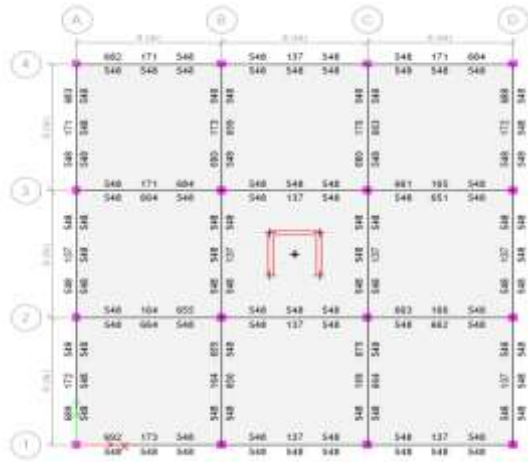


Fig.8. Beam rebars area in mm

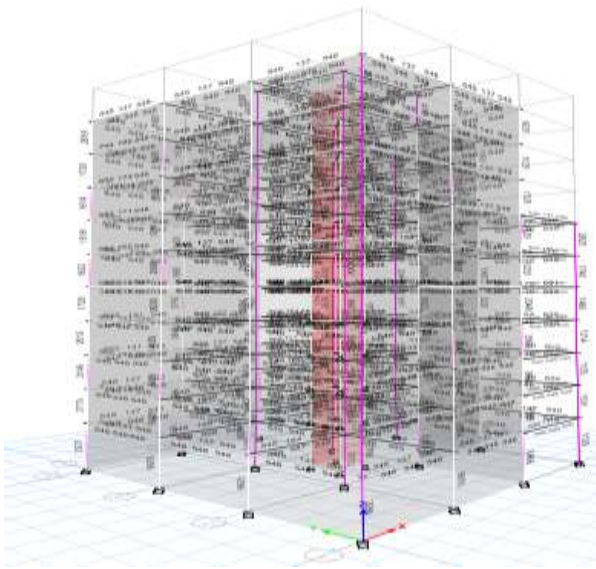


Fig.9. Longitudinal reinforcement area 3d view

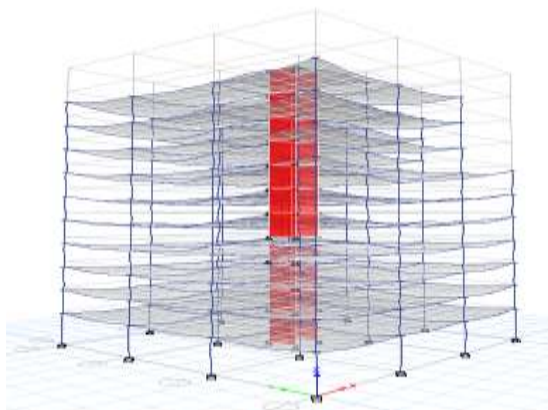


Fig.10. Deformation due to dead load

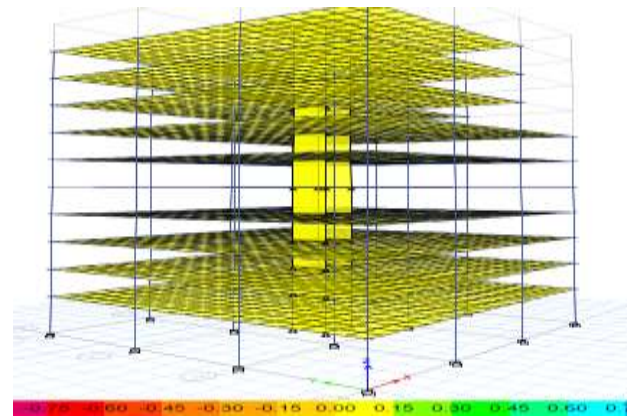


Fig.11. Resultant F11 direction windX

CONCLUSION

Designing using Software's like ETABS reduces lot of time in design work. Details of each and every member can be obtained using ETABS. All the List of failed beams can be obtained and also Better Section is given by the software. Accuracy is improved by using software. The CQC method should be used to combine modal maxima to minimize the introduction of avoidable errors. The response spectrum method is an approximate method used to estimate maximum peak values of displacements and forces and it has significant limitations. Symmetric structure gives economic results even when considered to high rise structures. Wind load application and analysis is not too complex when referred to particular codes with respective parameters. Response-spectrum analysis provides insight into dynamic behavior by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping.

10 Response-spectrum analysis is useful for design decision-making because it relates structural type-selection to dynamic performance.

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