DESIGN OF TALL RCC BUILDING WITH GUST FACTOR AND PUSHOVER ANAYLYSIS ON ETABS

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Abstract – *Tall building having height more than 20 m. these RCC buildings are build for residential or commercial perpose. Due to its high height Dead load , Live load, Wind load, Earthquake Load is take in consideration. We can design this building with special precaution and analyze with various static and dynamic method like pushover method.* In this paper *building frame is designed and analyze on ETAB 2016 and result are checked. Major parameter studied are force vs displacement. For that we are selected the square frame and DL,LL,WL,EL are applied on it and suitable load combination is selected for design and analysis. Hinges are assigned in beam and column. Hinges will be safe than Number of trials are taken for make section economical and safe.*

***Key Words*: Load, Displacement, pushover curve, Hinge, Reinforcement**

1. INTRODUCTION

In general, for design of tall buildings both wind as well as earthquake loads need to be considered. Governing criteria for carrying out dynamic analyses for earthquake loads are different from wind loads. According to the provisions of Bureau of Indian Standards for earthquake load, IS 1893(Part 1):2002, height of the structure, seismic zone, vertical and horizontal irregularities, soft and weak story necessitates dynamic analysis for earthquake load. The contribution of the higher mode effects are included in arriving at the distribution of lateral forces along the height of the building. As per IS 875(Part 3):1987, when wind interacts with a building, both positive and negative pressures occur simultaneously, the building must have sufficient strength to resist the applied loads from these pressures to prevent wind induced building failure. G+20 story frame is used for analysis.

1.1 Wind load calculation

Wind load can be calculated with various methods. In this pepper gust factor method is used to calculate the wind load. Gust factor G is calculated by following formula:

$G=1+gfr[B(1+Ø)^2 +SE/ β]^{1/2}$

Where,

T = Time period (pg.48, IS 875(part-3)-1987), Cf = Force coefficient for clad building (IS 875(part-3)-1987), gf = Peak Factor and Roughness Factor (IS 875(part-3)-1987), B = Background factor (IS 875(part-3)-1987), S = Size reduction factor (IS 875(part-3)-1987), Ø = Constant , E = Gust energy factor (IS 875(part-3)-1987) , β = (pg. 58,IS 875(part-3)-1987

F_x = Along wind load on the structure given by

$F_x=C_f.A_e.P_z.G$

Where, C_f is force coefficient/drag coefficient A_e is effective frontal area.

1.2 P_z calculation

As per (IS 875 part 3)

Vz = Vb *K1*K2*K3

V_z =design wind speed at any height z in m/s

k_1 = probability factor (risk coefficient)

k_2 = terrain roughness and height factor

k_3 = topography factor

Wind pressure:

$$P_z = 0.6 (V_z)^2$$

2. PUSHOVER ANALYSIS

Pushover Analysis in the recent years is becoming a popular method of predicting seismic forces and deformation demands for the purpose of performance evaluation of existing and new structures.

Pushover analysis is a partial and relatively simple intermediate solution to the complex problem of predicting force and deformation demands imposed on structures and their elements by severe ground motion. Pushover analysis is one of the analysis methods recommended by Eurocode and FEMA 273. Pushover analysis provides valuable insights on many response characteristics like Force Demand on Potentially brittle elements. Consequences of strength deterioration of individual elements on structural behaviour. Identification of critical regions in which the deformation demands are expected to be high and that have to become the focus of through detailing. Identification of strength discontinuities in plan or elevation that will lead to changes in dynamic characteristics in the inelastic region. Verification of completeness and adequacy of load path, considering all structural and non structural elements of the structural system.

Is a technique by which a structure is subjected to a incremental lateral load of certain shape. The sequence of cracks, yielding, plastic hinge formation and failure of various structural components are noted. The structural deficiencies are observed and rectified. The iterative analysis and design goes on until the design satisfies a pre-established criteria.The performance criteria is generally defined as Target displacement of the structure at roof level.
The Target displacement is calculated by

$$\delta_t = C_0 C_1 C_2 C_3 S_a T_e^{2} g/4\Pi^2$$

where:
C0 = Modification factor for SDOF → MDOF
C1 = Modification Factor to relate expected maximum inelastic displacements to displacements calculated for liner elastic response
C2 = Modification factor to represent the effect of hysteresis shape on the maximum displacement response
C3 = Modification Factor to represent increased displacements due to dynamic P-Δ effects.
Sa = Response spectrum acceleration
Te = Characteristic period of the response spectrum.
The following data is to be consider for analysis and design in ETAB2016

Table -1: 60 m height building frame data:

60 m height building frame data used in ETAB			
Number of story	G+20	Size of plan	35m x 35 m
Height of each story	3 m	Class of structure and terrain category	C 1
Earthquake zone	II	Grade of concrete Grade of steel	M30 HYSD 415
Live Load = 2KN/m^2		Basic wind speed	33m/ sec

From above data, prepare the model using ETAB2016. Decide the material and section properties and assign it to the every member. Give the loading like Dead load, live load, wind load, Seismic load with properly with given data and assign it to the relevant member. Then use proper load case and load combination or give it automatic combination. For pushover analysis there is extra load case is selected i.e. non linear statics in both the direction. Then hinges are given at 0.05L and 0.95L at both the ends of members. Model is run for these load case and load combination. For running this much time will take of iteration and finally results are shown. After the analysis we can get the graph which is shown in chart. 1 That graph have always similar shape but only displacement is getting change for various base shear.

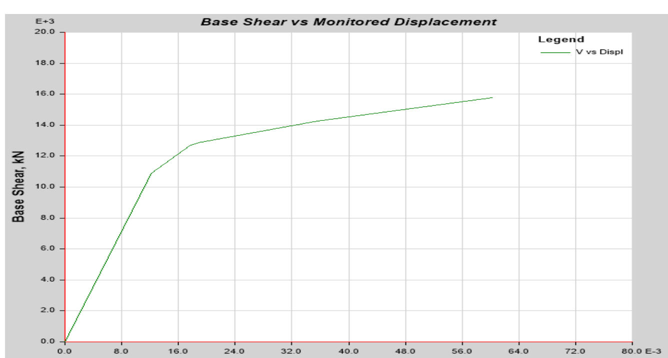

Chart -1: Output pushover curve form ETAB2016

Tabulated Plot Coordinates
Capacity Curve Coordinates

Step	Monitored Displ	Base Force	A-B	B-C	C-D	D-E	>E	A-IO	IO-LS	LS-CP	>CP	Total Hinges
	mm	kN										
0	0	0	14080	0	0	0	0	14080	0	0	0	14080
1	0.012	10880.6029	14078	2	0	0	0	14080	0	0	0	14080
2	0.018	12685.2997	13850	230	0	0	0	14080	0	0	0	14080
3	0.019	12868.9438	13830	250	0	0	0	14080	0	0	0	14080
4	0.036	14247.1454	13608	472	0	0	0	14078	0	0	2	14080
5	0.06	15757.2971	13250	830	0	0	0	14078	0	0	2	14080

Where, IO (Immediate Occupancy), LS (Life Safety) and CP (Collapse Prevention). Compare this chart with fig – 1. We can find out the lateral load increment on model .

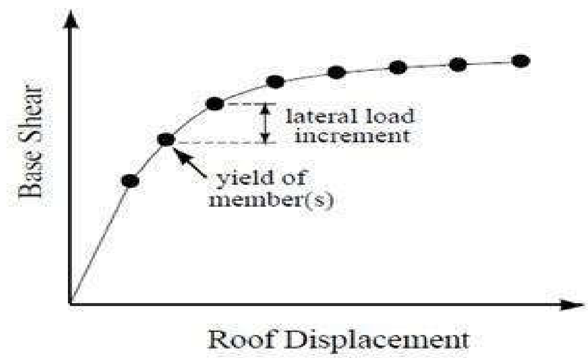

Fig -1: Global Capacity (Pushover) Curve of Structure

After the analysis Etab can run design process by RCC design command. The no of trial should be taken for changing size of beam and column to make structure safe and economical.

3. CONCLUSIONS

Pushover Analysis is a very useful tool for the evaluation of New and existing structures.
Pushover Analysis provided much useful information that cannot be obtained from elastic static and dynamic analysis. Pushover Analysis provides a relatively simple solution than nonlinear Dynamic analysis and more realistic and comprehensive solution than linear elastic analysis. Etab2016 can be effectively used for the pushover analysis. Table.1 shows the hinge state details at each step of the analysis. It can be seen that for the Performance Point, taken as all steps 99.9% of hinges are within LS and IO performance level.

ACKNOWLEDGEMENT

I would like to express my profound sense of gratitude and appreciation to my guide Prof. Hamane A.A.. for his valuable guidance, continuous encouragement and help rendered in carrying out the work presented in this report .His constant support has been the impetus for this work .I am especially thankful to him for reviewing the manuscript and valuable comments and suggestions he offered during the preparation of this report .I would like to extend my special thanks to, Prof. Patwari V. G. Head of Department of Civil Engineering, M. S. Bidve Engineering College, Latur for spending their valuable and helpful suggestions. I am thankful to all teachers and professors of our department for sharing with me invaluable knowledge in their respective fields. I would also like to thank library staff, internet staffs and laboratory staff for providing me cordial support and necessary facilities which were of great help for preparing this paper. Especially I am thankful to Prof. Khatod N.B. Principal, M.S. Bidve Engineering College, Latur without his kind and generous support it would have not been able for me to complete my work.

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