Analysis And Design Of High Rise (G+25) Residential Building.

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Abstract: High-rise buildings are constructed everywhere in the world. The height and Size of high-rise buildings are increasing. The structural design of high-rise buildings depends on dynamic analysis for winds and earthquakes.
Since today performance of computer progresses remarkably, almost structural designers use the software of computer for the structural design of high-rise buildings. ETABS stand for Extended Three Dimensional Analysis of Building Systems. ETABS integrates every aspect of the engineering design process. In the present situations of construction industry, the buildings that are being constructed are gaining significance, in general, those with the best possible outcomes which are referred to members like beams and columns in multi storey R.C structures. This software mainly used for structures like high-rise buildings, steel and concrete structures. The paper aims to analyze a high-rise building of 25 floors (G+25) by considering seismic, dead and live loads. The design criteria for high-rise buildings are strength, serviceability and stability.

***Index Terms* – High Rise Buildings, ETABS, Dynamic Analysis, Response Spectrum Analysis.**

I. INTRODUCTION

Earthquake has always been a threat to human civilization from the day of its existence, devastating human lives, property and man-made structures. Earthquake causes random ground motions, in all possible directions emanating from the epicenter. Vertical ground motions are rare, but an earthquake is always accompanied with horizontal ground shaking. The ground vibration causes the structures resting on the ground to vibrate, developing inertial forces in the structure. As the earthquake changes directions, it can cause reversal of stresses in the structural components, that is, tension may change to compression and compression may change to tension. Earthquake can cause generation of high stresses, which can lead to yielding of structures and large deformations, rendering the structure non-functional and unserviceable.

Response spectrum is an important tool in the seismic analysis and design of structures. It describes the maximum response of damped single degree of freedom system to a particular input motion at different natural periods. Response spectrum method of analysis is advantageous as it considers the frequency effects and provides a single suitable horizontal force for the design of structure. Response spectrum analysis (RSA) is a method widely used for the design of buildings. Conceptually the method is a simplification of modal analysis, i.e., response history (or time history) analysis (RSA) using modal decomposition, that benefits from the properties of the response spectrum concept. The purpose of the method is to provide quick estimates of the peak response without the need to carry out response history analysis. This is very important because response spectrum analysis (RSA) is based on a series of quick and simple calculations, while time history analysis requires the solution of the differential equation of motion over time. Despite its approximate nature, the method is very useful since it allows the use of response spectrum, a very convenient way to describe seismic hazard.

II. AIMS AND OBJECTIVES.

The main objective of the present work are:
• Design of multi storied building with shear walls using ETABS

• To carry out earthquake analysis by using Response Spectrum Method.

• To analyze and calculate storey drift and displacement.

III. METHODOLOGY.

3.1 METHODS OF ANALYSIS OF STRUCTURE:

The seismic analysis should be carried out for the buildings that have lack of resistance to earthquake forces. Seismic analysis will consider seismic effects hence the exact analysis sometimes become complex.
However for simple regular structures equivalent linear static analysis is sufficient one. This type of analysis will be carried out for regular and low rise buildings and this method will give good results for this type of buildings. Dynamic analysis will be carried out for the building as specified by code IS 1893-2002 (Part1) and IS 875-2015 (Part3). Dynamic analysis will be carried out by Response Spectrum for earthquake and Gust Factor for wind. Following methods are adopted to carry out the analysis procedure.

- Equivalent Static Analysis
- Linear Dynamic Analysis
- Response Spectrum Method

3.2 LOADS ACTING ON MULTI-STOREY G+25 BUILDING:

Loading on tall buildings is different from low-rise buildings in many ways such as large accumulation of gravity loads on the floors from top to bottom, increased significance of wind loading and greater importance of seismic effects. Thus, multi-storied structures need correct assessment of loads for safe and economical design. Except dead loads, the assessment of loads cannot be done accurately. Live loads can be anticipated approximately from a combination of experience and the previous field observations. Wind and earthquake loads are random in nature and it is difficult to predict them. They are estimated based on a probabilistic approach.

The following discussion describes some of the most common kinds of loads on multi-storied structures.

- Dead loads
- Live loads
- Earthquake loads

3.3 DESIGN PARAMETERS.

Building configuration	G+25
Structure type	Residential Apartment
Building length in X direction	32.11m
Building length in Y direction	18.97m
Height of structure	102.1m
Bearing capacity of soil	200 KN/m^2
Slab Thickness	150mm
Shear Wall Thickness	150mm,200mm,250mm
Storey height	3.5m for GF and Basement,3.2m Normal Storey
Wall Thickness	230mm,150mm
Parapet Wall	150mm
Loads	-3KN/m2 for Staircase. -2KN/m2 for Bedrooms, Kitchens, Living Room. -10KN/m2 for Lift Machine Room. -2.5KN/m2 for Parking.

3.4 MATERIAL SPECIFICATIONS.

Grade of concrete	M30 for Slab and Beams,M40 for Column and Foundation
Density of concrete	25 KN/m^3
Modulus of elasticity	Ec= 5000√fck N/mm^2 as per IS 456:2000 Clause 6.2.3.1
Grade of steel	Fe500
Density of walls considered	Autoclave Aerated concrete blocks. (AAC) with density 7 KN/m3

3.5 LAYOUT PLANS.

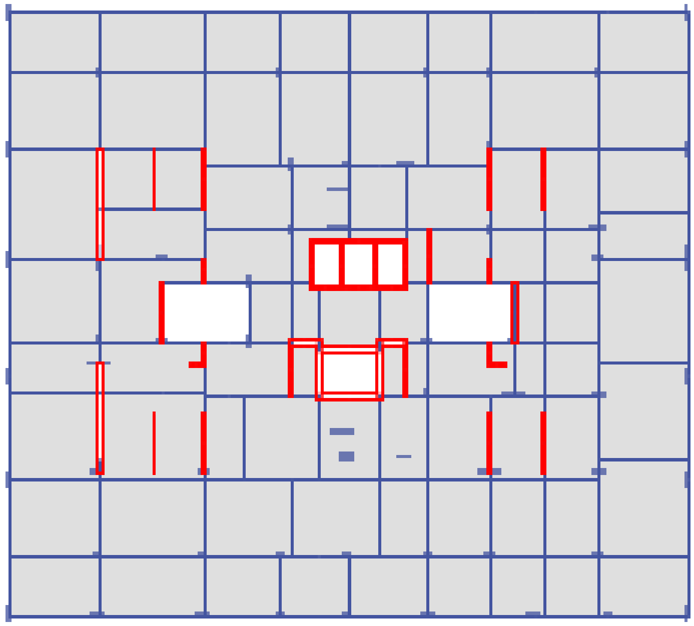

Fig. no. 1. Podium Plan

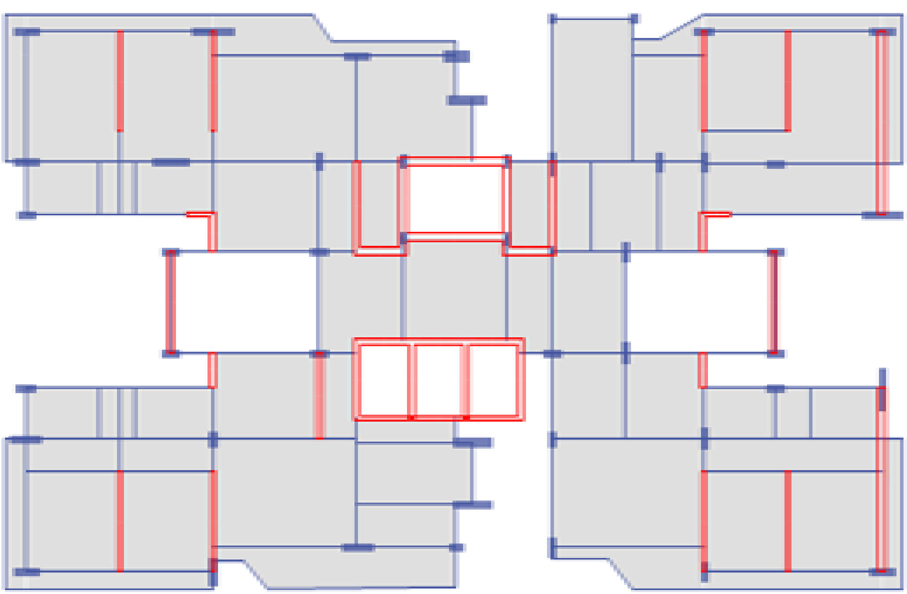

Fig. no. 2. Normal Storey Plan

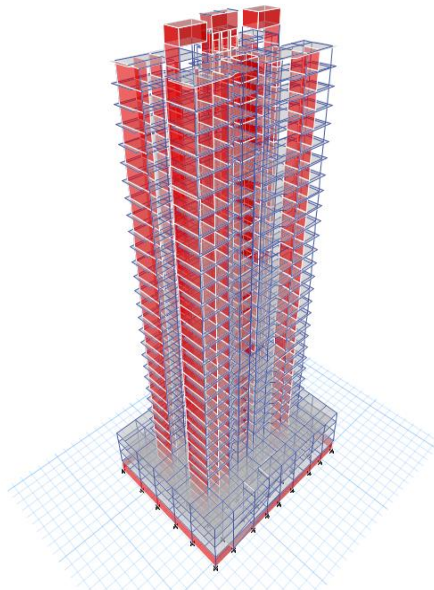

Fig. no. 3. 3D Model in ETABS

3.6 LOAD CASES.

Load Case Name	Load Case Type
Dead	Linear Static
Live	Linear Static
FF	Linear Static
Wall	Linear Static
RSx	Response Spectrum
RSy	Response Spectrum
Stair	Linear Static
WP	Linear Static
SP	Linear Static

Fig. no. 4.

3.7 RESPONSE SPECTRUM FUNCTIONS.

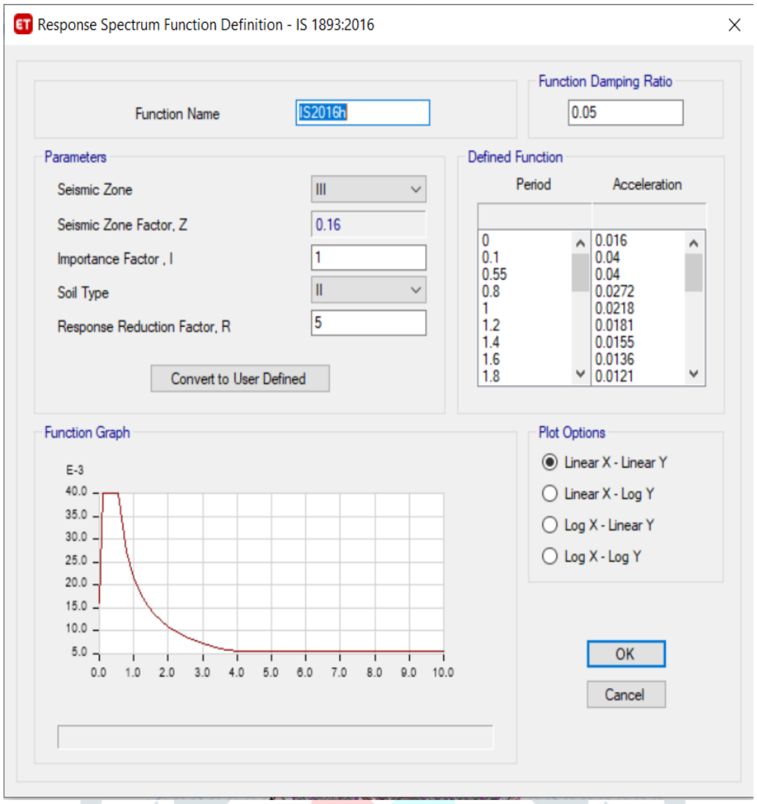

Fig. no. 5.

IV. ANALYSIS AND RESULTS.

4.1 TIME PERIOD (MODAL ANALYSIS).

Mode	Time Period (sec)	Mode	Time Period (sec)
1	2.774	26	0.116
2	2.644	27	0.115
3	2.317	28	0.114
4	0.731	29	0.109
5	0.695	30	0.104
6	0.576	31	0.104
7	0.36	32	0.104
8	0.324	33	0.102
9	0.317	34	0.102
10	0.281	35	0.102
11	0.252	36	0.1
12	0.234	37	0.099
13	0.227	38	0.099
14	0.198	39	0.097
15	0.182	40	0.09

16	0.177	41	0.084
17	0.163	42	0.084
18	0.156	43	0.083
19	0.147	44	0.075
20	0.144	45	0.074
21	0.141	46	0.073
22	0.124	47	0.073
23	0.123	48	0.071
24	0.12	49	0.068
25	0.118	50	0.068

4.2 RESPONSE SPECTRUM METHOD STOREY DISPLACEMENT IN X AND Y DIRECTION:

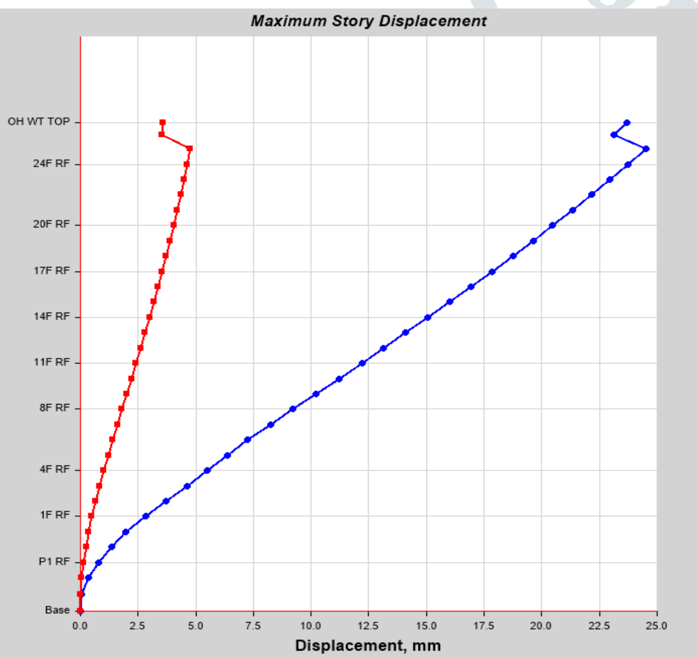

Fig. no.6. RSX

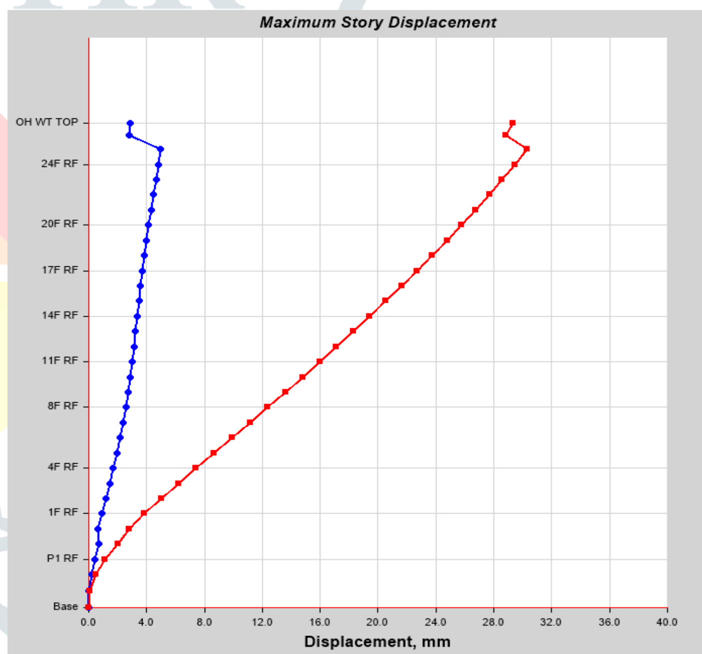

Fig. no.7. RSY

4.3 RESPONSE SPECTRUM METHOD STOREY DISPLACEMENT FOR MODE 1:

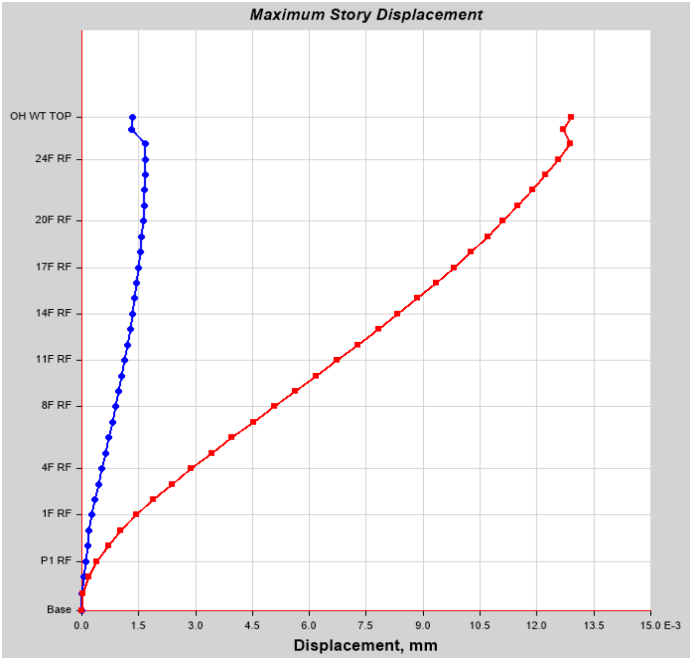

Fig. no.8. Mode1

4.4 RESPONSE SPECTRUM METHOD STOREY DRIFT IN X AND Y DIRECTION:

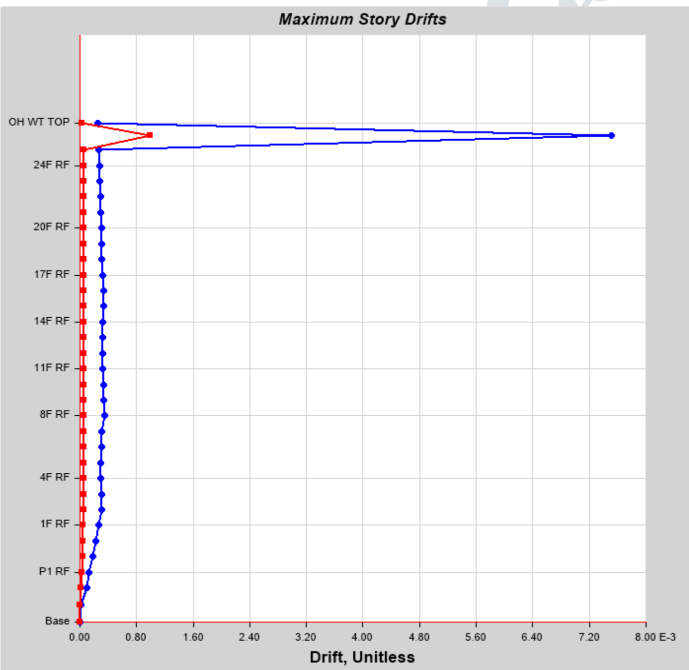

Fig. no.9. RSX

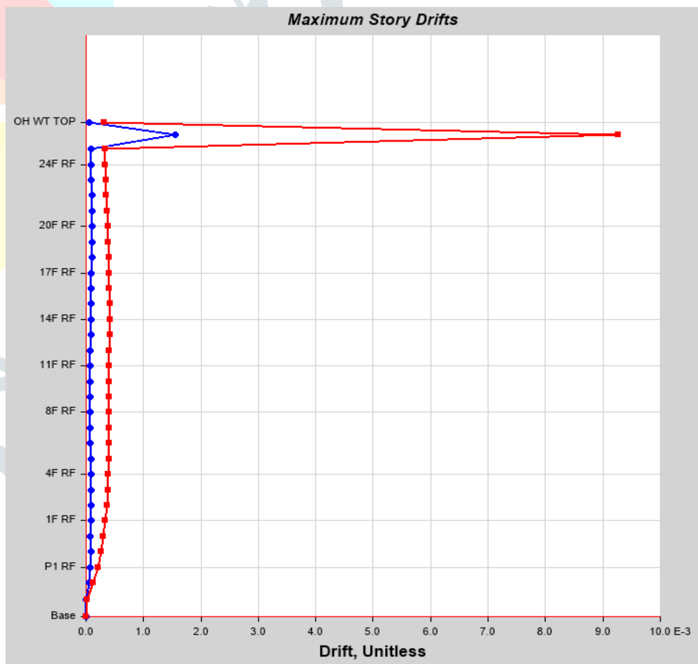

Fig. no.10. RSY

4.4 RESPONSE SPECTRUM METHOD STOREY DRIFT FOR MODE 1:

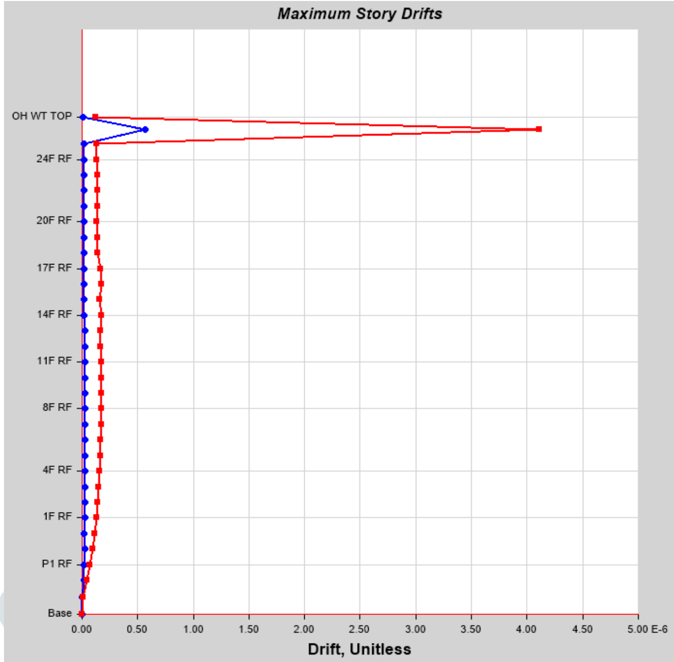

Fig. no.11. Mode1

V. CONCLUSION.

1. The design has been checked against seismic action.
2. The plan configuration of structures has important influence on the seismic response of structure in terms of storey displacement and storey drift.
3. Storey displacement of the building is within the limit as per IS- 1893 (Part-1) 2016
4. Storey drift of building is within the limit as clause no 7.11.1 of IS-1893 (Part-1):2016.
5. Shear wall is a must while designing a high rise building but more importantly the location and orientation of . shear walls is to be precisely selected. The placing of shear wall helped in coinciding the center of mass and center of rigidity which is subsequently made the torsion in the building negligible.
6. The design came out to be safe. Apart from the safety, the frame sections used in the design were selected so as to achieve economy by reducing the requirement of steel. (Since steel is way more expensive than concrete)

ACKNOWLEDGEMENT:

We are profoundly grateful to Prof. Majeed Pathan, (M.E Structures), for his expert guidance and continuous encouragement throughout to see that this project rights its target.

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