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Response spectrum Analysis of Multi-story building Using ETABS

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ABSTRACT:Now-a-days to design and analyse a high-rise structure to withstand from earthquakeand wind pressures is a tough thing for a rapid urbanisation. There is a probability for occurrence of earthquake impact in the senses of seismic waves which are going to sudden release of energy under the earth to change its ground motion, then their behaviour change in results and effects on the components of building structures like foundation, columns etc. Basically the structures are effected different kinds of forces in their life span in static & dynamic forces. In case of static force occurs dead & live loads and dynamic forces due to earthquake. Which leads to devastating to structural elements in such cases structural failure. Then its seems that the structures are not appropriately examined and developed with required quality. The planning of an high-rise multi-storey structure drawn in autocad which consist of 1650 sq.mts plan imported to ETABS software to perform response spectrum method. The multi-storey building is R.C.C. structure with 3 basements + ground floor + 12 upper floors in zone II with a maximum earth fill of 750 mm on the ground floor for landscape requirements. The aim is to analyse the response of a structure with respect to ground motion using Response Spectrum Analysis. The design response spectrum curve done as per IS 1893 Part-1 for seismic design is utilized to perform the dynamic analysis. The building was initially designed as per IS 456: 2000, Then it was analysed for earthquake loads IS 1893: 2016, again detailing has been obtained using ETABS. These analysis is done for response of (G+12) multi-storied building parameters like maximum storey displacement, drift & shear results are observed.

Keywords: multi-stored building, ETABS,storey displacement, drift, shear results

1. INTRODUCTION

1.1 General

Structural design & analysis are the backbone for civil engineering. Due to present situations, there has been a growing economy we are using computer aided software tools to design & analyses of structure. These developments are appropriate relieve for the engineer to calculat the often-lengthy calculations and procedures are required for a complicated structures to analyse. Now-a-days, most commonly prefering high rise and multi-storey buildings are used in metropolitan cities. Earthquake is a result of a sudden release of energy in the earths crust which ging to creates seismic waves. These seismic activities of an area refers to high frequency, type and size of earthquakes experienced over an period of time by buildings are subjected to ground motion. therefore high-rise residential building are very important need to be remained standing to the earthquake, so the design of such structures needs to bedesign as per earthquake considerations. The present study deals with seismic analysis using Equivalent static analysis of (G+12) story RC buildings using Structural Analysis and Design (ETABS) software. Each and every structure will be subjected to either one or the groups of loads, the various kinds of loads normally considered are Dead, Live & Wind load as per IS:875-1987 Part 1,2 & 3 then Earthquake load (IS:1893- 2016) and Wind load (IS:875-2015). Plinth Beam is taken as (1.5m) height, Basement 1 and 2 are taken as (3.3m) height, Basement 3 is taken as (3.9m) height, stilt and remaining stories are taken as (3m) height and making the total height of the structure (62.1m). The dynamic analysis of multi-storey buildings is done using ETABS 2018 by IS and SP codal provisions (ETABS User's Manual, 2018). The multi-storey building is R.C.C. structure with 3 basements + ground floor + 12 upper floors in zone II with a maximum earth fill of 750mm on the ground floor for landscape requirements.

1.2 Effect of Earthquakes on High Rise Buildings

The Effective Design & Construction of Earthquake safe Structures have a lot of significance in Engineering using various materials and properties of every material fundamentally to their exibility and economically tall structures are most appropriate. To Strengthen the Concrete casings are the most commonly in India,

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with expanding quantities of skyscraper structures significance. There are various kinds of significant places in Indian urban areas that fall in exceptionally dynamic seismic zones. So such tall structures, developed particularly in exceptionally inclined in seismic zones. Along this seismic tremor at the point of tall structures and sturdiness will turns out to be critically. Therefore expansion in number of storey in tall structures, will faces different impacts with exceptionally high quality because of sidelong loads like seismic powers. These are accomplishing significance in each architect should arrangement to give satisfy dependability & quality against parallel burdens. There are various kinds of significant places in Indian urban areas that fall in exceptionally dynamic seismic zones. So such tall structures. The present investigation is carried by utilizing ETABS for (G+12) multi-storey reinforced concrete work under seismic loads are seen as per IS 1893 (Part 1):2016. Finally an investigation has done for seismic examination of multi-celebrated structuresutilizing ETABS. The various parameters taken are mass distinctive structures so on. A structure with various kinds are investigated for wind and seismic loads. In the occasions of earthquake, sporadic multi celebrate structuress are progressively inclined to harm and even come into breakdown. During earthquake the harms are started to structure the most vulnerable

1.3 Response Spectrum Method

Response Spectrum Method is linear for dynamic analysis. It results the response ofeach and every mode of vibration responses in various modes to get the total responseof structural deformation and displacement etc. Plot a graph between maximumresponse vs natural period for response spectrum. It is for multi-story irregularstructure based on dynamic analysis and found more displacement and mode ofvibrations.

The computer ETABS program is used to determine this special types modes ofstructure. The design of acceleration coefficient for different soil types and responsespectrum graph obtained in IS 1893:2016 (part 1).The response of dynamic analysis for structure subjected to dynamic load cases like wind and earthquake loads etc. Then finally this method involves the calculations ofmaximum values of displacements and member forces in each mode of vibration.Response of a building can be observed in appearance of it deformation andacceleration. As per IS 1893-2016 the response spectrum analysis can be calculatedbased on the zone , response reduction and importance factors. These Z, I, and R aregiven in Indian codes based on soil conditions the response can observed with respectto time period. This method is appropriate for design spectrum to calculate average earthquakemotions will have different response spectrum helps for Structural Engineer as per IS1893:2016 has given a general response spectrum which is derived by considering earthquakes from past.

The objectives of these work is to model Reinforced Concrete structure using ETABS,then it studies behaviour changes in structure and obtain the maximum deflection underearthquake application. A different response like storey drift, story shear, base shear etc.

2. LITERATURE REVIEW

Ashish,et.al., (2010) The wind-induced response of a structure with a damper systemand to estimate the suppressing effects of dampers under earthquake loadings. Analysisof symmetrical moment resistance frame (MRF) 10th,12th,14th,16th,18th, and 21thstorey three dimensional model with tuned mass damper and without tuned massdamper by using ETABS Software: Tuned Mass Damper, TABS. **J.P.Annie Sweetlin (2010**) With the introduction of Limit state design of structures, thesafety and serviceability of the structure has accrued prime importance and the mostdamaging and recurrent phenomena is the earthquake. In this paper the earthquakeresistance of a G+20 multi-storey building is analysed using Equivalent static method with the help of ETABS 9.7.4 software. The method includes seismic coefficient methodas recommended by IS 1893:2002.

Bahador, et al., (2011) has been modelled a multi-storey irregular building consistof (G+20) storeys using Etabs. The height of building most probably affect thestructural response of the building of shear walls & also dynamic responses of buildingis investigated under actual earthquakes, EL-CENTRO 1949 and CHI-CHI Taiwan1999. has taken as building with different shapes like rectangular, L, H, C-shape forcomparison and dynamic analysis has been done to evaluate the deformation of the structure.

Jiang et., al (2012) Applied a scientific examination consequences of utilizing special\ style of bracing method in tall metal buildings making use of the program ABAQUS.\ Seismic performance of building with bracing as lateral load resisting individuals in tallbuilding. The researchers have studied on the metal bracing in RC frames. **Poonam et al. (2012**) has conclude that any storey

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should not be much softer than tocompare other storeys top or bottom. Irregular in mass distribution contributes to the increase in the response of high rise buildings.

3.METHODOLOGY

Planning of (G+12) multi-storey building using AUTOCAD

To draw a plan of (G+12) high rise residential building which consist of 1650sq.mts area in bangalore city drawn as per clients requirement in autocad.

• Initially by using total station have to collect land boundary details by Importeddata like Serial Number, Easting, Northing, Elevation etc in Excel to get generatinga topographical drawing plan.

• Then after as per government minimum setback requirements of site to be givenbased on site area, road width and number of floors of building.

• After that as per client requirement of no.of bed rooms, kitchen, balcony positionsand dimentions has been given to autocad.

• Then proper approach of an architect suggestions and based on soil conditionscolumn positioning is aligned in autocad.

• Finally after approaching of structural engineer to verify the positioning of beamsand other structural components are assigned. then finalised with cilents opinionand then started to structural calculations.

• If incase any changes and modifications are required for client are structuralengineer it has been done based on site location and soil conditions

Figure 1: Plan of (G+12) Multi-Storied Building

Loading Consideration

Table-1 Loadconsideration

Details of Live Load(L.L)	
Live1	5 kN/m^2
Live2	3 kN/m^2
Details of Wind Load (W.L)	
Wind Speed	44 m/s
Importance Factor	1
Topography (k3 factor)	1
Details of Earthquake Load(E.L)	
Seismic Zone Factor, Z	0.1 (per code)
Site Type	II
Importance Factor	1.2
Response Reduction Factor	3

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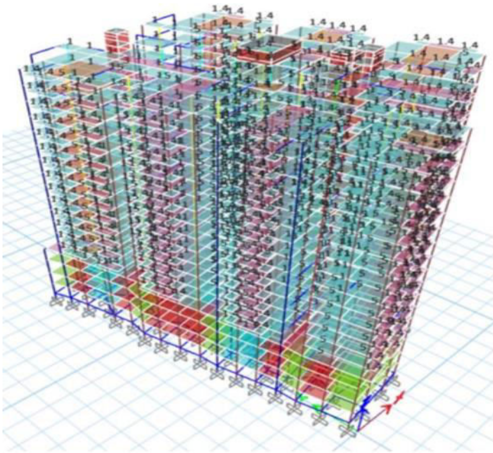

Figure2: details of load on structure

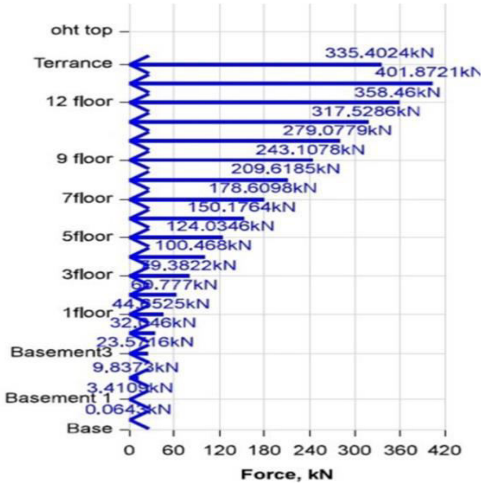

Figure 3: Lateral load in X- details

3. RESULTS & DISCUSSION

Maximum Storey Displacement

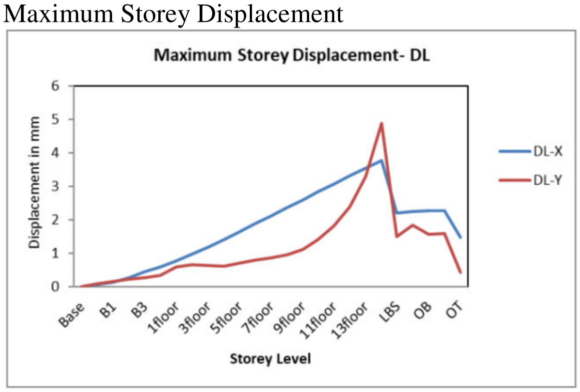

Figure:4 Maximum Storey Displacement for DL in X and Y directions

Figure:5 Maximum Storey Displacement for LL in X and Y directions

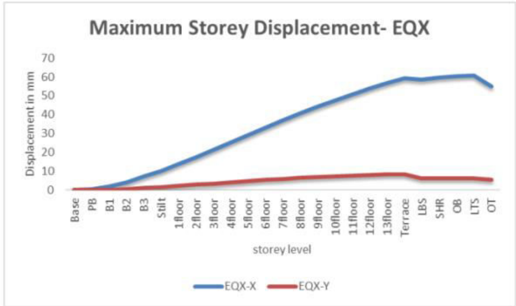

Figure:6 Maximum Storey Displacement for EQX in X and Y directions

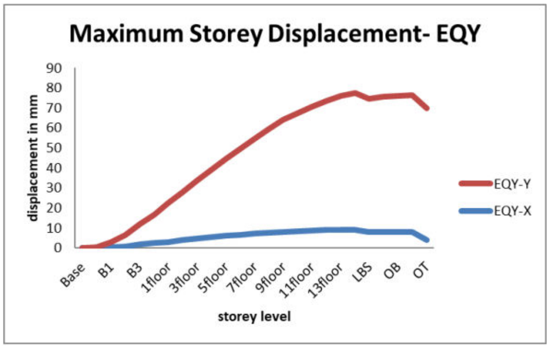

Figure 7:Maximum Storey Displacement for EQY in X and Y directions

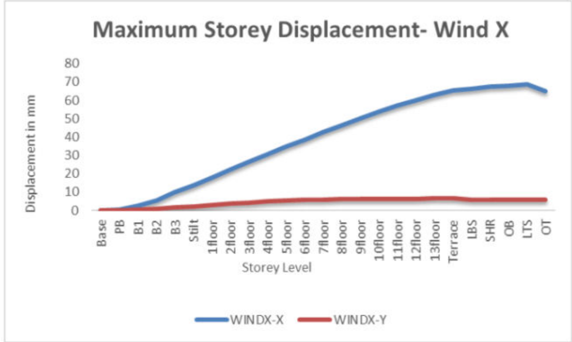

Figure 8:Maximum Storey Displacement for Wind X in X and Y directions

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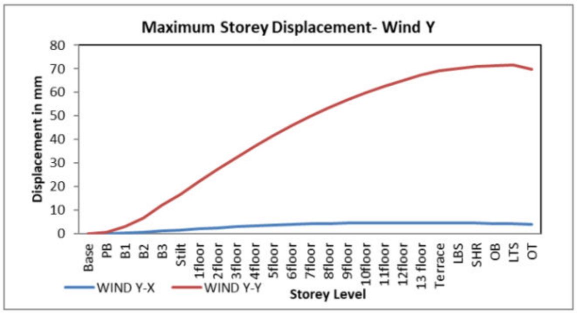

Figure 9:Maximum Storey Displacement for WindY in X and Y directions

Maximum Storey Drifts

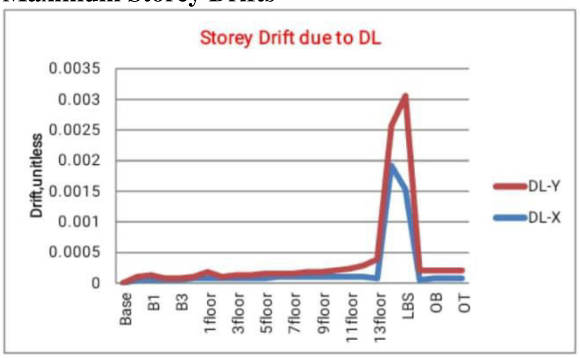

Figure:10 Maximum Storey Drift For DL in X and Y directions

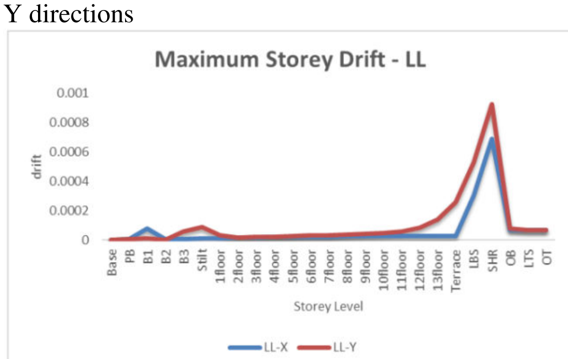

Figure:11 Maximum Storey Drift For LL in X and Y directions

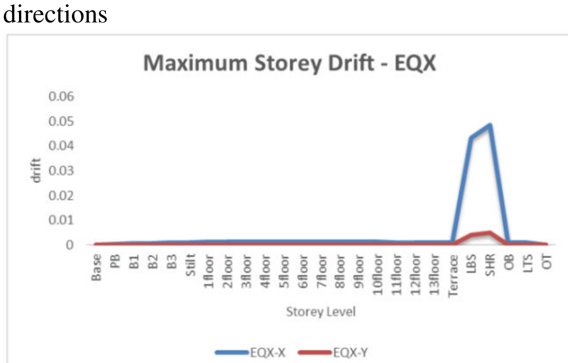

Figure:12 Maximum Storey Drift For EQX in X and Y directions

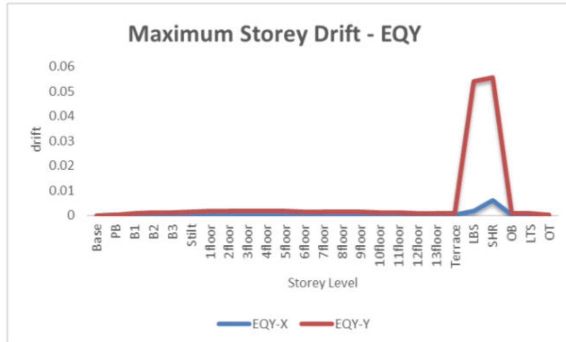

Figure:13 Maximum Storey Drift For EQY in X and Y directions

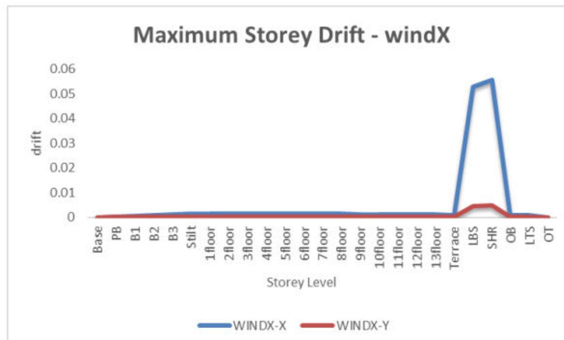

Figure:14 Maximum Storey Drift For WindX in X and Y directions

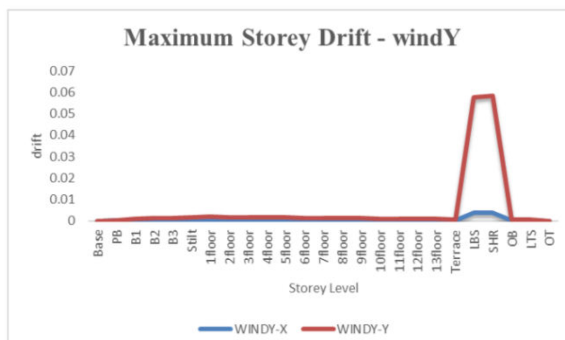

Figure 15: Maximum Storey Drift For WindY in X and Y directions

6. CONCLUSION

From the Software results outlined earlier, the following conclusions can be drawn:

1. For high rise structures having height more than 40m, static analysis is not enough.As the building of the present study is 62.5m tall, dynamic analysis was carriedout for more accurate results.

2. Modal mass participating of factor is more than 75% in the higher mode, thenconsider that structure is stiffer for earthquake movements.
3. Maximum storey drift was observed for the load case involving earthquake loadalong X direction in the case of overhead tank.
4. The storey shear is maximum for response spectrum method for EQX load case isincreased from first storey to last storey.
5. For high-rise buildings, response spectrum analysis is sufficient to predicts thestructural response more accurately based on result, it is necessary to provide lateral load resisting element such as shear wall to control maximum storeydisplacement, storey drift, storey shear in high rise building

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