Analysis of Multi-storey Building (G+7) due to Seismic Loading Using STADD-PRO

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ABSTRACT : *STAAD-PRO is the present day leading design software in the market. Many design companies use this software for their project design purposes. So, this project mainly deals with the comparative analysis of the results obtained from the design of a regular and a plan irregular (as per IS 1893) multi storey building structure when designed using STAAD-PRO software. The principle objective of this project is the comparative study on design and analysis of multi-storeyed building (G+7) by STAAD-PRO software. STAAD-PRO is one of the leading software for the design of structures. In this project we analyze the G+7 building for finding the shear forces, bending moments, deflections & reinforcement details for the structural components of building (such as Beams, columns & slabs). STADD-PRO is powerful design software licensed by Bentley .STAAD-PRO stands for Structural Analysis and Design any object which is stable under a given loading can be considered as structure. STADD-PRO has been used for analysis and design of rectangular Plan with vertical regular and rectangular Plan with Vertical geometrically irregular multi-storey building. STADD-PRO is powerful design software licensed by Bentley. STAAD-PRO stands for Structural Analysis and Design any object which is stable under a given loading can be considered as structure. In this studied the Analysis of multi-storey building (G+7) due to seismic loading using STADD PRO. Whereas analysis is the estimation of what are the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load.*

KEYWORDS – *Regular, Irregular, Shear force, Building moment and STAAD-PRO*

I. INTRODUCTION

STAAD.PRO is design software to design and analyze any kind of structure in static and dynamic approach. However this software will give different design and analytical results for the same structural configurations, this is due to their different analytical mechanism and the way they do analyse the structure. In case of analysis and design of structures with geometrical irregularities there is much more need to compare design results of different software to get safe as well as economical structures. *This paper carries out a comparative study of design results STAAD Pro software by taking structural irregularities in account. To conclude the feasibility of this software a G+7 building with irregular geometry has been analysed, designed.*

I.I Vertical and Plan irregular multistory buildings

According to IS 1893:2002 (Clause 7.1), there are mainly two types of irregularities,

I) Plan Irregularity

II) Vertical Irregularity

i) Plan irregularity –

Plan irregularity also of five types as follows:

(a) ***Torsion Irregularity*** *– To be considered when floor diaphragms are rigid in their own plan in relation to the vertical structural elements that resist the lateral forces. Torsional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure.*

(b) ***Re-entrant corners*** *–*

Plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction.

(c) ***Diaphragm Discontinuity –***

Diaphragms with abrupt discontinuities or variations in stiffness, including those having cut-out or open areas greater than 50 percent of the gross enclosed diaphragm area, or changes in effective diaphragm stiffness of more than 50 percent from one storey to the next.

(d) ***Out-of-plane offsets –***

Discontinuities in a lateral force resistance path, such as out-of-plane offsets of vertical elements.

(e) ***Non-parallel Systems –***

The vertical elements resisting the lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force resisting elements.

ii) Vertical Irregularity –

Plan irregularity also of five types as follows:

(a) Stiffness Irregularity –

1. Soft Storey –

A soft storey is one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above.

2. Extreme Soft Storey –

A extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storeys above. For example, buildings on STILTS will fall under this category,

(b) Mass Irregularity –

Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storeys. The irregularity need not be considered in case of roofs.

(c) Vertical Geometric Irregularity –

Vertical geometric irregularity shall be considered to exist where the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey.

(d) In-Plane -

Discontinuity in vertical elements resisting lateral force - An in-plane offset of the lateral force resisting elements greater than the length of those elements.

(e) Discontinuity in capacity –

Weak storey - A weak storey is one in which the storey lateral strength is less than 80 percent of that in the storey above, the storey lateral strength is the total strength of all seismic force resisting elements sharing the storey shear in the considered direction.

I.II OBJECTIVE OF THE STUDY

- *To check the behaviour of multi-storey regular and irregular building on STADD-PRO software.*
- *To understand the accuracy of softwares for analysis and design for plan and elevation Irregularity.*
- *To design a regular plan multi storey structure as per IS-456 & IS-875,(1,2,3).*
- *To find out shear force, bending moments and deflection of structural members.*
- *To observe the software gives more accurate and economical result.*

II. LITERATURE REVIEW (11 BOLD)

General

Most of the work for analysis of multi storey building has been done on STAADP ro. Evaluation of forces and moments for Dead load, Live load and Seismic load considered. But there is very less work has been done using load combination.

M C Griffith and A V Pinto (2000) have investigated the specific details of a 4-story, 3-bay reinforced concrete frame test structure with unreinforced brick masonry (URM) infill walls with attention to their weaknesses with regards to seismic loading. The concrete frame was shown to be a "weak-column strongbeam frame" which is likely to exhibit poor post yield hysteretic behaviour. The building was expected to have maximum lateral deformation capacities corresponding to about 2% lateral drift. The unreinforced masonry infill walls were likely to begin cracking at much smaller lateral drifts, of the order of 0.3%, and completely lost their load carrying ability by drifts of between 1% and 2%. [1]

Sanghani and Paresh (2011) studied the behaviour of beam and column at various storey levels. It was found that the maximum axial force generated in the ground floor columns, max reinforcement required in the second floor beams. [2]

Poonam et al. (2012) Results of the numerical analysis showed that any storey, especially the first storey, must not be softer/weaker than the storeys above or below. Irregularity in mass distribution also contributes to the increased response of the buildings. The irregularities, if required to be provided, need to be provided by appropriate and extensive analysis and design processes. [3]

Prashanth.P et al. (2012) investigated the behaviour of regular and irregular multi storey building structure in STAADPro. and ETABS. Analysis and design was done according to IS-456 and IS-1893(2002) code. Also manually calculations were done to compare results. It was found that the ETABS gave the lesser steel area as that of STAADPro. Loading combinations were not considered in the analysis and influence of storey height on the structural behaviour was not described. [4]

III. METHODOLOGY

A research presents the main features and organization of STAADPRO and ETABS, a computer programs that has been developed for the static and seismic stability evaluations of different civil engineering structures and concrete gravity dams. Our project involves analysis and design of multistoried building using a very popular designing software STAAD Pro and ETABs against all possible loading conditions. In this chapter a multistory building has been modelled and analyze with considering all loads like Dead load, Live load, Wind load, Seismic loads as per as IS standard

- Calculation of loads as per Indian Standards.
- Step by Step process of Methodology.
- Analysis using STAAD-PRO on multi-storied framed structure.
- Design using STAAD-PRO on multi-storied framed structure.

III.I PRELIMINARY DATA:

Type of frame : RC frame building.

- Seismic zone :III
- Number of storeys : 8
- Floor height :3 m
- Plinth height :1.5 m
- Spacing between frames :3m along both
- Directions Live load on floor level :3 KN/m^2
- Live load on roof level :1.5 KN/m^2
- Floor finish :1.0 KN/m^2
- Terrace water proofing :1.5 KN/m^2
- Thickness of infill wall :230mm
- (Exterior walls) Thickness of infill wall :150mm
- (Interior walls) Density of concrete :25 KN/m^2
- Density of infill :20 KN/m^2
- Type of soil :Medium Soil

- Response spectra :As per IS 1893(Part1) :2002
- Damping of structure :5 %

Live load on floor level and roof level are taken from IS-875 (Part-) considered RC framed buildings as residential usage.

a. MEMBER AND MATERIAL PROPERTIES:

Dimensions of the beams and columns are determined on the basis of trial and error process in analysis of STAAD-PRO software by considering nominal sizes for beams and columns and safe sizes are as show in the table below.

Beams: 250mmx230mm

Columns: 260mmx250mm

Material properties of the building are like M25 grade of concrete, FE415 steel and 13800N/mm^2 of modulus of elasticity of brick masonry in the buildings.

Dead Load:

Floor finish : 1.5 KN/m^2

Internal wall load : 6.27 KN/m

External wall load : 13.11 KN/m

Live Load: For typical floors : 3 KN/m^2

For top floor : 1.5 KN/m

IV. FIGURES AND TABLES

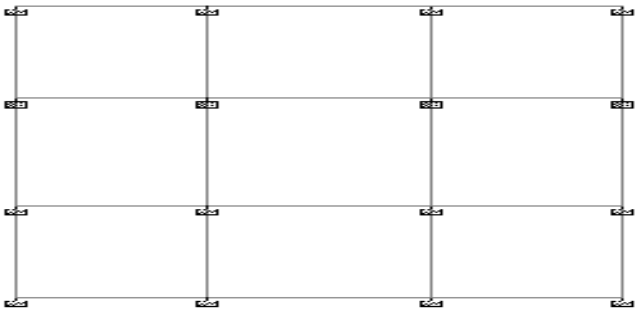

Fig 1: PLAN OF G+7 STRUCTURES

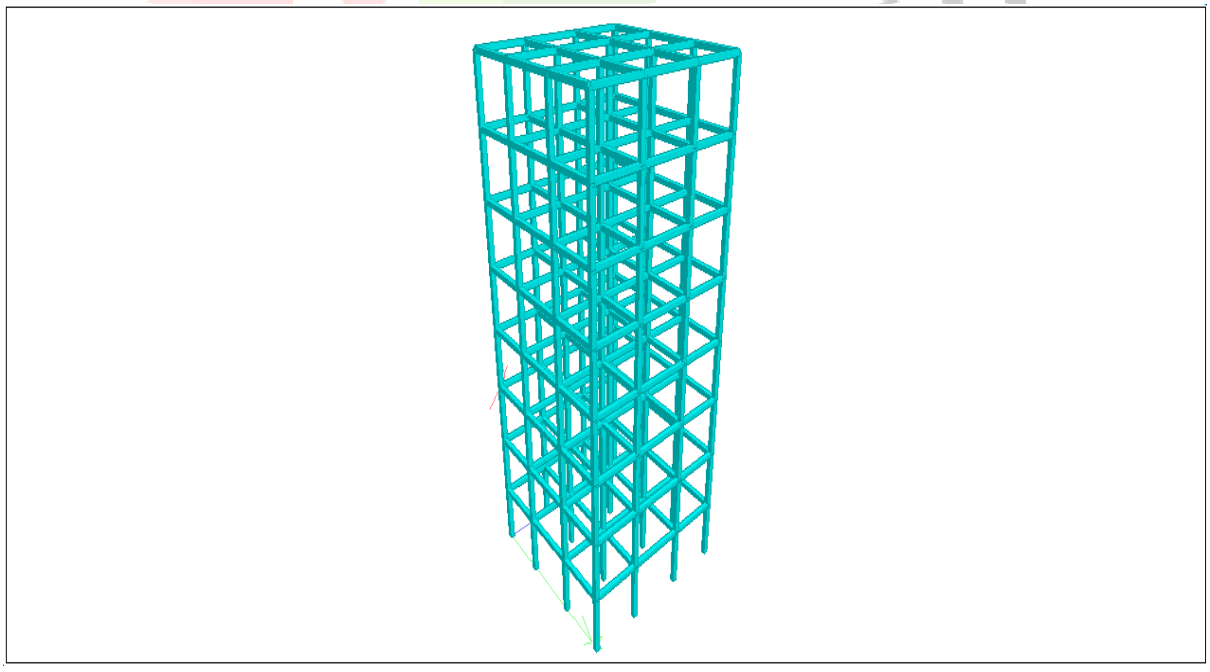

Fig.2: 3-D Rendered View of whole structure

Table No. 1: Maximum Values of Bending Moment

Floor Name	Maximum value in EQ-X (K-Nm)	Maximum value in EQ-Z (K-Nm)
1	15.617	15.592
2	16.555	16.675
3	15.982	16.081
4	14.668	14.709
5	12.566	12.675
6	10.560	9.662
7	8.021	6.046
Top Floor	4.413	3.040

TABLE NO 2: MAXIMUM VALUES OF DISPLACEMENT

Floor Name	Maximum value in EQ-X (MMconsumed)	Maximum value in EQ-Z (MM)
1	3.432	3.600
2	8.533	8.881
3	13.764	14.227
4	18.793	19.456
5	23.377	24.179
6	27.241	28.160
7	31.620	32.651
Top Floor	31.626	32.662

V. CONCLUSION

After Discussion of results and observation some of results are summarized. Based on the behaviour of RC building on STAAD-PRO some important conclusions are drawn:-

1. Results of max bending moment due to seismic loading at 2nd floor in X-direction are 16.55 KN-m and in Z-direction is 16.67 KN-m.

2.Results of max displacement due to seismic loading at top floor in X-direction are 31.625 mm and in Z-direction is 32.662 mm.

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