A REVIEW ON DESIGN AND ANALYSIS OF MULTI-STOREY BUILDING BY STAAD.PRO

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Abstract: Designing and analysis of structural buildings by manual calculation is a complicated and time-consuming work, it is not always the best option. A computer aided program named Staad.Pro is available which allows it to design and analyze a structural building in an easy way and consume less time prior to its construction. Staad.Pro can also apply static and dynamic loads and their combinations in a quite simple method. The Staad.Pro software can design and analyze a structure for different types of a materials such as concrete, steel and timber.

Keywords: **Staad.Pro, bending moment, shear force, seismic, wind, shear wall.**

I. Introduction

Today's world, the population is growing fast and the people need space to live. The structure should built in an efficient manner so that it can serve people and save money. In other words, the building means an empty space surrounded by walls and roofs, in order to give shelter to human beings. In early days people used to live in caves to protect themselves from wild animals, rain, etc. As people were developing and the type of the structures were developed as well. Now a days, the buildings vary into different types such as low-rise and high-rise buildings. Buildings are the necessary indicators of social progress of the country. At current situations, many types of technologies have been developed for constructions, so that buildings are built economically and fast in order to fulfil the needs of the people. A building structure consist of columns, beams and slabs. Also, buildings are constructed in different sizes, shapes and functions. The buildings should be constructed for the people's requirements and not for earning money. As the world is transforming, the need of advanced programming tools is in a great demand. An economical structure cannot be achieved by manual calculation hence, a programming tool such as Staad.Pro is needed which provides economical and faster approach to structural design and analysis with chances of minimum errors. There are various types of loads like live load, dead load, wind load and seismic load. Generally due to weakness of structure and geometry the failure of building structure occurs. earthquake is occurring due to earth shaking, when it occurs then many people kill and losses of highly economic. Therefore, structural engineers are responsible for the preparation of the design of the structure, planning and layout, etc. of the buildings using Staad.pro which is the foremost computer code for 3D model generation and multi material design and it's the world's leading software for the analysing and designing the high-rise complicated buildings in very less time with high accuracy.

II. Literature Review

For high rise buildings, more reinforcement is required to be calculated for the top beam, hence greater region of steel is required in static analysis than dynamic analysis. As examine to static analysis deflection and shear bending is more in dynamic analysis. More steel is required in the lower beam of the structure in the dynamic evaluation as in contrast to static analysis. From the evaluation of columns, the vicinity and percentage of steel is discovered greater for dynamic load aggregate in contrast to static load combination [1]. Analysis and design on "The storey shear force." Was found that the loaded irregular building longer and larger base shear than same regular building structure.[2]. The load was maximum when applied in the x-direction (parallel to shorter span) and the deflection get increased as the height of the building increases and the base shear was 5% more in the case of STAAD Pro as compared to manually calculation [3]. The wind load is more critical for the higher structures as compared the earthquake loads and the deflection is higher in wind load than the structures without wind load. The steel quantity was increased by 1.517% related to conventional design [4]. The reports are prepared on the effect of the wind velocity on the structure and structural response of the structure on the sloped ground. For this project work various frame geometries, a combination of static load and wind load is taken into consideration and many cases of the different wind zone are examined for this combination. Analysing the results for different heights in terms of axial force, displacement, moment, storey drift and shear force by using STAAD PRO software [5]. The structure is inspected against the base shear and roof displacement and they are in permissible limits. An RCC high rise building stories combined seismic load and wind loads. In the top beam of the structure requires more reinforcement required for static analysis as compare to dynamic analysis. Deflection and shear bending are less in static analysis compare to dynamic analysis. In column area of steel is always less for static load compared to dynamic load [6]. Structural loads, assist conditions, and intensive properties should be determined to perform a precise analysis. The results of such analysis usually grab support responses, stresses, and displacements. Under normal working conditions, the damage and splitting must not be larger for the structure. A maximum factor of safety should be considered in load combinations so the structure won't fail during natural hazards or because of overloading [7]. The effects in terms of bending moment, aid reaction, shear force, axial pressure is analysed. Due to the impact of wind load on the structure, the story wise variation of the result with respect to specific parameters are compared and the reinforcement is additionally calculated which will make sure the structural safety of the building [8]. In this study a comparison was done between two 30-storey buildings. After the basic work is done. Then it was made with two different load combination.1st 30-storey building was made with the combination of seismic load, live load and dead load. And 2nd 30- storey building was made with the combination of wind load, live load and dead load. The analysing and designing was done for the comparison between two 30-storey building taking same beam and column size using different load combination it was clearly visible that the top beams of a building in seismic load combination required more reinforcement than the building under wind load combination. But the deflection and shear bending is more in wind load combination compare to seismic. But in lower beams more reinforcement is required for wind load combination. For column the area of steel and percentage of steel always greater required for wind load combination than the seismic load combination [9]. This study was focused on to develop, design and analysis model of skyscraper building in Staad.pro. In this research the plan depended on IS 875-part1 for dead load, IS 875-part2 for live load IS 875-part3 for wind load IS code 1893-2002 for earthquake load resistant criteria which stated the separate analysis criteria based on Zone of area IS 456-2000 for concrete design in this work or research the analyst found that the earthquake load take place in x-direction acting on the building, in this study were found that the deflection and height of the building are direct proportion as height grows the deflection also grows [10]. In this study a 30-storey structure was designed and analysed for two load case combinations, 1st case is a load combination of seismic+ live load+ dead load whereas 2nd case is load combination of wind load+ live load+ dead load. After completing the design and analysing the structure, it was found that The top beam of the structure requires more reinforcement in 1st case compared to 2nd case. Hence it reveals that more reinforcement is required in static analysis than dynamic analysis. Deflection and shear bending is more in dynamic analysis compare static analysis. In lower beams more reinforcement is required for dynamic loads compared to static loads. For columns, area of steel and percentage of steel is always greater for dynamic load combination compared to static load combination [11].

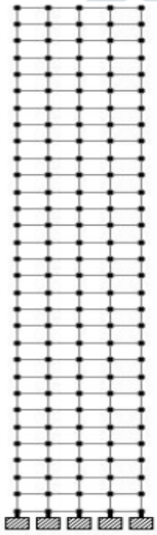

Fig-1. Elevation of structure

A G+3 building was designed and analysed in this study and a load combination of wind, live and dead loads were applied. A comparison of manual calculation and the software was done and it was observed that a higher of value of area of steel was found in the manual calculation when compared to the software [12].

V. RESULTS

Section	Reinforcement Area (A_{st}) in (mm^2)	
	Manual design	Software design
Slab	200.74	120
Beam	392.64	282.51
Column	1030.43(p_t%=1)	1619.20(p_t%=3)

Table 1

The two buildings are considered in the study, one is rectangular in shape and other is 'L' in shape and both are been analysed by linear Static method and Response Spectrum method. The two plans are studied for different variation of height i.e., G+5, G+10, G+15 and G+20 and seismic properties are kept similar for both the buildings. The parameter evaluated are Base Shear, Story displacement, Story shear, Story drift and Time period.

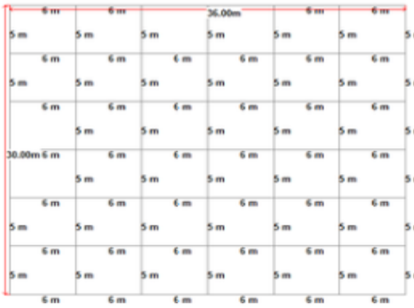

Figure 1: Plan of Symmetric Building

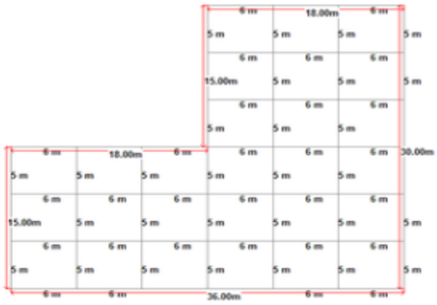

Figure 2: Plan of Symmetric Building

The Base Shear value obtained by manual analysis is less compare to the Software analysis. The Base Shear value of Symmetric building is more compared to the Asymmetric building. In Symmetric building the time period is more compare to Asymmetric building. The time period of Symmetric and Asymmetric building tries to match with each other when the height of building is increased. The regular building is preferred more compared to irregular building as the irregular building undergoes more deformation [13]. The principle objective of this paper was to design and analyse a multi-storeyed building of G+4 and comparing different models of shear walls. A four models of structure was analysed and designed such as; a structure with and without shear walls, shear wall at the centre of structure and at the corner. It was quite evident from the results shown above that without the use of shear wall it was nearly impossible to resist lateral loads applied on a structure. It was also very clear from the analysis that shear force gets considerably reduced by the use of shear wall. Not only shear force on the members but Max Moment and Displacements also gets reduced. The members near to the shear walls show very little or negligible displacement or moments and structure as a whole becomes more stable and safe against the lateral forces though the self-weight of the structure increases. From the above four models discussed it is quite clear from the results that 3rd model i.e. Shear walls at corners showed minimum displacement and moments hence from the above all cases this case can be considered most efficient and safe. Max shear force and Moments was also least for the 3rd model. Hence 3rd model i.e. shear wall at corner was most suitable and safe among the various models studied and analysed [14]. In this paper a design and analyse was done for G+14 multi-storey building and it was observed that a comparative between different shapes of buildings i.e. regular shape, L-shape and U-shape buildings. After analysis and designing was completed, this paper was concluded that Bending moments in Beams and columns showed a rise in the Regular Shape, L shape, U shape values as the storey height reduces, with L shape having the greatest value. Bending moments in continuous beams showed a rise in u shape building as the storey height is decreased. Nodal displacements Z directions falls gradually as the storey height is decreased. Displacements in U shape are about 2 times of displacements in Regular Shape building. Storey drift in Z directions rose gradually as the storey height is decreased. Drift in U shape building rise to more than 4.5 times of Regular Shape building. As the calculated drift was more than the allowable drift (h/500) due to combination of loads, lateral-load resisting element such as lateral bracings are provided to the RCC structure. Bending moments in beams and columns due to wind forces were observed to have much larger values compared to that due to static loads [15]. This paper was designed and analysed for G+9 multi-storeyed building. The main objective of this paper was to study the seismic behaviour of the concrete reinforced building by using the equivalent static method and response spectrum method by comparing static and dynamic analysis. After analysing the structure, it was observed that the values for beam stresses was 40-50% higher in dynamic analysis than compare to the values of static analysis. The values for the nodal displacement of column is 78 percent higher in dynamic compare to the static analysis. For the same point and conditions, it can be said that the results for the dynamic analysis were higher than the static analysis [16]. This study examined different parameters like displacements in longitudinal and transverse direction. After this, storey drift was calculated in both X as well as Z direction. There are total 13 cases of twin tower multi-storeyed building at medium soil condition under seismic forces for earthquake zone IV exist.

Table 3 Details of twin tower cases

CASE A	G + 12 (no floor twin)
CASE B	G + 12 (1 floor twin)
CASE C	G + 12 (2 floor twin)
CASE D	G + 12 (3 floor twin)
CASE E	G + 12 (4 floor twin)
CASE F	G + 12 (5 floor twin)
CASE G	G + 12 (6 floor twin)
CASE H	G + 12 (7 floor twin)
CASE I	G + 12 (8 floor twin)
CASE J	G + 12 (9 floor twin)
CASE K	G + 12 (10 floor twin)
CASE L	G + 12 (11 floor twin)
CASE M	G + 12 (12 floor twin)

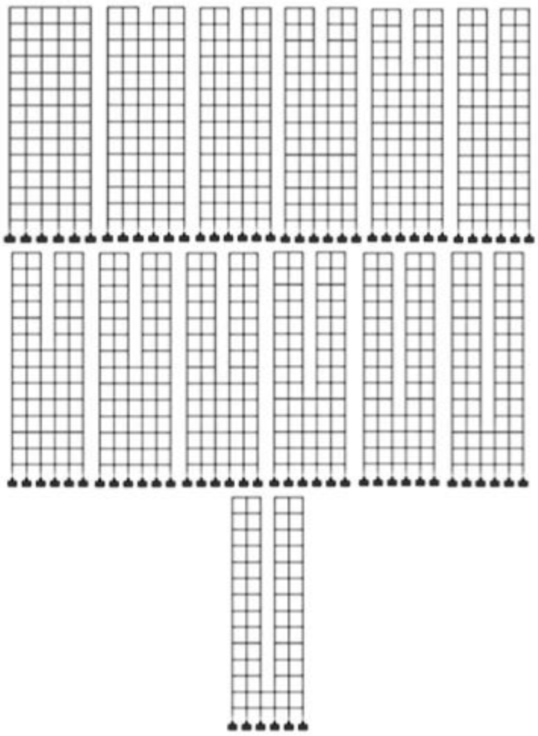

Fig. 2 Multi-storey building with different twin tower cases

After the design and analysis, it was found that The design of twin towers building subjected to seismic effects cannot be based on analytical results obtained from general multi-storeyed structure. As seen in results, the displacement values for twin tower cases for X direction gradually decrease to a lesser value of 39.059 mm i.e. Case M. Percentage decrease seems to be 20.37%. Displacement values for Z direction seem to be decrease by18.12 %. The plan of building which divides the whole structure into two parts for various cases, storey drift values seems to be maximum Case value of M and minimum value of F with a fall of 22.04% [17]. In this paper, it was studied that the effect of earthquake on two different shapes of structure. The building was designed and analysed for G+7 regular and irregular structure.

3.1. Plan of Regular Multi-Story Building

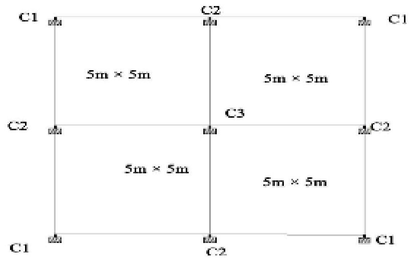

Figure 1 Regular Structure

3.2. Plan of Irregular Multi-Story Building

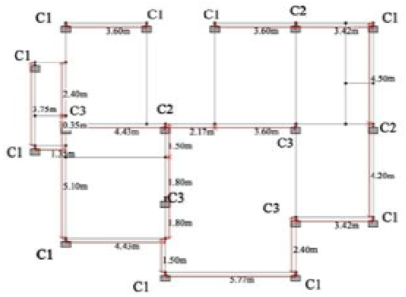

Figure 2 Irregular Structure

The results and discussions have been observed that when Compared to vertical irregular model lateral displacement is less in regular model. Almost the base shear was same in regular and irregular models, max base shear in zone 5 in regular was 1372.3 KN and in irregular 1349.5 KN. The values when Compared to irregular model the regular model showed less displacement with a max displacement of 55.16mm in zone 5. The behaviour of the structure was different for the different shape of the structure. Thus, the structure should be analysed for each particular angle, and it should be intended for the maximum value of shear force and maximum moments [18]. Analysis and design a G+8 storied commercial building with seismic resistance using Staad.Pro at Thandalam, Chennai. The design depended on Indian Standards on Staad.Pro was also designed in such a way that it would be economical. The design loads considered were dead load, live load, and wind load and were calculated on the basis of Indian Standards. the analysis of the building was done for the Frame by stiffness matrix method using Staad.Pro Software while Design of footings, columns, beams & slabs are done manually by limit state method as per IS456 – 2000, IS 875, and SP16 [19]. This study was focused a comparison between analyze and design of multistoried building for two different seismic zones by using Staad.Pro and manually calculations. The design includes load calculations and analyzing the entire structure by STAAD Pro. The design methods used in STAAD Pro analysis are Limit State Design refers to IS Code after going into some study they have found in their research that Seismic weight for zone 4 is greater than the seismic weight for zone 2.

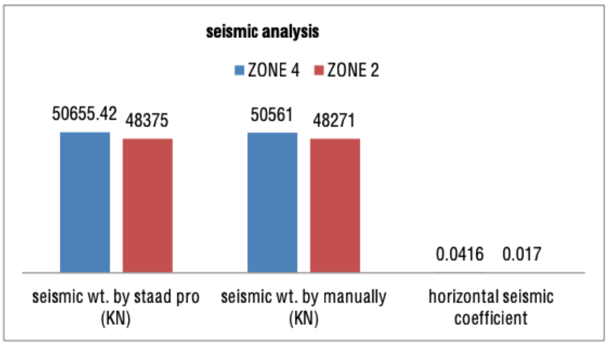

Fig. 4 seismic analysis

they found percentage variance 3.65% percent by Staad.Pro. But bending moment in beam 1 by manually as a 337.5 KN-m in zone 4 and 309.79 KN-m in zone 2, they get percentages difference of 8.2% [20]. This study gives data about static analysis of G+4 private structure which manages parallel static forces at beam and column joints and their displacements. The structure was planned as three-dimensional vertical frame also, analyzed for the maximum and minimum bending moments and shear forces. The load imposed were only dead, live load seismic load and Load on terrace (dead load+ live load) [21]. this paper the seismic reaction of the structures is researched under earthquake excitation expressed in the form of member forces, joint displacement, support reaction and story drift. In this paper the earthquake resistant style of G+7 RC building the steel amount raised by one point 517% to the convention concrete style. During this study seismic load controls the wind load below the seismic zone-II. mostly, the wind pressure is high for tall structure dependent on climate conditions like seaside zones, For Building prominently seismic forces produce the utmost cause of damage to the structure [22]. In this research they have come to know that Maximum lateral Storey displacement takes place at terrace floor level for all types of design model, As the tallness of the structure increases Storey acceleration also increases and is also directly proportional to the seismic intensity and the seismicity of the structure against the seismic force was straight forwardly corresponding to the intensity of the earthquake. In this paper, to understand the ways of structure located in different seismic zones like Zone III, Zone IV and Zone V a G+15 Storey RC bare frame building model was observed [23]. Studied the structural analysis of G+5 structure using the Staad.Pro software. In this study the design was based on the following Indian standard code IS 456-2000, for the design of RCC structural elements. IS 875-part1 for dead load, IS 875-part2 for live load SP-16 for depth and percentage of reinforcement SP-34 for detailing. Dead load and live load were the only two loads introduced to the structure therefore the load combination produced was 1.5(D.L. + L.L.) after which the analysis of the structure will run, also bending moment and shear force were calculated in this study the specific of all the structure members was addressed alongside the activities of slab, beam, column, footing and staircase. From which it was concluded that the horizontal bends was within 20mm and the structure was secure and inexpensive [24].

III. Conclusion

- Staad.pro provides much easier work than manual calculation.
- Staad.pro gives results which are almost accurate and economical when compared to manual calculation.
- The differences in wind load, seismic load, bending moment and shear with the height is showing direct relationship.
- Staad.pro is a user-friendly program which provides less time-consuming work.
- Also, we conclude that the more advanced technologies we got is the more knowledge we gain for a batter work.
- Staad.pro has the features to calculate the required reinforcement for the concrete section. Shear reinforcement is deliberately designed to stand up to all shear forces and torsion moments. The columns for axial and beams are designed flexure, shear and torsion are designed with the help of IS code.

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