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A Comptability Study Of Seismic & Wind Analysis Of Steel Structural Design Using Softwares - A Review

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Abstract:- *High Rise buildings are becoming increasingly common and economical in developed and developing countries with increase in urbanization all over the world. Many of these buildings do not have structural walls at ground floor level to increase the flexibility for use in parking or retail and commercial use. Reinforced concrete structures are mostly used since this is most convenient & economic system for low rise building. However, for medium to high rise buildings these are no longer economical because of increasing dead load, less stiffness, span restriction and hazardous formwork. So it becomes important to use steel frame building which reduces the weight of the structure or use the steel composite section for the framing construction of the building. This paper comprises of the comparative study of steel take off and analysis of steel structure by both wind and seismic forces on both the structural analysis and design softwares STAAD and ETABS.*

Keywords:- *Steel Frame Structure, Wind Analysis, Seismic Analysis, IS code, Pre-Engineering Building.*

I. Introduction

Many different types of loads such as dead, live, snow, wind, and seismic loads have been used in building codes for decades. Seismic loads are one of the most uncertain types of loads that have required engineers to consider in the design of buildings for many years. There have been a considerable amount of research work and study on different aspects of earthquakes and their consequent effects on the buildings in order to provide engineers with simple and practical instructions for performing a seismic design.

Severe earthquakes occur sparingly. Although it is possible to design and construct buildings for these earthquake events, it is generally considered uneconomical and un-necessary to do so. The seismic design is performed with the foresight that the earthquake which is severe would cause some damage and a seismic design philosophy on this basis has been developed over the years.

The aim of the seismic design is to cap the damage of the building to an acceptable level. The buildings designed with that goal in mind should be able to resist minor levels of earthquake ground motion without damage, resist medium levels of earthquake without structural damage, but possibly with some non-structural damage, and resist major levels of earthquake ground motion without collapse, but with more structural as well as non-structural damage. Steel structures are good at resisting earthquakes because of its ductility. The failures of many building may be explained by some of the specific features of steel structures. There are two ways by which the earthquake may be resisted:

a) structures which are made of sufficiently large sections subjected to only elastic stresses
b) structures which are made of smaller sections, designed to form numerous plastic zones.

A structure designed to the first way will be having large sections and may not provide a safety margin to cover earthquake actions that are higher than expected, as element failure is not ductile. In this case the structure"s global behavior is brittle and corresponds for instance to concept

a) in a Base Shear V- Top Displacement diagram. In a structure designed to the second option selected parts of the structure are intentionally designed to undergo cyclic plastic deformations without failure, and the structure as a whole is designed such that only those selected zones will be plastically deformed. The structures global behavior is "ductile" and corresponds to concept.
b) in the Base Shear V- Top Displacement d. The structure can dissipate a significant amount of energy in these plastic zones, this energy being represented by the area under the V-d curve. For this reason, the two design options are said to lead to "dissipative" and "non-dissipative" structures.

A ductile behavior, which provides extended deformation capacity, is generally the better way to resist earthquakes. One reason for this is that because of the many uncertainties which characterize our knowledge of real seismic actions and of the analyses we make, it may be that the earthquake action and/ or its effects are greater than expected. By ensuring ductile behavior, any such excesses are easily absorbed simply by greater energy dissipation due to plastic deformations of structural components. The same components could not provide more strength (a greater elastic resistance) when option 1 is adopted. Furthermore, a reduction in base shear V(V reduced < V elastic) means an equal reduction in forces applied to the foundations, resulting in lower costs for the infrastructure of a building. Steel structures are particularly good at providing an energy dissipation capability, due to

1. The ductility of steel as a material.
2. The many possible ductile mechanisms in steel elements and their connections.
3. The effective duplication of plastic mechanisms at a local level.
4. Reliable geometrical properties.
5. Relatively low sensitivity of the bending resistance of structural elements to the presence of coincident axial force

Variety of possible energy dissipation mechanisms in steel structures, and the reliability of each of these possibilities, are the fundamental characteristics explaining the excellent seismic behavior of steel structures.

II. Literature Review

Promod M. Gajbe, Prof. R.V.R.K. Prasad (2016)conducted work on ‘Analysis of Soft Story Multistored Steel Structure Building’. The Analysis was conducted on the Steel Structure Building having soft stories ie. The buildings which possess storey that are significantly weaker or more flexible than adjacent storey are known as soft storey building. It was found that soft storey building have poor performance during earthquake as they are subjected to large lateral loads during earthquake and under lateral loads their lateral deformations are greater than those of other floor so the design of structural member is critical . The displacement in the structure due to seismic effect for soft storey at different floor is increasing floor to floor and displacement is maximum at top storey at every floor. Storey drift in the structure due to seismic effect for soft storey at different floor is increasing floor wise.

Shubham Jain, S.S. Bhadoria, S.S. Kushwah.**(2016)** Conduted the work on “Comparative Study and Seismic Analysis of a Multistorey Steel Building”. In that research the time history analysis was carried out on a 7 storey and 12 storey steel frame building with different pattern of bracing system. I sections of different sectional properties were used for beam, column and bracings. The analysis was done as per IS 800:2007 Limit State Design philosophy. It was found that the bracing system was good to reduce the displacement occurred in building. The storey drift of the bracing structure either increases or decreases as compared to the without bracing building with the same configuration for the different bracing system. In 7 storey base shear is largest of X-bracing as compared to inverted V-bracing and without bracing with same configuration. In 7 storey building displacement is smallest in inverted V- Bracing as compared to without bracing and X-bracing with same configuration.

B. Ajitha, M.Naveen Naik(2016) Conducted work on “The Wind and Seismic Analysis on Different Height of Building by using Etabs” in this a steel frame building has been analysied for wind and seismic forces for buildings of height 20m, 30m, 40m, 50m, 60m, and for zone 2, zone 3, zone 4, along soil 3 in static analysis. It was found that the structural performance is analyzed in different height of building i.e. without bracing, With X Bracing, the displacement of 45% is reduced when lateral systems are provided. In Response Spectrum Analysis it was found that the displacement is 40% reduced when X bracing are provided. It was concluded that the lateral system in the framed structure the reduction in the displacement, shear, moment, thereby increasing the stiffness of the structure for resisting lateral loads due to earthquake.

I.Anusha, U.Arun Kumar,(2016) worked on the “Analysis of a steel building against earthquake loads” they worked on the analysis and design of multibay and multi storied G+5 steel structure for earthquake loads following the relevant IS code for earthquake and steel design. The analysis was done by using static load and response spectrum method. It was found that the displacement and storey shear in the structure of response spectrum method is less than that found by lateral force method. The steel quantity is less in lateral force method compared to the response spectrum method. This is because the response spectrum method, being dynamic in nature, is a more accurate method taking into account many more parameters like mode shape, mass participation factors to calculate the seismic vibration results. Response spectrum method is more realistic method of analysis and design of steel building frame and from this it was found that the lateral force methods leads to more cost effective of seismic design of steel frame.

Avani Mandlik, S K Sharma, Shahjad Mohammad, worked on "Behaviour of Symmetrical RCC and steel Framed Structures Under Seismic and wind Loading" In this 12 models were analysed and designed for multistoried as G+10, G+15 and G+20 with Wind and earthquake load for both RCC and Steel Structures. The results were found to be as displacement in steel structure is less than that in RCC structure in both the loading cases wind and seismic load. Column forces in RCC structure is also higher than that of steel structure in case of seismic load. The Steel structure has good resistant to the wind forces than that of concrete because of the steel's ductile property. Overall the steel building is better than the concrete frame building in both seismic as well as wind.

Jinsha M S et al., 2016, has investigated about Analysis of Pre-Engineering Buildings. In this paper Pre-Engineered Building of 25m width & 6m Eave Height have been analyzed and designed by using STAAD Pro.2007 to understand the behaviour of Pre –Engineered structure & to check in which case it achieve the economy in steel quantity by varying bay spacing as 6m, 8m, 10m, & 12m. Long Span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings fulfils this requirement along with reduced time and cost as compared to conventional structures. In the present work, Pre Engineered Buildings (PEB) is designed for wind forces. Wind analysis has been done manually as per IS 875 (Part III) – 1987.

Rohith E et al., 2016, has stated about weight optimization of pre-engineered steel building by genetic algorithm. Typically, a pre-engineered building is a metal building that consists of light gauge metal standing seam roof panels on steel purlins spanning between rigid frames with light gauge metal wall cladding. It is a relatively flexible structure v/s a conventional steel framed building. In other words, it has a much greater vertical and horizontal deflection. During the last few years, several methods have been developed for the optimal design of steel structures. Most of the methods are calculus based nature and leads to unrealistic solutions and therefore, they are not used in practice, which still prefers to rely on the more traditional iterative methods. This paper describes the use of genetic algorithm (GA) in performing optimization of 2D truss structures to achieve minimum weight. The GA uses fixed length vector of the design variables which are the cross-sectional areas of the members. The objective considered here is minimizing the weight of the structure.

Aditya P et al., 2016, has investigated about overview of Pre-Engineering Buildings. Buildings & houses are the basic requirements of any human being. There are several changes in construction technology since the beginning. The basic requirements of construction nowadays are best aesthetic look, fast, economical & high quality. Pre- engineered building is best option for these all requirements. Pre-engineered buildings are cost effective, time consuming as compared to other conventional buildings. Generally pre-engineered buildings are faster than conventional buildings, 25 % less time consuming & 30% lighter than conventional buildings. The plan & load on the building are calculated at the beginning, & the members are manufactured in factory & they are just assembled on actual site at time of construction.

Shrunkhal V B et al., 2015. has stated about a study on pre-engineered building – a construction technique. Steel industry is growing rapidly in almost all the parts of the world. The use of steel structures is not only economical but also eco-friendly at the time when there is a threat of global warming. Time being the most important aspect, steel structures (Pre-fabricated) is built in very short period and one such example is Pre Engineered Buildings (PEB).This review from the past experiences presents the results of experimental and analytical studies done on Pre Engineered Building. Results show that these structures are economic, reduces construction cost and time, energy efficient and flexibility of expansion.

III. Methodology

In this present study 5 models of G+15 will be designed and analyzed for the wind load and seismic load for different zonal regions and terrain category. The analysis will be done for STAAD and ETABS and the results will be compared depending upon the relevant optimization and cost effectiveness. The design will be carried out as per Indian Standard codes and analysis will be done by linear static analysis method. The power tool for computerized structural engineering where the three dimensional model is generated and loadings will be applied as per IS 875 and seismic forces as per IS 1893. The analysis will be done as per the steel structure code IS 800:2007 by limit state method by providing the parameters and commands by using softwares.

IV. Conclusion

1. Different researchers have proven that the structures with RCC frame with lower storey height have a good resistance to the earthquake forces, but it also has its limitations of spanning and ductility property so for that more reinforcement is to provided to make it resistive to the seismic forces, where as the steel frame

building have more responsive performance towards both seismic and wind forces because of its flexibility and ductile properties.

2. The buildings overall weight is also become less because of the steel frame structure, and eventually reduces the seismic forces acting on the structure. So the overall of cost of construction also reduces.

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