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Structural Analysis of Industrial Building

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Abstract:
Worldwide different types of RC and steel structures with various floor systems are being used for multistory buildings. In the past, masonry structures were widely used for building construction. Day by day technology has developed. Later, steel structural systems were started for multistory buildings. With the introduction of reinforced concrete, RC structural systems started for multistory building construction. RC floor system supported on steel beam was historically designed as non composite. With the advent of welding, it became practical to provide mechanical shear connectors to consider composite action. Due to failure of many multi-storied and low-rise RC and masonry buildings due to earthquake, structural engineers are looking for the alternative methods of construction. Use of composite or hybrid material is of particular interest. Bare steel structure is sensitive to fire. Now a day, different fire proofing system has developed significantly. In India, mostly masonry and RC structures were being used. During last decade, steel structural systems are being popular. So, alternative structural systems are gradually developing to compete with RC structural systems. Now a day, use of masonry structure is very limited. RC structure is dominating and steel structure is entering gradually for multistory building structures in India. So, comparative study is required to identify most effective structural system for a particular building.
Key Words: *Laterally Unsupported Beam, Lateral Torsional Buckling, Gantry Girder*

I. Introduction

Steel Worldwide different types of RC and steel structures with various floor systems are beingused for multi-storey buildings. In the past, masonry structures were widely used for building construction. Day by day technology has developed. Later, steel structural systems were started for multi-storey buildings. With the introduction of reinforced concrete, RC structural systems started for multi-storey building construction. RC floor system supported on steel beam was historically designed as non-composite. With the advent of welding, it became practical to provide mechanical shear connectors to consider composite action. Due to failure of many multi-storied and low-rise RC and masonry buildings due to earthquake, structural engineers are looking for the alternative methods of construction. Use of composite or hybrid material is of particular interest. Bare steel structure is sensitive to fire. Now a day, different fire proofing system has developed significantly. In India, mostly masonry and RC structures were being used. During last decade, steel structural systems are being popular. So, alternative structural systems are gradually developing to compete with RC structural systems. Now a day, use of masonry structure is very limited. RC structure is dominating and steel structure is entering gradually for multi-storey building structures in India. So, comparative study is required to identify most effective structural system for a particular building.

Every industrial structure has own requirement of the structure. Long unobstructed span, large headway, heavy weight of machine, minimum vibration, gantry requirement, natural sunlight, heating and cooling etc., are ideal requirement of industrial structures. We provide structural scheme by keeping in view of all the requirements of particular industries with high safety, serviceability and durability at optimum cost. Our technical team acquires the data related industries functional requirements, weight and size of each machine, vibrations of machines, dead stock of material and ancillary part of machinery etc., and finalized the structural geometry keeping all aspect of safety, serviceability and durability of structure. Building structure analyze in dead load, live load, wind load and earthquake load condition as per standard cord of practices and finalized design with optimum material usage in worst condition of loading.

Steel industry is one of the super growing industries in almost every part of the world. Beingthe second fastest growing economy in the world India has a huge percentage of it isattributed to the construction industries. They are not just economical but also highly eco-friendly when it comes to a treat of global warming, steel is 100% recyclable and the mostrecycled material Thus, each ton of recycled steel saves 2,500 pounds of iron ore andapproximately 1,000 pounds of coal Steel members also have the advantages of high tensilestrength and ductility. Steel is mostly used in the construction of industrial building withlarger span when the concrete is not under the feasible state or the construction time iscritical. In CSB, the sections used for columns and beams

are the mill produced hot rolledsections. The hot rolled sections are of constant depth therefore on the area of low internalstress it leads to excess design of the member. The frames of PEB on other hand are designedby tapered and often have with the flanges and web with variable thickness plates based onthe level of internal stress over the sections. The graphical growth of steel industrialstructures have been going high with the introduction of PEB along with the existence ofConventional Steel Building. These are low rise steel structures which are characterisedby low heights, less or lack of interior floors, walls and partition. The structure composed ofwalls which are of steel column which are profiled by steel caddling either profiled or G.Isheeting Although PEB systems are intensely used in industrial structures and many othernon-residential constructions worldwide, it is still a fresh concept in India; it was introducedlately in 1990s with the expansion of economy and setting up of many Multinational projects.

Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue. Structural analysis employs the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structures. After analyzing the structure, a structural engineer should assign proper structural sections so that the structure can sustain existing loads along with wind and seismic loads. Structural members are beams, columns, sub beams, footings and other necessary sections that is required for an industrial building.

The objective of the thesis is to improve the design of a warehouse building. Structural analysis is important as the reliability of the structure is investigated. Can the building withstand the loading conditions? That is the question asked during most of the analysis. The structural analysis is essential since it identifies the critical parts that need special attention. Furthermore, the analysis helps to understand the design of the structure in more detail. Every part of the structure has a purpose and this should be identified before any adjustments are made. Architectural layout plan of a six story garments factory has been prepared. The typical floorheight is 3.35 meter and column spacing is 7.62 meter in both directions. Following the plan,RC shear walled-rigid frame structure with two-way slab supported on beam and flat platefloor system is formed. Using the same plan, eccentric braced steel frame with steel girder-beam floor system topping RC slab on corrugated steel deck is formed as composite and non-composite. To activate composite action, mechanical shear connectors have been used. Then the building is designed and estimated for these four types of structural system including foundation. Total building cost including foundation, plumbing, sanitary, wall, floor finishing etc. has been prepared excluding electro mechanical cost for the selected four types of structure. Cost of fire proofing spray is considered separately. For steel structure, columns are non-composite for both cases i.e. steel I-section. Static analysis is performed. Duration of construction time is not considered. Span and height is constant. Construction cost, structural behavior and other related matters are observed to evaluate the better structural system for the selected garments factory building.

Formulation of Present Work

The A structure may be defined as any assemblage of materials which is intended to sustain loads'. Since the gravity, wind and temperature effects are loads, the living creations and plants are also structures in the broad sense though they may not always intentionally sustain loads. The wings of bat and a spider's web are the typical tension structures, while the increasing thickness of trunk and branches of tree toward their supports can be explained by the fact that they are subject to bending and compression caused by the self weight and wind force. Any structure across this world needs a roof, because roof is one of the most important elements of a building structure to provide protection to the inmates from the sun, rain, wind, etc. The roof also protects the interior of a building from direct exposure to the weather. Roof is provided to structures depending upon their purpose and use is providing with different types of roof. The utility of different roof systems for different purposes use and type different authors/ industrialist is reviewed with the help of webography, research papers, books etc.

A model consisting of Industrial building unit is prepared fig 3.1 shows architectural plan of model. It is two level models. It has foundation depth of 1.5 m . Level I : Plinth Level Refer Fig. 3.3.It has Storey height of 4:00 m and parapet of 1:00 m. Level 2 is at column height level Refer Fig. 3.2 . The model prepared and analysed in Etabs .

Fig: 3.1 Architectural Plan

Model I: Conventional Beam Column System

A conventional model of beam column system is created by using ETabs. Plan dimensions are 10.5 m X 21.3 m . It consists of storage unit processing unit.Total height of building is 5.5 m . Size of beam is 300 mm X 900 mm and size of column is 300 mm X 750 mm. Seismic zone III is considered . Grade of concrete is M25 and grade of steel is Fe 500. Table 3.1 gives details of plan for type I model consisting conventional column and beam system.

Plan dimensions	10.5x21.3 m
Total height of building	5.5 m
Height of storey	4.0m
Height of parapet	1m
Depth of foundation	1.5m
Size of beams	300 mm x 900 mm
size of columns	300 mm x 750 mm

Thickness of slab	125 mm
Thickness of walls	230 mm
Seismic zone	III
Soil condition	Hard
Response reduction factor	5
Importance factor	1
Floor finishes	1.5kN/m^2
Live load on floors	4 kN/m^2
Grade of Concrete	M25
Grade of Steel	Fe500
Density of Concrete	25 kN/m^3
Density of brick masonry	20 kN/m^3

II. Conclusion & Suggested Further Work

5.1 Conclusions

Most of the structural engineers use ETABS or StadPro for analysis and design purpose. Further knowledge of more detailed software is a must for later run. Moreover one should always have a clear concept of theoretical knowledge prior to operating software. Regular updates of codes and conduct should be kept in mind while designing. For this purpose, attending national and international seminars on Structural Engineering is required.

From the design it is clear that using angle section for Truss and channel section for purlins, Steel Truss Building using pipe section and PEB is found to be economical compared to Steel Truss Building using angle section. By using proper selection of material the Industrial Steel truss Building is economical compared to PEB. In the future, Design of Industrial Building and PEB for multistoried can be studied. Design of Industrial Building and PEB considering crane load can be studied.

The main aim of this thesis was to analyse aindustrial building using the Etabs. The method of analysis was chosen carefully since there are many numerical techniques of doing the analysis. The residential building was critically investigated and the necessary changes to the design were made. The main question that was asked throughout was, could the building sustain the forces generated by the loads? Changes were made using strength of materials and other design of mechanics knowledge. The analysis improved the integrity of the building and after the new design the residential building is regarded as more reliable in terms of strength.

This method of structural analysis has been thoroughly criticized at times due to the analyst´s mistakes. A lot of caution was taken at the start of the analysis so that no errors accumulate. The example problems that were analysed before the main analysis were veryimportant. This was because they show in a nut shell, how the whole process is followed. Another example was how the loads flow from one part of the buildingto another. Identifying the correct loads is essential as this acts as the start of analysis and if the loads are incorrect then wrong designs are made.

The usual practice in the design of multi-storey steel buildings is to provide a structure with sufficient lateral stiffness to keep the drift index between approximately 0.0015 and 0.0030 of the total height. Normally, the provision of lateral stiffness.

On the other hand, if the change in stiffness is small enough, it makes sense to assume that neither the shape nor material properties change at all during the deformation process. This assumption is the fundamental principle of linear analysis. The modelling beam-column connection are ideally neither pinned nor fixed and posses finite-zero stiffness. However, they are classified as simple (pinned), semi-rigid (semi-pinned) and rigid (fixed) depending on the connection stiffness. Such classification helps in simplifying the analysis of frames. A connection having a small stiffness can be assumed as pinned while connection having a large stiffness can be assumed as fixed. In the former case, the actual mid span bending moment will be less than what is designed for while in the later case the mid-span deflection will be more than what is calculated. The common methods of beam-column connection in steel frame structures include welds, rivets, unfinished bolts and high strength bolts. The analysis of braced frame in this dissertation assumes proper and intact beam-column connection for MSBF without taking into account the study of type of joints as a welded/riveted/bolted (or fully simple or rigid). The types of connections are so rigid that their displacement can be neglected under normal loading condition. Despite of the rigidity of connections, the beam-column joint assemblage can nevertheless exhibit some degree of flexibility under seismic ground motion.

Model of conventional RC beam column is created by Etabs and model by column and steel roof is crerated. Comparative analysis done to understand quantitative and qualitative analysis. As per results amount of concrete required in steel roof model is 33.68 m^3 as compare to RC beam column system 85.43 m^3.

Concrete quantity Required :

	Conventional RC Beam Column System	**Column & Steel truss System**
Columns	25.2 m3	16.8m3
Plinth Beams	11.14m3	11.14m3
Floor Beams	22.84m3	5.74m3
Floor Slab	26.25m3	-
TOTAL	**85.43m3**	**33.68m3**

Model of conventional Rc beam column shows Steel consumption of 5947 Kg whereas for steel roof model steel required is 6345 Kg. It shows that its convenient to construct Column and steel roof structure than convention RC beam column structure.

Steel quantity required :

	Conventional RC Beam Column System	**Column & Steel truss System**
Columns	2407 kg	1547kg
Plinth Beams	720 kg	720 kg
Floor Beams	1710kg	438kg
Floor Slab	1110kg	-
Structural Steel	-	3640 kg
TOTAL	**5947 kg**	6345 kg

Thus from the all above results we have concluded that Column and steel truss system is more economical than Conventional RC beam Column system.
Truss system is Easy to Construct as compared to conventional system.
Truss system can be taken out also as all the connections are bolted which is not possible in conventional system.
Quantity of steel and concrete required is less as compared to conventional system.

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