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RESEARCH ARTICLE

COMPARISION OF EFFECTIVENESS OF STRUCTURAL FRAME SYSTEMS IN TALL BUILDINGS (RIGID FRAME and BRACED FRAME)

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ABSTRACT

Growth of high rise building has always depends upon available material and level of construction technology and the state of developing of the services necessary from time for the use of the building. The primary design concern for many high rise building is their operational efficiency rather than environmental impact. A new balance needs to be stuck between these two factors, insufficient energy use is a particular concern whilst energy use is currently a relatively minor financial cost, It is associated in major environmental cost. The present study is indented to find the efficiency of structural form systems in high rise building. For this study two structural foam systems are compared. The high rise building with each system is analyzed with a separate model ie RIGID frame and Braced frame in ETAB software. The load calculations are calculated as per is relevant Indian Standards

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INTRODUCTION

Tall structures have fascinated mankind from the beginning of civilization. The growth of modern tall structures construction has begun much earlier in 1980's has been largely for commercial and residential purposes. However in India it was popular in late 20th century. The main philosophy of the high rise building is to select appropriate structural form systems for the better performance of the tall building. The form system can be different types depending on the framing of tall building. The general types of form systems include braces system and rigid systems

Overview of performance objectives

Performance objectives relevant for high rise buildings are based upon the performance expectations embedded in the prescriptive of most building design codes. Implict within the seismic design procedures of American, Japanese, Chinese, New Zealand codes and Eurocode 8 is the expectation that a building designed in conformance with the provisions will:

- Resist a minor level of earthquake ground shaking without damage
- Resist the design level of earthquake ground shaking with damage (which may or may not be economically repaired) but without causing extensive loss of life.
- Resist strongest earthquake shaking expected at the site without total collapse, but potentially with extreme damage.
- Resist the gust wind loads which are to be performed based on the wind tunnel experiments carried out on Wind tunnel model.
- Sustain erection loadings depends upon the construction methodology adopted.

These performance objectives have formed the basis of structural design of countless high rises building worldwide over the last several decades, although these performance levels are rarely verified explicitly.

Design Philosophy

Design philosophy or process is carried out in working or ultimate strength in early days. However at present days, limit state design philosophy is used for carrying the design of each element within the high rise building.

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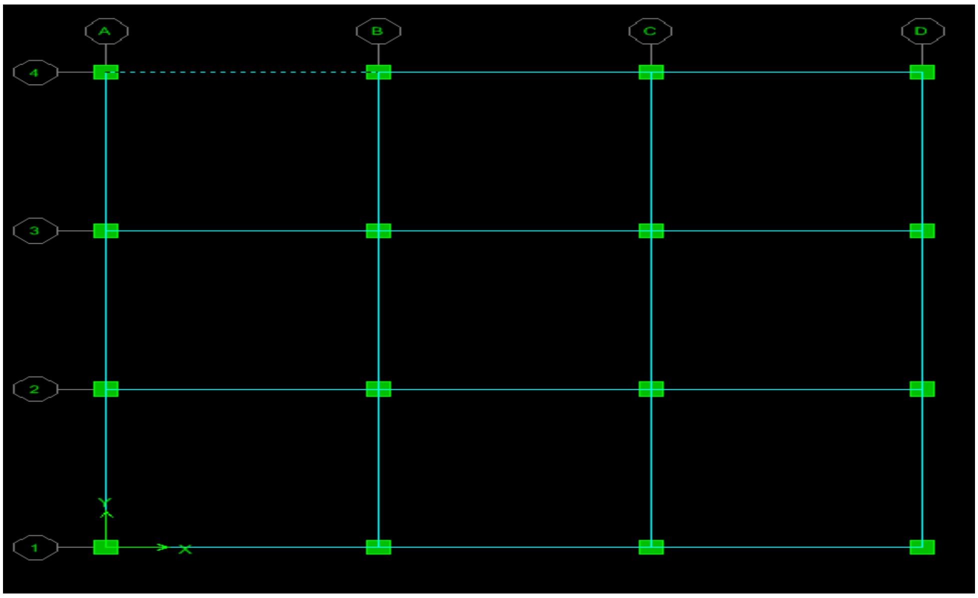


Fig. 1. Plan View of the Model

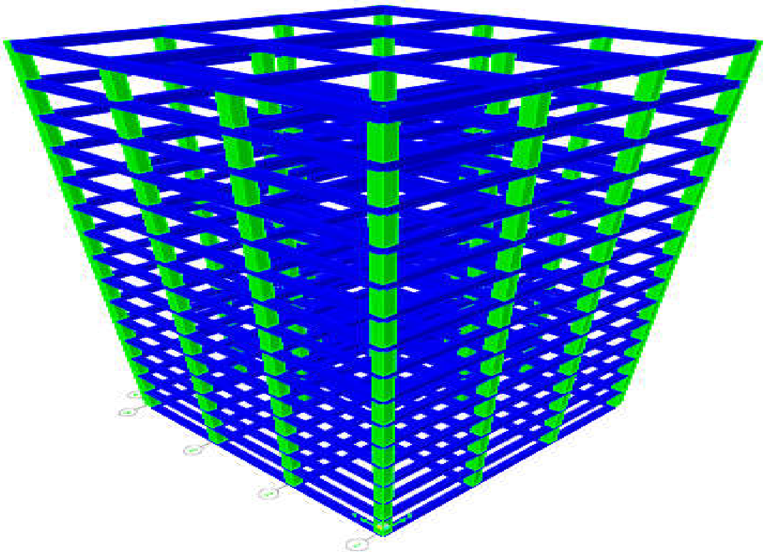


Fig. 2. Rigid Frame Model

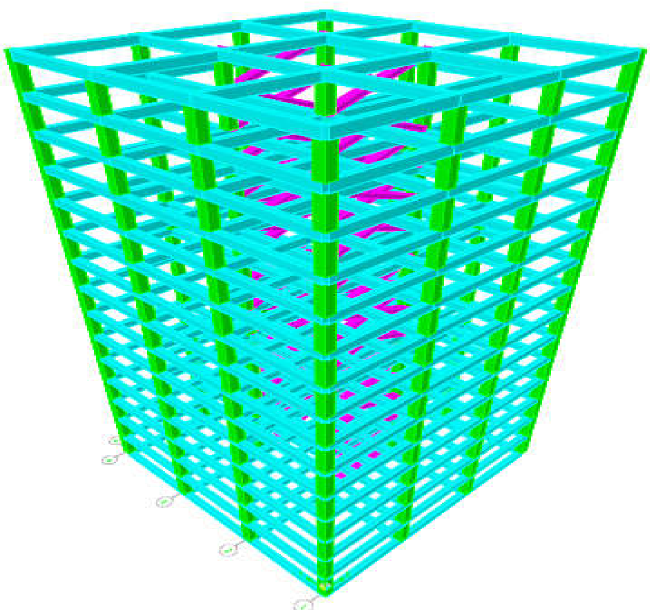


Fig. 3. Braced Frame Model

The limit state design philosophies were accepted universally by all the countries codal procedures. Since the high rise building is indented to resist the predominantly lateral loads like wind and seismic loads, high rise building should have adequate stiffness particularly lateral stiffness. This is a major consideration in the design of high rise buildings for several important reasons. For serviceability and human comfort the drift (or) lateral deflection are limited to prevent the second order p-delta effect design to service.

Structural Analysis and Modeling Procedures

General

Different types of analysis can be employed for the multiple design assessments indentified. Detailed 3-dimensional finite element models should be prepared for analysis to capture translational and torsion effects. Elastic analysis is appropriate for the service-level assessment component responses are generally smaller than those that cause yielding.

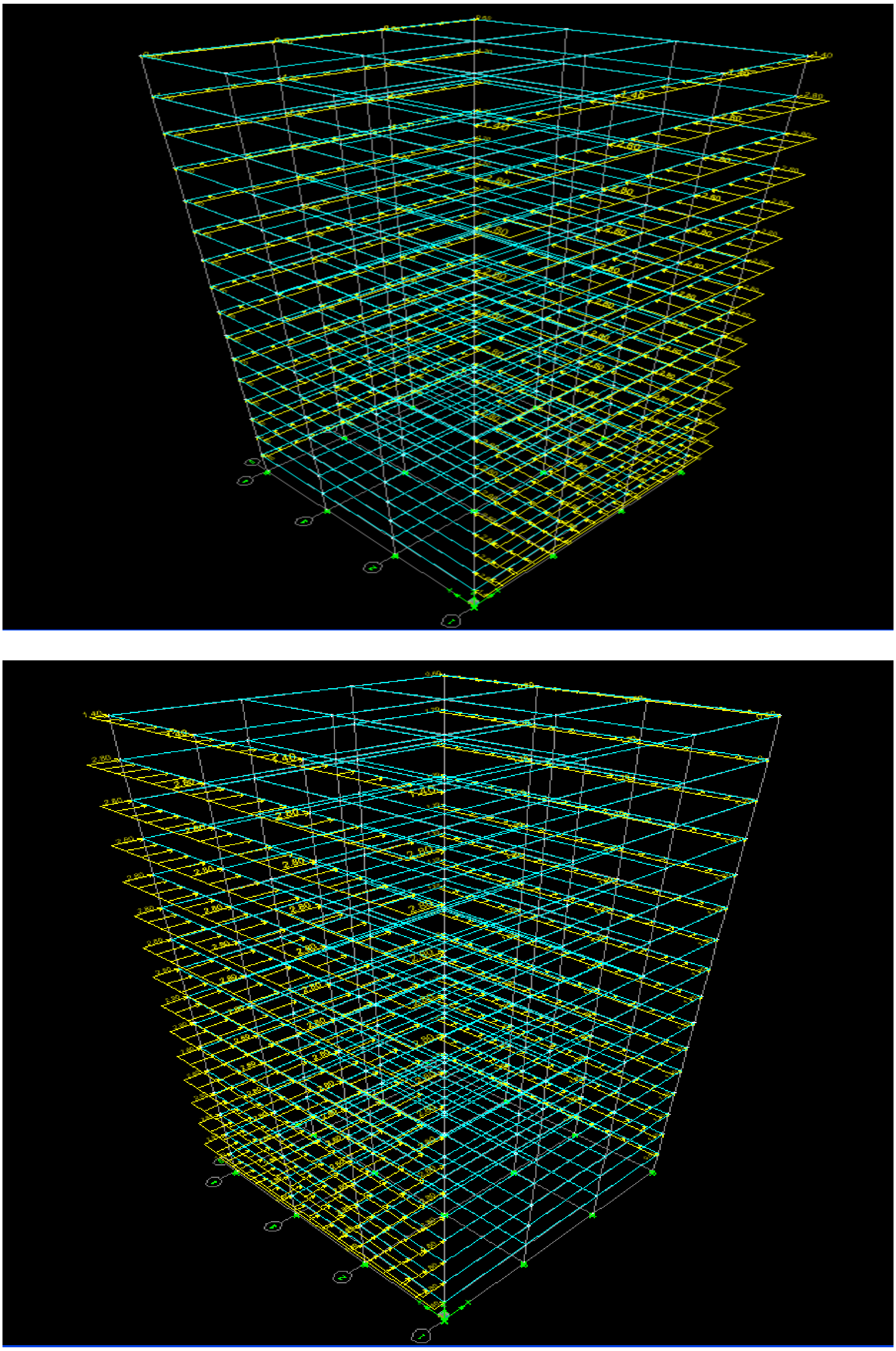
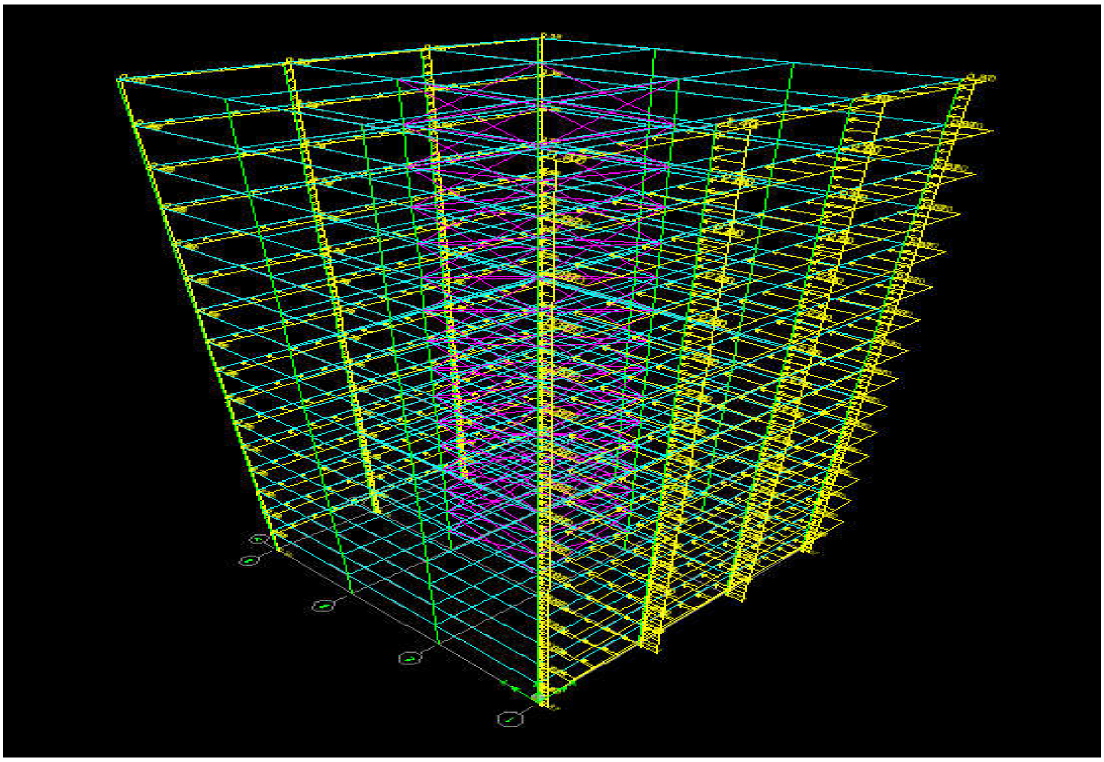


Fig. 4. Loading Details of Rigid Frame



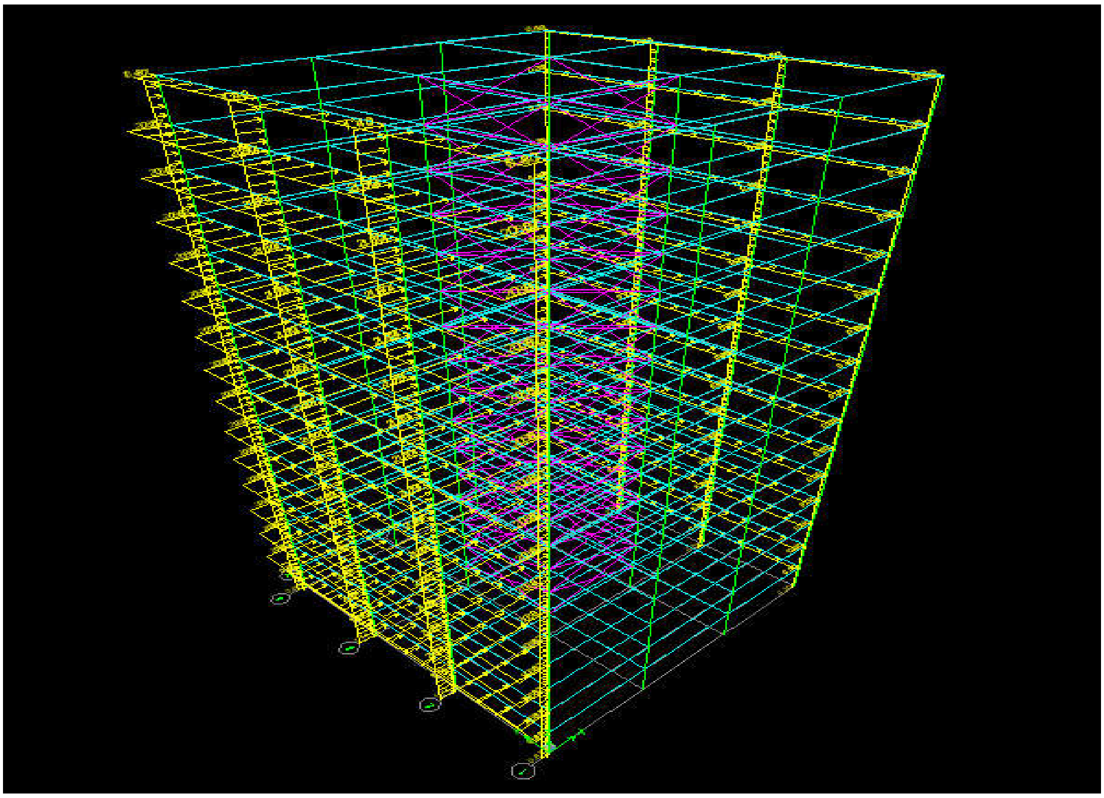


Fig. 5. Loading Details of Braced Frame

Nonlinear response-history analysis is required for the collapse prevention level assessment unless it can be demonstrated that all required for the collapse prevention level assessment unless it can be demonstrated that all structural components do not yield for maximum with the bi-directional excitation discussed above unless it can be shown to have insignificant effect.

(If tri-directional earthquake shaking is considered, the ground motion scaling guidance provided above must be extended to address vertical shaking.) Nonlinear static analysis (pushover) should not be for analysis of tall buildings because this method of analysis cannot the higher mode effects and torsion that are important in such structures and cannot be easily extended to accommodate supplemental damping devices.

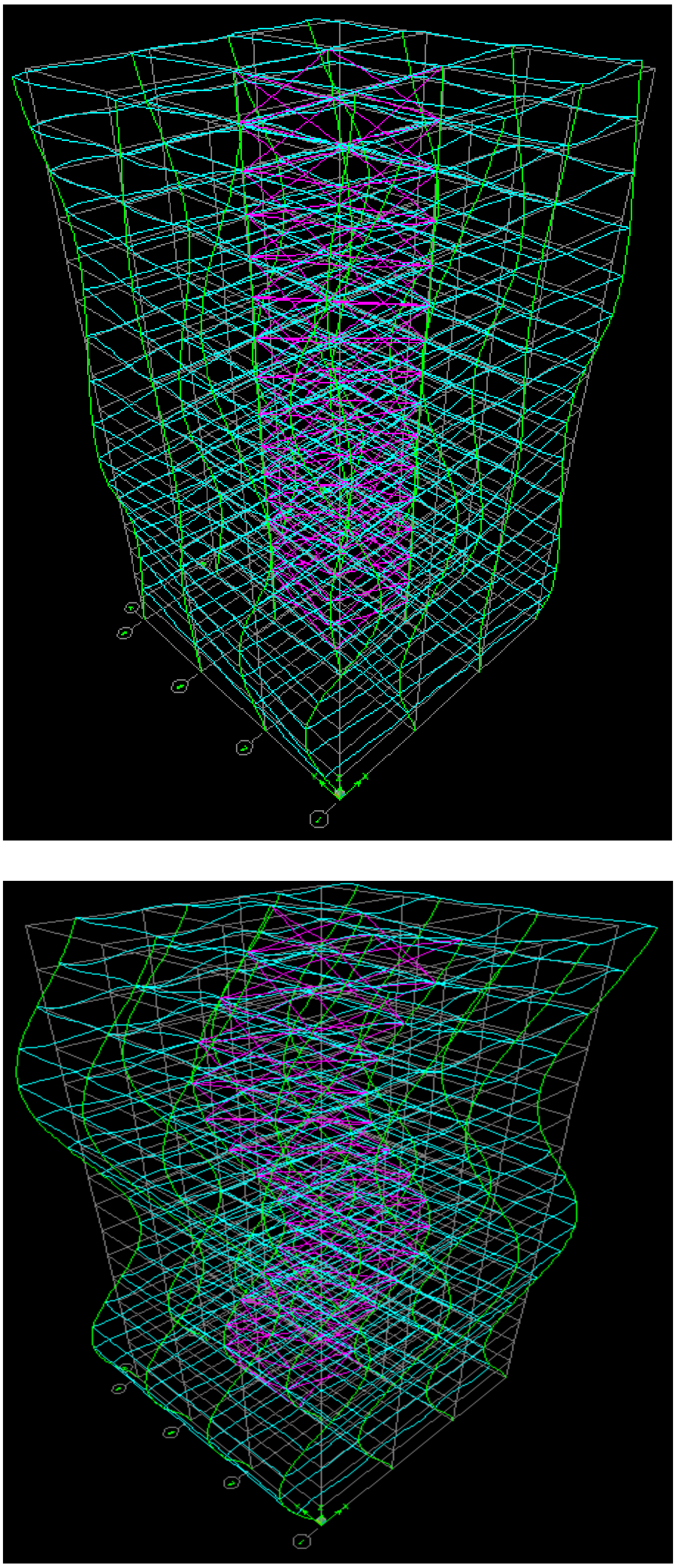


Fig.6. Deflected Mode shape for Braced Frames

Basic Modeling Principles

Basic principles for modeling structural components in tall buildings are introduced here. The numerical model should be sufficiently so as to enable consideration of the interaction of all structural and non-structural elements that affect significantly the linear and nonlinear response of the building.

Mass: The reactive mass included in the model should be the estimate of the structural mass, the permanent imposed mass including cladding, finishes, mechanical equipment and fixed furniture. Some jurisdictions will require a small proportion of the live load to be included as a permanent load.

Component force versus displacement relationships: The cyclic force-displacement relationships (mechanical properties) of steel and reinforced concrete components should be determined in the presence of gravity load effects. For steel components, initial stiffness should be based on gross section properties. For reinforced concrete and steel reinforced concrete, initial stiffness consider the effects of cracking up to the point of yielding. The guidance provided in ASCE-41on initial stiffness of concrete elements may be adopted or first principles analysis of cracked section properties can be used to determine values of initial stiffness. Component yield strengths or yield surfaces must be established considering interaction between shear, axial and flexural forces. The post-Yield force-displacement response should be based on industry standard relationships (e.g., ASCE 41) where they exist and appropriate. Deterioration of component strength and stiffness with repeated cycling should be modeled explicitly using industry – accepted models if the loss of maximum strength exceeds 20% of the peak strength. For non-linear response history analysis the properties should be based on upon excepted material strengths used for conventional design.

Load Calculation

Dead Load

The dead loads of the elements of the high rise buildings are assessed considering following unit weight of materials.

Plain Concrete : 24.00 kN/m^3
Reinforced Concrete : 25.00 kN/m^3

Live Load

The Live loads on the floor sytems are estimated based on the values suggested in IS codal provisions based on the utility of the structure. For the present conditions and analysis a live load of 4 kN/m^2 is considered for the floors and 1.5kN/m^2 for the roof assuming accessible condition.

Wind Load

The Wind loads on structure has been considered as per IS 875: Part 3. Design wind speed to be obtained using the formulae given below:

Design wind speed Vz= k1x k2x k3x Vb

Where,

K1 – risk co-efficient = 1
K2 – Based on terrain category and Height of structure
K3 – Topography factor=1.0

Earthquake Loads

The earth quake effect on the high rise buildings are considered as per the general design principles furnished as per

IS 1893 part 1:2002: The horizontal seismic coefficient is calculated as per the guidelines given in the IS code as follows.

Ah	=	Z I (Sa/g)/(2R)
Where, Ah	:	Design horizontal seismic coefficient
Z	:	Zone factor
I	:	Importance factor
R	:	Response reduction factor
Sa/g :		Average response acceleration coefficient

ETAB Model

The analysis of the proposed high rise building with appropriate type of forms are modeled in the 3D Finite element model using ETAB analysis software. The basic plan dimension between each grid is 8m in each direction. Totally 3bays system is considered in each direction. The floor height is 3m and totally 16 stories are considered for the present study.

Analysis results

The analysis was carried out various type of loading condition as estimated in the previous section. The loads applied on the two types of the structural forms are described in the below figures.

Conclusion

The analysis was carried out for the two types of structural forms i.e. Rigid frame model and Braced frame model. The major finding of the analysis results indicates that the braced frame form is performing better compared to Rigid frame model in High rise buildings. However the advantage of bracing system is nullified due to the hindrance of the bracing members for the utility of the structure and it should be used in limited area only like lift room, outer periphery. Hence to overcome these difficulties in the mid high rise buildings it is always preferable to adopt the rigid frame system. In case of tall towers having higher stories braced frame systems are very economical and more effective system against the lateral loading.

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