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Research Article

Effect of Stiffness of Core and Infill Walls in RC Framed StructureSubjected to Wind Load

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Abstract

The action of lateral loads is more observed in tall buildings, inorder to counteract these loads, systems which resist lateral loads are provided. The resistance might be offered from Action frame, Main Walls, or combined Walls and Frames (Dual System). In this report to design and analyze the three-dimensional structures, and assess the relative effectiveness of the systems that resist lateral load subjected to wind effect, a 3D structural modeling software known as "STAAD.Pro V8i "has been used. In this study five non-identical types of reinforced concrete frames that have no staircase and frames and main wall have been considered; "a frame with both external infill & internal infill of 230 &115mm thick respectively", "a bare frame", "a frame that has external infill of 230mm thick and zero infill", "a frame that has external infill of 150mm thick and zero infill" and "an external infill frame of 115mm thick". The number of the storey has been G+30. Each building model was analyzed to determine the side displacements on top of the storey.

Keywords: STAAD.Pro, Infill walls, Without staircase

Introduction

Upon the increase in the height of the building, accountable lateral loads on the building increase, when such reactions have reached to a point where they cannot be neglected they have to be considered during design. Usually, all multi-story buildings are high. More the height of the building, more the displacements in building due to lateral loads, making the certain measures mandatory to reduce the impact of these displacements. And these effects on a structure have to be countered by taking certain measures like Shear walls and Frame action [1]. The two main important factors which judge the stability and stiffness of the systems that resist the lateral forces are "side sway" and "high inner-storey stray". The main aim of the structural engineer is to select the systems which can minimize the effect as per codal provisions.

Wind Load

Probabilistic-statistical" method is used to determine the wind load basing the "Static equivalent wind load" concept, and assuming that frames and components behave elastically on the action of study wind loads [2].

Usually, fluctuating wind and mean wind act on tall buildings and these have effects on buildings depending on size and vibration [3]. These recommendations analyze the maximum loading effect on a structure. Summation of statistical wind load and mean wind load gives the design wind load [4].

Importance of Wind Loads on the Tall Building

People use buildings for different purposes. Since there is a scarcity of land now a days, multi-storey buildings are highly encouraged. Wind has following effects significantly on the Tall buildings [5]

- Wind exhibits the moments and forces on the structure and its components.
- Wind Pressure.

Hence it is important that wind forces are studied as a fundamental part of the construction.

Wind potency is considered in four important categories of building structures:

I. High rise buildings
II. Normal (low) buildings
III. Identical-Side Block Buildings
IV. Roofs and Cladding

Wind load estimations for high rise buildings are more important than the low buildings since the air has the maximum effect on buildings upon the increase in height.

Methdology
Basic Model Specifications
Building Type: High rise RC frame
Floor area: 60.10m x 19.23m
Storey Height: 3m
Number of Storeys: G+30

• Modeling done for bare frame, frame with infill wall of various thicknesses and frame with staircase & core wall (with and without infill wall of different thicknesses) prone to wind load.

• Comparison of frames with and without the inclusion of staircase & core wall, having different thickness of infill walls for lateral displacement.

Modelling of Structures

Ten different reinforced concrete frames with exclusion of Staircase and main wall have been considered; "a bare frame", a frame with External & Internal infill of 230mm & 115mm thick, a frame with external infill of 230mm thick, a frame with external infill of 150mm thick and a frame with external infill of 115mm thick. The number of storey has been G+30. The overall plan dimension of RC frame structures is 60.10m x 19.23m. Buildings are at ground level and height of each floor is considered to be 3m. A 150 mm thick solid slab is considered, members are assumed as homogeneous, isotropic and elastic modulus is considered to be equal in both tension zone and compression zone. Details are shown below Table 1.

Building Nomenclature

Adopted nomenclature model for analysis is given in Table 2.

A typical plan of RF1 is shown in Fig. 1 and RFSC1 is shown in Fig. 2, three dimensional view of RFSC1 is given in Fig. 3 and for RF3 is given in Fig. 4. The external and internal masonry infills considered in the study are 230 mm and 115 mm respectively.

Table 1 Section Details

Member	Size (mm)
Plinth Beams	300 X 300
Floor & Roof Beams	300 X 450
Columns	300 X 1200
External Walls	230, 150 & 115
Internal Walls	115
Slab	150

Table 2 Building Nomenclature

S.No	Type of Model	Without Staircase &Core Wall
1	Bare Frame	RF1
2	Frame with External infill 230mm and Internal infill 115mm thick	RF2
3	Frame with external infill of 230mm thick	RF3
4	Frame with external infill of 150mm thick	RF4
5	Frame with external infill of 115mm thick	RF5

Fig. 1 Plan of Building RF1

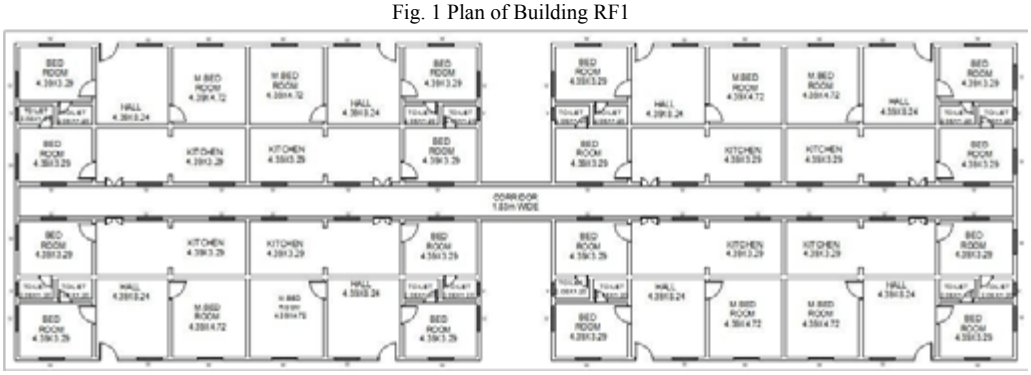


Fig. 2 -D view of model RFSC1

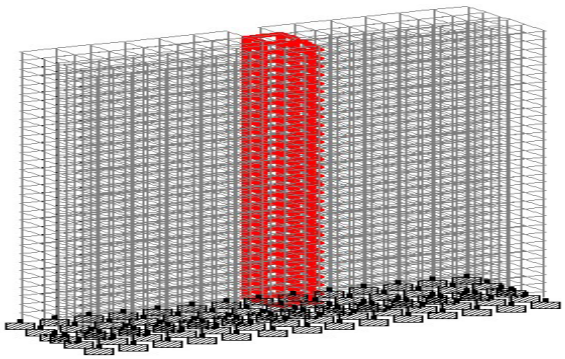
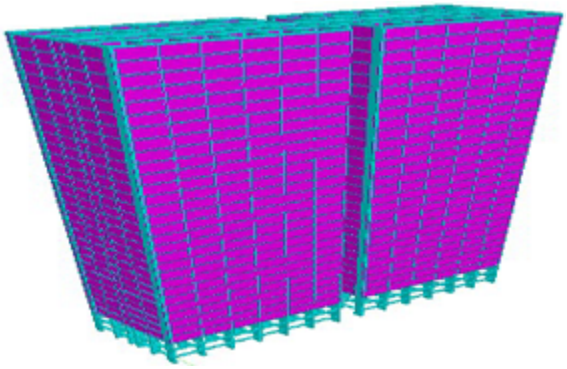
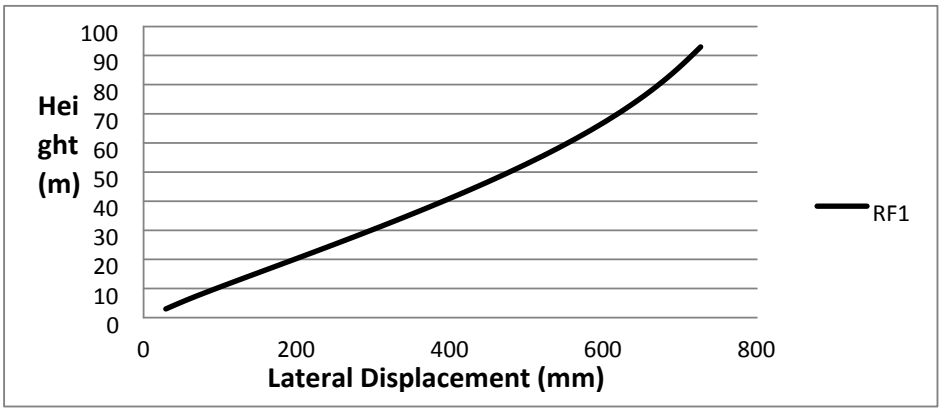


Fig. 3 - D view of model RF3



From Fig. 4, it's clear that the maximum displacement of 726.714mm is exhibited at top storey (i.e., 93m level) and it's not satisfied the requirement of permissible lateral displacement (i.e., H/500, H = Height of structure) as per IS 456:2000.



Results and Discussions

General Consideration

• Analyzed for G+30 storey structure with a 60.10m x 19.23m plan area.
• Ten types of RC space frames analyzed without Staircase and Core wall having different thickness of Infill walls.
• Considered under permanent vertical loads and Wind load (basic wind speed 50m/s).
• Lateral Displacements checked.

C Framed Structures with Variable Stiffness Configurations as Follows

Case 1: Bare Frame

• The columns are of 300mm x 1200mm size, plinth beams are of 300mm x300mm, floor & roof beams are 300 x450mm and slab with thickness of 150mm is considered on the all floors & Roof.
• The loads acting on the structure are assigned. Here self weight, live load, wall loads, slabs Loads and Wind loads are considered.
• Then the structure is analyzed for linear static analysis.
• From Fig. 5, it's clear that the maximum displacement of 726.714mm is exhibited at top storey (i.e., 93m level) and it's not satisfied the requirement of permissible lateral displacement (i.e., H/500, H = Height of structure) as per IS 456:2000.

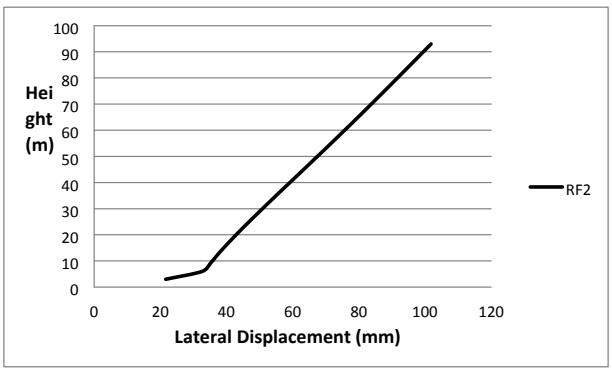


Fig.5 Lateral Displacement Vs Height for frame with External & Internal infill of 230mm & 115mm thick

Case 2: Frame with External infill 230mm and Internal Infill 115mm

• The columns are of 300mm x 1200mm size, plinth beams are of 300mm x300mm, floor & roof beams are 300 x450mm and size150mm thick Slab is considered on the all floors & Roof.
• The External infill of 230mm and internal infill of 115mm thick are provided.
• The loads acting on the structure are assigned. Here self-weight, live load, wall loads, slabs Loads and Wind loads are considered.
• Then the structure is analyzed for linear static analysis.

From Fig.6, observed that the maximum displacement of 101.816mm occurs at top storey (i.e., 93m level) and it's satisfied the requirement of permissible lateral displacement (i.e., H/500, H = Height of structure) as per IS 456:2000.

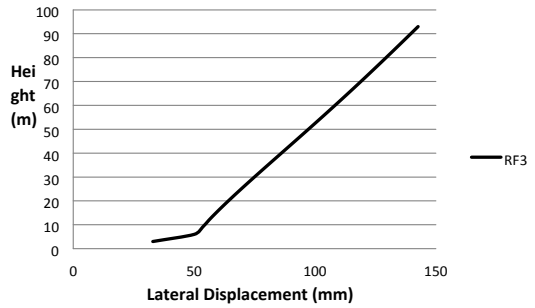


Fig.6 Lateral Displacement Vs Height for frame with only External infill of 230mm thick

Case 3: Frame with only External Infill of 230mm Thick

• The columns are of 300mm x 1200mm size, plinth beams are of 300mm x300mm, floor & roof beams are 300 x450mm and size150mm thick Slab is considered on the all floors & Roof.
• The External infill of 230mm thick provided.
• The loads acting on the structure are assigned. Here self-weight, live load, wall loads, slabs Loads and Wind loads are considered.
• Then the structure is analyzed for linear static analysis.

From Fig. 7, learned that the maximum displacement of 142.626mm occurs at top storey (i.e., 93m level) and it reached the requirement of permissible (i.e., H/500, H = Height of structure) lateral displacement as per IS 456:2000.

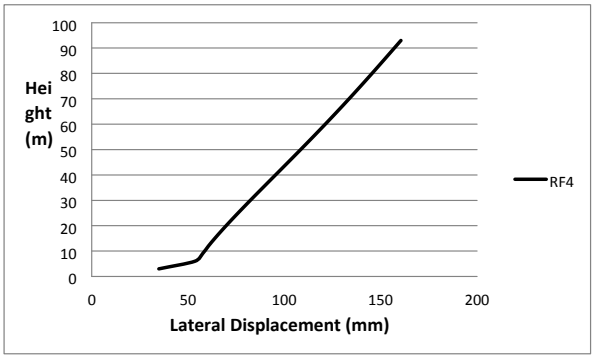


Fig. 7 Lateral Displacement Vs Height for frame with only External infill of 150mm thick

Case 4: Frame with only External Infill of 150mm Thick

• The columns are of 300mm x 1200mm size, plinth beams are of 300mm x300mm, floor & roof beams are 300 x450mm and size150mm thick Slab is considered on the all floors & Roof.
• The External infill of 150mm thick provided.
• The loads acting on the structure are assigned. Here self-weight, live load, wall loads, slabs Loads and Wind loads are considered.
• Then the structure is analyzed for linear static analysis

• From Fig. 8, observed that the maximum displacement of 160.448mm exhibit at top storey (i.e., 93m level) and it reached the requirement of permissible (i.e., H/500, H = Height of structure) lateral displacement as per IS 456:2000.

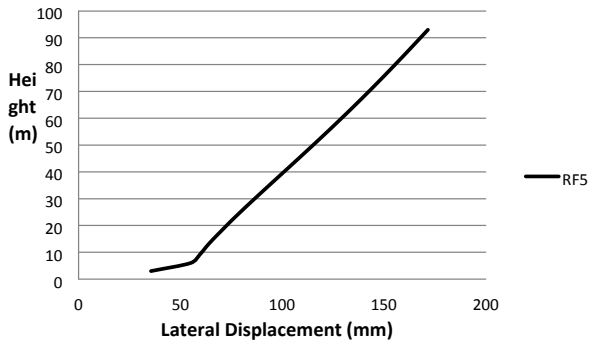


Fig. 8 Lateral Displacement Vs Height for frame with only External infill of 115mm thick

Case 5: Frame with only External Infill of 115mm Thick

• The columns are of 300mm x 1200mm size, plinth beams are of 300mm x300mm, floor & roof beams are 300 x450mm and size150mm thick Slab is considered on the all floors & Roof.
• The External infill of 115mm provided.
• The loads acting on the structure are assigned. Here self-weight, live load, wall loads, slabs Loads and Wind loads are considered.
• Then the structure is analyzed for linear static analysis.
• From Fig.9, observed that the maximum displacement of 171.598mm occurs at top storey (i.e., 93m level) and it's satisfied the requirement of permissible (i.e., H/500, H = Height of structure) lateral displacement as per IS 456:2000.

Comparison I

From Table 3, observed that, there is a reduction in percentage of variation in lateral displacement of 86.45 % at top storey, while comparing with the bare frame.

Table.3 Bare Frame External infill 230mm & Internal infill 115mm (RF2)

Type of Structure	Max. Lateral Displacement (mm)	Permissible Lateral Displacement (mm)	Percentage of Variation in Lateral Displacement ((RF1-RF2)/ RF1))X100
Bare Frame (RF1)	726.714	186	86.45
Frame with external infill 230mm and internal infill 115mm (RF2)	101.197	186	

Conclusions

The lateral displacement of reinforced concrete framed structure including and excluding Staircase, Core wall & infill walls was investigated using the linear static analysis. Following were the major conclusions taken from the study.

1. The lateral displacement in the Bare frame (RF1) is the highest among the ten lateral load counteracting systems studied.
2. In all the options the values of story lateral displacements are within the permissible limits as per code limits except Bare Frame (RF1) and Frame with staircase & core wall (RFSC1). However, it is observed that there was a considerable variation in the lateral displacement of the frame with staircase & core wall while compared with the bare frame.
3. There is a reduction in the percentage of variation in later displacement of 86.45% at the top storey (i.e., 93m level) when compared to bare frame (RF1) to frame with staircase, core wall and external infill 230mm (RFSC3).
4. It is concluded, consideration of stiffness of different elements (i.e., staircase, core and infill walls) in the analysis of frame shows a notable difference in the lateral sway.

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