THE EFFECTIVENESS OF DIFFERENT STRUCTURAL FORMS FOR MEDIUM-RISE APARTMENT BUILDINGS

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To fulfil the housing requirements of the ever-growing population with the scarcity of valuable land, the best solution is to come up with high-rise or medium-rise apartment buildings. The effect of lateral forces (wind and seismic) on those structures is significant to be studied because they govern the structural design. The selected structural system should be optimal in the aspects of associated cost, structural efficiency and maximum usable floor area. Therefore, once the structural form of the lateral load-resisting system of a building is defined, the optimal element sizes should be derived while satisfying all serviceability lateral stiffness and practical sizing requirements. This comparative study evaluates the effectiveness of six different structural forms of 20-story RC (Reinforced Concrete) structures under the effect of wind and seismic loadings including a moment-resisting frame as the base model, four wall frame structures, and a frame-tube structure. Maximum top story displacement, inter-story drift ratios, member forces and moments utilisation, associated cost, and human perception level for wind-induced lateral acceleration were considered as the parameters to carry out the comparison.

The main objectives of this study are to assess and compare the wind-induced lateral behaviours and behaviours against earthquake loadings of rigid-frame,wall-frame, and frame-tube medium-rise structures and to determine the most effective structural system for medium-rise apartment buildings based on established parameters. The methodology which was followed,

1. Establish the parameters/ design criteria that need to be satisfied.
2. Study the wind load and seismic load effect on typical medium-rise structures.
3. Select six different structural forms including a moment-resisting frame as the base model, four wall frame structures, and a frame-tube structure for the case study.
4. Develop FEM models and do the comparison based on established parameters.
5. Optimisation and cost analysis.

The major findings can be identified as followings. The lateral stiffness of bare frame structures can be increased considerably by increasing the depth of beams rather than increasing the size of columns. As well as in bare frame structures, the columns which are in line with the shear walls along the windward direction are subjected to high axial forces when the structure is subjected to wind effects. Also, with the addition of a sufficient amount of shear walls at lucrative positions, the required axial forces and bending moment capacities in both columns and beams can be reduced drastically. Even though the frame-tube structure shows better performances in lateral stiffness, the columns and beams are subjected to high axial forces and bending moments because the overall lateral stiffness is provided by columns and beam-column rigid joints.

Keywords: Wall-frame structures, Top story displacement, Structural optimisation, Dynamic behaviour, Flexural rigidity

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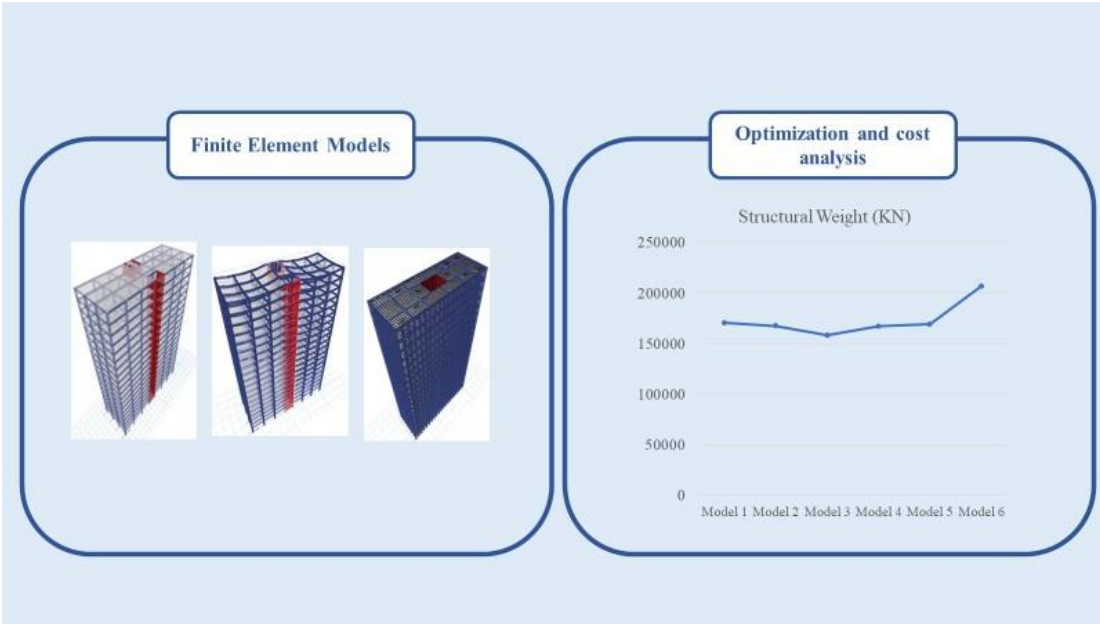
Finite Element Models
Optimization and cost analysis
Structural Weight (KN)
250000
200000
150000
100000
50000
0
Model 1 Model 2 Model 3 Model 4 Model 5 Model 6