Earthquake Resistant Design Of Open Ground Storey Framed Building

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Abstract: Today all over the world, multistoried buildings with open (soft) ground floor are inherently vulnerable to collapse due to earthquake load, their construction is still largely practiced in the developing nations. Social and functional need to provide car parking space at ground level gives the warning against such buildings from engineering community. The building is being modeled as an 3D space frame with six degrees of freedom at each node using the software STAAD-Pro V8i. Analysis is performed for Bare Frame,Bare frame having open ground storey, Frame with infill wall, open ground story frame, frame with stiffer column size having open ground storey. Results are obtained for axial force, shear and moments for columns and are compared.

***Key Words*:** Soft Storey,Earthquake,infill,multistorey.

1.INTRODUCTION

It has always been a mans desire to create taller and bigger structures. Development of metro cities in India there is increasing demand in High Rise Building.The building with soft story behaves differently as compared to a bare framed building(without considering any infill) or a fully infilled framed building under lateral load. A bare frame is drastically less resistant than a fully infilled frame; it resists the applied lateral load through frame action and shows well-distributed plastic hinges at failure. An appropriate way to analyze the Soft story buildings is to model the strength and stiffness of infill walls. Unfortunately, there are no guidelines are given in IS 1893: 2002 (Part-1) for modeling the infill walls.the upper storey during the earthquake move almost together as a single block and most of the horizontal displacement occurs in the soft ground storey of the building. In other words, these types of buildings sway back and forth like an inverted pendulum. Analytical models based on the concept of the equivalent diagonal strut, considering the whole structure as an Monolithic and equivalent braced frame system with a diagonal compression strut replacing the infill,provide an accurate prediction of the behavior of steel frames. The total seismic base shear as experienced by a building during an earthquake is fully dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height

Fig-1: Soft storey

2.ANALYSIS AND MODELLING

The building considered in the present report is G+6 Bare Frame structure, Frame structure with infill wall, Open ground story structure and Frame structure with stiffer column size. Complete analysis is carried out for dead load, live load & seismic load using STAAD-Pro V8i. All combinations are Considered as per IS 1893:2002.

Typical plan of building is shown in Fig-2

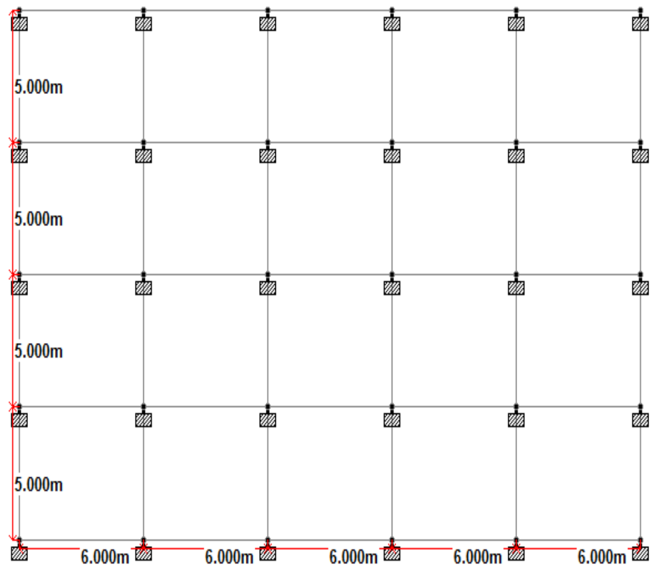

Fig-2: Plan of G+6 Structure

2.1BUILDING PROPERTIES

2.1.1 Site Properties:

Details of building:: G+6

Outer wall thickness:: 230 mm

Inner wall thickness:: 230mm

Floor height ::3 m

Depth of foundation :: 1500mm

Bearing capacity of Soil:: 150kN/m^2

2.1.2 Seismic Properties:

Seismic zone:: II, III

Zone factor::0.1,0.16

Importance factor:: 1.0

Response Reduction factor R:: 3

Soil Type:: Medium

2.1.3 Material Properties:

Material grades of M30& Fe415 were used for the design.

2.1.4 Loading on structure:

Dead load :: self-weight of structure

Weight of 230mm wall

Live load:: Floor 3.5 kN/m^2

Roof 1.5 kN/m^2

Wind load :: Not considered

2.1.5 Preliminary Sizes of members:

Column::

Zone II - 300mm x 500mm

Zone III - 350mm x 600mm

Zone IV - 400mm x 800mm

Zone V - 500mm x 850mm

Beam:: 300mm x 650mm

Slab thickness:: 125mm

2.2LOAD COMBINATIONS

Load combinations that are to be used for Limit state Design of reinforced concrete structure are listed below.

1. 1.5(DL+LL)
2. 1.2(DL+LL±EQ-X)
3. 1.2(DL+LL±EQ-Y)
4. 1.5(DL±EQ-X)
5. 1.5(DL±EQ-Y)
6. 0.9DL±1.5EQ-X
7. 0.9DL±1.5EQ-Y

2.3MODELING

This building has been modeled as 3D Space frame model with six degree of freedom at each node using STAAD-Pro V8i, software for stimulation of behavior under gravity and seismic loading. The isometric 3D view and plan of the building model is shown as figure. The support condition is considered as fully fixed

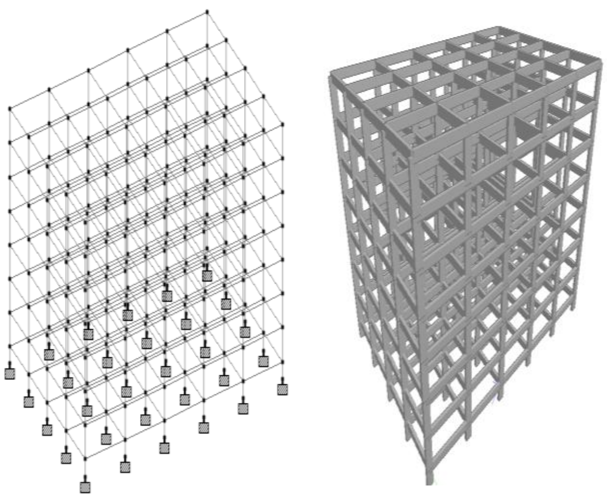

Fig-3: 3D View of G+6 Bare Frame Structure

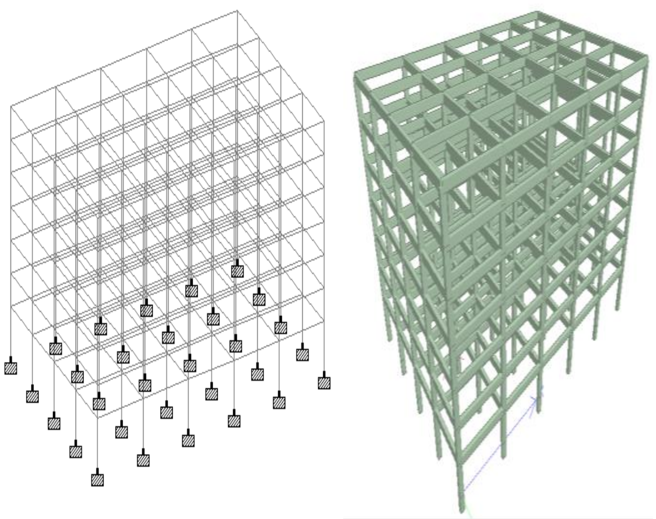

Fig-4: 3D View of G+6 Bare Frame with open ground story Structure

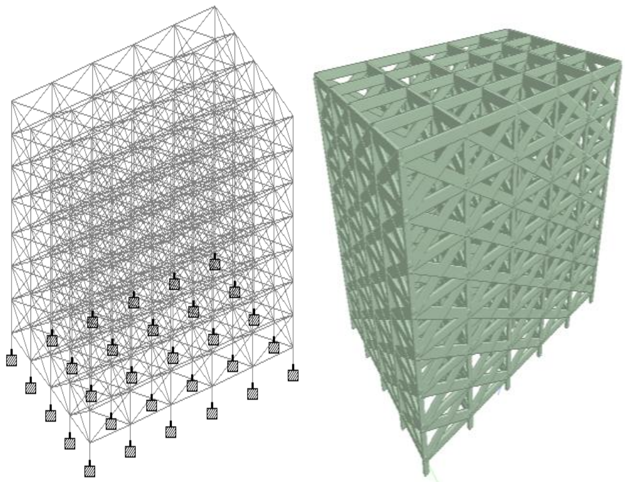

Fig-5: 3D View of G+6 Frame with Infill wall Structure

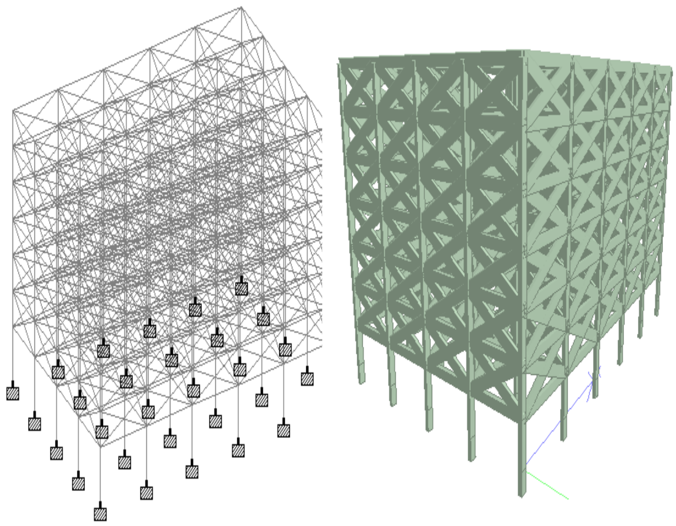

Fig-6: 3D View of G+6 Frame with Infill wall and open ground story Structure

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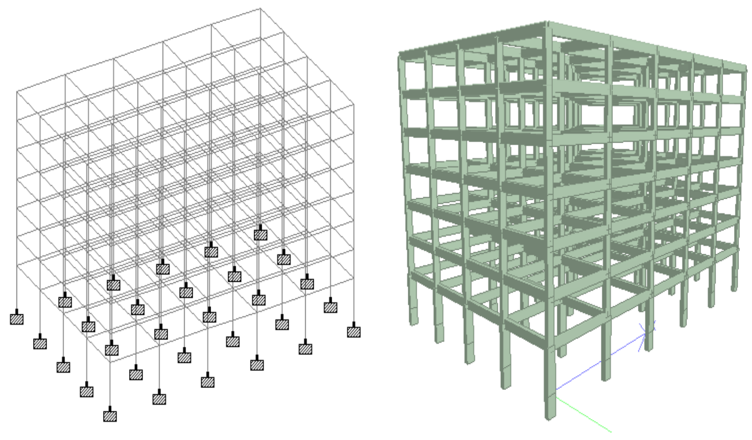

Fig-7: 3D View of G+6 Frame with stiffer column in open ground story Structure

3.RESULTS AND GRAPHS

Table-1: Maximum Axial Force(kN)

Type of Model	Maximum Axial Force in kN	
	Zone II	Zone III
Bare Frame	4743.676	4766.1
Bare Frame with ground open storey	4434.854	4458.112
Frame with Infill wall	3846.064	3971.871
Frame with Infill wall and open ground storey	3649.568	3768.654
Frame with stiffer column	4445.246	4479.004

Table-2: Maximum Shear Force(kN)

Type of Model	Maximum Shear Force in kN	
	Zone II	Zone III
Bare Frame	113.976	187.28
Bare Frame with ground open storey	108.356	175.554
Frame with Infill wall	153.981	249.308
Frame with Infill wall and open ground storey	113.389	192.097
Frame with stiffer column	106.618	169.949

Table -3: Maximum Moment(kNm)

Type of Model	Maximum Moment in kNm	
	Zone II	Zone III
Bare Frame	173.1	300.462
Bare Frame with ground open storey	227.38	405.324
Frame with Infill wall	138.85	265.998
Frame with Infill wall and open ground storey	268.47	478.375
Frame with stiffer column	267.634	503.02

4.CONCLUSIONS

- Maximum axial force is found in bare frame model.
- In interior columns, with considering infill wall effects and open ground storey the value of shear force are maximum.
- In interior columns, without considering infill wall effects and stiffer size column the value of moments are maximum.
- Soft storey building exhibits poor performance during earthquake.
- Damage induced for ground floor columns and ground storey are very large for soft storey building.
- Soft storey at ground level in RC frame building shows poor performance during earthquake as the stiffness of soft storey is less.

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