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Analysis and Design of Earthquake Resistant Multistoried Residential Building

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***Abstract*: Structural Analysis is a branch of engineering which involves in the determination & prediction of how real structures such as bridges, buildings, trusses etc., behave in certain loading conditions during the service life of a structure. The results of analysis are used to verify the structure stability for use. Computer aided software is also being used for calculation of forces, bending moment, stress, strain vs deformation or deflection of a complex structural system. The aim of this project is the comparative study on design and analysis of high-rise multistorey building by using STAAD. Pro software. STAAD. Pro is one of the most commonly used software for fast and efficient construction of high-rise buildings. In this project we analyze a multistorey building by considering the building components (such as beams, columns & slabs) to develop the economic design. The total structure was completely analyzed by computer using STAAD. Pro software.**

***Keywords*: STAAD.Pro, Dead load, Live load, IS1893:2002, IS-456:2000, Seismic analysis.**

1. Introduction

In our daily lives, we need to have significant needs. Housing is important amongst them. In addition, we need food, water, apparel, and so on. This shows the significance of civil engineering inlife. In ultra-modern times, structural seismic design is adding inspeed. In our design, we concentrate on" seismic design of multistory apartments".

A. Seismic Forces

Seismic forces are the bones generated during the earthquake. In the event of an earthquake, the structure is set in stir because of its own mass and acceleration. It acts primarily in the vertical direction. These are the main forces taken into account in earthquake analysis. This side force is the force at the origin of the structural break. The attendant torsion effect also causes the structure to rupture. Consideration must also be given to torsion in the analysis.

B. Types of Seismic Swells

During the earthquake many swells of energy are generated inside the earth. There are principally three types, S- swells, P-swells, and L-waves. Amongst them, S and P swells have no effect on the Earth's Surface. L swells or swells of love are those that affect the face of the earth.

A seismic surge is a surge that passes through the Earth, substantially because of a monumental earthquake, occasionally an explosion. Seismic swells are also continuously excited by the pounding of ocean swells and wind. Seismic swells are studied by the seismologist, and measured by a seismograph, seismometer, and geophones. For seismic studies of canvas budgets, hydrophones may give fresh information.

Body Swells travel through the innards of the earth. follow shaft paths bent by the varying viscosity and composition of the Earth's interior. This effect is analogous to the refraction of light swells. Body swells transmit the first arriving temblors of an earthquake. There are two kinds of body swells,

- Primary swells (P swells)
- Secondary swells (S swells)

P swells are longitudinal or contraction swells, which means that the ground is alternatively compressed and expanded in the direction of propagation.These swells generally travel slightly lower than doubly as presto as S swells and can travel through any type of material. In the air, those pressure swells take the shape of sound swells, so they travel at the speed of sound.Typical pets are 330m/ s in air, 1450 m/ s in water and about 5000 m/ s in determinedness. P swells are occasionally called" primary swells", and aren't as destructive as the S swells and face swells that follow them.

S swells are transverse or shear swells, meaning that the ground is displaced perpendicularly to the direction of propagation. In the case of horizontally concentrated S swells, the ground moves alternately to one side and also the other. S swells can travel only through solids, as fluids don't support shear stresses. Their speed is about 60% that of P swells in a given material. S swells are occasionally called" secondary swells" and are several times larger breadth than the P swells.

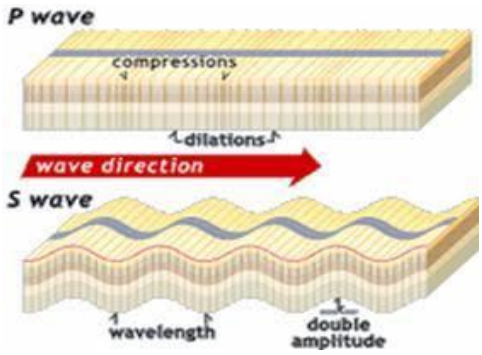

Fig. 1. P- surge and S- surge

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Face swells are similar to water swells and trip just under the earth face. They travel slower than body swells. Because of their low frequency, long duration and large breadth they can be the most destructive type of seismic swells. There are 2 types of face swells,

- Rayleigh swells
- Love swells

Rayleigh swells, also called ground roll, are face swells that travel as ripples analogous to those on the face of water. The actuality of these swells was predicted by John William Strutt, Lord Rayleigh, in 1885. They're slower than body swells and according to legend can readily be seen during an earthquake in an open space like a parking lot where the buses move over and down with the swells.

Love swells are face swells that beget vertical shearing of the ground. They're named after A.E.H. Love, a British mathematician who created a fine model of the swells in 1911. They generally travel slightly faster than Rayleigh swells.

A quick way to determine the distance from a locate to the origin of a seismic surge lower than 200 km down is to take the difference in appearance time of the P surge and the S surge in seconds and multiply by 8 kilometers per second. Ultramodern seismic arrays use more complicated earthquake position ways

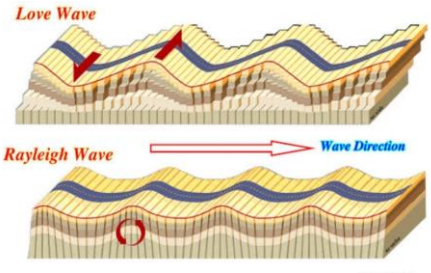

Fig. 2. Love wave and Rayleigh wave

C. *Seismic Analysis*

Seismic analysis can be done by many methods. They includes,

- Dampers
- Base isolation

Increasing stiffness

1) *Dampers*

In this method seismic resistance is obtained by using dampers. Dampers are materials which help in the absorption of seismic energy. They are mainly made of rubber.

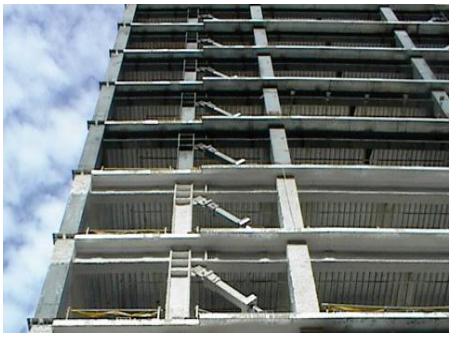

Fig. 3. Dampers in building

2) *Base Isolation*

Base isolation technique is another effective method for seismic design. Here the basement or foundation is isolated from super structure by different methods.

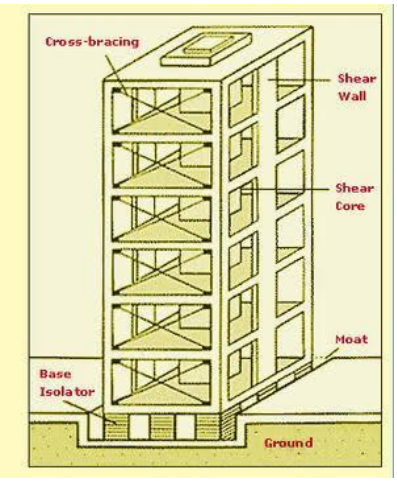

Fig. 4. Base isolation

D. *Earthquake Effects on Building*

The top concern in structural design for earthquake forces is for the side force defying system of the structures. In utmost of the structures this system consists of some combinations of vertical distribution of rudiments and perpendicular bracing rudiments. Failure of any part of the system or of the connections between the corridor can affect in major damage to structures including the possibility of total collapse. The earthquake shakes the whole structure. If the structure is to remain fully complete the implicit movement of all its corridors must be considered. A major design consideration is that of tying the structure together. Indeed though earthquake stir involves perpendicular vertical and torsional oscillations, the vertical stir and torsional stir are considered of significance in structural design. Vertical forces are only a bit of gravity loads and these are assumed to be taken care of by the factors of safety.

Fig. 5. Earthquake affected building

2. Planning and Modeling

Plan and the elevation of the building is drawn on AutoCAD software. From the cad drawing the centreline drawing is drawn

and is imported to the Staad Pro software.

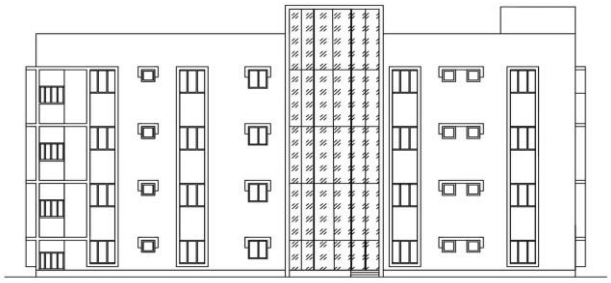

Fig. 6. Front elevation

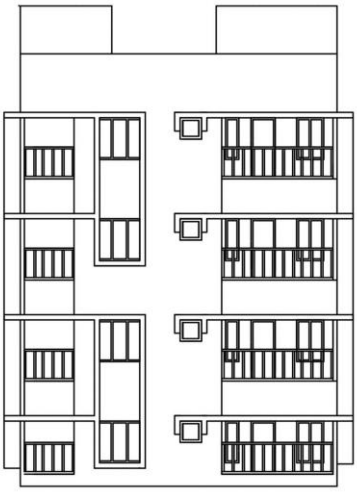

Fig. 7. Left side elevation

Fig. 8. Back elevation

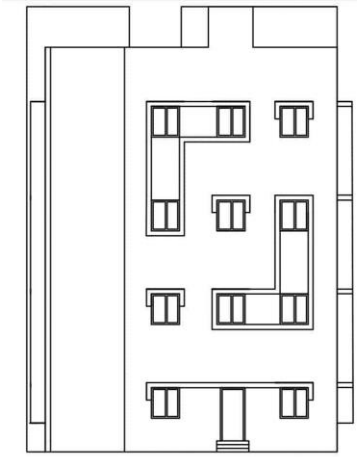

Fig. 9. Right side elevation

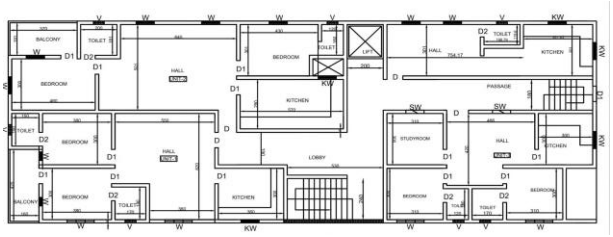

Fig. 10. Ground,1st,2nd, and 3rd floor plan

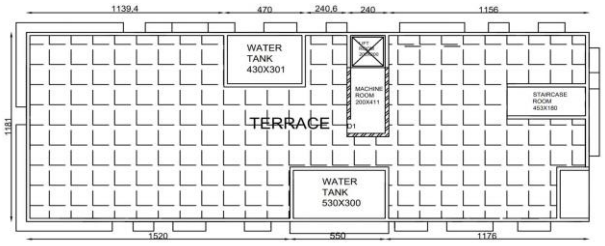

Fig. 11. Terrace floor plan

3. Analysis and Design

Structure frames correspond to a multistoried and multi paneled network of shafts and columns cast monolithically and rigorously connected with each other. The structure frames were vanquished to vertical as well as perpendicular loads. In frames the side forces produce moments and shears in the columns and shafts. Seismic analysis involves both side and vertical loads. We used STAAD Pro. software for the analysis and design of the structure.

A. Analysis as per IS 456- 2000 and IS 1893- 2002

The analysis was done through the following

- Modeling

The model was created using the structural wizard option in STAAD Pro software. All the shafts and columns were modeled.

- Member Forces

The confines of all shafts and columns were given as per the primary design and it was assigned.

- Support Specifications

In our structure we assumed to give a pile foundation as the sub structure and therefore the support specification was given as fixed. It was also assigned to the corresponding bumps.

- Loading

We considered dead weight as per IS 875 (Part 1), live weight as per IS 875 (Part 2), seismic weight as per IS 1893-2002 in our structure. We also considered various weight combinations as per IS 1893- 2002. The various loads and its combinations are as follows:

1. DL
2. LL
3. SLX (seismic load in X-direction)
4. SLZ (seismic load in Z-direction)
5. 1.5 (DL+LL)
6. 1.2 (DL+LL+SLX)
7. 1.2 (DL+LL+SLZ)
8. 1.5 (DL+SLX)
9. 1.5 (DL+SLZ)

10. 0.9DL+1.5SLX
11. 0.9DL+1.5SLZ

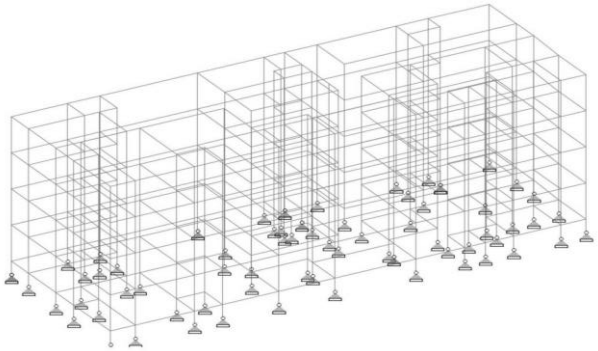

Fig. 12. Isometric view obtained from Staad Pro software

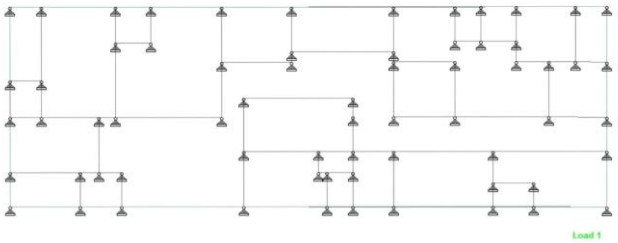

Fig. 13. Plan of the model from Staad Pro software

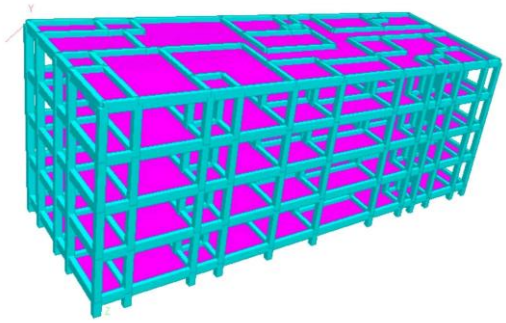

Fig. 13. 3-D rendering view in Staad Pro software

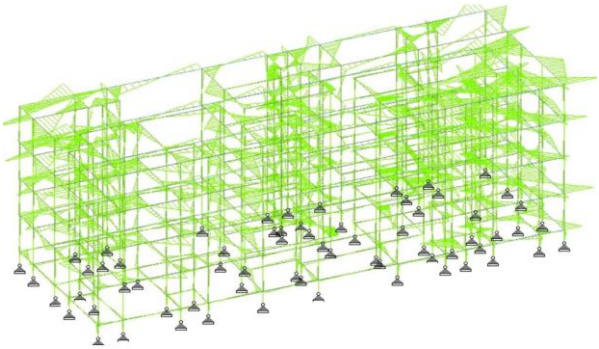

Fig. 14. Bending in Y direction

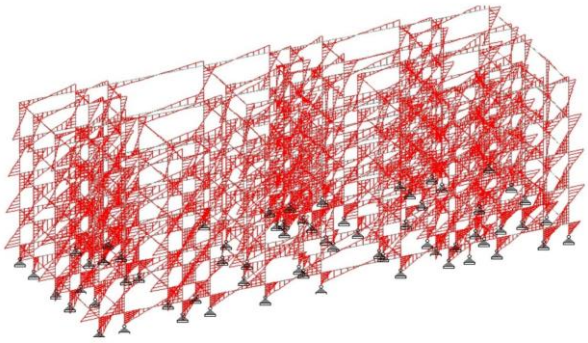

Fig. 15. Bending in Z direction

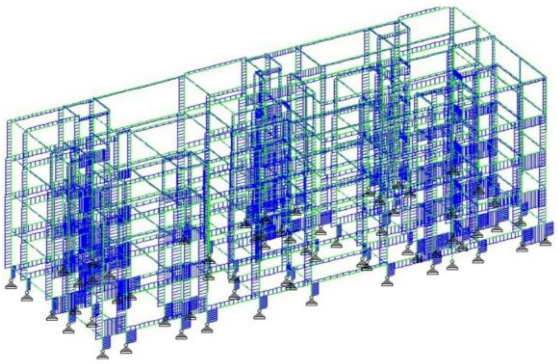

Fig. 16. Shear in Y direction

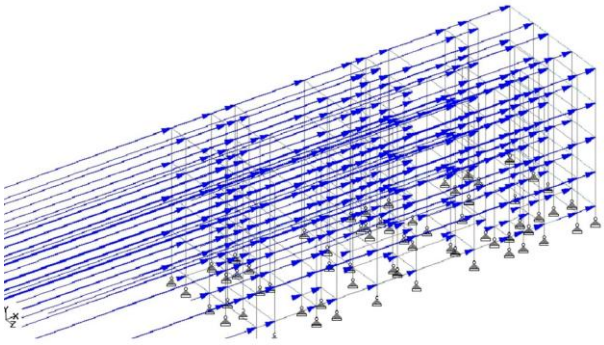

Fig. 17. Seismic load in X direction

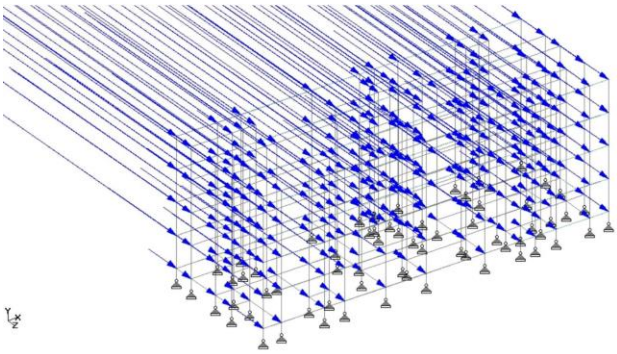

Fig. 18. Seismic load in Z direction

4. Conclusion

Our project was 'Analysis and Design of Earthquake Resistant Multistoried Building using STAAD Pro.'. In our project we planned, analyzed and designed a four storied (G+3)

apartment. We analyzed and designed it using STAAD Pro software. We had also manually designed the beam, column, slab and stair. As we were doing this project we came to know about the structural members and its behavior to seismic action. Since we are the beginners in this field, it was a bit challenging for us, but with the help of our guide and other materials we were able to complete it successfully. We were sure that this will be an encouragement for us to proceed in our career.

References

[1] Jacky Gurnani, "To Analyze and Study the Behaviour of MultiI-Storey Building in Different Zones of India- A Review", in *International Journal of Creative Research Thoughts*, vol. 9, no. 4, pp. 1368–1372, April 2021.

[2] Nikhil H. Pitale, "Seismic Analysis of Multi-Storey Building Using STAAD.Pro & Comparison between Manual and software Calculation", in *International Research Journal of Engineering and Technology*, vol. 7, no. 5, pp. 7150–7160, May 2020.

[3] Kamlesh Kumar Choudhary, "Earthquake and Wind Analysis of Multi Storey Building using STAAD.Pro", in *International Journal of Recent Development in Engineering and Technology*, vol. 10, no. 10, pp. 1–5, Oct. 2021.

[4] T. Jayakrishna, "Seismic Analysis of Regular and Irregular Multi-storey Buildings by using Staad-Pro", in *International Journal of Civil Engineering and Technology*, vol. 9, no. 1, pp. 431–439, Jan. 2018.

[5] Komal S. Meshram, "Seismic Analysis of Building Using Staad-Pro", in *International Journal of Innovations in Engineering and Science*, vol. 4, no. 5, pp. 17–24, 2019.