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"Exploration of Multi-Bay Steel Frames for High-Rise Buildings using Seismic Design''

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Abstract: - *One of the most widely utilized building materials in the world is steel. Steel's inherent strength, hardness, and ductility make it the perfect material for earthquake design. The design engineer must be conversant with both the purpose stated in the codes and the pertinent steel design provisions in order to take use of these advantages in seismic applications. This project's building structure was created in accordance with IS 1893-2002 and IS 800. The goal of this project is to investigate and design a multistory and multibay (G+5) building structure that is earthquake-resistant using IS 1893 and IS 800:2007. The structure has six stories and three lateral bays and five horizontal bays. The random piece selection was carried out methodically by using equivalent static load methodology.*
Key Words: *Steel, Earthquake, Multistory & Multibay structure, Equivalent Static load.*

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I. Introduction: -

Seismic analysis is a subset of structural analysis that involves estimating the seismic reaction of a building. It is part of the structural design, earthquake engineering, or structural evaluation and retrofit process in earthquake-prone areas. The most powerful earthquakes occur at the tectonic plate borders of the Earth. These plates have a natural inclination to move relative to one another, but friction prevents this from happening until the stresses between plates under the epicenter point become so severe that they abruptly shift. There was an earthquake. The local shock causes ground waves to propagate over the earth's surface, triggering movement at structural foundations. Waves become less significant as you move away from the core. As a result, parts of the planet have a higher or lower seismic risk based on their closeness to the main tectonic plate borders. Steel constructions are resistant to earthquakes due to their ductility. Steel structures that have been subjected to earthquakes have performed admirably. Structures made of various materials are commonly related with global collapses and a huge number of victims. Because element failure is not ductile, a structure built to the first choice will be heavier and may not provide a safety margin to cover higher-than-planned earthquake actions. In this circumstance, the structure's global behavior is "brittle," which corresponds to concept a) in a Base Shear V- Top Displacement diagram. In the second option, specific areas of the structure are designed to withstand cyclic plastic deformations without failure, while the structure as a whole is designed so that only those selected zones are plastically deformed.

II. Literature Review: -

Rong Chen Dongxue Hao (December 2021) [1] Multi-story steel frames are popular building structures. For those with insufficient seismic resistance, their seismic capacity can be improved by installing buckling-restrained braces (BRBs), which is known for high energy dissipation capacity, and the corresponding frame is denoted as BRB frame (BRBF).
Akshay. P. Wawge (June 2021) [2] Generally Structure framework are designed for gravity loading. In case of Rigid connection, the full 100% strength of Beam section is never utilized due to the fact in Beam at the end the end support Moment are always having greater value than Mid-Span Moment.
Iman Faridmehr (October 2019) [3] A test program was considered to clarify the cyclic characteristics of eight full-scale unstiff ened extended end-plates with variable parameters and one Side Plate moment connection.
Concepción Díaz (May 2011) [4] Steel portal frames were traditionally designed assuming that beam-to-column joints are ideally pinned or fully rigid.

Objectives: -

- Storey Drift by using Lateral Force method & Response Spectrum Method.
- Compare Base shear for Lateral as well as Response Spectrum Method.
- Find the optimum percentage of steel.

III. Methodology: -

In that present work, the structure consisting of six stories with three bays in horizontal direction and six bays in lateral direction is taken and analyzed it by both equivalent static method and response spectrum analysis and designed. The storey height is 3 meters and the horizontal spacing between bays is 8 meters and lateral spacing of bays is 6 meters.

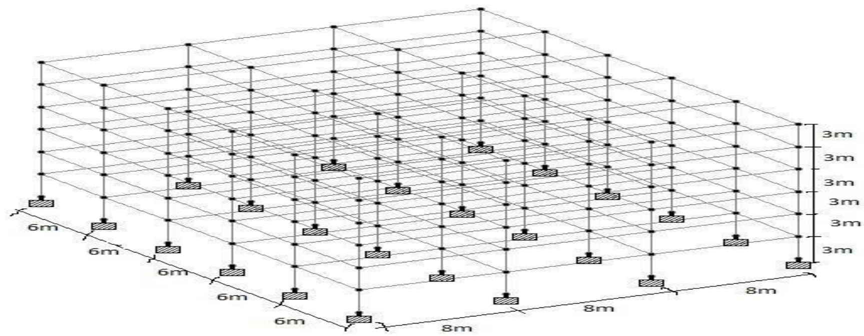
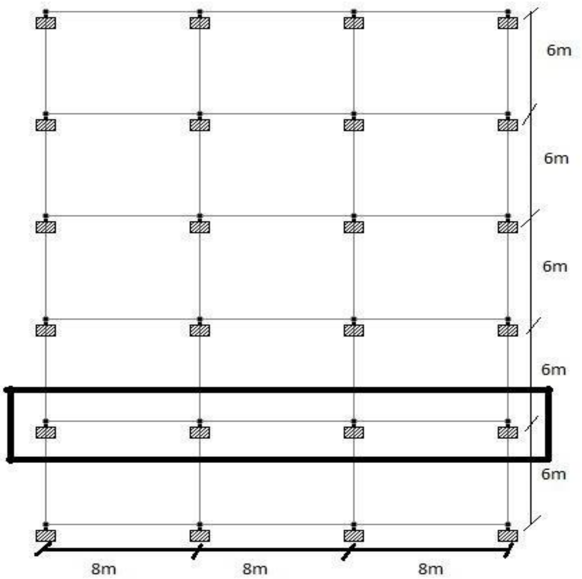


Fig: 3-Dimensional view of the Steel Building Frame



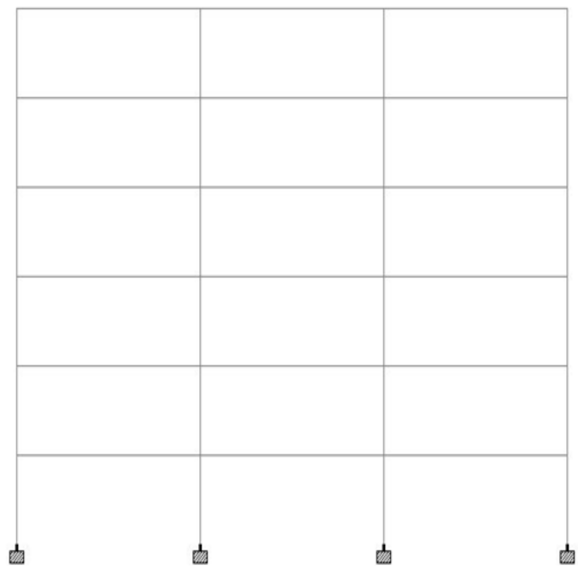


Fig: Plan of the Building Frame

Fig: Elevation of the Building Frame

Performance Analysis:

Analysis is done by using Lateral Force Method & Response Spectrum Analysis for a selected problem statement and results are carried out.

Table: Analysis by Lateral Force Method

Storey no.	Absolute displacement ofstorey D_i (m)	Design inter storey drift D_r(m)	Storey lateral force V_{tot} (KN)	Shear at storeyP_{tot} (KN)
1	0.003869	0.003869	1.969	179.201
2	0.012595	0.008726	7.951	177.232

3	0.023837	0.011242	17.83	169.281
4	0.035892	0.012055	31.657	151.451
5	0.047566	0.011674	49.212	119.794
6	0.058123	0.010557	70.582	70.582

Table: Analysis by Response Spectrum Method

Storey no.	Absolute displacement of storey D_i (m)	Design inter storey drift D_r (m)	Storey lateral force V_{tot} (KN)	Shear at storey P_{tot} (KN)
1	0.00491	0.00491	1.877	120.981
2	0.0115	0.0066	6.112	119.104
3	0.0161	0.0046	10.651	112.992
4	0.0196	0.0035	17.331	102.341
5	0.0219	0.0023	29.98	85.01
6	0.0234	0.0015	55.03	55.03

IV. Result & Conclusion:

The P-Δ effect refers to the additional moment produced by the vertical loads and the lateraldeflection of the column or other elements of the building resting lateral forces.

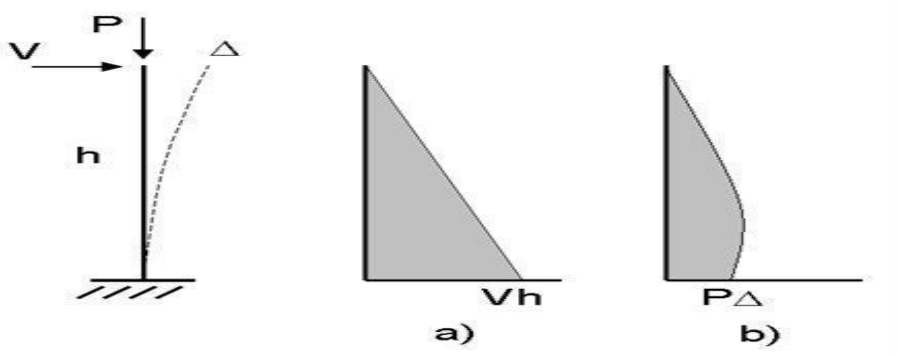


Fig: P-Δ effect

Table: Correction for P-Δ effect (Lateral Force Method)

Storey no:	Absolute displacement of the storey D_i (m)	Design inter storeydrift D_r(m)	Storey lateral forces	Shear at storey V_{tot}(KN)	Total cumulative gravity load at storey P_{tot}(KN)	Storey height: H_i(m)	Inter storey drift sensitivity coefficient:(θ)
1	0.003869	0.003869	1.969	179.201	7344	3	0.05285
2	0.012595	0.008726	7.951	177.232	6120	3	**0.10043***
3	0.023837	0.011242	17.83	169.281	4896	3	**0.10838***
4	0.035892	0.012055	31.657	151.451	3672	3	0.09742
5	0.047566	0.011674	49.212	119.794	2448	3	0.07951
6	0.058123	0.010557	70.582	70.582	1224	3	0.06102

Table: Correction for P-Δ effect, (Response Spectrum Analysis)

Storey no:	Absolute displacement of the storey D_i (m)	Design inter storeydrift D_r(m)	Storey lateral forces	Shear at storey V_{tot}(KN)	Total cumulative gravity load at storey P_{tot} (KN)	Storey height: H_i(m)	Inter storey drift sensitivity coefficient:(θ)
1	0.00491	0.00491	1.877	120.981	7344	3	0.09935
2	0.0115	0.0066	6.112	119.104	6120	3	**0.11304***
3	0.0161	0.0046	10.651	112.992	4896	3	0.06644
4	0.0196	0.0035	17.331	102.341	3672	3	0.04186
5	0.0219	0.0023	29.98	85.01	2448	3	0.02207
6	0.0234	0.0015	55.03	55.03	1224	3	0.01112

Results of Lateral Force Method: Maximum bending moment, shear force etc. are obtained for load combination 1.7(EQ+DL)

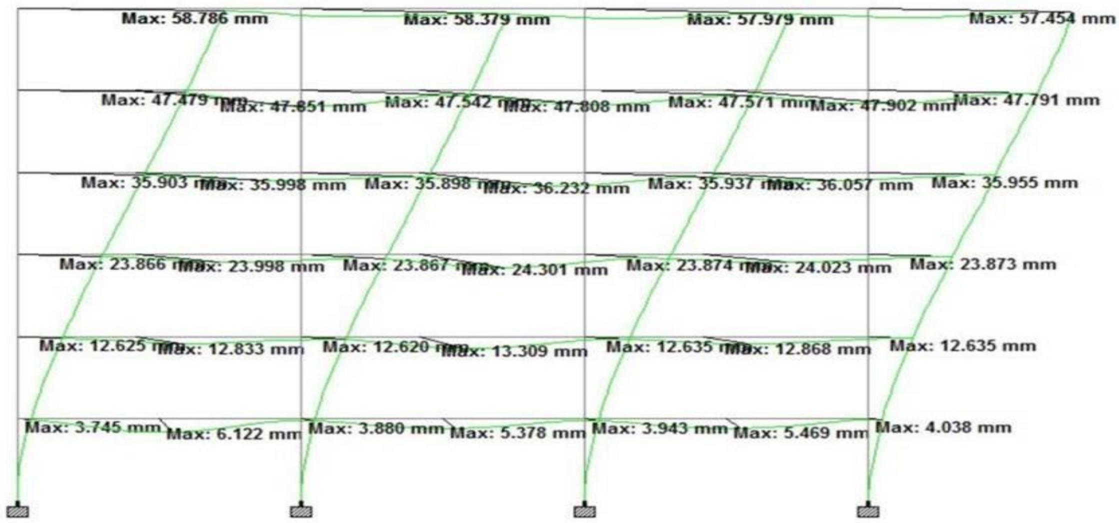


Fig. Displacement Diagram for Load Combination 1.7(EQ+DL)

Results of Response Spectrum Analysis: Maximum bending moment, shear force etc. are obtained for load combination 1.3(DL+LL+EQ)

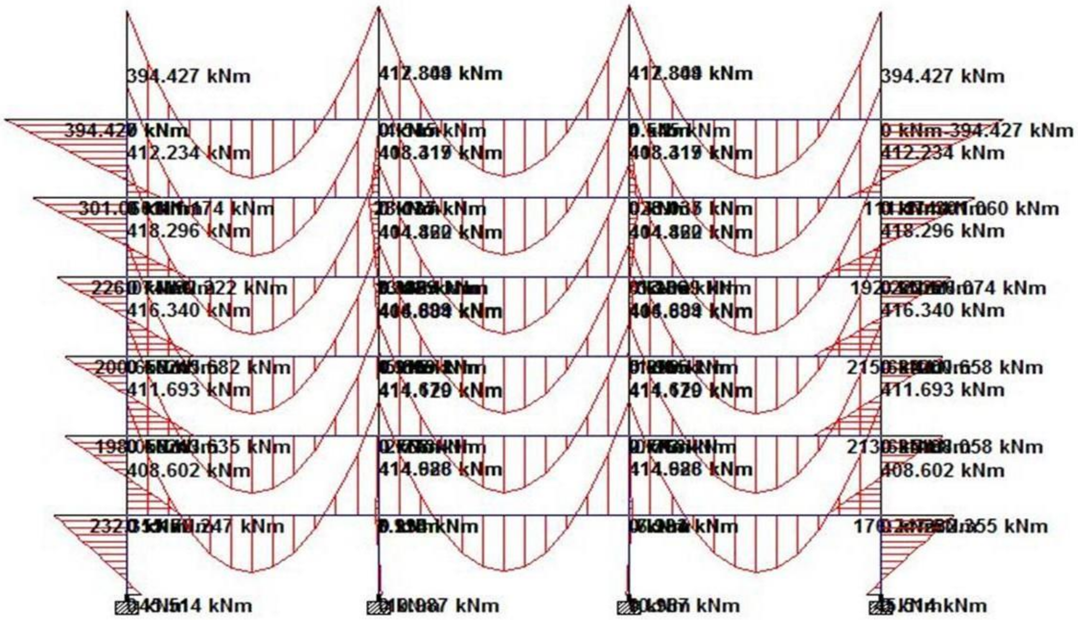


Fig. Bending Moment Diagram for Load Combination 1.3(DL+LL+EQ)

V. Conclusion:

1. As an Inter storey drift result was found that the displacements of response spectrum method were less than that of lateral force method.
2. Storey shear found by response spectrum method is less than that found by lateral force method.
3. The amount of steel required for seismic design by using lateral force method is found to be 19.73% less than that by using response spectrum analysis.
4. Because of the heavier sections used in response spectrum method the absolute displacement, storey drift are less than lateral force method.
5. The values of resultant base shear in lateral force method is 49.33 % more than that of response spectrum method.

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