SEISMIC DESIGN OF MULTISTORIED AND MULTI BAY STEEL BUILDING FRAME

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Abstract :- Steel is one of the world's most extensively used building materials. Steel is an ideal choice for earthquake design due to its inherent strength, hardness, and ductility. To take advantage of these benefits in seismic applications, the design engineer must be familiar with the relevant steel design provisions as well as the purpose represented in the codes.

The building structure for this project was designed according to IS 1893-2002 and IS 800. The purpose of this study is to explore and develop an earthquake-resistant multistory and multibay (G+5) building frame using IS 1893 and IS 800:2007. The building stands six floors tall, with three horizontal bays and five lateral bays. The random piece selection was done in a systematic manner. The equivalent static load approach and the Response Spectrum method were both used in the investigation.

INTRODUCTION :-

Seismic analysis is a subset of structural analysis that involves estimating a building's seismic response. In earthquake-prone areas, it's part of the structural design, earthquake engineering, or structural evaluation and retrofit process.

The most powerful earthquakes strike near the boundaries of the world's major tectonic plates. These plates have a natural tendency to move relative to one another, but friction prevents them from doing so until the stresses between plates under the epicenter point grow so great that they suddenly shift. There has been an earthquake. The local shock causes ground waves to travel throughout the earth's surface, causing movement at the foundations of structures. Waves become less important as you get further away from the core.

As a result, depending on their proximity to the main tectonic plate borders, there are regions of the world with a higher or lower seismic risk. Because of their ductility, steel structures are good at resisting earthquakes. Steel structures that have been subjected to earthquakes have shown to perform well. Structures composed of different materials are generally associated with global collapses and large numbers of victims.

Because element failure is not ductile, a structure constructed to the first choice will be heavier and may not provide a safety margin to cover earthquake actions that are higher than planned. The global behavior of the structure in this scenario is "brittle," which corresponds to concept a) in a Base Shear V- Top Displacement diagram. In the second option, certain areas of the structure are built to withstand cyclic plastic deformations without failure, and the structure as a whole is designed so that only those selected zones will be plastically

LOAD PARAMETERS:

Load Calculation The dead load is set to = 5KN/m^2 while the live load is set to 3 KN/m^2

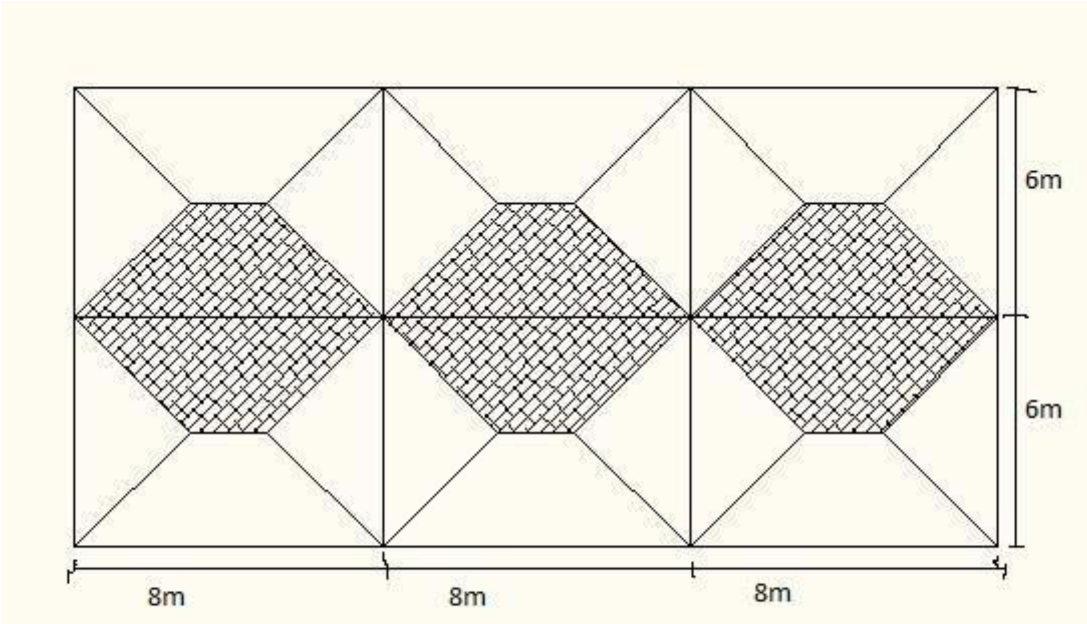

Fig: Load distribution diagram

METHODOLOGY:

The preliminary design of the building frame is the first phase. The technique entails the choosing of sections of frame members. Because the dynamic action effects are a function of member stiffness, a lot of iteration is unavoidable.

Moment resistant frames (MRF) provide earthquake resistance in both the x and y directions in the building under consideration here. MRFs (moment resistant frames) are a type of flexible structure. As a result, they are frequently designed to meet deformation standards under service earthquake loading or to limit P-effects under design earthquake loading. Because of this, stiff connections are preferable.

The steps in the preliminary design are as follows:

1. Beam Sections Selection
2. Checking the "weak beam strong column criteria" when defining column sections.
3. Check for buckling or compression at ground level under gravity loading.
4. Seismic mass calculation
5. A static analysis of a single plane structure subjected to lateral loads.
6. Gravity loading static analysis.
7. In a seismic loading situation, check for stability using P-effects (parameter).

1. LATERAL FORCE METHOD:-

The seismic load on each floor is calculated at full dead load and imposed load. Any level's column and wall weight should be evenly distributed between floors above and below it. Large percentages of service load are predicted to be present in buildings built for storage at the time of the earthquake. The imposed weight on the roof is not taken into account.

The equivalent static technique, which accounts for the dynamics of the buildings in an approximate manner, is used to calculate the design seismic base shear.

The following assumptions are made by the identical static method technique.

- The fundamental mode of construction contributes the most to base shear.
- The whole building mass is compared to the modal mass used in the dynamic technique, and. Both of these assumptions apply to typical low and medium-rise structures.

Table: Analysis by lateral force 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	0.003869	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

2. RESPONSE SPECTRUM ANALYSIS:-

This is one of the most used ways to seismic analysis. A design spectrum diagram is used to achieve this. To idealize a multi-story shear structure, the response spectrum technique employs a basic assumption. The mass is gathered at the roof diaphragm and floor levels, according to the assumption. The diaphragms are endlessly stiff, and the column is axially rigid but laterally flexible. The dynamic response of the spectrum is represented as lateral displacements of the lumped mass, because the number of masses matches the number of degrees of dynamic freedom (or modes of vibration n).

The deflected form is just a mixture of all mode shapes that can be generated by superposition of the vibrations of each individual lumped mass if the ground motion is provided at the base of the multi mass system. The dynamic response of a multi-degree-of-freedom system is determined using a modal analysis approach. Modal analysis, which is detailed in this article, is recommended by IS 1893.

Each vibration mode has its own vibration period (and its unique shape, which is generated by the locus of points of the deflected masses).

Table: Analysis by response spectrum method.

No. Storey	Absolute displacement of storey D_i (m)	Design inter storey drift D_r (m)	Storey lateral force V_{tot} (KN)	ear 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

RESULTS OF LATERAL FORCE METHOD:

The maximum bending moment, shear force, and other parameters were determined for the load combination 1.7(EQ+DL).

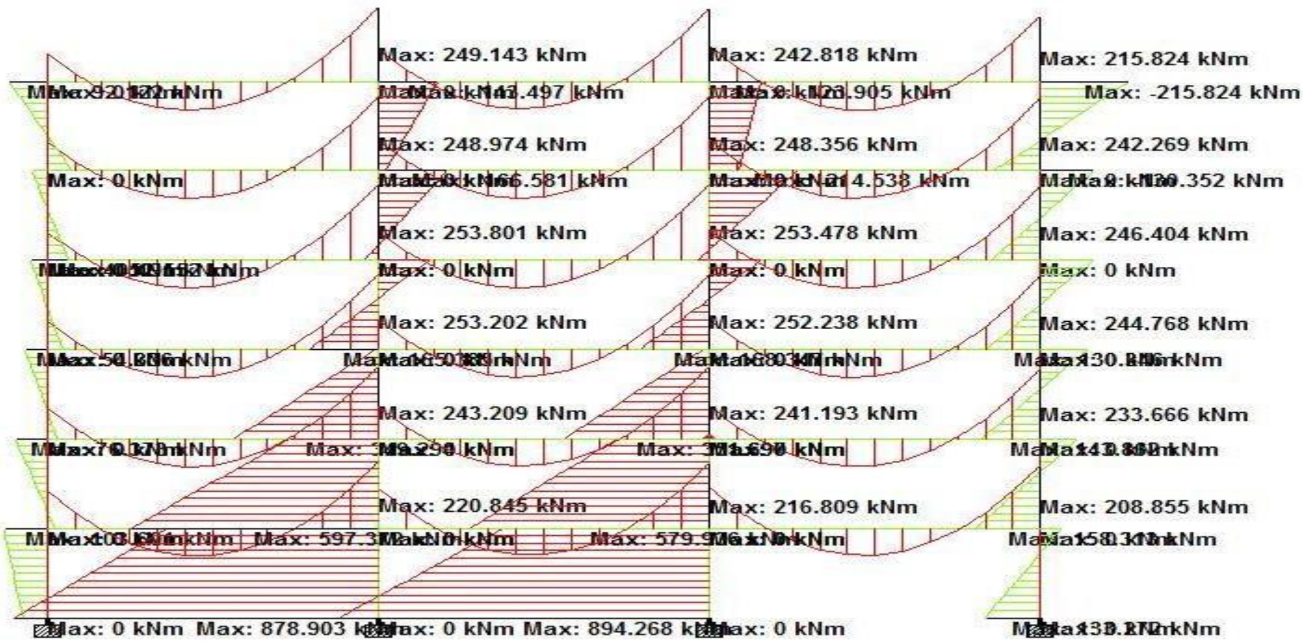

FIG Bending moment diagram for load combination 1.7(EQ+DL)

RESULTS OF RESPONSE SPECTRUM ANALYSIS:

The maximum bending moment, shear force, and other parameters are calculated for the load combination 1.3(DL+LL+EQ).

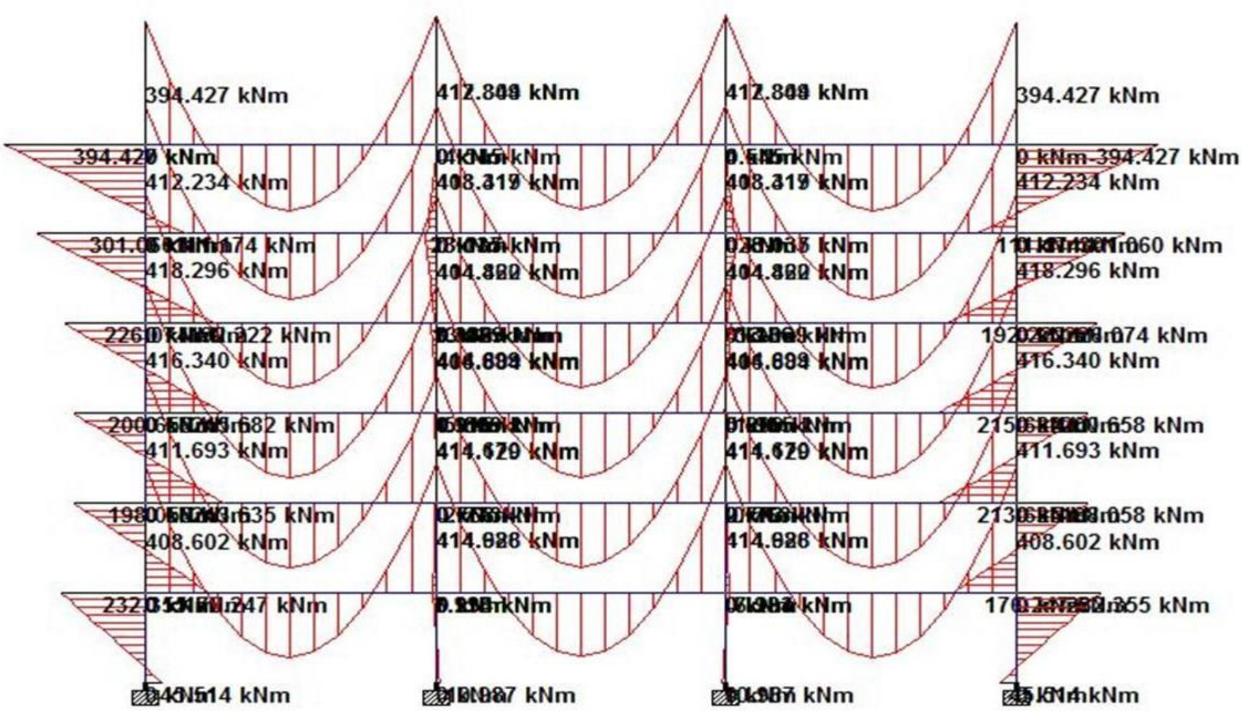

Fig (6.3) Bending moment diagram for load combination 1.3(DL+LL+EQ)

CONCLUSION:-

1. Inter-storey drift was determined using the lateral force method and the response spectrum method, with the response spectrum method yielding smaller displacements than the lateral force method.
2. The response spectrum method finds less Storey shear than the lateral force method.
3. The lateral force method's assumptions are to blame for the disparity in results between the response spectrum and lateral force methods. They are:
4. a. The fundamental mode of the construction has the most impact on the base shear.
5. b. The total mass of the building is compared to the modal mass employed in the dynamic method. Both assumptions are correct for normal low and medium rise buildings.
6. As seen in the above data, the values obtained by dynamic analysis are lower than those produced through the lateral force approach. This is because the dynamic analysis initial mode period of 0.62803 is longer than the projected 0.33 s of the lateral force approach.
7. The first modal mass accounts for 85.33 percent of overall seismic mass, according to the research. The time period is 0.19s, and the second modal mass is 8.13 percent of the overall seismic mass m.

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