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Parametric Study of Seismic Effect on R.C.C. Structure Considering With and Withoutstaircase Model at Multiple Location

chandrashekhar bhiwaji gawalkar, Sanjay Bhadke,
Department of Civil Engineering Tulsiramji Gaikwad-Patil College of Engineering and Technology Nagpur 441108
Asst. Professor in Department of Civil Engineering. Tulsiramji Gaikwad-Patil College of Engineering and Technology

Abstract— *Analysis, design and modelling of the structure constitute the three major activities in structural engineering practices. Generally structural analysis and design are coupled processes. The structural frame of a building consists of floor and roof slab, and supporting beams ,columns and foundation. All the components of the frame are usually cast together forming a monolithic construction. The resulting frame acts as one integral unit. The rigidity of the connection is also desirable or rather essential for resisting horizontal loads like wind load or earthquake load. While designing the model of building we can calculate the analytical result and from that result we accordingly design different component of building. These are foundation, column, slab, RCC wall, water tank, staircase etc..*
Keywords*—Seismic load, stresses, shear force, high rise building, staad Pro, bending moment, deflection*

I. Introduction

Analysis, design and modeling of the structure constitute the three major activities in structural engineering practices. Generally structural analysis and design are coupled processes. The structural frame of a building consists of floor and roof slab, and supporting beams ,columns and foundation. All the components of the frame are usually cast together forming a monolithic construction. The resulting frame acts as one integral unit. The rigidity of the connection is also desirable or rather essential for resisting horizontal loads like wind load or earthquake load. While designing the model of building we can calculate the analytical result and from that result we accordingly design different component of building. These are foundation, column, slab, RCC wall, water tank, staircase etc. [7]. Out of this staircase generally not modeled Stair use is essential component of any building the purpose of which is to allow the flow of traffic to be accommodated between floor levels within the building. Due to the complex modeling of the staircase, it is designed separately for non-seismic and seismic forces. Building design is the process of providing all information necessary for construction of a building that will meet its owner's requirements and also satisfy public health, welfare, and safety requirements.

II. Methodology

Terminology for Earthquake Engineering:

a. Critical Damping:
The damping beyond which the free vibration motion will not be oscillatory.

b. Damping
The effect of internal friction, imperfectly elasticity of material, slipping, sliding etc. in reducing the amplitude of vibration and is expressed as a percentage of critical damping.

c. Design Acceleration Spectrum:
Design acceleration spectrum refers to an average smoothened plot of maximum acceleration as a function of frequency or time period of vibration for a specified damping ratio for earthquake excitations at the base of a single degree of freedom system.

d. Design Horizontal Acceleration Coefficient:
It is the horizontal acceleration coefficient that shall be used for design of structure.

e. Design Lateral Force:
It is a horizontal seismic force prescribed by this standard, which shall be used to design of structure.

f. Floor Response Spectra

A floor response spectrum is the response spectra for a time history motion of a floor. This floor motion time history is obtained by an analysis of multi-storey building for appropriate material damping values subjected to a specified earthquake motion at the base of structure.

g. Importance Factor (I)

It is a factor used to obtain the design seismic force depending on the functional use of the structure, characterized by hazardous consequences of its failure, its post-earthquake functional need, historic value, or economic importance.

h. Response Reduction Factor (R)

It is the factor by which the actual base shear force that would be generated if the structure were to remain elastic during its response to the Design Basis Earthquake (DBE) shaking, shall be reduced to obtain the design lateral force.

i. Response Spectrum

The representation of the maximum response of idealized single degree freedom systems having certain period and damping, during earthquake ground motion. The maximum response is plotted against the un-damped natural period and for various damping values, and can be expressed in terms of maximum absolute acceleration, maximum relative velocity, or maximum relative displacement.

j. Seismic Mass

It is the seismic weight divided by acceleration due to gravity.

k. Seismic Weight (W)

It is the total dead load plus appropriate amount of specified imposed load

l. Structural Response Factors (Sa/g)

It is a factor denoting the acceleration response spectrum of the structure subjected to earthquake ground vibrations, and depends on natural period of vibration and damping of the structure.

m. Zone Factor (Z)

It is a factor to obtain the design spectrum depending on the perceived maximum seismic risk characterized by maximum Considered Earthquake (M.C.E) in the zone in which the structure is located. The basic zone factors included in this standard are reasonable estimate of effective peak ground acceleration.

n. Zero Period Acceleration (ZPA)

It is the value of acceleration response spectrum for period below 0.03 s (frequencies above 33 Hz).

3.2 TERMINOLOGY FOR EARTHQUAKE ENGINEERING OF BUILDINGS

a. Base

It is the level at which inertia forces generated in the structure are transferred to the foundation, which then transfers these forces to the ground.

b. Base Dimensions (d)

Base dimension of the building along a direction is the dimension at its base, in meter, along that direction.

c. Centre of Mass

The point through which the resultant of the masses of a system acts. This point corresponds to the centre of gravity of masses of system.

d. Centre of Stiffness

The point through which the resultant of the restoring forces of a system acts.

e. Design Eccentricity

It is the value of eccentricity to be used at floor in torsion calculation for design.

f. Design Seismic Base Shear

It is the total design lateral force at the base of a structure.

g. Diaphragm

It is a horizontal or nearly horizontal system, which transmits lateral forces to the vertical resisting elements, for example, reinforced concrete floors and horizontal bracing systems.

h. Height of Floor (hi)

It is the difference in levels between the base of the building and that of floor

i. Lateral Force Resisting Element
It is part of the structural system assigned to resist lateral forces.
j. Moment-Resisting Frame
It is a frame in which members and joints are capable of resisting forces primarily by flexure.
I. Ordinary Moment-Resisting Frame
It is a moment-resisting frame not meeting special detailing requirements for ductile behaviour.
k. Special Moment-Resisting Frame
It is a moment-resisting frame specially detailed to provide ductile behaviour and comply with the requirements given in IS 4326 or IS 13920 or SP6.
Method Used for Analysis :
Seismic analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent.

- **Equivalent Static Analysis**

The equivalent static analysis procedure is essentially an elastic design technique. It is, however, simple to apply than the multi-model response method, with the absolute simplifying assumptions being arguably more consistent with other assumptions absolute elsewhere in the design procedure.
The equivalent static analysis procedure consists of the following steps:
1. Estimate the first mode response period of the building from the design response spectra.
2. Use the specific design response spectra to determine that the lateral base shear of the complete building is consistent with the level of post-elastic (ductility) response assumed.
3. Distribute the base shear between the various lumped mass levels usually based on an inverted triangular shear distribution of 90% of the base shear commonly, with 10% of the base shear being imposed at the top level to allow for higher mode effects.
The natural Period of the building is calculated by the expression "T" given in IS 1893:2002 where are h is the height and d is the base dimension of the building in the considered direction of vibration. Does the natural periods for all the models in this method is the same the lateral load calculation and its distribution around the height are done as per IS: 1893-1984 the seismic weight is calculated using full dead load + 50% of live load.

III. Conclusion

From the study made and the results presented in the previous section, the following important conclusions have been drawn within the preview of the building considered.

- The presences of staircase tremendously influence the peak value of result obtained by equivalent static method for columns around staircase.
- It has been observed that when we compared all structural model under consideration, in case of model AX3 (G+5)& AX6 (G+10), as staircase is along shorter direction the shorter span will divide in two parts. Hence the values for drift, displacement, and time period is observed to be lesser as compared to other models .Hence it is better to provide stair case in shorter direction (Y-direction) for the model.
- In with stair model it is observed that, columns supporting landing beam have been found to be max axial force. The lateral moment in such columns in landing beam increases enormously, the failure of beam is resolved by not providing the area of steel at negative moment locations and by increasing the depth of beam.
- In absence of staircase in model it is observed that, the force drift, displacement & time period increases due to absence of inclined slab, it is necessary to considering the inclined behaviour of staircase during modelling.
- Because of the mid landing the column under the staircase will be act like a short column, as the short column gone through tremendous stresses and forces the beam connecting the short column is failed in the results obtained from ETAB 15. Hence the redesigning of the section is required.
- If building and there components are not design properly by considering diagonal effect of staircases, it may get fail under major earthquakes.

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