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Dynamic Analysis of H - Shape Multistorey Building By Using Response Spectrum Method In Staad Pro V8i

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ABSTRACT

Structural Engineers are facing the challenge of striving for the most efficient and economical design with accuracy in solution while ensuring that the final design of a building must be serviceable for its intended function over its design life - time. This project presents G +15 storey RCC framed building analyzed and designed under the lateral loading effect of earthquake using STAAD PRO V8i. Because of the facilities provided in this software at the modeling stage, the buildings can be modeled as per the arrangement of the members of the project in Practical, and this software considers the beams, columns walls are as area members. Taking the horizontal loading effects of Seismic forces; In the design of this project, I take dynamic loading along with the Dead load and Live loads as per IS Code; And almost all the members of the project can be analyzed and designed as per Indian code using this software.

Keywords - *Multi-storey Building, Non-linear Analysis, Base Shear, Displacements, Story Drift, STAAD Pro V8i*

1. INTRODUCTION:-

Structural analysis is mainly concerned with finding out the behavior of a structure when subjected to some action. This action can be in the form of load due to weight of things such as people, furniture, snow etc. or some other kind of excitation such as earthquake, shaking of the ground due to a blast nearby etc. In essence all these loads are dynamic including the self-weight of the structure because at some point in time these loads were not there. The distinction is made between the dynamic and static analysis on the basis of whether the applied action has enough acceleration in comparison to the structure's natural frequency. If a load is applied sufficiently slowly, the inertia forces (Newton's second law of motion) can be ignored and the analysis can be simplified as static analysis. Structural dynamics, therefore, is a type of structural analysis which covers the behavior of structures subjected to dynamic (actions having high acceleration) loading. Dynamic loads include people, wind, waves, traffic, earthquake and blasts. Any structure can be subjected to dynamic loading. Dynamic analysis can be used to find dynamic displacements, time history, and modal analysis.

Reinforced concrete multi-storied buildings in India were for the first time subjected to a strong ground motion shaking in Bhuj earthquake. It has been concluded that the principal reasons of failure may be attributed to soft stories, floating columns, mass irregularities, poor quality of construction materials and faulty construction practices, inconsistent earthquake response, soil and foundation, effect of pounding of adjacent structures. All over world, there is high demand for construction of tall buildings due to increasing urbanization and spiraling population, and earthquakes have the potential for causing the greatest damages to tall structures. Since earthquake forces are random in nature and unpredictable, the engineering tools need to be sharpened for analyzing structures under the action of these forces.

The earthquake ranks as one of the most destructive events recorded so far in India in terms of death toll & damage to infrastructure. The major cities affected by the earthquake are Bhuj, Gandhidham, and Rajkot etc. Every earthquake leaves a trail of misery because of the loss of life and destruction.

Structural response to earthquakes is a dynamic phenomenon that depends on dynamic characteristics of structures and the intensity, duration, and frequency content of the exciting ground motion. Although the seismic action is dynamic in nature, building codes often recommend equivalent static load analysis for design of earthquake-resistant buildings due to its simplicity. This is done by focusing on the predominant first mode response and developing equivalent Static forces that produce the corresponding mode shape, with some empirical adjustments for higher mode effects. The use of static load analysis in establishing seismic design Quantities is justified because of the complexities and difficulties associated with dynamic analysis. Dynamic analysis becomes even more complex and questionable when nonlinearity in materials and geometry is considered.

2. LITERATURE REVIEW

Mayuri D. Bhagwat et.al studied dynamic analysis of G+12 multi-storeyed practiced RCC building considering for Koyna and Bhuj earthquake is carried out. The time history analysis and response spectrum analysis and seismic responses of such building are comparatively studied. The modelled with the help of ETABS software is made. Two time histories (i.e. Koyna and Bhuj) have been used to develop different acceptable criteria (base shear, storey displacement, storey drifts).

In the study of **Mohit Sharma et.al** he take (G+30) storied regular building for analysis. The buildings have the plan area of 25m x 45m, storey height 3.6m each, depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis is carried out on computer with the help of STAAD-Pro software using the parameters for the design as per the IS-1893- 2002-Part-1 for the zones- 2 and 3.

A.R. Chandrasekaran and D. S. Prakash Rao some of the poor planning and construction practices of multi-storeyed buildings in Peninsular India in particular, which lead to irregularities in plan and elevation of the buildings are discussed in this paper. The large scale collapse of reinforced concrete multi-storeyed buildings (RCMS) in Gujarat (January 2001) could have been avoided by suitable planning, and good constructional practices. Inadequate detailing of columns, seismically unfavourable layouts and weak story at the ground floor appear to be the primary causes of the structural damage and collapses; ignorance of structural behaviour and noncompliance with building regulations may be the contributory causes.

Mohammed Yusuf, P.M. shimpale (2013) This paper aims towards the dynamic analysis of reinforced concrete building with plan irregularity. Four models of G+5 building with one symmetric plan and remaining irregular plan have been taken for the investigation. The analysis of R.C.C. building is carried out with the FE based software ETABS 9.5.

Pralobh S. Gaikwad and Kanhaiya K. Tulani (2015) The paper aims towards the dynamic analysis of RCC and Steel building with unsymmetrical configuration. For the analysis purpose models of G +9 stories of RCC and Steel with unsymmetrical floor plan is consider. The analysis is by carried by using F.E based software E TABS. Various parameters such as lateral force, base shear, story drift, story shear can be determined .For dynamic analysis time history method or response spectra method is used. .If the RCC and Steel building are unsymmetrical, torsional effect will be produce in both the building and thus are compared with each other to determine the efficient building under the effect of torsion.

A.M. Mwafy, A.S. Elnashai In this paper, the applicability and accuracy of inelastic static pushover analysis in predicting the seismic response of RC buildings are investigated. The dynamic pushover' idealised envelopes are obtained from incremental dynamic collapse analysis. This is undertaken using natural and artificial earthquake records imposed on 12 RC buildings of different characteristics. The results of over one hundred inelastic dynamic analyses using a detailed 2D modelling approach for each of the twelve RC buildings have been utilised to develop the dynamic pushover envelopes and compare these with the static pushover results with different load patterns.

P. Mendis Bhagwat et.al has investigated that the paper provides an outline of advanced levels of wind design in the context of the Australian Wind Code and also explain the exceptional benefits it offers over simplified approaches. Wind tunnel testing, which has the potential benefits of further refinement in deriving design wind loading and its effects on tall buildings is also emphasized. He the conclusion is made on various key factors with the design of tall buildings to the effects of wind loading. The general design requirements for structural strength and serviceability are assume particular importance in the case of tall building design as significant dynamic response can result from both buffeting and cross-wind loading excitation mechanisms.

3. OBJECTIVE OF THE STUDY:

Main objectives of the thesis are to perform Dynamic analysis and to obtain Seismic performances of different shape of structures located in severe earthquake zone (V) of India and to evaluate lateral forces, overturning moment, deflections and storey drift.

4. METHODOLOGY:

The method of analysis used for the present study are-

A. Equivalent static force analysis

B. Response spectrum method

A. **Equivalent static force analysis:** The equivalent static force analysis for an earthquake is an exceptional concept which is used in earthquake resistant design of structure. This concept is useful since it converts a dynamic analysis into a partly static & dynamic analysis to evaluate the maximum displacements produced in the structure because of earthquake due to ground motion. For earthquake resistant design of structures, only these maximum displacements are of interest, but not the time history of stresses. Equivalent lateral force for an earthquake is defined as a set of static lateral forces which produces the similar peak responses of the structure as that have been produced in the dynamic analysis of the building under the similar ground motion. This concept has drawback since it uses only a single mode of vibration of the structure.

B. **Response spectrum method:** In this concept the multiple modes of vibration of a structure can be used. This analysis can be used in many building codes for all except for simple or complex structures. The vibration of a building is defined as the combination of many special modes that are in a vibrating string corresponding to the "harmonics". Computer aided structural analysis is used to determine these mode shapes for the structure. For every mode shape, from design spectrum responses are studied, with the help of parameters such as modal participation mass and modal frequency and then they are combined to provide an evaluation of the total responses of the structure

FIGURE- TOP PLAN OF H SHAPE BUILDING

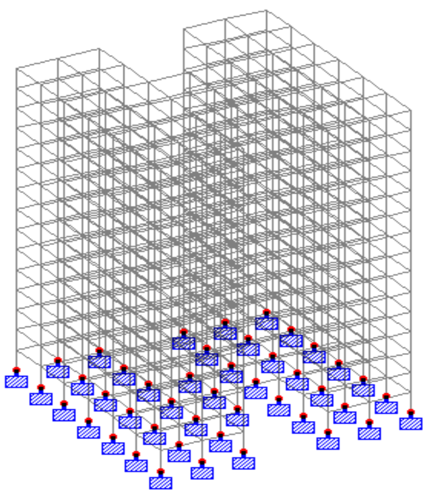
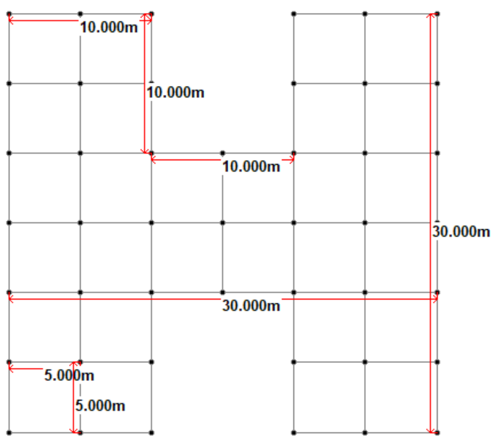


FIGURE- H SHAPE 3D BUILDING WITH FIXED SUPPORT



C. THE PROCEDURES FOR THE EARTHQUAKE ANALYSIS OF THE STRUCTURES:

- Linear Static Procedure
- Linear dynamic Procedure
- Response Spectrum method
- Time history method
- Nonlinear Static Procedure (Pushover analysis)
- Nonlinear dynamic procedure

As per IS-1893:2002, Methods Adopted are:

- Equivalent Static Lateral Force (or) Seismic Coefficient Method
- Response Spectrum Method
- Time history method

D. LINEAR STATIC PROCEDURE: The linear static procedure of building is modelled with their linearly elastic stiffness of the building. The equivalent viscous damps the approximate values for the lateral loads to near the yield point. Design earthquake demands for the LSP are represented by static lateral forces whose sum is equal to the pseudo lateral load. When it is applied to the linearly elastic model of the building it will result in design displacement amplitudes approximating maximum displacements that are expected during the design earthquake. To design the earth quake loads to calculate the internal forces will be reasonable approximate of expected during to design earth quake. C. RESPONSE SPECTRUM METHOD: I. The representation of the maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. The maximum response plotted against of undamped natural period and for various damping values and can be expressed in terms of maximum absolute acceleration, maximum relative velocity or maximum relative displacement. For this purpose response spectrum case of analysis have been performed according to IS 1893.

E. Effect of Drift on the Structure: In terms of seismic design, lateral deflection and drift can affect both the structural elements that are part of the lateral force resisting system and structural elements that are not part of the lateral force resisting system. In terms of the lateral force resisting system, when the lateral forces are placed on the structure, the structure responds and moves due to those forces. Consequently, there is a relationship between the lateral force resisting system and its movement under lateral loads; this relationship can be analyzed by hand or by computer. Using the results of this analysis, estimates of other design criteria, such as rotations of joints in eccentric braced frames and rotations of joints in special moment resisting frames can be obtained. Similarly, the lateral analysis can also be used and should be used to estimate the effect of lateral movements on structural elements that are not part of the lateral force resisting system, such as beams and columns that are not explicitly considered as being part of the lateral force resisting system. Design provisions for moment frame and eccentric braced frame structures have requirements to ensure the ability of the structure to sustain inelastic rotations resulting from deformation and drift. Without proper consideration of the expected movement of the structure, the lateral force resisting system might experience premature failure and a corresponding loss of strength. In addition, if the lateral deflections of any structure become too large, P-Δ effects can cause instability of the structure and potentially result in collapse.

F. Seismic weight of building: The seismic weight of the building means that is calculated on the entire floors weight of the building Fundamental Natural period as per IS 1893(part1):2002

The approximate fundamental natural period of vibration (Ta) in seconds,

$$\mathbf{Ta = 0.09h/\sqrt{d}}$$

Where h = height of building
d = Base dimensions of the building at the plinth level in m, along the considered direction of lateral force

In X- direction
Ta = 0.09 x 45/√30 = 0.74 sec.
Similarly in Z- direction
Ta = 0.09 x45/√30 = 0.74 sec.

G. Design Seismic Base Shear: The total design lateral force or design seismic base shear (Vb) along any principal direction shall be determined by the following expression

$$\mathbf{Vb = Ah \times W}$$

Where Ah = Design horizontal acceleration spectrum value as per clause 6.4.2 IS 1893(part1):2002 using the fundamental natural period Ta as per clause 7.6 IS 1893 (part 1):2002 in the consider direction of vibration W = Seismic weight of building Here

Ah = (Z/2) x (I/R) x (Sa/g)

Z = zone factor
I = Importance factor
Sa/g = is depending up on the Ta and type of soil

H. Load combination: In the limit state design of reinforced and prestressed concrete structures, the following load combinations shall be accounted for as per IS1893 (part1):2002

1. 1.5(DL+IL)
2. 1.2(DL+IL±EL)
3. 1.5(DL±EL)
4. 0.9DL±1.5EL

In staad we are using these following combinations

1. 1.5(DL+LL)
2. 1.2(DL +LL +ELx)
3. 1.2(DL+ LL -ELx)
4. 1.2(DL+ LL+ ELz)
5. 1.2(DL+LL- ELz)
6. 1.5(DL+ ELx)
7. 1.5(DL- ELx)
8. 1.5(DL+ ELz)
9. 1.5(DL - ELz)
10. 0.9DL + 1.5 ELx
11. 0.9DL - 1.5 ELx
12. 0.9DL + 1.5 ELz
13. 0.9DL - 1.5 ELz

I. Dynamic analysis should be carried by various methods. Here we are using response spectrum method, in which by using complete quadratic combination (CQC) method. This is done as per IS1893:2002 (part-I) considerations.

1. Eigen solution for mode shapes:

Further we design the beam and column for the structure as per IS 456:2000 considerations:

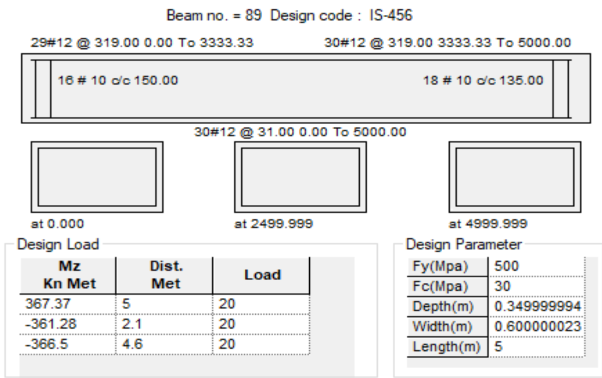


FIGURE – CONCRETE DESIGN OF H SHAPE BUILDING

5. CONCLUSION:

Base shear in irregular shape buildings are

CALCULATED FREQUENCIES FOR LOAD CASE 3

MODE	FREQUENCY(CYCLES/SEC)	PERIOD(SEC)
1	0.392	2.55265
2	0.394	2.53603
3	0.404	2.47654
4	0.655	1.52662
5	0.946	1.05696
6	1.186	0.84338

lower and higher in regular buildings.

From the dynamic analysis, mode shapes are generated and it is concluded that H shape building undergoes more deformation than rectangular building.

Irregular shape building undergoes more deformation and hence regular shape building must be preferred.

Response spectrum method allows a clear understanding of the contributions of different modes of vibration. It is also useful for approximate evaluation of seismic reliability of structures.

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