Comparative Study of Response Spectrum and Time History Analysis in Multistory Commercial Structures

Dr. Emily Watson
Department of Environmental Science, University of Sydney, Australia

ABSTRACT

A Research for high strength and better performance characterstics of floor and roof systems are designed to carry gravity loads and transfer these loads to supporting beams, columns or walls. furthermore, they play a key role in distributing earthquake-induced loads to the lateral load resisting systems by diaphragm action. when building structures are subjected to dynamic loadings, the induced inertial forces are transmitted through floor slabs and resisted by vertical structural components such as shear walls and frames. in this situation, the floor slabs function as diaphragms placed between the vertical components. in analysis and design of three dimensional structures under seismic loading, the diaphragms are frequently assumed to be perfectly rigid. in certain type of structures, however, this assumption is found to create significant discrepancy on the lateral load distribution.this discrepancy frequently occurs in frame-wall structures, in which the vertical components consist of shear walls with high storey stiffness and relatively flexible frames. therefore, in the present work analytical parametric studies are done on high rise structures with simple frame and plate frame structures.

Keywords*: Time History Analysis, Spectrum Responses, Multistoried Buildings, scaling.*

I. INTRODUCTION

Many urban multi storey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height.The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.

II. LITREATURE REVIEW

Maison and Ventura [16], (1991), Members of ASCE computed dynamic properties and response behaviours OF THIRTEEN-STORY BUILDING and this result are compared to the true values as determined from the recorded Acan predict the actual dynamic properties. **Arlekar, Jain &Murty**[2], (1997) said that such features were highly undesirable in buildings built in seismically active areas; this has been verified in numerous experiences of strong shaking during the past earthquakes. They highlighted the importance of explicitly recognizing the presence of the open first storey in the analysis of the building, involving stiffness balance of the open first storey and the storey above, were proposed to reduce the irregularity introduced by the open first storey**Awkar and Lui**[3], (1997) studied responses of multi-story flexibly connected frames subjected to earthquake excitations using a computer model. The model incorporates connection flexibility as well as geometrical and material nonlinearities in the analyses and concluded that the study indicates that connection flexibility tends to increase upper stories' inter-storey drifts but reduce base shears and base overturning moments for multi-story frames.

Greeshma and Jaya (2006) are investigation the proper · connection detailing of shear wall to the diaphragm. The shear wall and diaphragm connection with hook deflects more when compared to the other two configurations. Hence, the shear wall- diaphragm connection with hook was more efficient under dynamic lateral loA full time history will give the response of a structure over time during and after the application of a load. To find the full time history of a structure's response, you must solve the structure's equation of motion

III. OBJECTIVES

- To analyze the multi storied building with mass irregularity during response spectrum for safety of structure.
- Modeling and analyzing effect of mass irregularity for different stories location of multistoried commercial building.
- To analyze multistoried commercial building by using e tabs software as per IS 1893(Part 1):200211 and IS 456-200012 codes.
- Comparative study of structural parameters like base shear, storey drift, displacement of commercial building**.**

IV. METHODOLOGY

If the structure not properly designed and constructed with required quality they may cause large destruction of structures due to earthquakes. Response spectrum analysis is an useful technique for time history analysis of structure when the structure shows linear response.

ETABS is integrated software for analysis and design of structures. Using ETABS nonlinear time history analysis is performed on the proposed building. Models are prepared by using assumptions; input data is feed into the ETABS to analyse the structural parameters such as base shear, base moment, lateral displacement, storey drift, time period, bending moment and axial force. Advanced analytical techniques allow for step-by-step large deformation analysis, Eigen and Ritz analyses based on stiffness of nonlinear cases, Catenary cable analysis, material nonlinear analysis with fiber hinges, multi-layered nonlinear shell element, buckling analysis, progressive collapse analysis, energy methods for drift control, velocity-dependent dampers, base isolators, support plasticity and nonlinear segmental construction analysis. Nonlinear analyses can be static and/or time history, with options for FNA nonlinear time history dynamic analysis and direct integration.

ETABS is general-purpose civil-engineering software ideal for the analysis and design of any type of structural system. Basic and advanced systems, ranging from 2D to 3D, of simple geometry to complex, may be modelled, analysed, designed, and optimized using a practical and intuitive object-based modelling environment that simplifies and streamlines the engineering process. An additional suite of advanced analysis features are available to users engaging state-of-the-art practice with nonlinear and dynamic consideration.
Integrated modelling templates, code-based loading assignments, advanced analysis options, design-optimization procedures, and customizable output reports all coordinate across a powerful platform to make ETABS especially useful for practicing professionals

V. SEISMIC ANALYSIS

For the determination of seismic responses there is necessary to carry out seismic analysis of structure. The analysis can be performed on the basis of external action, the behaviour of structure or structural materials, and the type of structural model selected. Based on the type of external action and behaviour of structure, the analysis can be further classified as:

Linear static analysis
Linear static analysis or equivalent static method can be used for regular structure with limited height. Linear dynamic analysis can be performed by response spectrum method. The significant difference between linear static and linear dynamic analysis is the level of the forces and their distribution along the height of structure. Nonlinear static analysis is an improvement over linear static or dynamic analysis in the sense that it allows inelastic behaviour of structure. A nonlinear dynamic analysis is the only method to describe the

Non-linear static analysis
Non-linear static analysis is the method of seismic analysis in which behaviour of the structure is characterized by capacity curve that represents the relation between the base shear force and the displacement of the roof. It is also known as Pushover Analysis.

Linear Dynamic Analysis

Linear Dynamic Analysis Response spectrum method is the linear dynamic analysis method. In that method the peak response of structure during an earthquake is obtained directly from the earthquake response, but this is quite accurate for structural design applications.

Nonlinear Dynamic Analysis

Nonlinear Dynamic Analysis It is known as Time history analysis. It is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear.

VI. NON-LINEAR DYNAMIC ANALYSIS – TIME HISTORY ANALYSIS

Nonlinear dynamic analysis is most accurate method to determine the seismic responses of structures. In this method the structure is subjected to actual ground motion which is the representation of the ground acceleration versus time. The ground acceleration is determined at small time step to give the ground motion record. Then the structural response is calculated at every time instant to know its time history and the peak value of this time history is chosen to be design demand. Hence "A mathematical model directly incorporating the nonlinear characteristic of individual component and element of the building shall be subjected to earthquake shaking represented by ground motion time history to obtain forces and the displacement". Since numerical model directly accounts for the effect of material nonlinearity, inelastic responses and calculated internal forces will be reasonably approximate to those expected during the design earthquake. There are two methods by which the time history analysis is carried out a) Nonlinear Modal Time History Analysis b)Nonlinear Direct Integration Time History Analysis.

Non-linear Modal Time History Analysis

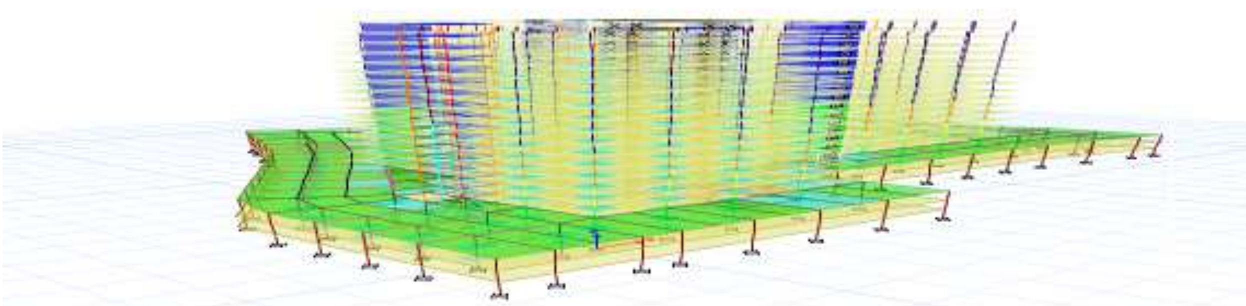
As mentioned earlier, from the fundamental of structural dynamics it is clear that the response of the MDOF system can be estimated from its modal responses. In this analysis, also called as Response history Analyses, the modal load vectors are determined for the predefined no of modes. For the selected mode, the static analysis of the structure is carried out to estimate its modal static responses, the structure being subjected to corresponding modal load vector. Then the dynamic analysis of the corresponding ESDOF system is carried out to get its spectral ordinates at every time step. This spectral ordinate at each time step is multiplied with the corresponding modal static response to get the actual Time history of that response for that modal quantity. The same procedure is carried out to other modes and corresponding modal response history is determined. These modal responses are then added at each time step to get the time history of the selected response for the design ground motion record.

Nonlinear Direct Integration Time History Analysis

The fundamental equation governing the response of MDOF system subjected to ground acceleration is given by ̈(t)
m ̈+ c ̇+ fs(u.sin ̇) = -mt ̈g(t) 32

The only unknown quantity in the above expression is the displacement vector u. In this method the above equation is formulated for the entire structure at every time step at which the ground acceleration is determined. This equation is then solved by any of the well-known methods to get directly the displacement at each time step. The other response quantity time history is then calculated from known displacement time history. The peak from the particular response time history is then selected as the design demand.

V. GEOMETRY OF THE STRUCTURE



VI. CONCLUSION

It is observed that the structure displaces maximum of 127.5mm for the load case EQy, because of unsymmetry of plan in Y direction, which is less than the permissible limit of 241.6mm (0.4% of building height). And the maximum story shear of magnitude 1795 tonf is observed in EQ x load case.

The seismic demand in the capacity spectrum method can be represented by inelastic spectra. In principle, any realistic inelastic spectra can be used. However, they should be compatible with the basic elastic spectrum. The speci"c demand spectra applied in this paper are simple and reasonably accurate for a broad range of design situations. It has been shown that the performance evaluation procedure, called the N2 method, can be formulated in the format of the capacity spectrum method. Furthermore, by reversing the procedure, a direct deformation-based design can be performed.

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