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A NOVEL AND COMPREHENSIVE ANALYSIS OF SHEAR BENDING AND TORSION IN SYMMETRICAL AND UNSYMMETRICAL MULTISTORY BUILDING

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Abstract-
Structural Unsymmetrical can be a major reason for the poor performance of buildings under severe seismic loading, Unsymmetrical contributes significantly for translational-torsional coupling in the seismic response which can lead to increased lateral deflections, increased member forces and ultimately collapse. In this paper the inelastic seismic behaviour of symmetric and asymmetric single & multi-storied buildings are studied. The effects of torsion on buildings are investigated. There is an increase in shear in columns and the rotation of columns need some special attention. Although seismic response of building asymmetric in the plan has been studied in the past in great detail, the contribution of the torsional resistance of the individual columns in total torsional response is not well understood. In order to study that, in the present work a multi storey structure (asymmetric plan) with three degrees of freedom is modelled in two ways, viz. Once with column replaced by springs and next with columns modelled is they are. In the latter case the torsional rotation of individual columns can be obtained while in the former case, it is not possible. Considerable difference between the two responses is observed.
Keywords — Symmetric & Asymmetric buildings, spring model, base shear, time history, spectral acceleration, spectral displacement, spectral velocity.

I. OVERVIEW

The structural design of a building should ensure that the building can stand safely, operate without excessive deformation or movement that could lead to fatigue of structural elements, cracks or failure of fixtures, fittings or partitions, or failure. Inconvenience to occupants. It must take into account the movements and forces due to temperature, creep, cracks, and imposed loads. It must also verify that the design is nearly buildable within acceptable manufacturing tolerances of the materials. It must allow the architecture to function and the building services to adapt to the building functionally (ventilation, lighting, etc).
This project work is to analyze a Multi storeyed building for different load combinations using STAAD Pro software [1].
Based on the analysis, the design of the structure is done mainly following IS specifications The requirements of a properly designed building structure are:
Good Structural Configuration: The size, shape and structural system taking loads are such that they ensure a direct and smooth flow of inertia forces to the ground.
Lateral Strength: The limit transverse force that it can resist is such that the damage induced in it does not result in collapse [2].

Adequate Stiffness: Its transverse load resisting system is such that the earthquake induced deformations in it do not damage its filling under low-to moderate shaking.

II. MULTI STOREY BUILDING

The design should be carried so as to conform to the following Indian code for reinforced concrete design, published by the Bureau of Indian Standards, New Delhi: Purpose of Codes - National building codes have been formulated in different countries to lay down guidelines for the design and construction of the structure [3-5]. The codes have evolved from the collective wisdom of expert structural engineers, gained over the years. These codes are periodically revised to bring them in line with current research, and often, current trends. Firstly, they ensure adequate structural safety, by specifying a certain essential minimum requirement for design. Secondly, they render the task of the designer relatively simple; often, the result of sophisticate analyses is made available in the form of a simple formula or chart. Thirdly, the codes ensure a measure of consistency among different designers. Finally, they have some legal validity in that they protect the structural designer from any liability due to structural failures that are caused by inadequate supervision and/or faulty material and construction [6-9].

A building should possess four main attributes, mainly having simple and regular configuration, adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry in plan as well as in elevation, suffer much less damage than the irregular configuration. A building shall be considered as irregular as per IS 1893-2002, if it lacks symmetry and has discontinuity in geometry, mass or load resisting elements. These irregularities may cause problem in continuity of force flow and stress concentrations. Structural analysis is mainly concerned with finding out the behavior of a structure when subjected to some action. The dynamic loads include wind, waves, traffic, earthquakes, and blasts. Any structure can be subjected to dynamic loading. Structural symmetry can be a major reason for buildings poor performance under severe seismic loading, Unsymmetrical contributes significantly to increased lateral deflections, increased member forces and ultimately the buildings collapse. This project is concerned with the study of seismic analysis and design of multi storey symmetric and asymmetric building. The structural analysis of G+12 storey reinforced concrete symmetrical and asymmetrical frame building is done with the help of Etabs software. The building is assumed as commercial building. In the present study, The Response spectrum analysis (RSA) of regular and irregular RC building frames compare the results and Time history Analysis (THA) compare with Response spectrum analysis of regular building and carry out the ductility based design [10-12].

III. PROBLEM FINDING

In summary, most existing studies on progressive collapse have mainly focused on single-story structures. In contrast, there are limited experimental data currently available for multi-story frames and these are mostly regarding RC structures and skeletal steel frames without slabs. Thus, more research is urgently needed on multi-story composite-frame systems to provide more information and facilitate a deeper understanding of the load-resisting mechanisms of 2-D multi-story frames. Multi-story planar composite frames involve a multiplicity of key parameters and the corresponding experimental data are still very scarce owing to the high cost and excessive time required to acquire them. Consequently, some key parameters could not be investigated in experimental studies; therefore, it is imperative to employ numerical analysis methods to improve our understanding of the critical parameters affecting the collapse performance and load-resisting mechanisms of multi-story composite frames [13].

IV. RESEARCH MOTIVATION

The majority of these studies focused on their behaviour loaded seismically in the direction parallel to the setback. These studies also used 2D plane frame models and analysis so that torsional effects were not of concern. The very few studies that looked at the coupled translational-torsional behaviour of setback buildings loaded in the direction perpendicular to the direction of the setback used specific setback configurations whose results could not be extended to generic setback configurations [14]. Jhaveri (1967) conducted one of the few analytical studies on this subject but his hypotheses were simplistic and hardly practical. He used the shear beam idealisation model and considered that the base portion of the building was regular. From this study, there was some suggestion that both the degree and level of setback could affect the base shear, base torque and displacements of the building in a proportional manner. Here, and throughout the present paper, the degree of setback refers to the ratio of the plan area of the lower base to the plan area of the upper tower, and the level of setback refers to the ratio of the height of the lower base portion to the total height of the structure. In all of the above-mentioned studies on setback buildings, none accounted for in-plan mass irregularity due to eccentricity with respect to the centers of mass of the floors in the base and the tower portions, which characterizes an asymmetric setback building [15].

V. PROPOSED METHODOLOGY UNSYMMETRICAL BUILDING

A lack of symmetry produces torsional effects that are sometimes difficult to assess, and can be very adverse. The preferred method of minimizing torsional effects is to select floor plans that are regular and reasonably compact. Complex plan buildings should be divided by seismic separation joints introduced between rectangular blocks. The behaviour of buildings during earthquakes will be satisfactory only if all measures are taken to provide a favourable failure mechanism. A special account must be taken so that torsional effects do not endanger or preclude the global ductile behaviour of the structure. Buildings with an asymmetric distribution of stiffness and strength in plan undergo coupled lateral and torsional motions during earthquakes. Because of torsion, the seismic demands of asymmetric buildings increase above those required by just translational deformation. It is well-known that the larger the eccentricity between the centre of stiffness and the centre of mass, the larger the torsional effects. An important aspect of the inelastic behaviour of asymmetric structures is the considerations of the degree of control over inelastic twist. One of the design aims should be to restrain the system against unrestricted inelastic twist. In the structures, which remain elastic during an earthquake, torsional vibrations may cause significant additional displacements and forces in the lateral load resisting elements. However, the design of the majority of buildings relies on inelastic response. In that case torsional motion leads to additional displacement and ductility demands. Hence, the relevance of current code recommendations, based on elastic torsional response, is open to questions.

In every aspect of human civilization we needed structures to live in or to get what we need. But it is not only building structures but to build efficient structures so that it can fulfill the main purpose for what it was made for. Here comes the role of civil engineering and more precisely the role of analysis of structure. The design consists of symmetric and asymmetric plan of building. The building is designed for the six storey residential flats. There are many classical methods to solve design problem, and with time new software's also coming into play. Asymmetrical buildings undergo large amount of torsion and hence extreme corners are subjected to heavy force. Avoid asymmetrical buildings like: I, L,U, and T shape buildings. As CoM & CoR coincide in plan twisting will not occur due to earthquake. Building will need to resist the horizontal inertia force only. Symmetrical plans like Rectangular, Square, Polygonal or Circular are favourable. A lack of symmetry produces torsional effects that are sometimes difficult to assess, and can be very adverse. The preferred method of minimizing torsional effects is to select floor plans that are regular and reasonably compact. Complex plan buildings should be divided by seismic separation joints introduced between rectangular blocks. The behaviour of buildings during earthquakes will be satisfactory only if all measures are taken to provide a favorable failure mechanism. A special account must be taken so that torsional effects do not endanger or preclude the global ductile behaviour of the structure. Buildings with an asymmetric distribution of stiffness and strength in plan undergo coupled lateral and torsional motions during earthquakes. Because of torsion, the seismic demands of asymmetric buildings increase above those required by just translational deformation.

VI. RESULT AND ANALYSIS STAAD INPUT DETAIL

The STAAD Input file represents our thought about what we want to analyze or design with knowledge of the STAAD command language, any other person can also verify the accuracy of work. There are many ways to create structure in STAAD Pro

• Structure Wizard
• Staad Editor
• Using building planner
• Add Beam
• Add plate
• Copy and pasting the nodes

UNSYMMETRICAL BUILDING DESIGN

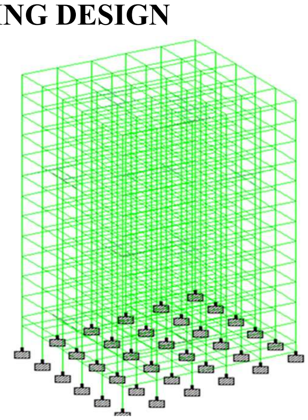

Fig.6.1 Unsymmetrical Building Design.

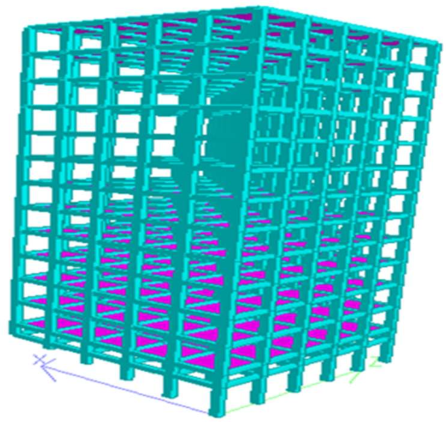

Fig.6.2 Final View.

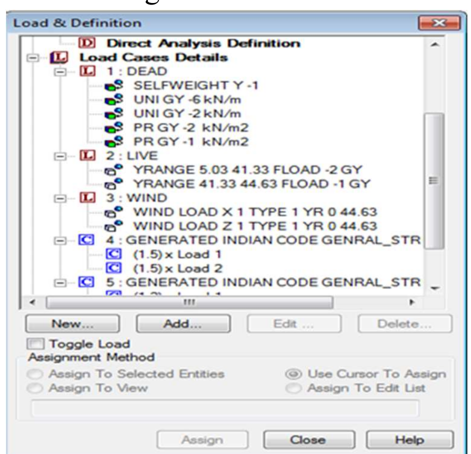

Fig.6.3 Load Cases.

Symmetrical Building Design

Design Parameters	Values
Length	12
Height	33
Width	12
No of bags Length	4
No of bags Height	13
No of bags Width	4

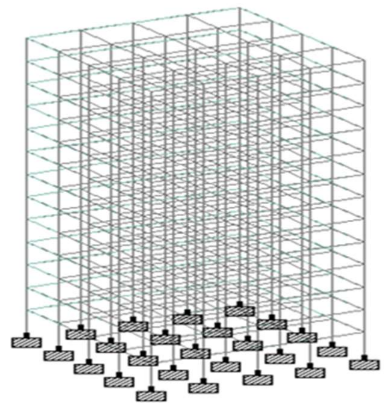

Fig.6.4 3D modelling View.

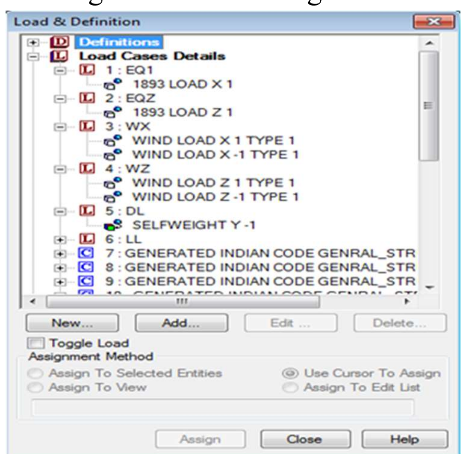

Fig.6.5 Load Case.

Symmetrical Building Analysis parameters

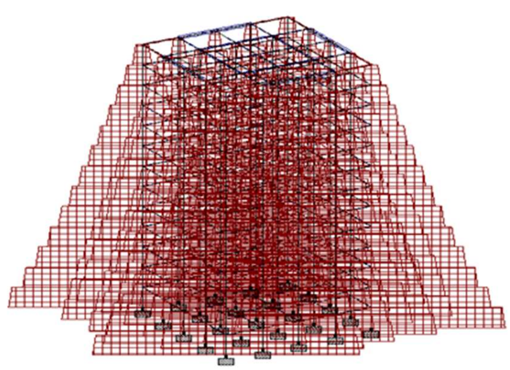

Fig.6.6 Axial Case.

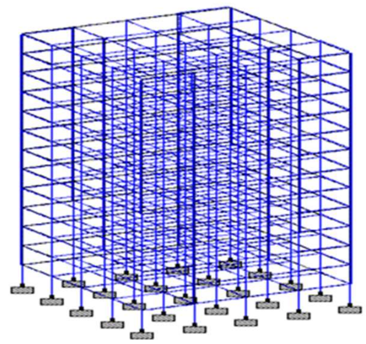

Fig.6.7 Share YY.

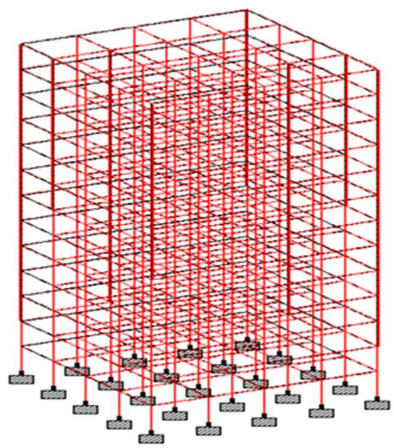

Fig.6.8 Share ZZ.

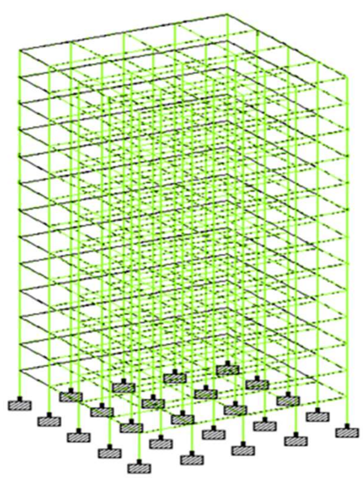

Fig.6.9 Bending YY.

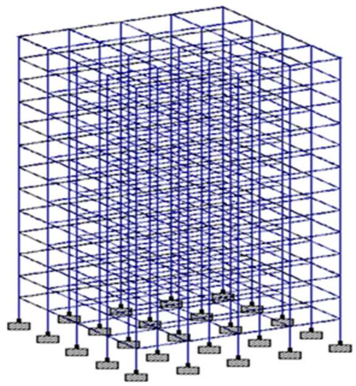

Fig.6.10 Torsion.

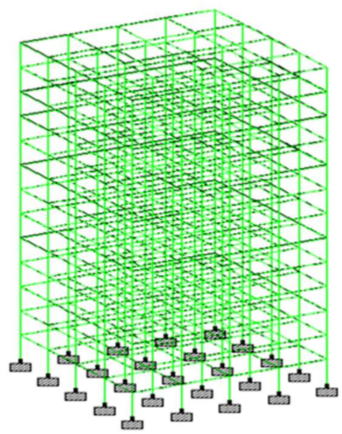

Fig.6.11 Displacement.

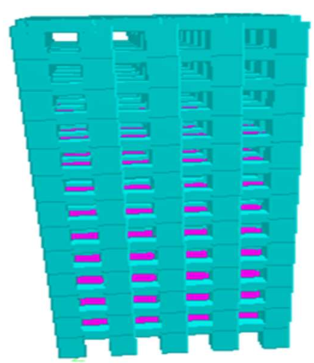

Fig.6.12 Symmetrical Building.

Unsymmetrical Building Analysis parameters

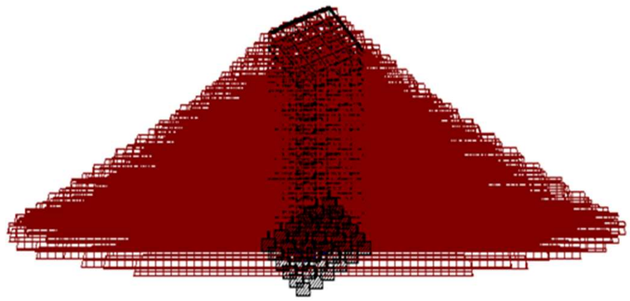

Fig.6.12 Axial Case.

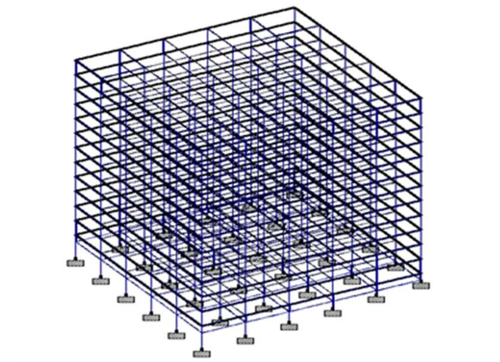

Fig.6.13 Torsion.

VII. CONCLUSIONS

The natural frequencies of an asymmetric spring model are greater than those of symmetric spring model while the rotations about the vertical axis through the mass centre of an asymmetric model are lesser than those of symmetric model. Maximum displacement of asymmetric column model due to an earthquake ground motion is greater than that of symmetric column model. Similarly, maximum displacement of an asymmetric spring model due to an earthquake is greater than that of symmetric spring model. The base shear of an asymmetric multi story building is larger than that of a symmetrical multi story building.

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