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'Impact of Shear Wall to Reduce Torsional Effect for Unsymmetrical R.C. Frames with and without Infill Walls'

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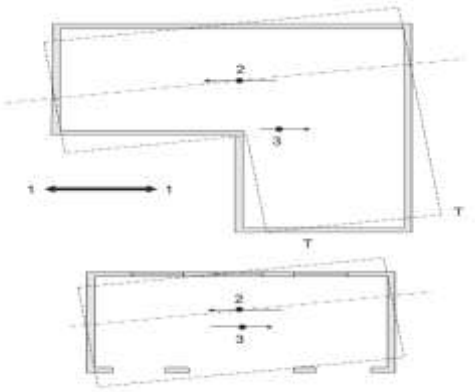
Abstract - *Torsional irregularity leads to increased unequal displacements at the extremes of the building and may cause distress in the lateral load resisting elements at the edges. Torsion is nothing but twisting moment induced in structures. Torsional effects may significantly modify the seismic response of buildings and it caused severe damage or collapse of structure in several past earthquakes. These effects occur due to different reasons, such as uneven distribution of the mass, stiffness and strength etc. This is well known that torsion adversely affects the response of conventional structures, as well as base isolated structures. In buildings mass asymmetry is usually present at different floor level This mass asymmetry may be due to water tank provided at top of building, any heavy weight machine placed at any level, etc. Due to this mass asymmetry in building center of mass is shifted from center of stiffness causing eccentricity. As this eccentricity increases, torsion in building also increases. So torsion is based on the static eccentricity and floor plan dimension which is effective for irregular structures. Right from the evolution of the earth, earthquakes have been cause great disasters in the form of destruction of property, injury and loss of life to the population. The effective design and construction of earthquake resistant structures has much greater importance in India due to rapid industrial development and concentration of population in cities.*

From the literature review it is noted that torsional effect was little addressed for multistorey unsymmetrical building. Hence in this dissertation an attempt has been made to study the nonlinear behavior of building structure subjected to seismic loading, considering torsional effect. IS: 1893 (Part 1)-2002 is used for this dynamic analysis. Time history analysis will be carried out and response quantities viz. natural time period, base shear, torsional moment, displacement will be obtained. The plan layout of the reinforced concrete ordinary moment resisting frame is consider with infill walls, without infill walls and shear wall. Seismic response of ten storey (G+9) symmetrical and unsymmetrical (L-shape) building with Plan irregularity is considered for study purpose. The plan areas of building is 15mx15m (symmetrical) and 15mx24m ((L-shape) with 3.0 m as height of each typical storey. The modal analysis will be done by using MATLAB/simulation and the results will be validated using standardized ASCE paper.

Key Words: Torsion, symmetrical, unsymmetrical, Time-histoy, analysis, MATLAB.

1. INTRODUCTION

Over the past century, several devastating earthquakes of the world had occurred in and around India. Few of these occurred in cities and towns and caused severe damages to human lives as well as to infrastructures with various categories. In metro city there is necessity to build a high rise structure due to high population and less land availability. Also the human ambition is force to create taller structure. Large numbers of high rise reinforced concrete structure are constructing to full fill the human requirement. Among the various categories, buildings under residential occupancy are mainly responsible for life losses. Buildings under commercial occupancy and other structures contribute to huge economic losses, in addition to the loss of precious lives.



1-Earthquake Force, 2-Centre of Stiffness or resisting force, 3-centre of gravity, T-Twisted building

Fig -1: Torsion of unsymmetrical plans

Buildings with non-uniform mass, stiffness and/or strength over their plan are often described as being torsionally irregular. Even for structures designed to be perfectly regular, the movement of live loads around the structure can cause torsional irregularity which in turn changes the member demands. There is effective an understanding of how different parameters may influence torsion. So these parameters we can see by taking with bare building structure and adding different considerations like infill wall, shear wall and base-isolation. we can obtained list which provision minimizes torsional moment for the building structure.

1.1 Objectives

The primary objective of this study is to carry out non linear time-history of symmetrical and unsymmetrical ten storey R.C.C. framed structure. The main objectives of undertaking the present study are as follows:

1. To analyze a Ten storey RC framed building using time-history analysis in MATLAB, for symmetrical and unsymmetrical structure.

2. To study the torsional effect for bare frame, frame with infill wall, frame with shear wall for symmetrical and unsymmetrical building.

1.2 Need of the Study

Most of the structures are subjected to vibrations with ground motion. To protect structures from significant damage and torsional effect in structures under severe earthquakes has become an important issue in structural engineering. So it is important to reduce torsion or twisting in multistorey building structures by applying various control strategies like infill wall, shear wall and isolators which reduces torsion, displacement and Base shear.

Many of the researchers have worked on earthquake resistant techniques which use different types of controlling methods in structures but, minimum work is reported for torsional moment or torsional effect on structures. Hence, the present study deals with Non-linear Time History Analysis of R.C. framed structures by using infill walls, shear wall and isolation. The main objective of this study is to know torsion reduction in ten storey R.C.C. framed structure by applying various control strategies.

2. METHODOLOGY

The torsion forces shall be distributed to various vertical components of the seismic resisting system with due consideration given to the relative stiffness of vertical components and diaphragms. It is then corrected with torsion taken into account .If x and y are various elements and KX and Ky are relative stiffness in two directions. The coordinates (Xr and Yr) of centre rigidity or point of rotation determined as,

$$Xr = \frac{\sum KyX}{\sum Ky} \quad \text{---------- (1.1)}$$

$$Yr = \frac{\sum KxY}{\sum Kx} \quad \text{---------- (1.2)}$$

The rotational moment IP of the structure about the centre of rotation Cr is given by,

$$IP = \sum (Ky.*X2 + Kx.*Y2) \quad \text{---------- (1.3)}$$

Torsional Moment is,

$$T = V.ed \quad \text{---------- (1.4)}$$

Where,

ed = 1.5 e, with ed= design eccentricity and

e=eccentricity respectively,

The torsional shears Vx and Vy, can be calculated by,

$$Vx = (T/IP)*Y*Kxx \quad \text{----------(1.5)}$$

$$Vy = (T/IP)*X*Kyy \quad \text{----------(1.6)}$$

Where,

Kxx, Kyy are the total stiffness of column line under consideration and X and Y coordinates w.r.t. centre of rigidity Cr.

2.1 Governing Equation of Motion

The governing equation of motion for a system subjected to an earthquake excitation can be given as,

$$[M]\{\ddot{x}\} + [C]\{\dot{x}\} + [K]\{x\} = f(t) \quad \text{---------- (1.7)}$$

$$f(t) = -[M]\{r\}\{\ddot{u}_g\} \quad \text{---------- (1.8)}$$

2.2 Problem Formulation

In the present study the response of an R.C.Framed building structure with Ten storey (G+9) symmetrical and unsymmetrical (L-shape) plan. The floor to floor height of building is 3m.Grade of concrete and steel considered are M20 and Fe 415 respectively. Standard design parameters of earthquake resisting building structures taken by using IS-1893-I(2002).

The geometry of Symmetrical and Unsymmetrical building is as given:

Plan of building=15mx15m (s1) &24mx15m (u-1)

Size of column=0.6x0.6m

Size of beam=0.5mx0.5m

Zone= IV, Slab thickness=0.15m

Damping=5%

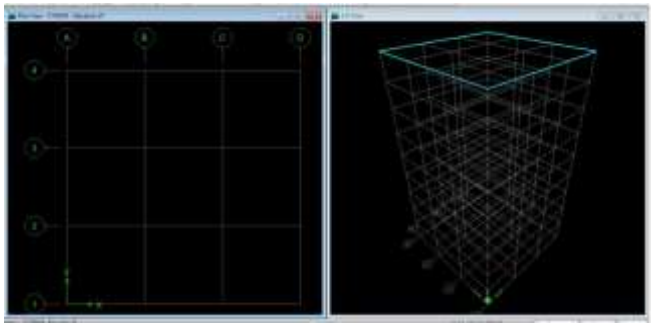


Fig -2: Symmetrical Plan & Elevation

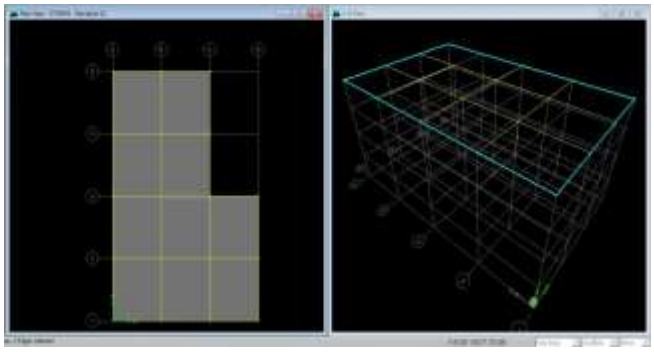


Fig -3: Unsymmetrical Plan & Elevation

3. MODELLING & ANALYSIS

The building structure symmetrical and unsymmetrical modeled and analyzed in a mathematics work coding tool is MATLAB software. The response for various building conditions such as bare frame, frame with infill walls, frame with shear walls are carried out. Two combinations of cases are studied viz. considered for symmetrical building and with unsymmetrical building frame. The non-linear time history analysis is carried out for the recorded ground motion of EI-Centro earthquakes.

4. RESULTS OF ANALYSIS

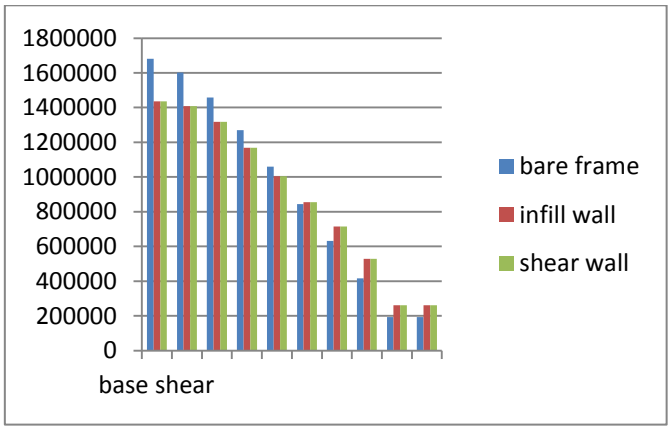


Chart -1: Base Shear-Symmetrical Frame and unsymmetrical frame

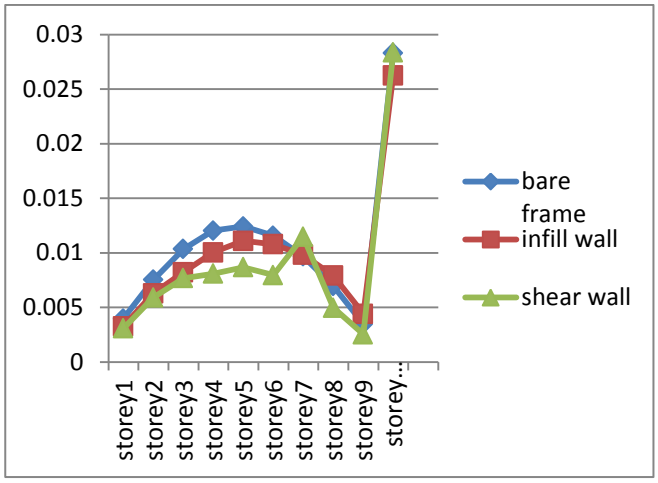


Chart -2: Displacement- Symmetrical Frame and unsymmetrical frame

From the above diagrammatic results shows large variation in base shear and displacement of symmetrical and unsymmetrical building structures with different parameters as bare frame, with infill wall and shear wall.

Table -1: Torsional Moment (KN.m)-Symmetrical Frame and unsymmetrical frame.

Model	Bare Frame	Infill Wall	Shear wall
Symmetrical	0	0	0
Unsymmetrical	719.589	205.396	188.627

5. CONCLUSIONS

1. From the analysis of symmetrical and Unsymmetrical building Bare structures having the maximum base shear, displacement.

2. From the result it is clear that consideration of infill wall stiffness is important in both symmetrical and unsymmetrical building structure.

3. Torsional moment in Unsymmetrical building structures is reduced by providing infill wall and shear wall.

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