ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 9 , September 2017

Comparative Study of Response of Multi Storied Structure with Different Column Shapes and Orientations

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ABSTRACT: The present day scenario witnesses a series of natural calamities like earthquakes, tsunamis, floods etc. Of these the most damaging and recurrent phenomena's are the earthquake and wind forces. The Effective design and the construction of Earthquake resistant structure have gained greater importance all over the world. Earthquake load is changing into a great concern in our country as a result of not one zone may be selected as earthquake resistant zone. One of the most important aspects is to construct a building structure, which can resist the seismic force and wind force efficiently. Study is made on the different structural arrangement to find out the most optimized solution to produce an efficient safe earthquake and wind forces resistant building.

The project work focuses on the earth quake and wind forces resisting building among six different cases of building structure by changing column shape and orientations in RESPONSE SPECTRUM method by using STAAD PRO and E TABS softwares.

I. INTRODUCTION

Natural disasters are inevitable and it is not possible to get full control over them. The history of human civilization reveals that man has been combating with natural disasters from its origin but natural disasters like floods, heavy winds, tornados, cyclones, earthquakes, volcanic eruptions have various times not only disturbed the normal life pattern but also caused huge losses to life and property and interrupted the process of development. With the technological advancement, man tried to combat with these natural disasters through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But unfortunately it is not true for all natural disasters.

Earlier people lived in caves, over bushes or beneath bushes, to safeguard themselves from wild animals, rain, sun, etc. Because the occasions handed as people being started dwelling in huts created from trees branches. The shelters of these previous are developed at the moment into wonderful residences.

Day-to-day new techniques are being developed for the development of residences economically, speedily and pleasing the requirements. Here, the construction body which we analyzed consists of variety of bays and story. A multi-storey, multi-paneled body would be a tricky statically intermediate structure. A design of R.C building of G+5 flooring body work is preoccupied. The constructing in arrange (26×16) consists of columns designed monolithically forming a community. The scale of constructing is 26×16m. The number of columns are thirty. It is residential advanced.
The analysis is done by using STAAD PRO and ETABS software's. The vertical load consists of dead load of structural elements equivalent to beams, columns, slabs etc and live loads includes floor loads. The lateral load includes the earth quake forces and wind forces so building is intended for dead load, live load, earth quake load and wind load as per IS 875. The construction is meant as three dimensional vertical body and analyzed as per IS 456-2000.

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II. INTRODUCTION TO STAAD PRO V8i

Staad.Pro V8i is the most popular structural engineering software product for 3D model generation, analysis and material design. It has an intuitive, user-friendly guide GUI, visualization tools, powerful analysis and design facilities and seamless integration to several other modeling and design software products. The software is fully well suited and compatible with all windows operating systems but is optimized for Windows xp.

For static or dynamic analysis of bridges, containment structures, embedded structures (tunnels and culverts), pipe racks, metal, concrete, aluminum or timber buildings, transmission towers, stadiums or any other simple or complex structure, staad.pro has been the choice of design experts round the arena for their specific analysis and evaluation desires.

III. INTRODUCTION TO ETABS

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modeling, analytical, and layout processes, all included the use of a not unusual database. Despite the fact that quick and clean simple structures, etabs also can handle with the most important and most complex building models, including a extensive range of geometrical nonlinear behaviors, making it the device of preference for structural engineers within the building industry (2003.computer systems and systems).

The accuracy of analytical modeling of complicated wall systems has usually been of concern to the structural engineer. The pc models of these systems are usually idealized as line elements instead of continuum elements. Single walls are modeled as cantilevers and walls with openings are modeled as pier and spandrel systems. For simple systems, where lines of stiffness can be defined, these models can give a reasonable result. However, it has constantly been recognized that a continuum model based upon the finite element method is more appropriate and desirable. Nevertheless this option has been impractical for the Structural Engineer to use in practice primarily because such models have traditionally been costly to create, but more importantly, they do not produce information that is directly useable by the Structural Engineer.

IV. OBJECTIVE OF THE PROJECT

To study irregularities in structures analyze and design of G+5 storied structure as per code (IS1893:2002) provision by using different cross sections of the columns (rectangular, circular, T shaped columns).

To analyze the buildings in Etabs and Staad pro V8i SS6 software's to carry out the storey drift, axial force, storey shear force and bending moment of structures using response spectrum analysis and compare the results. To identify the better case among six cases which can resist seismic forces and wind forces by resulting minimum axial force, minimum shear force and minimum bending moment among six cases. And identifying min storey drift. And also comparing the six cases of multi storied building frame in two soft wares, Staad pro and E Tabs in linear dynamic analysis also known as response spectrum analysis.

V. Linear Dynamic Analysis

This method is also known as "response spectrum method". Static methods are suitable when higher mode consequences aren't considerable. That is generally real for short, regular buildings. Consequently, for tall structures, and structures with torsional irregularities, or non-orthogonal structures, a dynamic procedure is needed. In the linear dynamic technique, the building is modeled as a multi-degree-of-freedom (mdof) device with a linear elastic stiffness matrix and an equal viscous damping matrix.

The seismic enter is modeled the use of both modal spectral evaluation and time records evaluation but in both instances, the corresponding internal forces and displacements are determined using linear elastic evaluation. The gain of these linear dynamic techniques with respect to linear static tactics is that higher modes may be taken into consideration. However, they're based on linear elastic reaction and therefore the applicability decreases with growing nonlinear conduct, that's approximated through worldwide force reduction elements.

In linear dynamic evaluation, the reaction of the shape to floor movement is calculated inside the time domain, and all segment facts is therefore maintained. Most effective linear houses are assumed. The analytical method can use modal decomposition as a way of decreasing the degrees of freedom inside the analysis.

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VI. LOADS ACTING ON STRUCTURE

Dead loads: Dead loads encompass the permanent construction loads comprising the roof, floor, wall, and basis systems, such as claddings, finishes, and fixed equipment. The values for lifeless masses are for commonly used materials and buildings in mild-frame residential homes.
Right from the initiation, it is going to be menu kind driven. Choosing one of the known options actually gives another kind pop up menu with more of the options. Data type entry form primarily wherein the user can premeditate entering the data.
Live loads: Live loads are produced with the aid of the use and occupancy of a building. Loads encompass those from human occupants, furniture, and non fixed device, storage, and creation and upkeep sports.
Wind load: Wind load is in most cases horizontal load resulting from the motion of air relative to earth. Wind load is needed to be taken into consideration in structural design specifically when the heath of the building exceeds times the size transverse to the exposed wind floor.
Earthquake load: Seismic motion includes horizontal and vertical floor motions, with the vertical motion usually having a much smaller significance. Further, issue of safety provided against gravity loads usually can accommodate additional forces due to vertical acceleration because of earthquakes.

Dead load: Wall load, Parapet wall load and floor load (IS 875(Part1))

A) wall load = (unit weight of brick masonry x wall thickness x wall height)
= 19 kN/m3 x 0.230m x 3m
= 13.11 kN/m (acting on the beam)

B) Interior walls = 6.55 kN/m (acting on the beam)

C) Wall load (due to Parapet wall at top floor) = 5.24 kN/m (acting on the beam)

Live load:
Floor load: All rooms 2kN/m2
Balconies, corridors- 3kN/m2

Seismic Load:
Seismic zone: 3 (Z=0.16),
Soil type: medium,
Importance factor: 1, Response reduction factor:5
Damping: 5%. IS 1893(Part-1):2002.
Here seismic load is taken into consideration along two directions,
Earth quake forces acting towards length and
Earth quake forces acting towards width

Wind load:
Intensity: 1.5 for total building height 18m
wind speed for the zone 3 is 39 km/hr
Here wind load is considered along two directions,
WL length and WL width

VII. BUILDING DESCRIPTION

Building Description	Dimensions
Length x Width	26m x16m
No. of storeys	6
Storey height	3m
Slab thickness	125mm
Thickness of main wall	230mm
Thickness of secondary wall	115mm

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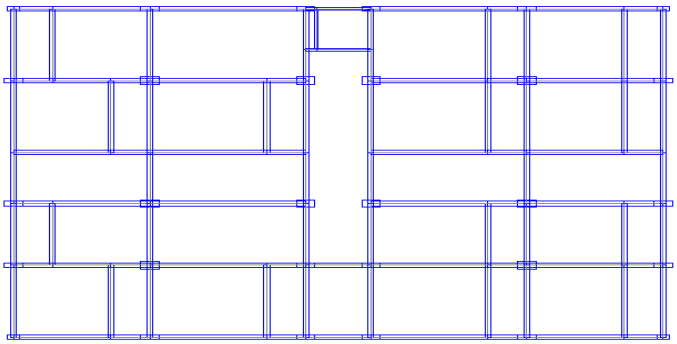
Support conditions Fixed	Fixed

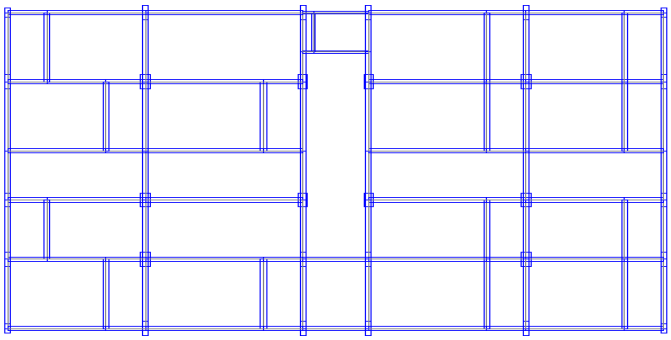
VIII. TYPES OF CASES ANALYZED

Here, in this project we are considering the columns of different shapes like rectangular columns, circular columns, T section shaped columns by changing the orientation of those columns in different combination ways in multi storied structure in six cases as mentioned below.

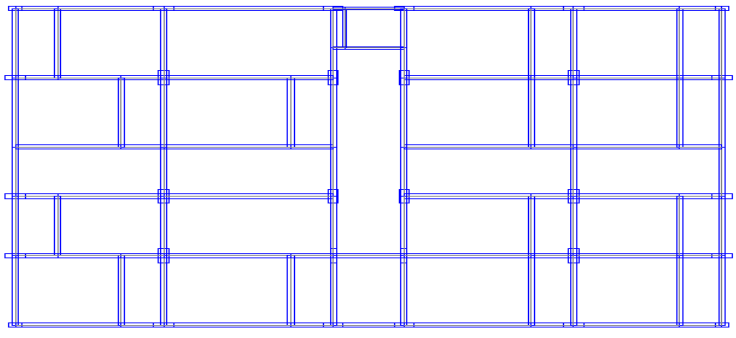
Change in column orientation and column shape
DIAGRAMMATIC REPRESENTATION
Case:1 – Multi storied building with all columns zero degrees orientation



Case:2 -- Multi storied building with all columns 90 degrees column orientation



Case:3 -- Multi storied building with exterior columns orientation is zero degrees and interior column orientation is 90 degrees



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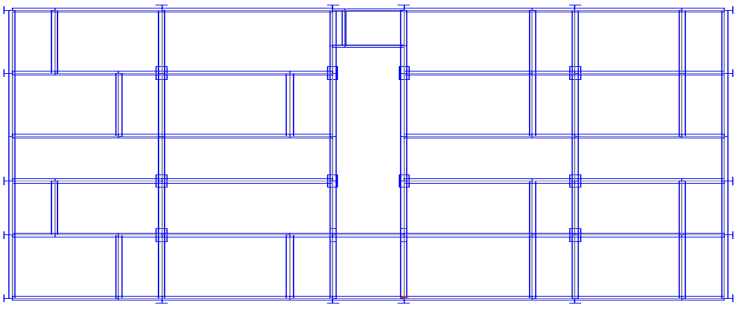
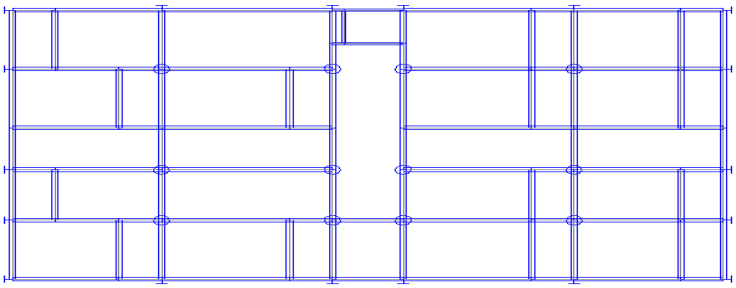
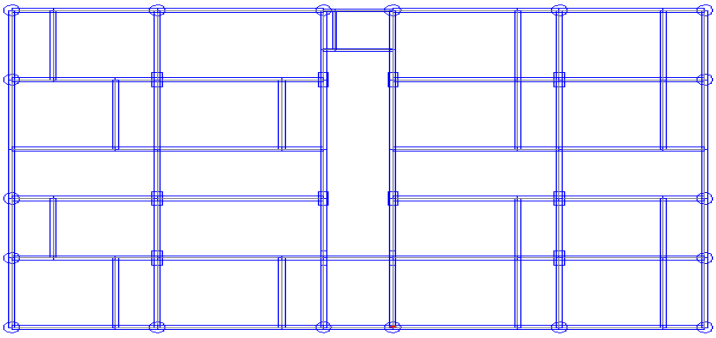
Case:4 – Multi storied building with T shaped columns as exterior columns and rectangular columns as interior columns



Case:5 -- Multi storied building with T shaped columns as exterior columns and circular columns as interior columns



Case:6 -- Multi storied building with circular columns as exterior columns and rectangular columns as interior columns



IX. Comparison of those six cases

- Analysis is done in linear dynamic method(response spectrum method) and compared in staad pro and e tabs

The parameters identifying with this comparison are,

- Storey drift
- Shear force
- Bending moment

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X. SIZE OF COLUMNS

In the present project, we are changing column shape and orientation in six different ways shown in six cases. So that, we are taking equal cross sectional area of columns having different shapes and orientations which are mentioned below.

- cross section of columns having area 0.246m^2
- cross section of columns having area 0.161m^2
- cross section of columns having area 0.105m^2

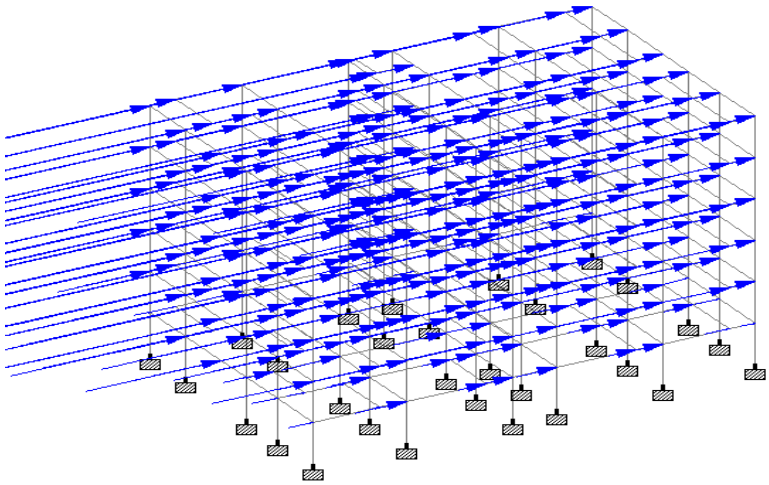
Area of rectangular columns(A)=width x height
=0.37 x 0.70
= 0.246m^2

Area of circular columns(A) = ΠD^2/4
= (3.14 x0.56^2)/4
= 0.246m^2

Area of T shape column (A) = BH + bh
= (0.3x 0.4)+(0.45x 0.28)
=0.246m^2

X1. ANALYSIS RESULTS

Earth quake forces acting towards X direction in load combination **(Dead load + Live load + Earth quake load X positive)**



COMPARISION OF STOREY DRIFT BETWEEN SIX CASES WITH STAAD RESULTS

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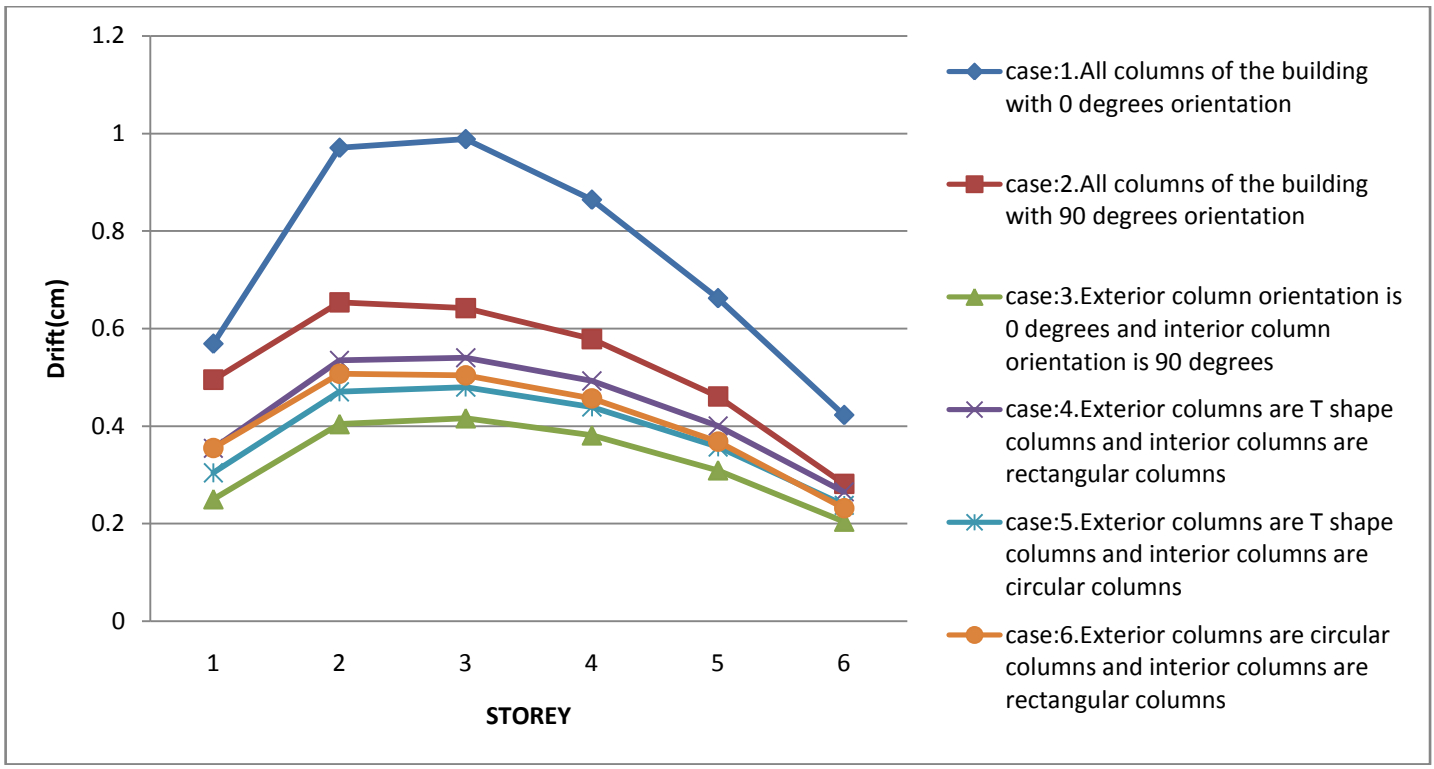
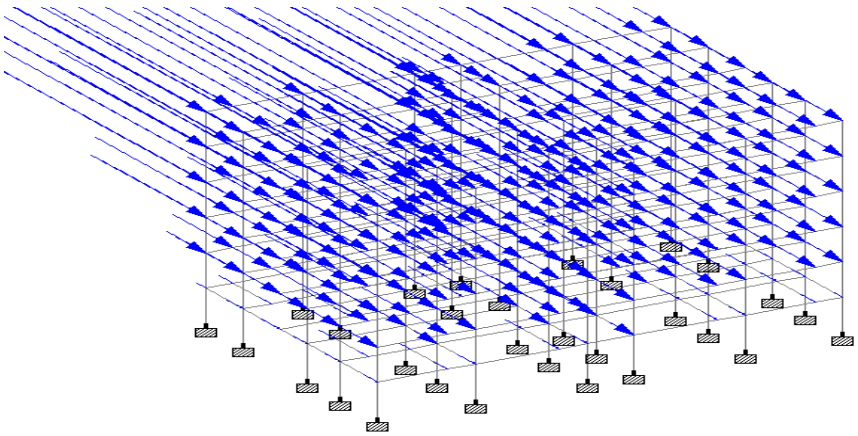


Earth quake forces acting towards Z direction in load combination (Dead load + Live load + Earth quake load Z positive)



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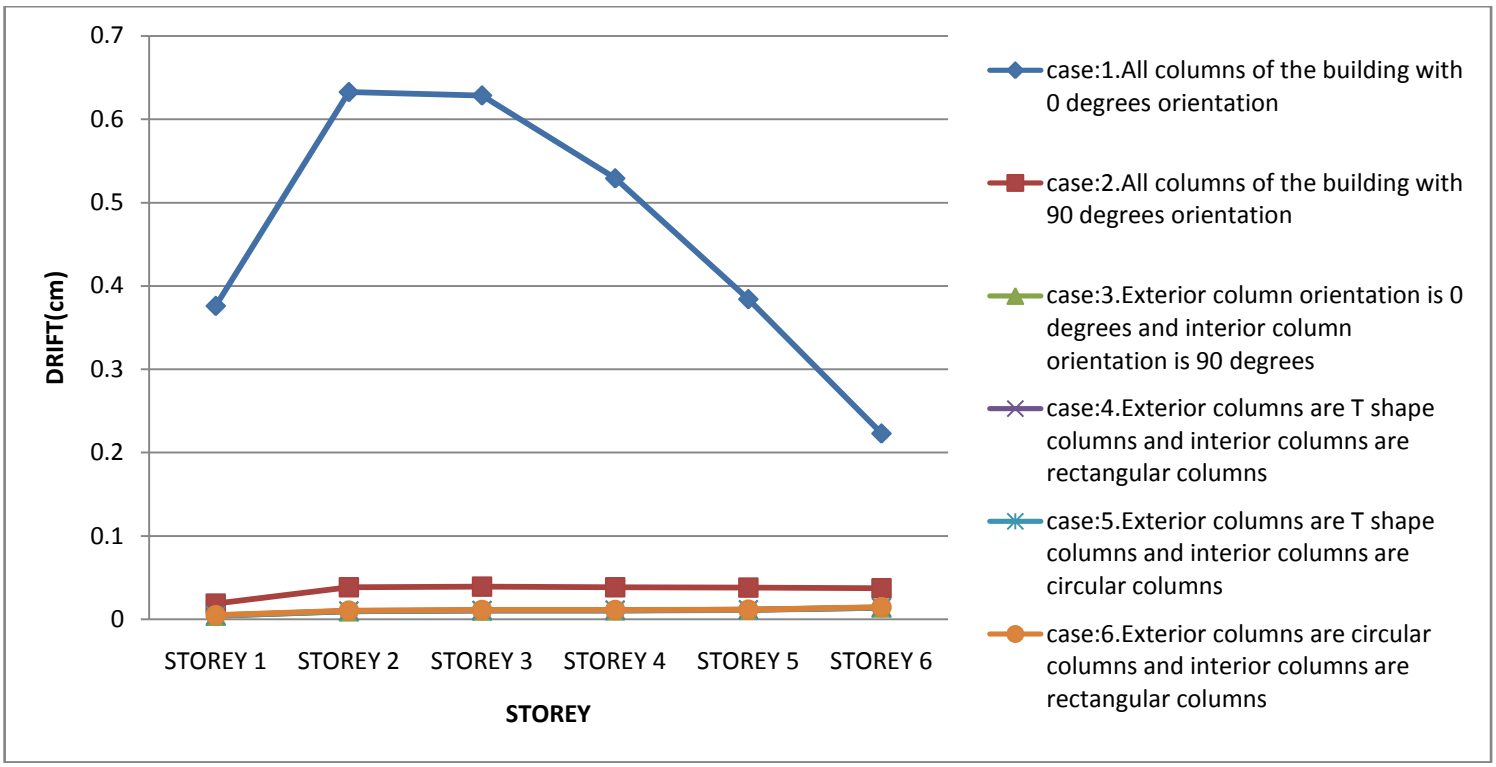
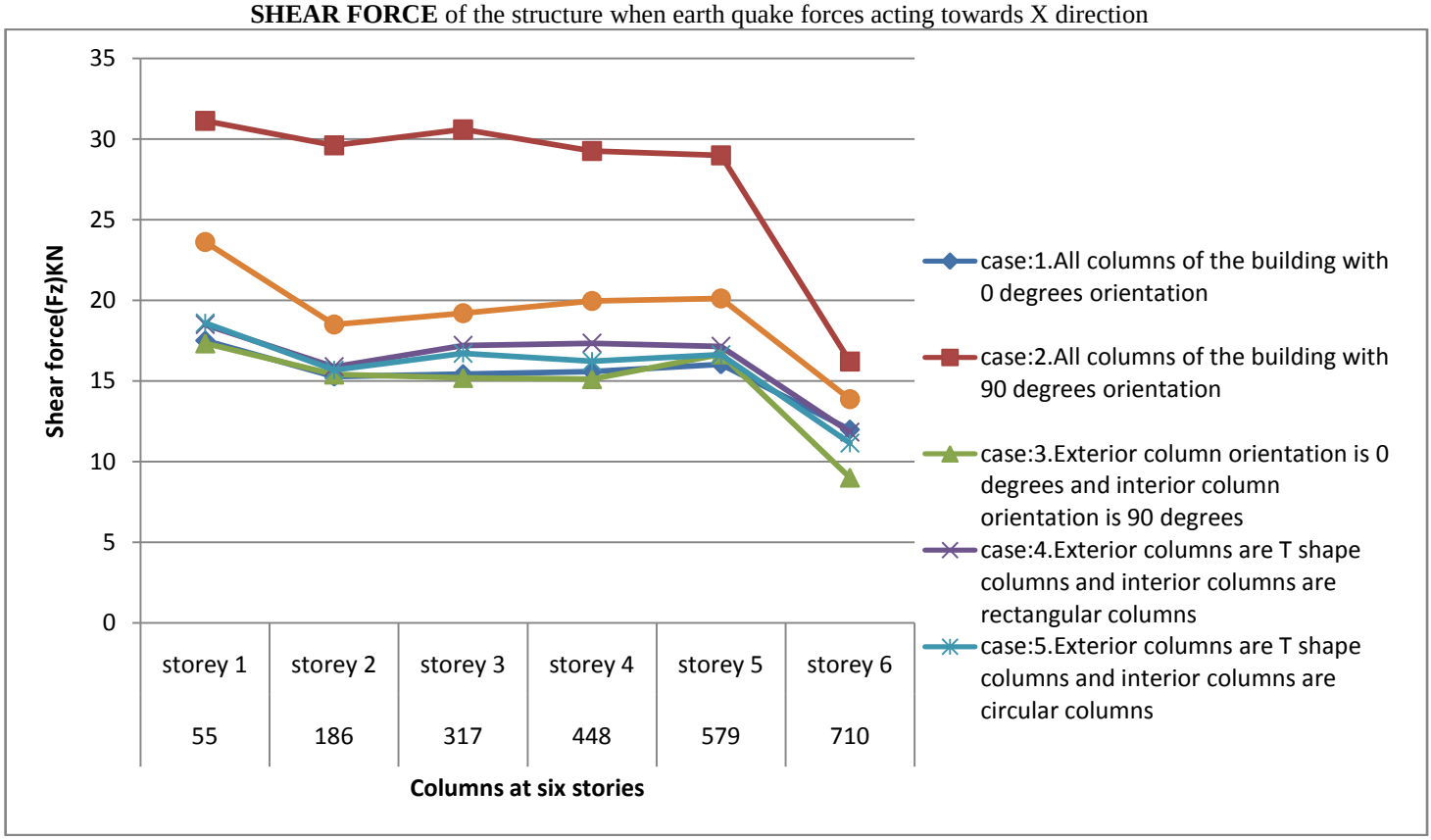


SHEAR FORCE of the structure when earth quake forces acting towards X direction



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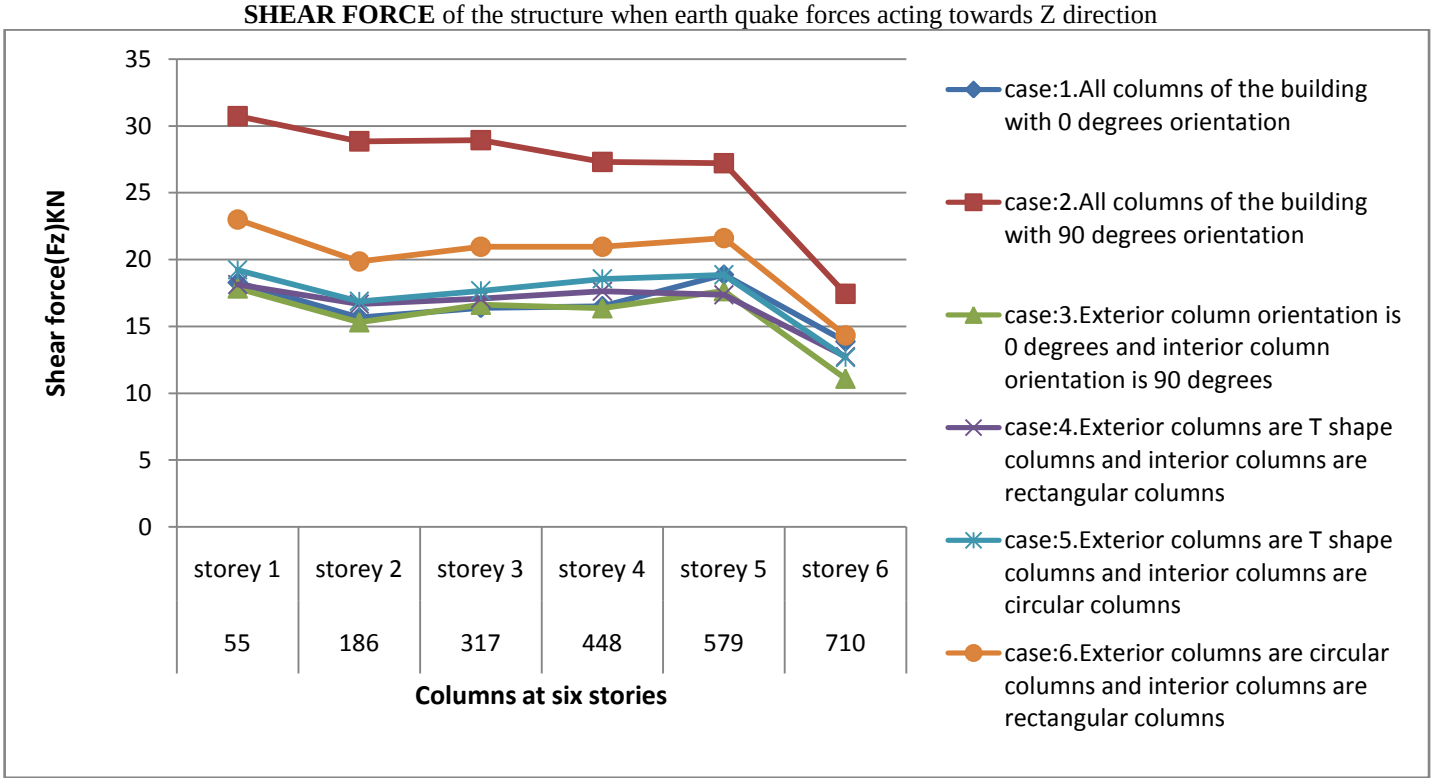
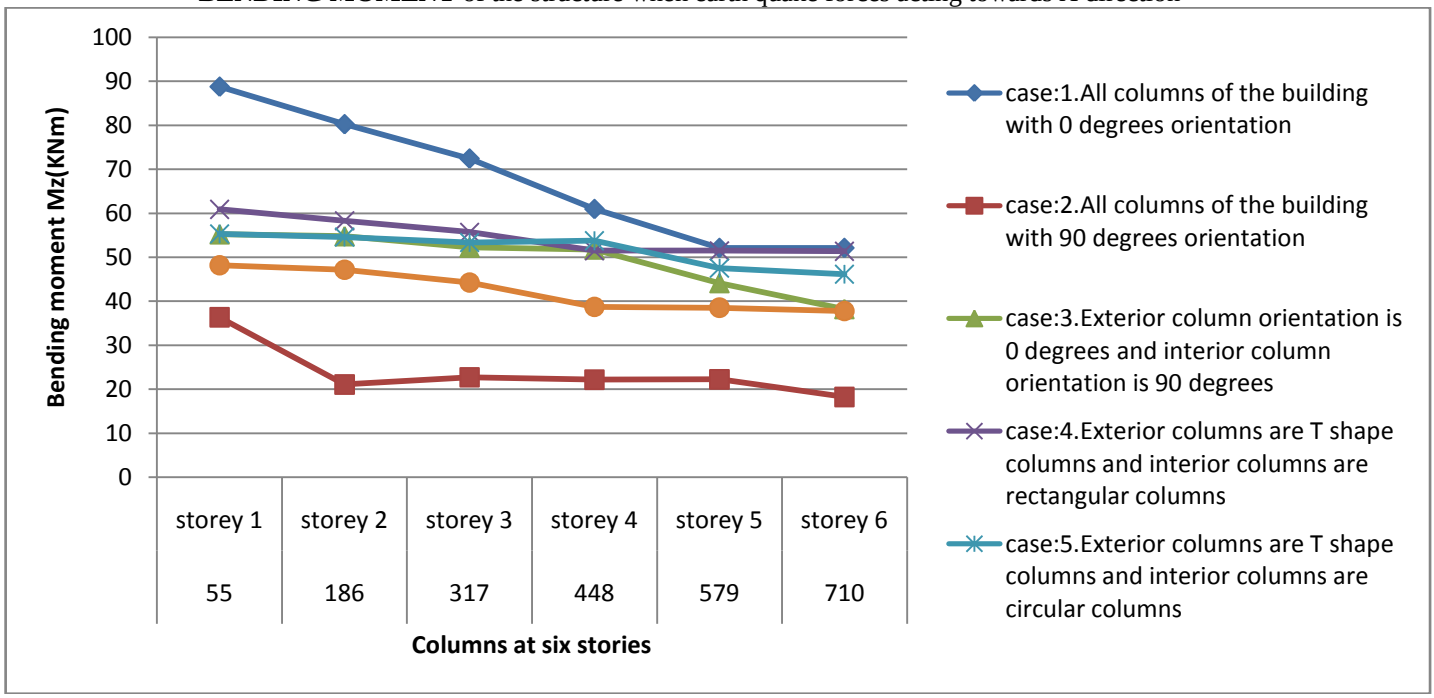
SHEAR FORCE of the structure when earth quake forces acting towards Z direction



BENDING MOMENT of the structure when earth quake forces acting towards X direction



BENDING MOMENT of the structure when earth quake forces acting towards Z direction

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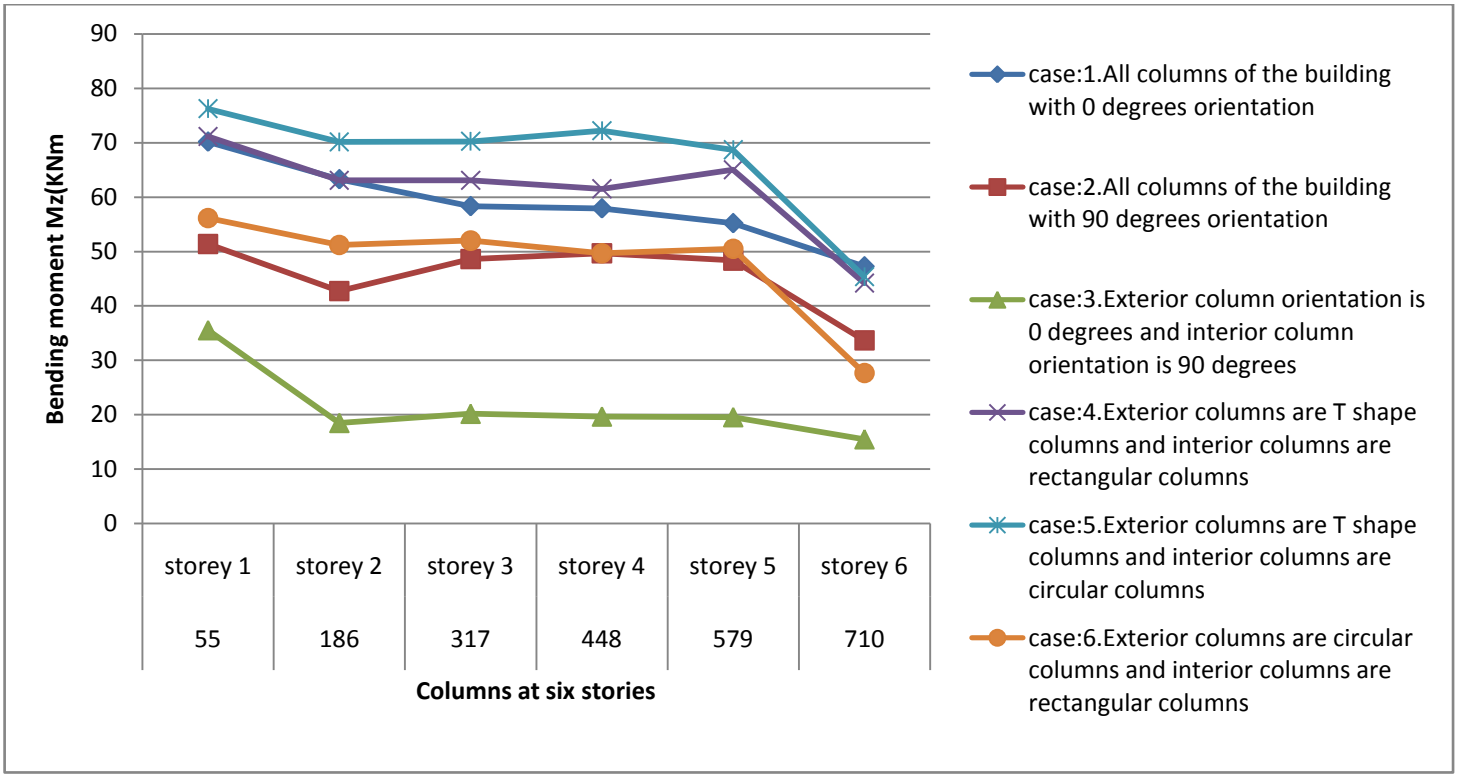


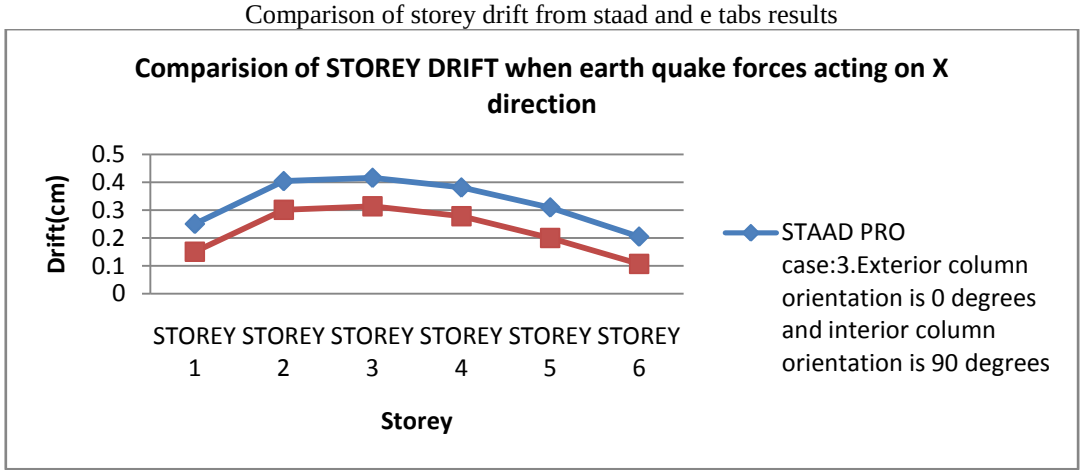
. **X1. COMPARISION OF RESULTS BETWEEN STAAD AND E TABS**

STOREY DRIFT RESULTS

case:3.Exterior column orientation is 0 degrees and interior column orientation is 90 degrees

STOREY	HEIGHT	STOREY DRIFT VALUES OF STAAD	STOREY DRIFT VALUES OF E TABS
1	**3**	0.2504	0.248
2	**6**	0.4045	0.4016
3	**9**	0.4164	0.4137
4	**12**	0.3814	0.3778
5	**15**	0.3097	0.3071
6	**18**	0.2045	0.2018

Comparison of storey drift from staad and e tabs results



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X11. CONCLUSION

The following conclusions are made from the dynamic analysis of multistoried building by changing columns shape and orientation.

 Storey drift, Axial force and Shear force are found to be minimum in the case where **the exterior columns orientation is 0 degrees and interior columns orientation is 90 degrees.**

 We found that, Bending moment is minimum in case where **all columns orientation is 90 degrees** for load combination of **Dead load +Live load+ Earth quake load in X direction**,

 And, Bending moment is minimum in case where **the exterior columns orientation is 0 degrees and interior columns orientation is 90 degrees** for load combination of **Dead load +Live load+ Earth quake load in Z direction**.

 It is understood that stiffness is equally distributed in the case where the Storey drift, Axial force and Shear force are found to be minimum.

By comparing the analysis results obtained from STAAD PRO and E TABS it is observed that,

 Storey drift, Axial force, Shear force and Bending moment values are higher in STAAD PRO than E TABS.

X111. SCOPE

Storey drift, Axial force, Shear force and Bending moment values are higher in STAAD PRO than E TABS from our analysis results. The reason behind why the results between the staad pro and e tabs had variation is worked out. For the further scope the case 3 **the exterior columns orientation is 0 degrees and interior columns orientation is 90 degrees** is taken and analyzed for further scope and checked manually and compare with software results.

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