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A Study on Dynamic Analysis of Tall Structure with Belt Truss Systems for Different Seismic Zones

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***Abstract*— Tall building development has been rapidly increasing worldwide introducing new challenges that need to meet through engineering decision. As the height of the building increases the stiffness of the building reduces. Therefore to improve the performance of the building under seismic loading, belt truss system is proposed in the present study of work. In the present work, contains a comparative study on type of belt truss has been used which provide more economical for human beings under different seismic zone criteria with and without shear core for building. The modelling of the structure is done using 'ETABS" software. The analysis of the model is carried out by equivalent static method and response spectrum method. To know most economical and stiffness building here we find % reduction of displacement and storey drift for different seismic zones with and without shear core.**

Keywords*— *Tall building; Different belt truss; Seismic zones; ETABS; Response spectrum; Displacement; Storey drift.

I. INTRODUCTION

Elevated towers and buildings have enthralled mankind from the establishment of civilization. Contemporary tall buildings begins to development in the 1880 has mostly for commercial and residential building purposes. Due to quick augmentation of population and pressure on the limited space available tends to increase tall buildings. Tall buildings are constructed based on purpose they use whether it may be for commercial or residential purposes. Loads act on a building will be of vertical, horizontal or torsion type of load which give different effects on building. The primary function of the structural elements is to resist the gravity loading from the weight of the building and its contents. Secondary function of the vertical structural elements is to resist the wind and earthquakes whose magnitude will be varied from the epicenter to epicentral distance whose magnitude obtained in the IS 1893 2002 code book. As height of structure increases its displacement, story drift, story shear of the building decreases abruptly. So, in order to restrain those parameter in the building especially under seismic and wind load suitable method to be taken to reduce those effect in the building.

Convection currents develop in the viscous mantel because of high temperature and gradient crust and core due to convective flours of mantle material cause the crust and a few section of the mantel to slide on the blistering molten outer core. This sliding of earth's mass takes place in pieces called tectonic plates. The surface of the earth consist of seven of foremost tectonic plates and there plates more in different direction [plate in the front slower then, the plate at the rear and vice versa and other types of plates moves side by side i.e., it may be of convergent, divergent and transform boundaries] and at different speeds since those of the neighboring ones the plates will be in motion. Bulky seismic activity at huge spaces can generate strong waves that may not harm buildings or humans. Then, sensitive mechanisms like seismograph and accelerograms can measure these. This makes it happen to find far-away earthquakes. Still, from engineering point of view, strong movements that can probably harm structures are of interest. This can happen with earthquakes in surrounding area or even with large earthquakes at reasonable medium to large distances. Thus, a seismic zone map is necessary so that buildings and other structures situated in different regions can be designed to hold out different level of ground quaking. The present zone map subdivides India into II, III, IV, and V.

In present tall buildings, lateral loads induced by wind or earthquake forces are often resisted by a system of belt Truss. Belt truss can be defined as the truss provided to the peripheral column of the structure around the core at particular height of the building, in order to provide sufficient firmness and strength against lateral loads. The building can have one or a number of belt truss; the more trusses used. They should be located at locations within the building where the diagonal bracing will not interfere with the building's function. The structural principle of employing belt trusses at the top and mid-height of a building seems to be cost-effective in applications up to roughly 60 stories. Shear core present at the center also had the capacity to reduce deflection and acts as a uniformly distribution of load throughout structures along with increasing the stiffness of building. Belt truss can be used different types it may be of x, v, inverted v, diagonal etc... Each type of trusses gives different results for different seismic zones so, based on economical condition we have choose belt truss. Belt truss drew to the model in the ETAB software will be shown in below.

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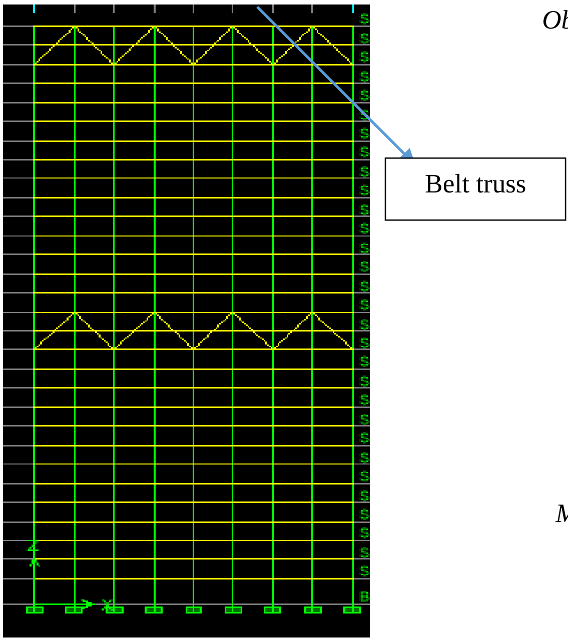

Fig1: shows belt truss provided to the exterior columns

Effect of earthquake on Reinforced concrete buildings

In recent past year's reinforced concrete buildings have become common in urban places. The main challenge in tall building is to resist the wind and earthquake forces. The reinforcing steel bars and concrete are the two key materials used in reinforced concrete building. A typical RC tall building is made of horizontal and vertical member and supported by foundation on rest of the ground. To resist the earthquake forces the RC frames plays a vital role. The inertia forces generated by earthquake shaking are proportional to mass of the building. The mass of the building is present at the floor level, the inertia forces due to earthquake is always induced at floor levels. As the forces from top of the building are transferred to the base of the building, the base of the building is more affected by the earthquake induced forces.

II. SCOPE AND OBJECTIVE OF WORK

Scope of work

The Present work aims towards analyzing the behavior of a plan with 30 storey high rise building, with the implementation of different belt truss system. To know the importance belt truss systems, a conventional base model is created with only beams, slabs and columns, and it is compared with implementation of different belt truss systems. As per code IS 1893 2002 dynamic analysis is carried out by response spectrum method before that equivalent static process of analysis is carried using ETABS. The shear core wall has been exhibited as shell element with meshing, beams and columns are exhibited as beam elements with concrete structure. Further study is extended to find out the % reduction of displacement and storey drift at the different seismic zones.

Objectives

- A 3-Dimensional plan building is modeled.
- For the model, additional belt truss is implemented and analyzed.
- Analysis is carried out using Equivalent static and response spectrum method as per IS 1893 – 2002.
- Response of the buildings are studied and compared and conclusions are drawn regarding the effectiveness of structural systems for different seismic zone of the building.
- Finding the % reduction of displacement and story drift of the different seismic zone of the building.

III. METHODOLOGY

Modelling: **-** Modeling will be done using ETAB [extended three dimension analysis of building system] software of version 9.7.4.

- M1-Base model of 30 story building.
- M2- 30 story building with x type of belt truss.
- M3- 30 story building with shear core and x type of belt truss.
- M4- 30 story building with inverted v type of belt truss.
- M5- 30 story building with shear core and inverted v types of belt truss

Loading: **-** loading will be taken from

- As per IS-875 (Part 1) 1987 for dead load is 2KN/M2
- As per IS 875 (Part 2) 1987 for live load is 4 KN/M2
- The earthquake parameter considered from code as per IS 1893(part-1)-2002 for analysis are given below tables.

Table 1: Earth quake different parameter used for analysis

	Values	Page no	Table	Clauses
Importance Factor	1	18	7	6.4.2
Response reduction factor	3	23	8	6.4.2
Soil type	II	16	2	6.4.2

Table 2: Zone factor for different seismic zone as per clause (6.4.2) in IS- 1893 2002

Seismic zone	Seismic intensity	Zone factor (Z)
II	Low	0.10
III	Moderate	0.16
IV	Severe	0.24
V	Very severe	0.36

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Modelling data of Building

1 Type of Structure Multi Story: Ordinary Moment Resisting Frame: RCC
2 Zone: II, III, IV, V
3 Layout Plan Dimension (X, Y): 40 m x 20 m, Each Bay 5 m
4 No. Of Stories: 30 Stories
5 Total Height of the Building above Ground Level: 91 m
6 Floor Heights
All Typical Floors = 3.00 m,
Bottom Story Ht. 4m
7 External walls: 6 kN/m2
8 Live load: 4.0 kN/m2
9 Super Dead Load: 2 kN/m2
10 Materials: M25, Fe 500
11 Section Properties
Beam 450x750 mm
Columns 450x750 mm
Slab Thickness 175mm
12 Seismic analysis: Equivalent static and response spectrum method as per IS 1893 – 2002.

The model will be regular building of dimension 40mx20m in which each bay having 5m as shown in below fig. For structure fixed support had given at ground level. The building will be of 30 stories at bottom is 4m height and remaining will be of 3m height. The three dimensional analysis for the model is carried out. The columns and beams are represented by frame type element. Building plan view will be shown below

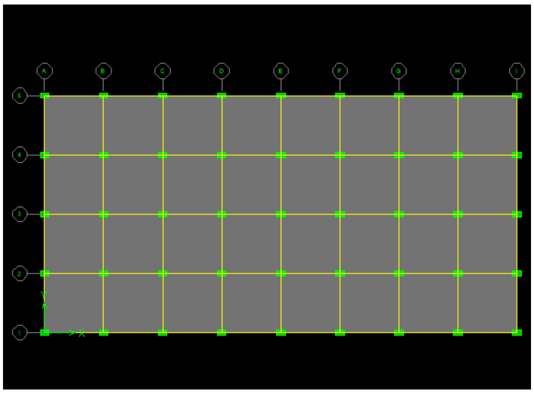

Fig 2 : plan view

Analysis: - For an 30 story building with and without shear core using ETAB software results will be extracted by using equivalent static and response spectrum method (dynamic analysis) for different seismic zones done by providing different type of belt trusses to the model.

Extraction of Results: The results obtained under different seismic zones will be compared and a graph will be drawn to check which model is more suitable for the seismic protection. Than we have to find the percentage reduction of displacement and story drift for 30 story building.

As per IS 1893 (part 1) 2002, for different seismic zone and importance factor is I=1. The medium type of soil is used with response reduction factor (R) is 3. The fundamental time period is calculated as per clause 7.6.2 is

$$T_a = 0.075h^{0.075}$$

Method of Analysis

In this present study method of analysis is made for Equivalent Static method and Dynamic analysis method (only response spectrum method) for seismic loads acting on the structure.

1. Seismic analysis is the calculation of the building response of structure to earthquake and is a relevant part of structural design where earthquakes are prevalent.
2. The seismic analysis of a structure involves evaluation of the earthquake forces acting at various levels of the structure during an earthquake and the effectiveness of such forces on the behavior of the overall structure. The analysis may be static or dynamic in approach as per the code provisions.
3. In the process of structural analysis system the analysis is carried out to predict its behaviors by using mathematical equation and physical laws.
4. Under various load effects, the main objective of structural analysis is to determine internal forces, stresses and deformation of structures.

The analysis of the building is carried out by following methods of analysis

1. Equivalent Static Analysis Method
2. Dynamic Analysis Method

Equivalent Static Analysis: The dynamic nature of the load must be considered when designing against seismic loads. The equivalent linear static method is sufficient for analysis for simple regular structure by using formula given in the IS code the distribution and estimate of base shear is calculated. Tall buildings with second and higher modes can be important with torsion effects are less suitable for this method and require more complex method to be used in these circumstances. Equivalent static Analysis method is used for estimation of structural displacement demands. The total applied force shall be equal to the product of the acceleration response spectrum (ARS) and the tributary weight. The horizontal force shall be applied at the vertical centre of the superstructure mass and is distributed horizontally in proportion for mass distribution.

Dynamic analysis: It should be performed to get the design seismic force, and its allotment to different levels along the height of the building and to different lateral load resisting elements, for the following buildings:

- Regular buildings- Those are bigger than 40 m in height in zone IV, V and those are bigger than 90 m height in zones II,III, and
- Irregular buildings-All framed buildings elevated than 12 m in zone IV and V, and those are bigger than 40 m in height in zone II and III.

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Dynamic analysis can be performed by time history method or by the response spectrum method. Though in both methods, the design base shear (Vb) should be compared with a base shear (vb) calculated using a basic period Ta. When (Vb) is less than (vb) all the response quantities shall be multiplied by Vb /vb .The values of damping for a building may be taken as 2 and 5 percent of the critical, for the purpose of dynamic analysis of steel and reinforced concrete buildings, respectively.

IV. RESULTS AND DISCUSSIONS

The lateral displacement and storey drift play an important role, especially for tall building due to sudden variation of load because of its more deflection and less stiffness. To increase stiffness and strength of the building we are going to provide belt truss and also shear core. Models which we used for results extraction are

- M1-Base model 30 story building.
- M2- 30 story building with x type of belt truss.
- M3- 30 story building with shear core and x type of belt truss.
- M4- 30 story building with inverted v type of belt truss.
- M5- 30 story building with shear core and inverted v types of belt truss.

30 story building has been used for extraction of results. Results are extracted using ETAB software. The building will be of concrete so, concrete type of belt truss are provided are effective at coupling exterior columns to the core of a tall building. The belt truss would result in a stiffer building which is not the more flexible so we have provide core to the building tends to give effective results. Belt trusses engage all the exterior column during application of seismic load so the load from core has converted to horizontal forces from core to the outrigger through belt truss.
The results we extracted from two methods one is equivalent static and other is response spectrum method. Here, live load and dead load implemented from code book IS 875 (part 1 and part 2). And earthquake values are taken from code book IS 1893 2002 (part 1) and dynamic analysis are done based on code book than the results had been checked after running the analysis. The results extracted will be for displacement and storey drift.
After extracting results we can see from the graph that for zone 2, zone 3, zone 4 and zone 5 displacement value along x and y increases both in equivalent and response spectrum increases in the base model. After implementation of belt truss at top and middle there will be % reduction of displacement and storey drift along both axis in both method. Reduction of displacement will be around 35% in response spectrum and in equivalent method below 10% under all seismic zones.

Results obtained for 30 storey building in Zone 2

Table 3:- % Reduction of zone 2 along x and y axis of equivalent and response spectrum method.

Methods	Axis	% Reduction of Displacement	
Equivalent static method	X- axis	M2 & M4	7
		M3 & M5	31
	Y-axis	M2 & M4	3.46
		M3 & M5	32
Response spectrum method	X-axis	M2 & M4	5
		M3 & M5	31
	Y-axis	M2 & M4	2.6
		M3 & M5	36

Under zone 2 the intensity of earthquake will be of 0.10 so, that less effects to the building will happen under earthquake load. Here, for 30 storey building lateral displacement and storey drift for X and Y axis in equivalent and response spectrum method will be found.
In Equivalent method along X and Y displacement value will be of 32.86 and 61.14, after application of belt truss X and inverted V type to the building without shear core 7% and 3.46% along X-axis and Y-axis reduction take place. And If the building with belt truss and shear core than, % reduction value will be of 31% and 32% along X and Y axis.
In response spectrum method along X and Y displacement value will be of 25.24 and 45.24, after application of belt truss X and inverted V type to the building without shear core 5% and 2.6% along X-axis and Y-axis reduction take place. And if the building with belt truss and shear core than, % reduction value will be of 31% and 36% along X and Y axis.
In case of storey drift, both in equivalent and response spectrum method from the graph shown in fig (3, 4, 5 and 6), in base model a drift will be more at top up to middle than sudden falling of drift take place due to that stiffness reduces and building damage take place. So, after providing belt truss of X and inverted V only at the middle drifting will reduces and at top and bottom will be of same as base model. But, if we provide the building with shear core drift at bottom, top and middle reduces because of coupling phenomena and tends to increasing of stiffness in the building.

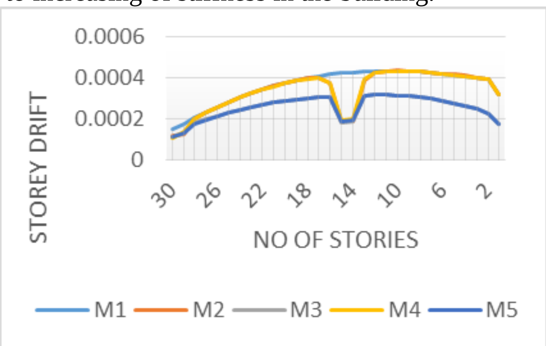

Fig 3:- Storey drift values of equivalent along x-axis

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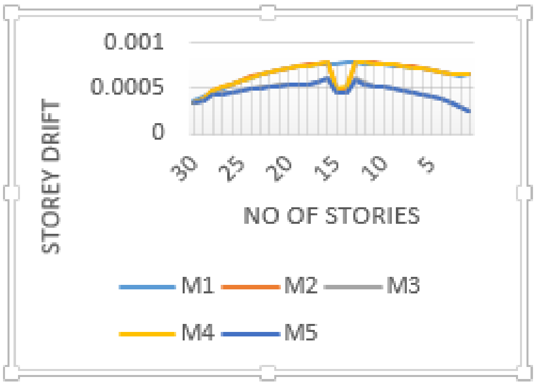

Fig 4:- Storey drift values of equivalent along y-axis

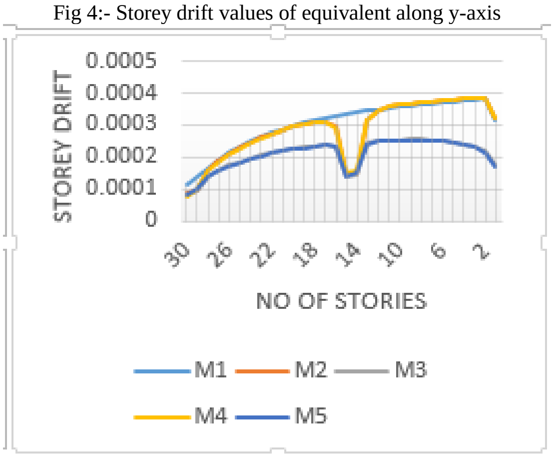

Fig 5:- Storey drift values of response spectrum method along x-axis

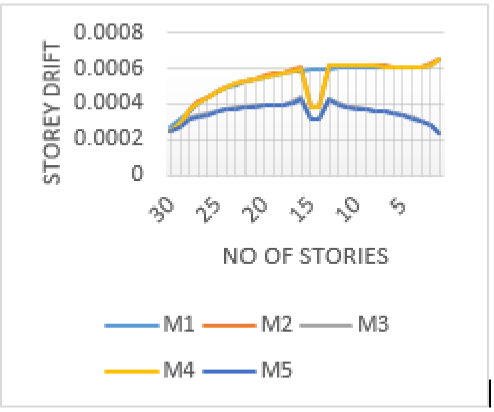

Fig 6:- Storey drift values of response spectrum method along y-axis

Graphs are drawn to know the % reduction and which model is best suitable in zone 2

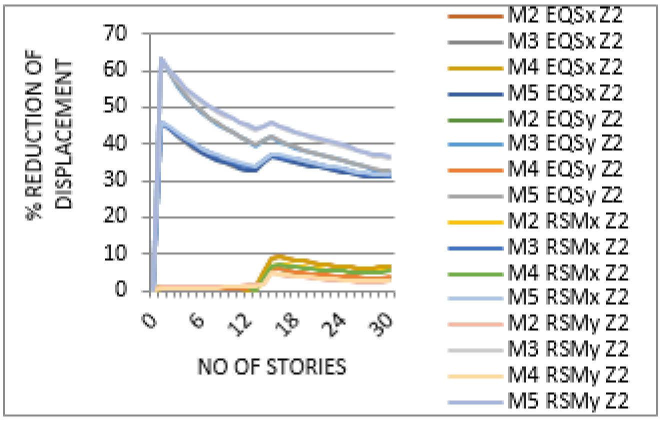

Fig 7: % reduction of displacement.

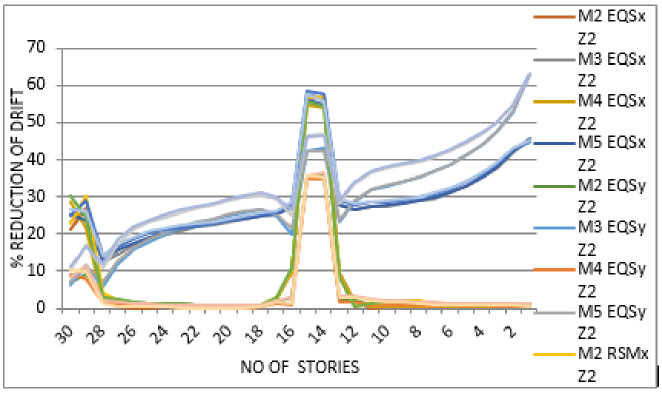

Fig 8: % reduction of storey drift.

From the graphs shown in fig (7 and 8) we can say that in zone 2 if we provide the model with X or inverted V type of belt truss, at bottom no changes in displacement only after belt truss provision at the middle, from there to top it will reduces. In case of drift only at the middle drift reduces but, in case of shear core reduction will take place in top, middle and bottom both in drift and displacement.

So, we can say that in zone 2 due to less intensity from an economical purposes we can provide a building with inverted belt truss without shear core and also we built building with shear core along with inverted V or X type of belt truss can be used.

Results obtained for 30 storey building in Zone 3

Table 4:- % Reduction of zone 3 along x and y axis of equivalent and response spectrum method

Methods	Axis	% Reduction of Displacement	
Equivalent Static method	X- axis	M2 & M4	6.68
		M3 & M5	31
	Y-axis	M2 & M4	3.5
		M3 & M5	32
Response spectrum method	X-axis	M2 & M4	3.1
		M3 & M5	31
	Y-axis	M2 & M4	1
		M3 & M5	36

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Under zone 3 the intensity of earthquake will be of 0.16 so, more effects to the building compare to zone 2 under earthquake load. Here, for 30 storey building lateral displacement and storey drift along X and Y axis in equivalent and response spectrum method have to be find.

In Equivalent method along X and Y displacement value will be of 52.57 and 97.82, after application of belt truss X and inverted V type to the building without shear core 6.68% and 3.5% along X-axis and Y-axis reduction take place. And If the building with belt truss and shear core than, % reduction value will be of 31% and 32% along X and Y axis.

In response spectrum method along X and Y displacement value will be of 40.399 and 72.45, after application of belt truss X and inverted V type to the building without shear core 3.1% and 1% along X-axis and Y-axis reduction take place. And if the building with belt truss and shear core than, % reduction value will be of 31% and 36% along X and Y axis.

In case of storey drift, both in equivalent and response spectrum method from the graph shown in fig (9, 10, 11 and 12), in base model a drift will be more at top up to middle than sudden falling of drift take place due to that stiffness reduces and building damage take place. So, after providing belt truss of X and inverted V only at the middle drifting will reduces and at top and bottom will be more compared to base model. But, if we provide the building with shear core drift at bottom, top and middle reduces because of coupling phenomena and tends to increasing of stiffness in the building.

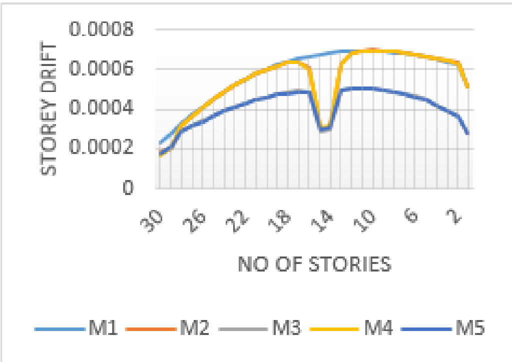

Fig 9:- Storey drift values of equivalent method along x-axis

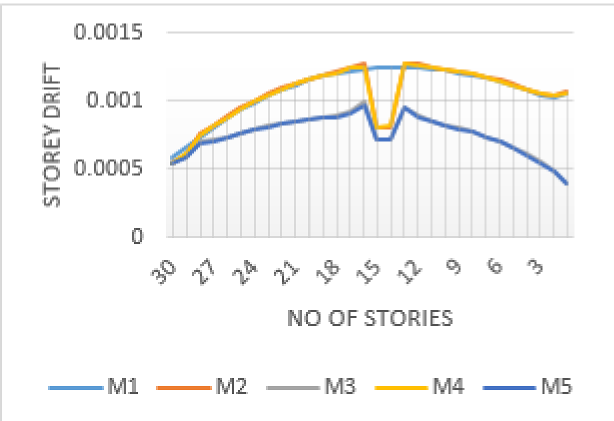

Fig 10:- Storey drift values of equivalent method along y-axis

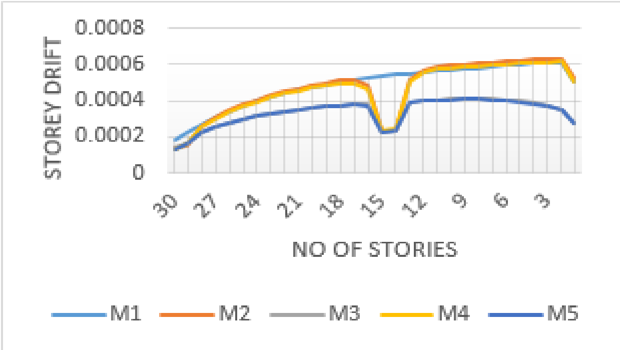

Fig 11:- Storey drift values of response spectrum method along x-axis

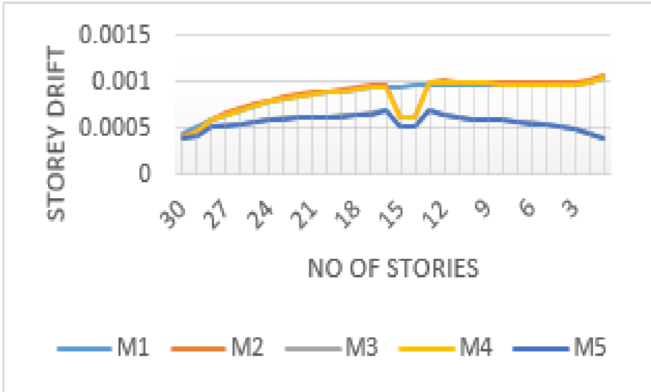

Fig 12:- Storey drift values of response spectrum method along y-axis

Graphs are drawn to know the % reduction and which model is best suitable in zone 3

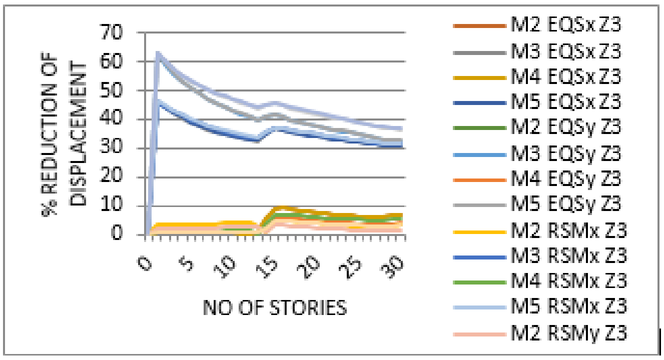

Fig 13: % reduction of displacement

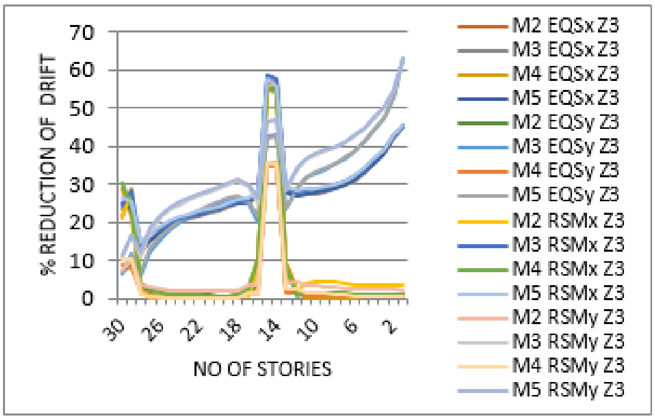

Fig 14: % reduction of storey drift.

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From the graphs shown in fig (13 and14) we can say that in zone 3, if we provide the model with X or inverted V type of belt truss, at bottom no changes in displacement only after belt truss provision at the middle, from there to top it will reduces. In case of drift only at the middle drift reduces but, in case of shear core reduction will take place in top, middle and bottom both in drift and displacement.
So, we can say that in zone 3 from an economical purpose building with shear core along with inverted V or X type of belt truss can be used.

Results obtained for 30 storey building in Zone 4

Table 5:- % Reduction of zone 4 along x and y axis of equivalent and response spectrum method

Methods	Axis	`% Reduction of Displacement	
Equivalent Static method	X- axis	M2 & M4	6.68
		M3 & M5	31
	Y-axis	M2 & M4	3.5
		M3 & M5	34
Response spectrum method	X-axis	M2 &M4	5.4
		M3 & M5	32
	Y-axis	M2 & M4	3.2
		M3 & M5	36

Under zone 4 the intensity of earthquake will be of 0.24 so, more effects to the building compare to zone 2 and zone 3 under earthquake load. Here, for 30 storey building lateral displacement and storey drift along X and Y axis in equivalent and response spectrum method have to be find out. In Equivalent method along X and Y displacement value will be of 78.86 and 137.83, after application of belt truss X and inverted V type to the building without shear core 6.68% and 3.5% along X-axis and Y-axis reduction take place. And If the building with belt truss and shear core than, % reduction value will be of 31% and 34% along X and Y axis.
In response spectrum method along X and Y displacement value will be of 60.59 and 108.67, after application of belt truss X and inverted V type to the building without shear core 5.4% and 3.2% along X-axis and Y-axis reduction take place. And if the building with belt truss and shear core than, % reduction value will be of 32% and 36% along X and Y axis.
In case of storey drift, both in equivalent and response spectrum method from the graph shown in fig(15, 16, 17 and 18), in base model a drift will be more at top up to middle than sudden falling of drift take place due to that stiffness reduces and building damage take place. So, after providing belt truss of X and inverted V only at the middle drifting will reduces and at top and bottom will be more compared to base model. But, if we provide the building with shear core drift at bottom, top and middle reduces because of coupling phenomena and tends to increasing of stiffness in the building.

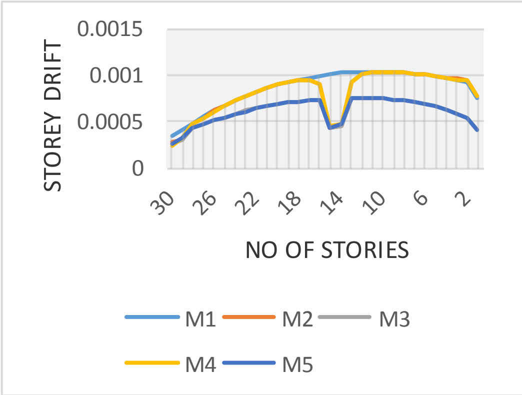

Fig 15:- Storey drift values of equivalent method along x-axis

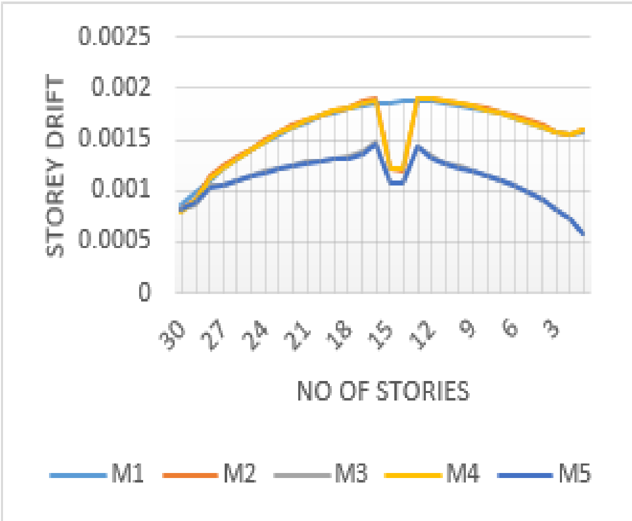

Fig 16:- Storey drift values of equivalent method along y-axis

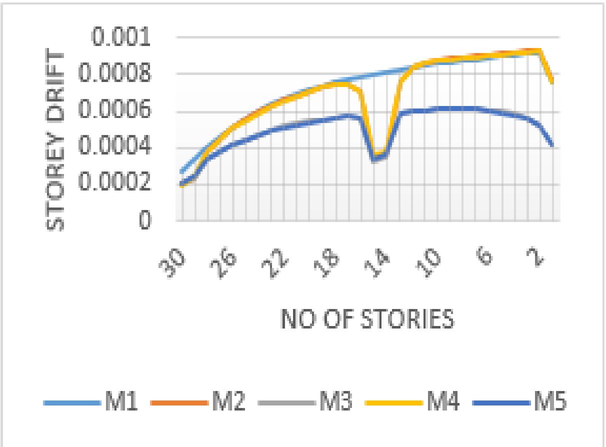

Fig 17:- Storey drift values of response spectrum method along x-axis

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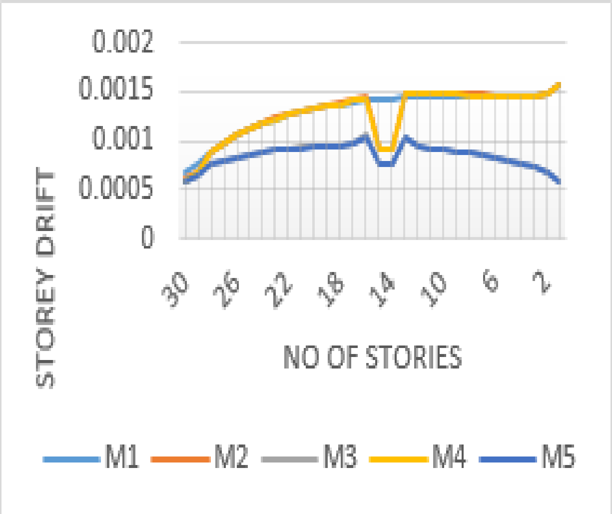

Fig 18:- Storey drift values of response spectrum method along y-axis

Graphs are drawn to know the % reduction and which model is best suitable in zone 4

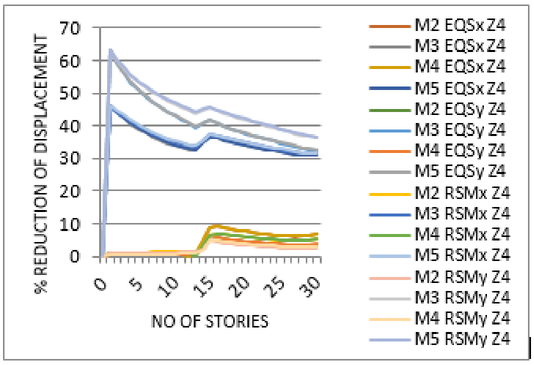

Fig 16: % reduction of displacement

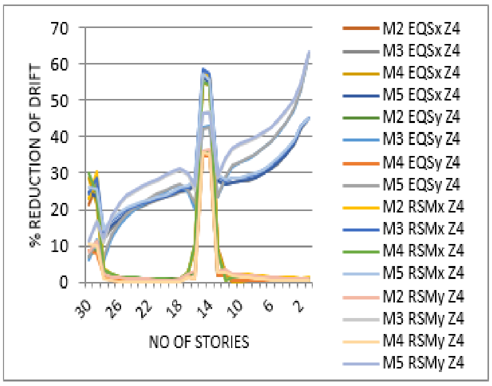

Fig 17: % reduction of storey drift.

From the graphs shown if fig (16 and 17) we can say that in zone 4, if we provide the model with X or inverted V type of belt truss, at bottom no changes in displacement only after belt truss provision at the middle, from there to top it will reduces. In case of drift only at the middle drift reduces but, in case of shear core reduction will take place in top, middle and bottom both in drift and displacement. So, we can say that in zone 4 from an economical purpose building with shear core along with inverted V of belt truss can be used.

Results obtained for 30 storey building in Zone 5

Table 6:- % Reduction of zone 5 along x and y axis of equivalent and response spectrum method

Methods	Axis	% Reduction of Displacement	
Equivalent Static method	X- axis	M2 & M4	6.7
		M3 & M5	31
	Y-axis	M2 & M4	3.5
		M3 & M5	32
Response spectrum method	X-axis	M2 & M4	4.9
		M3 & M5	31
	Y-axis	M2 & M4	3.2
		M3 & M5	36

Under zone 5 the intensity of earthquake will be of 0.36 so, more effects to the building compare to zone 2, zone 3 and zone 4 under earthquake load. Here, for 30 storey building lateral displacement and storey drift along X and Y axis in equivalent and response spectrum method have to be find out. In Equivalent method along X and Y displacement value will be of 118.30 and 220.10, after application of belt truss X and inverted V type to the building without shear core 6.7% and 3.5% along X-axis and Y-axis reduction take place. And If the building with belt truss and shear core than, % reduction value will be of 31% and 32% along X and Y axis.

In response spectrum method along X and Y displacement value will be of 90.44 and 163.01, after application of belt truss X and inverted V type to the building without shear core 4.9% and 3.2% along X-axis and Y-axis reduction take place. And if the building with belt truss and shear core than, % reduction value will be of 31% and 36% along X and Y axis.

In case of storey drift, both in equivalent and response spectrum method from the graph shown in fig (18, 19, 20 and 21), in base model a drift will be more at top up to middle than sudden falling of drift take place due to that stiffness reduces and building damage take place. So, after providing belt truss of X and inverted V only at the middle drifting will reduces and at top and bottom will be more compared to base model. But, if we provide the building with shear core drift at bottom, top and middle reduces because of coupling phenomena and tends to increasing of stiffness in the building.

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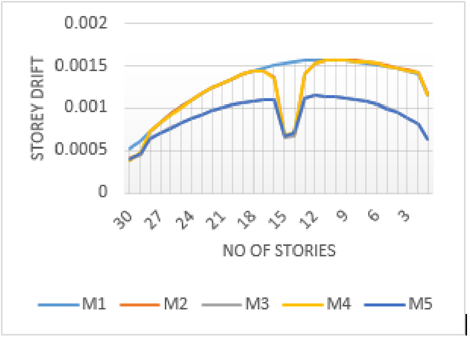

Fig 18:- Storey drift values of equivalent method along x-axis

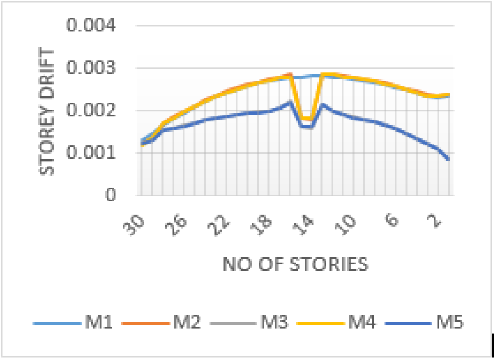

Fig 19:- Storey drift values of equivalent method along y-axis

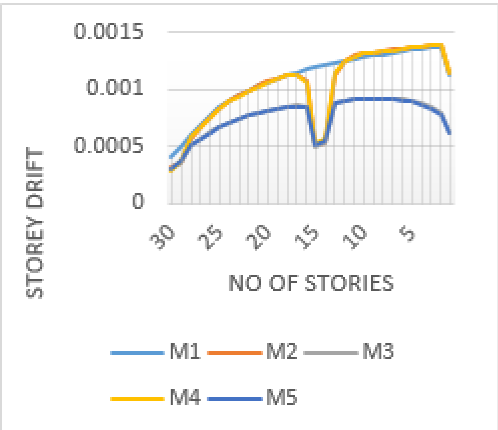

Fig 20:- Storey drift values of response spectrum method along x-axis

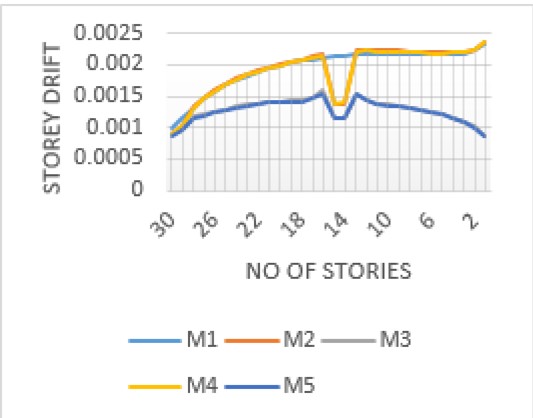

Fig 21:- Storey drift values of response spectrum method along y-axis

*Graphs are drawn to know % reduction and which model is best suitable in zone **5***

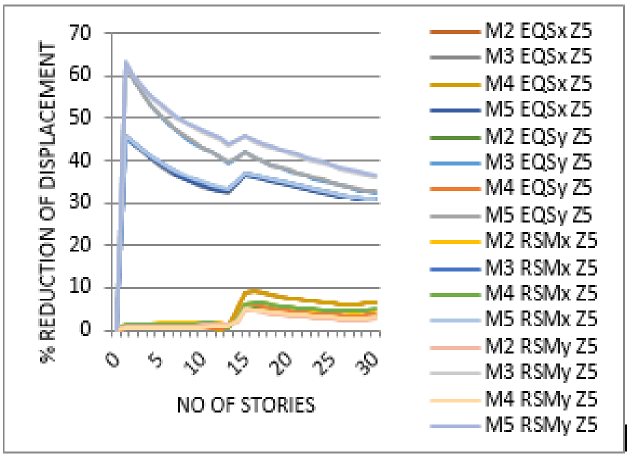

Fig 22: % reduction of displacement.

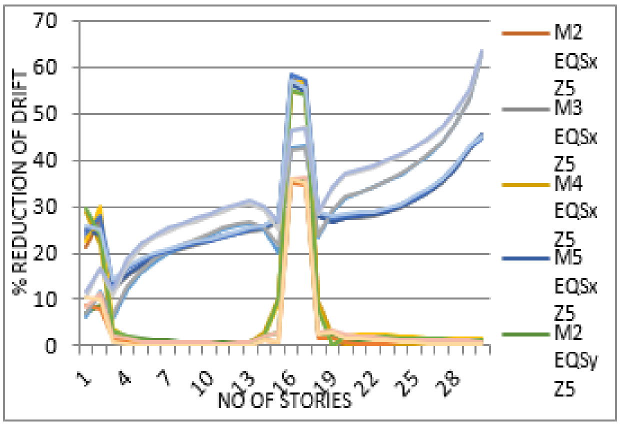

Fig 23: % reduction of storey drift.

From the graphs of (22 and 23) we can say that in zone 5, if we provide the model with X or inverted V type of belt truss, at bottom no changes in displacement only after belt truss provision at the middle, from there to top it will reduces. In case of drift only at the middle drift reduces but, in case of shear core reduction will take place in top, middle and bottom both in drift and displacement.

So, we can say that in zone 5 from an economical purpose and also high intensity it's better to use a building with shear core along with inverted V type of belt truss.

V. CONCLUSION AND SCOPE FOR FUTURE STUDY

Structure strength, stiffness and stability can be increased only by proper designing along with that we have to consider some parameter like type of soil, seismic zone area, structural height, environmental condition etc... The present study compares the difference in the behavior of building by using different belt truss and also with and without shear core of the building.

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The following conclusions were drawn based on the project study along with observing % reduction of displacement and storey drift graphs with different seismic zone criteria.

- The usage of belt truss system in the building increases the efficiency when compared to the building without belt truss under the action of seismic loads.
- Belt truss plays a vital role in increasing structural stiffness by reducing base shear under the action of static and dynamic loads.
- Provision of shear core at the center of the building plays vital role by increasing the % reduction of displacement and storey drift.
- Concrete belt truss is more efficient in reducing the lateral displacement and storey drift for the concrete building. We should not use steel type of belt truss to the concrete building which gives negligible results.
- The introduction of belt trusses with shear core will increase % reduction of storey drift in the top, middle and bottom storey in all the seismic zones.
- In zone III, IV and V, building have to provide with shear core along with belt truss because of its intensity is more and damages to the building and sudden collapse of building chances are more.
- In zone II, III, IV and V, building have to provide with shear core along with belt truss because of no variation in the graph at top and bottom storey and at middle % reduction take place at the 14 and 15 storey but, at particular point in storey approximately 13 and 16 slight increases of drift more than base model..
- In zone II, there will be no problem even we can built a building without shear because of its less intensity and also % reduction in displacement will be at least 10 and at storey drift only at middle changes and at top and bottom no variation in graph.
- By absorbing results of graph we can tell that a building with inverted V type of belt truss is best for all seismic zones.

Scope for future study

- The building models can also compared by changing the type of soil to provide better % reduction of displacement and storey drift.
- The shear wall can be used instead of using core wall.
- The behavior of building with irregular shape can also be studied.
- Providing different type of belt truss to the setback building under different seismic zone can also be checked.
- The base isolation can be used along with belt truss without outrigger.
- More % reduction of displacement and storey drift can happen when we provide a building with outrigger and belt truss.

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