TEST Engineering & Management

January - February 2020
ISSN: 0193-4120 Page No. 8395 – 8401

Torsional Behavior of Multistorey Buildings with Different Structural Irregularities

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Article Info
Volume 82
Page Number: 8395 – 8401
Publication Issue:
January-February 2020

Article History
Article Received: *18 May 2019*
Revised: *14 July 2019*
Accepted: *22 December 2019*
Publication: *07 February 2020*

Abstract:
Currently we can see most of the buildings are asymmetric in map or in altitude dependent upon allocation of accumulation and rigidity along each storey all the way through the tallness of the structure. current earthquakes have revealed the unbalanced allocation of mass, solidity and strengths might reason serious damage in structural systems. break information on current earthquakes indicate to facilitate torsion moments often reason important break to structure, at time most important to their fall down. Torsional performance of multistory asymmetric structure can be the mainly common causes of structural harm and breakdown throughout strong earth movements. A study is going on the influence of the torsion belongings on the performance of structure is done by Response spectrum analysis (Dynamic Analysis).Different types of irregular buildings are analyzed with and without considering torsional provisions in the code, for analysis ETAB Software is used. A three dimensional examination by ETAB is clever to compute the middle of rigidity and center of mass, by getting these values and calculating designed eccentricity as per code provisions the analysis is performed. It is observed from results that percentage of reinforcement in building elements is increased while considering torsion in the building. From the cost comparison of different buildings it is observed that, for multi-storey buildings it is effective and economical to provide shear wall structure symmetrically in the building.

Keywords:*Vertical irregularity, Earthquake, Eccentricity, Torsion*.

1. INTRODUCTION

Quakes are the most unusual and obliterating of every single cataclysmic event, where it is hard to spare lives and properties, against it. The conduct of a structure during a tremor relies upon a few components, firmness, satisfactory horizontal quality and flexibility, basic and customary designs. The structures with customary geometry and consistently conveyed mass and solidness in plan just as in rise endure substantially less harm contrasted with unpredictable arrangements. Be that as it may, these days need and request of the most recent age and developing populace has made the draftsmen or architects unavoidable towards arranging of unpredictable setups. Basic plan of structures for seismic burdens is essentially worried about basic wellbeing during significant ground movements. A normal structure can be imagined to have consistently disseminated mass, firmness, quality and basic structure. At the point when at least one of these properties is non-consistently circulated, either separately or in blend with different properties toward any path, the structure is alluded to as being unpredictable. If there is torsion, the building will rotate about its center of rigidity, due to the torsional moment about the center of structural resistance.Thus the designers prefer to use symmetrical forms rather than asymmetrical ones. Fig.1 shows how torsional effects develop in a building.

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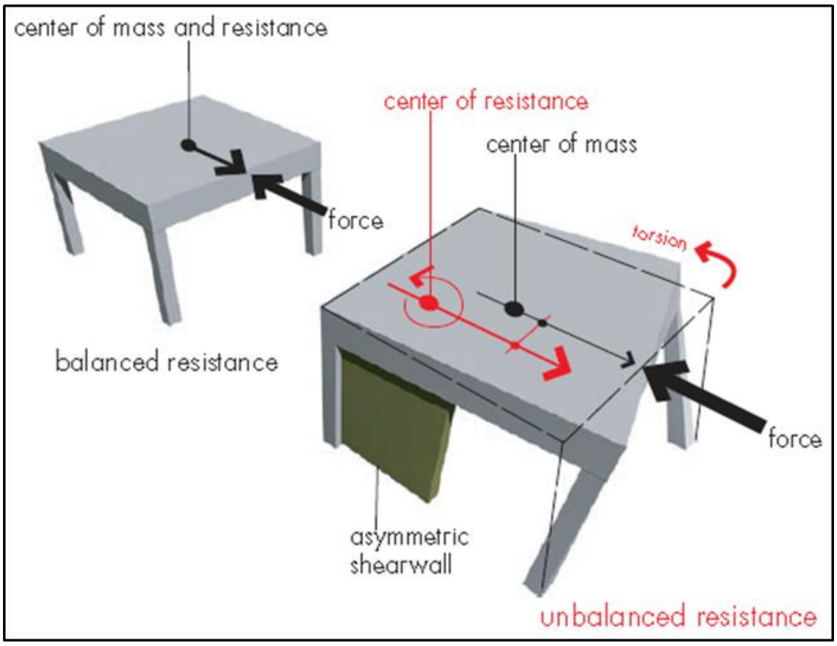

Fig 1 - Generation of torsion during seismic excitation

2. IS CODE PROVISIONS FOR TORSION:IS 1893 (PART 1): 2002 (CLAUSE 7.9):-

Torsion provisions are incorporated in most building codes to redistribute the strength among elements to minimize the torsion effects. Codes usually divide the buildings into regular and irregular buildings and consider that static torsion provisions will be suitable for regular buildings. For irregular buildings, design based on dynamic analysis, such as the response spectrum method, is suggested.

Torsion: Provision shall be made in all buildings for increase in shear forces on the lateral force resisting fundamentals resulting starting the level torsional moment coming owing to eccentricity flanked by the centre of accumulation and middle of rigidity. The mean forces intended as need to get functional to middle of mass properly moved as a result to effect plan peculiarity among the moved middle of mass with middle of inflexibility. though, -ve torsional cut off be abandoned.

Design peculiarity: The design peculiarity, e_{di} to be worn at level i : $e_{di} = 1.5e_{si} + 0.05b_i$

$= e_{si} – 0.05\ b_i$

Anyone amongst produce extra severe result within the cut off of any frame.

Where, e_{di} = Designed peculiarity

e_{si} = fixed eccentricity at ground i

b_i= Floor map measurement i, at right angles to the direction of force.

NOTE – The feature 1.5 shows dynamic amplification, while the feature 0.05 showsaccidental eccentricity.

Dynamic Amplification – Under dynamic condition, the effect of eccentricity is higher than under static load. Hence, a dynamic amplification is often applied to static eccentricity for computing design eccentricity.

An Accidental Eccentricity – An accidental eccentricity is considered because,

a) The computation of static eccentricity is approximate.
b) During the service life of building, there could be change in its use that may relocated the center of mass.
c) Ground motion itself may have some torsional component.

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Two Possible Cases for Design Eccentricity in Each Direction:

The center of mass is shifted through a distance equal to 0.05 bi. For each earthquake direction there are two earthquake load cases, for earthquake in X direction and in Y direction. There are total four earthquake load cases for building.

LOAD COMBINATIONS USED:

As per IS 1893 (part 1): 2002 Clause no. 6.3.1.2, the following load cases have to be considered for analysis:

1) 1.5(DL + LL)
2) 1.2(DL + IL $\pm$ EL)
3) 1.5(DL $\pm$ EL)
4) 0.9 DL $\pm$ 1.5 EL

Earthquake load must be considered for +X, -X, +Y and –Y directions. Moreover, design eccentricity can be such that it cause clockwise or anticlockwise moments. Thus $\pm$ EL above implies cases, and in all, 25 cases considered.

3. BUILDING DETAILS AND STRUCTURAL DATA:

One structural modelis used. All the models are asymmetric with respect to both X and Y axis to demonstrate many of the features expected from multi-story buildings subjected to seismic loading.

Building Details for Vertical Geometric Irregular (Setback) Building: The building is 15 storey with steps in 6th and 10th floor. The setback is along X direction.

Top Storey Width = 16; Ground Storey Width = 40

40/16 = 2.5 > 1.5

Table 1 - Structural data for Vertical Geometric Irregular (Setback) building.

Storey	=	15
Ground floor storey height	=	3.50 m
Intermediate floorstorey height	=	3.50 m
Depth of footing	=	3.00 m
Slab Depth	=	125 mm
External wall	=	230mm
Parapet (1m height)	=	230mm
Beam size	=	B1- 300 X 600 mm
Column size	=	99 Columns - 600X600 mm
		22 Columns - 450X450 mm
Shear Wall Thickness	=	230mm
Live load	=	4 kN /m^2
Roof Live load	=	3kN /m^2
Floor finish	=	1.875 kN /m^2
Dead load due to Outer wall	=	13.34 kN /m
Dead load due to Parapet wall	=	4.60 kN /m

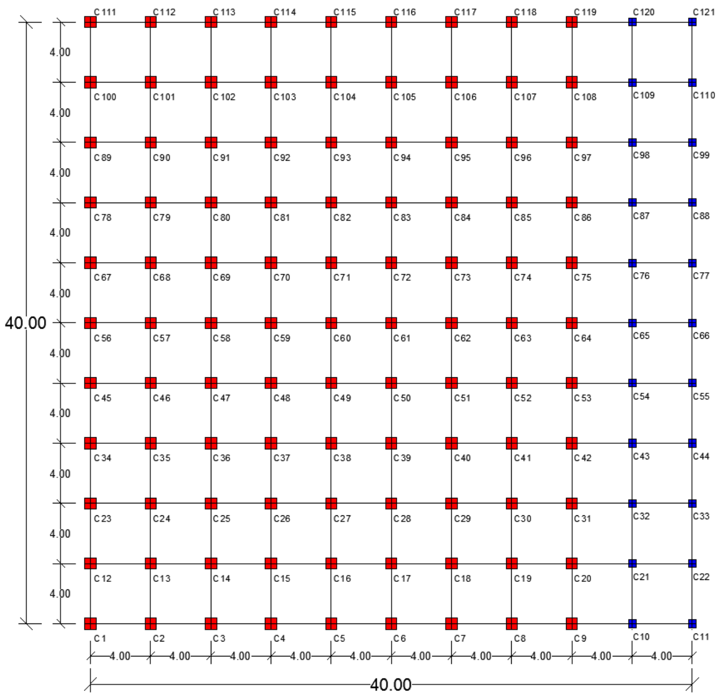

Figure 2- Plan view of Vertical Geometric Irregular (Setback) building.

4. RESULTS FOR VERTICAL GEOMETRIC IRREGULAR (SETBACK) BUILDING

Comparison of Maximum Storey Displacement

Maximum Storey Displacement in X Direction: The height of building is 55.5m. The maximum storey displacement allowable is 222 mm. The maximum storey displacement is exceeded in Torsion case.

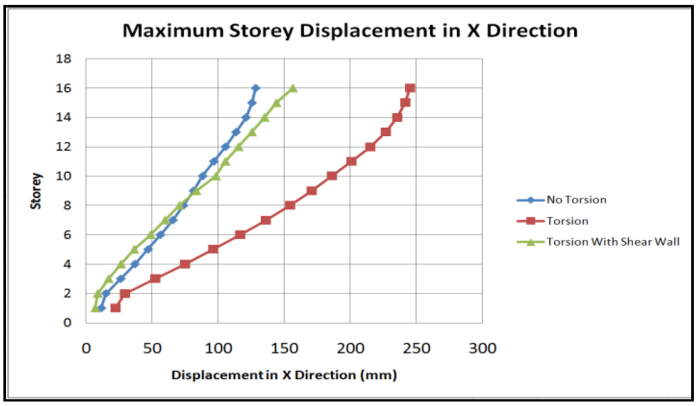

Figure 3- Layer disarticulation (X - Direction)

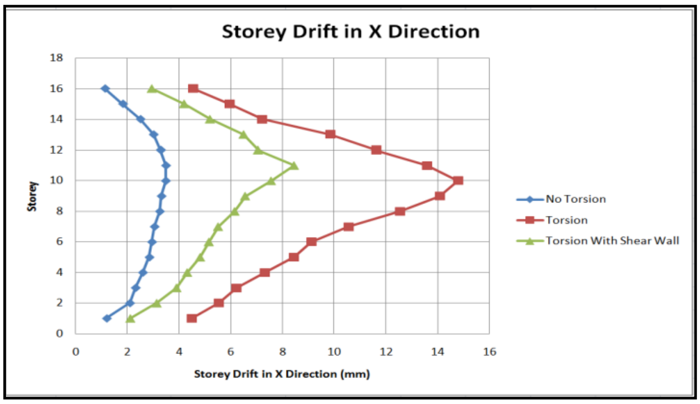

Figure 5 - Storey flow (X path)

Maximum Layer disarticulation (Y Direction): The height of building is 55.5m. The maximum storey displacement allowable is 222 mm. The maximum storey displacement is exceeded in Torsion case.

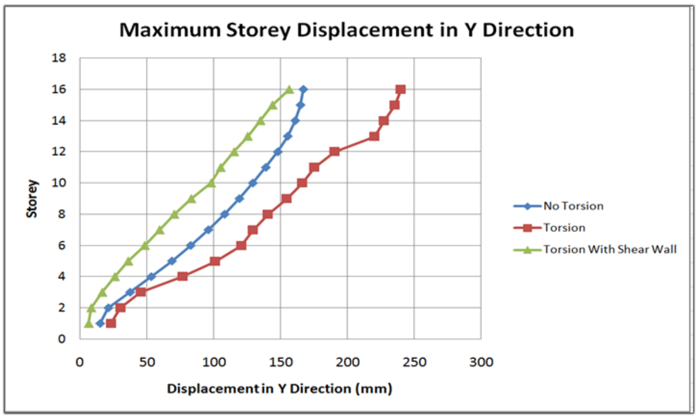

Figure 4 - Comparison of Layer disarticulation (Y Direction)

Difference Between Storey Drift

Storey Drift (X Direction): According to Clause no. 7.11.1 of IS 1893 (section 1):2002, the story float in any story because of indicated plan horizontal power with incomplete burden factor of 1.0,shall not surpass 0.004 occasions the story stature. The greatest story float allowed for all storey is 14 mm.

Storey flow (Y path): The maximum storey drift permitted for all storey is 14 mm.

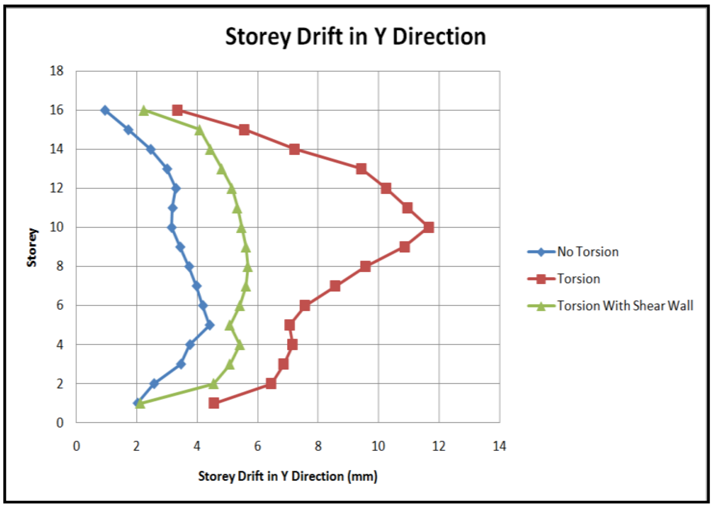

Figure 6 - Storey Drift (Y Direction)

Difference Between Storey Shear

Storey Shear (X Direction): Shear is maximum after addition of shear partition. It is found that after considering the effect of torsion, storey shear decreases from upper storey.

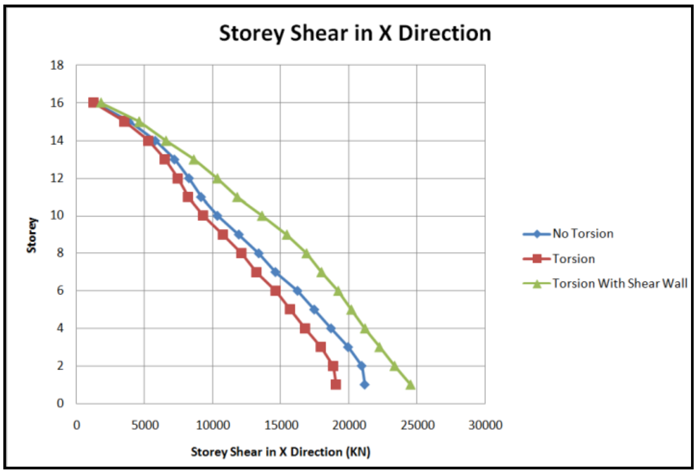

Figure 7 - assessment of Layer Shear (X way)

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Storey Shear (Y Direction):it is observed to facilitate shear is highest after addition of shear wall. It is found that after addition of eccentricity in building, storey shear decreases from upper storey.

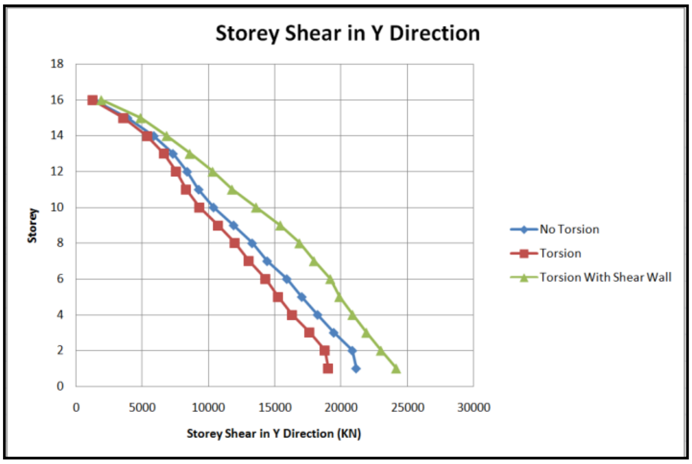

Figure 8 - Comparison of Storey Shear (Y Direction)

Comparison of StoreyStiffness

Storey Stiffness in X Direction: it is observed that shear stiffness is maximum after addition of shear wall. It is found that considering the effect of torsion, storey stiffness is decreases as compare to without torsion case.

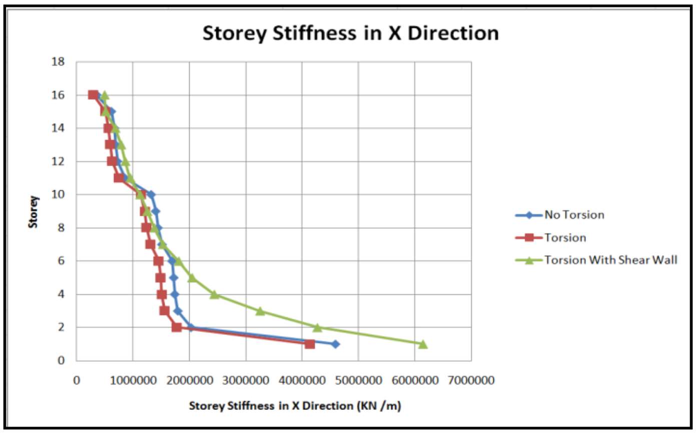

Figure 9- Comparison of Levels rigidity in X Direction

Levels rigidity in Y Direction: it is observed that shear stiffness is maximum after addition of shear wall. It is found that considering the effect of torsion, storey stiffness is decreases as compare to without torsion case.

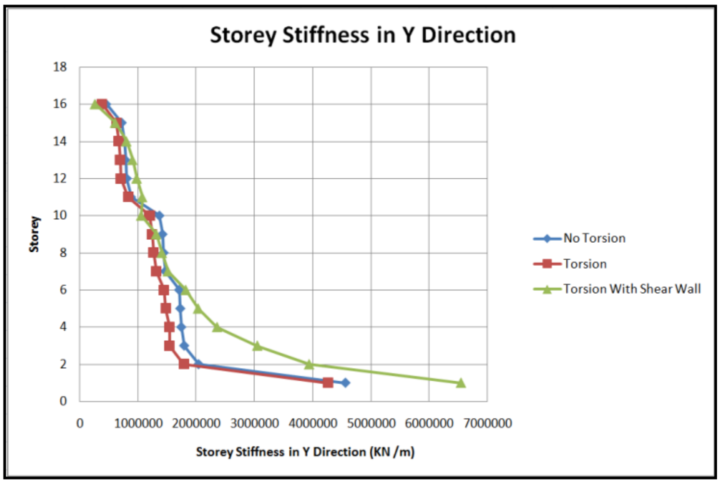

Figure 10 - assessment of Layer rigidity in Y track

assessment of Area of Steel in Column.

Reinforcement in columns: The reinforcement required for columns without considering torsion (No Torsion) and with considering torsion (Torsion) and with addition of shear wall. It is observed that after addition of torsion in the building, area of steel increasing in column and area of steel decreases after addition of shear wall.

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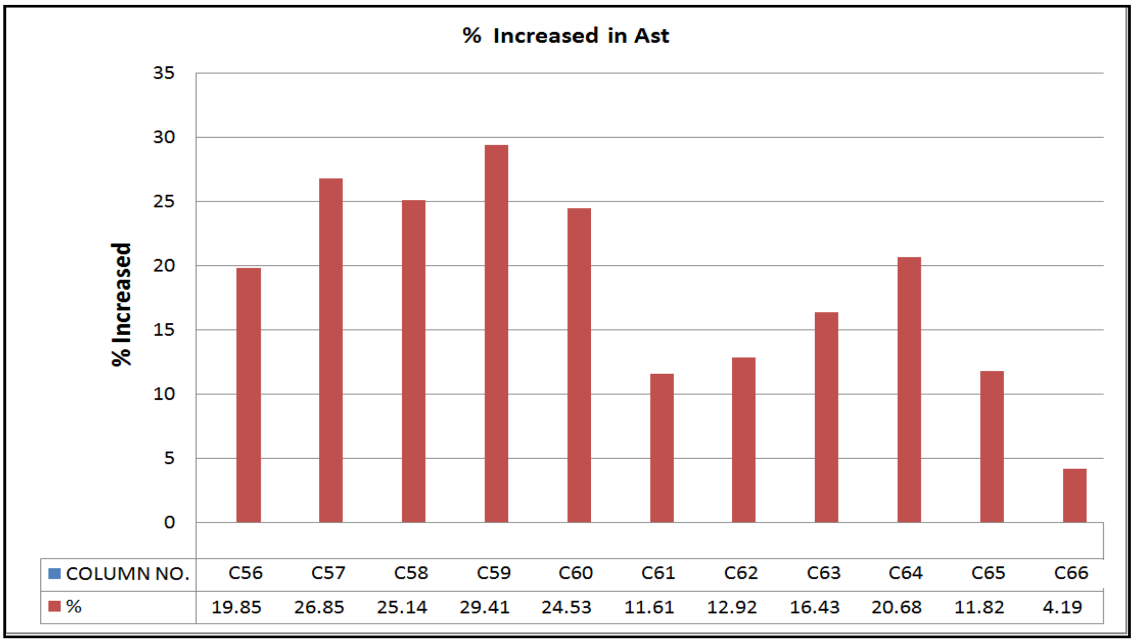

Figure 11 –Increase in Area of steel of column

Cost Comparison of Column: RCDC software is used for calculation of Estimate (Bill of Quantity).Table gives the cost of column for different cases.

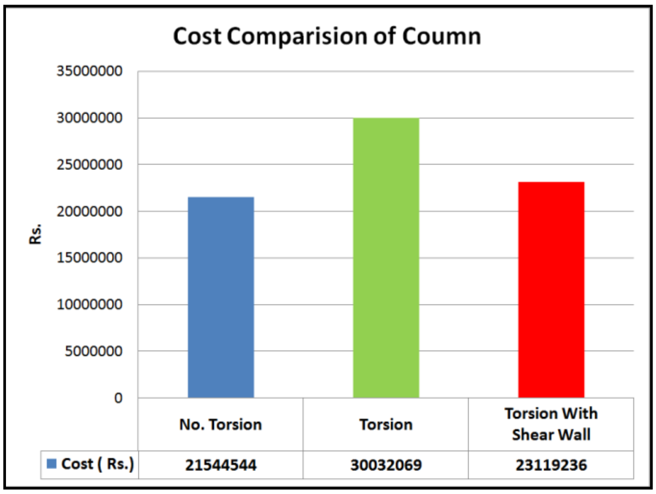

Figure 12 -Cost Comparison of Column(For Whole Structure)

Cost Comparison of in Beam: RCDC software is used for calculation of Estimate (Bill of Quantity).Table gives the cost of beam for different cases.

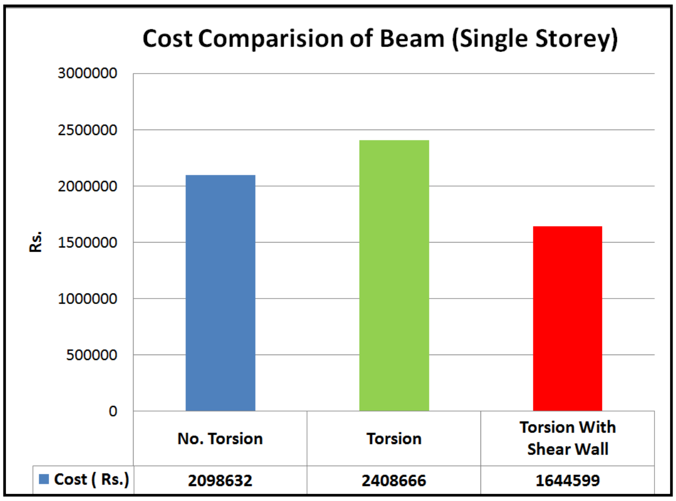

Figure 13 -Cost Comparison of Beam (For Single Storey)

5. CONCLUSION

Analysis and design work have been done. From the study and obtained results, conclusions are explained below.

1. In all buildings without shear walls the storey displacement exceeds permissible limits, that may be restricted by giving shear walls symmetrically.
2. By all structuress without shear wall the storey drift exceeds permissible limits in middle storey, which restricted by given that shear walls symmetrically.

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3. From Above results it is observed that the storey shear force is maximum for the first storey and it decreased to minimum in the top storey in all cases.
4. All buildings required higher percentage of reinforcement while considering torsion effect and after adding shear wall the percentage of reinforcement is less as compare to torsion case.
5. From results, it is concluded that cost of column increase in building having shear wall but at the same time cost of beam in each storey decreases.
6. From cost comparison graph,it can be concluded that the building must be design with addition of shear wall as there is not much difference in overall cost of structure.
7. For high-rise building with shear wall structure is very effective in resisting torsional forces,also less displacement and storey drift as compared to framed structure.

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