

# Comparative Study of Seismic Behaviour for Steel and Aluminium Framed Structures with Using Shear Links Brace

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**ABSTRACT:**As population of India is increasing rapidly, there is a high requirement of more shelters to settle down this population, thus there is a high demand of tall structure. Tall structures are generally facing a problem of lateral forces such as wind & seismic forces, in this study seismic forces are considered, which may causes failure of structure therefore to counteract these vast lateral forces there is need to have some special techniques in such tall structures. In this study some extra innovative technique are used to stabilize the structure by providing bracings and shears links in the structure and prepared a comparison between bare frame, frame with bracings and shear links with two different type of material such as steel and aluminium. For this Comparative study symmetrical plan of G+6 floors are considered in seismic zones IV & medium type soil as per I.S. 1893 part 1 2002. For analysing and modelling purpose STAAD.Pro programming is utilized and study is done on the premise of maximum storey displacement, axial forces, shear forces, maximum bending, storey drift, stiffness and displacement in X and Z direction. In this study 13 loading combination in each case as per Indian Standards are considered, dimensions of column and beam are taken as (400 mm x 400 mm) and (400 mm x 230 mm) respectively in all the cases. Result of all the cases are in the manner, aluminium bracing with shear link shows better result as compared to steel bracing with shear link on all parameters, steel bracing frame shows better results as compare to aluminium bracing.

**KEYWORDS:**Structural analysis, staad.pro, axial force, soil, seismic zone, shear links, bracings.

## I. INTRODUCTION

As the population of our country is increasing very rapidly, therefore to settle down this population there should be some arrangement like tall structure, which help to reduce the settlement problem of vast population. Tall structure is one of the alternate with the help of which, problem can be settled but construction of this type of structure in seismic area is most difficult task for engineers. Tall structure also helps us in many areas which include complex factors, financial matters, style looks, innovations, civil directions, and legislative issues. Among these, financial matters have been the essential administering factor. Contrasting and traditional orthogonal structures for tall structures, for example, encircled tubes, vertical shear connect improved structures convey parallel seismic loads substantially more productively by their corner to corner part's pivotal activity. A shear interface structure gives incredible basic productivity to limit stretch convergence of a structure with bracings. A shear interface structure is a sort of auxiliary framework comprising of bracings associated through even rings which make an exquisite and excess structure that is particularly productive for elevated structures. A vertical shear connect structure is unique in relation to supported casing frameworks, since shear board is vertically introduced at joints of propping as fundamental basic components take an interest in conveying gravity stack notwithstanding conveying horizontal load because of their design.

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## II. LITERATURE REVIEW

**Akshay Sonawane et al. (2016)**, focuses on the effect of bracing system on the storey that is critical in the structure. They studied on bracing systems like cross bracing, diagonal bracing, inverted V bracing and V bracing systems and results on components like storey drift and bending moment in columns and storey displacement were calculated.

**Vishwanath B. Patil (2016)**, studied on stability analysis of multistorey building with underneath satellite bus stop having Service soft storey and floating columns. In this investigation, the study of analysis of columns, shear walls, coupled component, single and multistorey structure was done. For the stability of the building, arrangements like bracing system and shear system is provided or combination of both was used.

**Giulia Milana et al. (2015)** analysed a G+40 tall structure with Different diagrid structures were considered, namely, three geometric configurations with inclination of diagonal members of 42°, 60° and 75°, and geometry considered is 36 x 36 m in lateral dimensions, and 160 m tall structure with circular shape. In this work the consider seismic Zone IV and did pushover analysis and concluded that providing diagrid is not only making economical building but also much stable in terms of safety.

**Anuj K. Chandiwala et al. (2014)** studied on seismic response of RC building with soft stories. The strong column and weak beam construction is done for the safety of building during earthquake. Because of this concept, beams yield before columns collapse. In this research, different models are analysed with soft storey for proper assessment of the stiffness of the storey. They concluded that displacement would be more at upper stories and less at lower stories.

**Raut Harshalata et al. (2014)** studied the effect of steel plate shear wall on behaviour of structure. In this paper, design and analysis of steel building is done with and without steel plate shear wall. G+6 storey building for seismic zone III is studied and static analysis is done using STAAD Pro software. The main components which were found out for the seismic performance are bending moment, shear force, deflection and axial force and comparison is done. The effect of shear wall is also considered.

## III. BUILDING DESCRIPTION

This study have selected five cases for comparison are-

1. First one is bare frame.
2. Second is frame with bracing of steel at the corners.
3. Third one is frame with bracings of steel and shear links.
4. Fourth one is bracings of aluminum at the corners.
5. Fifth one is bracings of aluminium and shear links.

The building configuration selected is a representative of building that is common in Indian seismic Zones IV as per IS: 1893-2002 (Part-1) located in medium soil region in seismic zone IV. The building is found to be deficient of the lateral seismic load corresponding to that of particular earthquake zone. Hence, it needs to be strengthened by providing aluminium and steel bracing with or without shear links; assumed value for this problem and material specification are shown in table 3.1 and table 3.2 respectively.

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Table 3.1: Building Description

S no.	Specifications	Value
1	Seismic zone	IV
2	Soil type Medium	Medium
3	Importance factor	1
4	Response reduction factor	3
5	Number of storey	6
6	Grade of concrete	M-20
7	Grade of steel	Fe-415
8	Slab thickness	150mm
9	Exterior wall thickness	230mm
10	Interior wall thickness 120 mm	120mm
11	Bay width in X direction	3 m
12	Bay width in Z direction	5 m
13	Size of beam	230 x 400 mm
14	Size of column	400 x 400 mm
15	Storey height	3.5

Table 3.1: Material Specification

s. no	Description	Values
1	Material property	Values
2	Grade of concrete	M-25
3	Young's modulus of concrete, $E_c$	$2.17 \times 10^4$ N/mm <sup>2</sup>
4	Poisson ratio	0.17
5	Tensile Strength, Ultimate steel	505 MPa
6	Tensile Strength, Yield steel	215 MPa
7	Elongation at Break steel	70 %
8	Modulus of Elasticity steel	193 - 200 GPa
9	Ultimate Tensile Strength aluminium	310 MPa
10	Tensile Yield Strength aluminium	276 MPa
11	Elongation at Break aluminium	12

## IV. MODELING AND ANALYSIS

A performance based approach is used for the seismic retrofitting design of the building, The performance of the building on various loading condition are find out to give precise result of this investigation, selection of building geometry rectangular shape(12 X 15 m) G+6 storey building, plan of structure shown in figure 1 and 3-D frame as shown in Figure.4.1.

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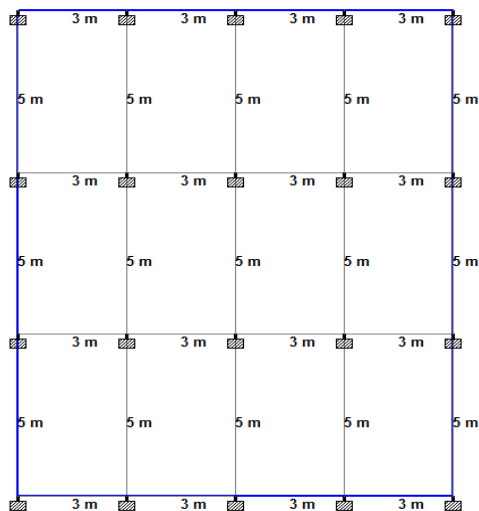


Fig 4.1 shows plan

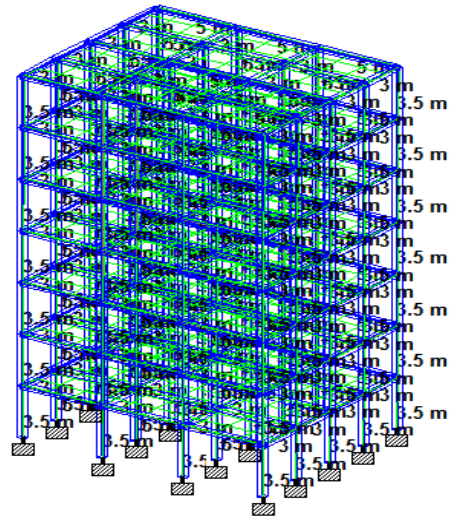


Fig 4.2 shows bare frame

**Case 1: Structure bare frame:** In this figure 4.2 shows structure without any extra innovative technique is modeled and analysed to compare with other cases to determine the variation in different cases respective to bare frame simple model. Geometry and loading is same for each case to determine the best stable case.

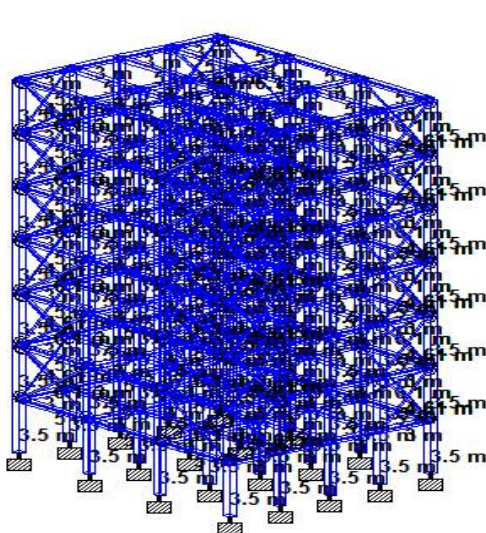


Fig 4.3 Shows structure with steel bracings at corners

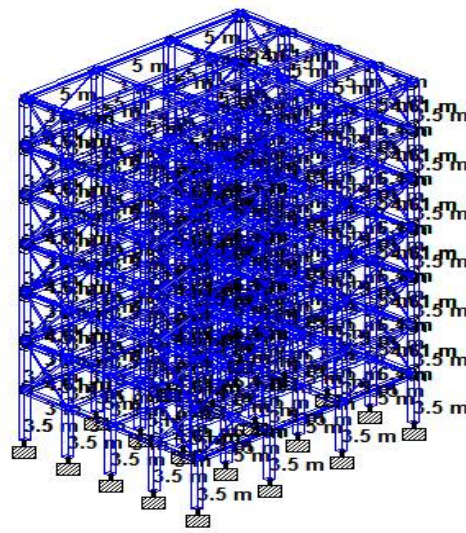


Fig 4.4 Shows structure with steel bracings with shear links

**Case 2: Structure with steel bracings at corners:** In this figure 4.3 shows X bracing is introduced at the corners of frame to determine its impact on lateral forces for which in this case they have selected steel as a material of bracing to diagnose its stability for comparative study. Here geometry and loadings are same as of bare frame frame, these steel X bracings are of size 110X 5 mm.



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**Case 3: Structure with steel bracings with shear links:** In this figure 4.4 shows X bracing with links at the joint is introduced at the corners of frame to determine its impact on lateral forces for which in this case we have selected steel as a material of bracing to diagnose its stability for comparative study and links to resist lateral load more easily with increasing its life span. Here geometry and loadings are same as of bare frame frame, these steel X bracings are of size 110X 5 mm with shear links at the supports of bracings.

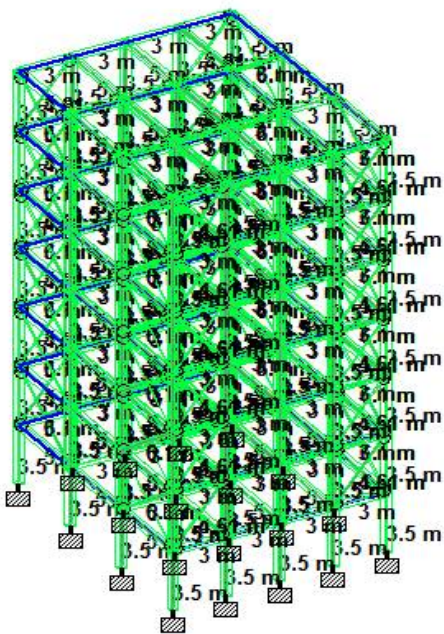


Fig 4.5 Shows structure with aluminium bracings

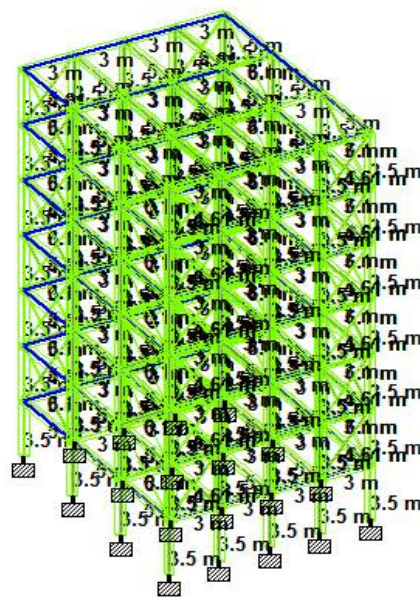


Fig 4.6 Shows structure with aluminium bracings and shear links

**Case 4: Structure with aluminium bracings:** In this figure 4.5 shows aluminium is taken as a material for bracing to determine its good resistibility effects comparing to steel bracings. In this case X bracing is introduced at the corners of frame to determine its impact on lateral forces. Here geometry and loadings are same as of bare frame frame, these aluminium X bracings are of size 110X 5 mm.

**Case 5: Structure with aluminium bracings and shear links:** In this figure 4.6 aluminium is taken as a material for bracing to determine its good resistibility effects comparing to steel bracings. In this case X bracing is introduced at the corners of a frame with shear links to enhance its life and resistivity to determine its impact on lateral forces. Here geometry and loadings are same as of bare frame frame, these aluminium X bracings are of size 110X 5 mm with shear links at the supports of bracings.

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## V. RESULTS AND INFERENCES

### 5.1 Maximum Bending Moment in Z direction:

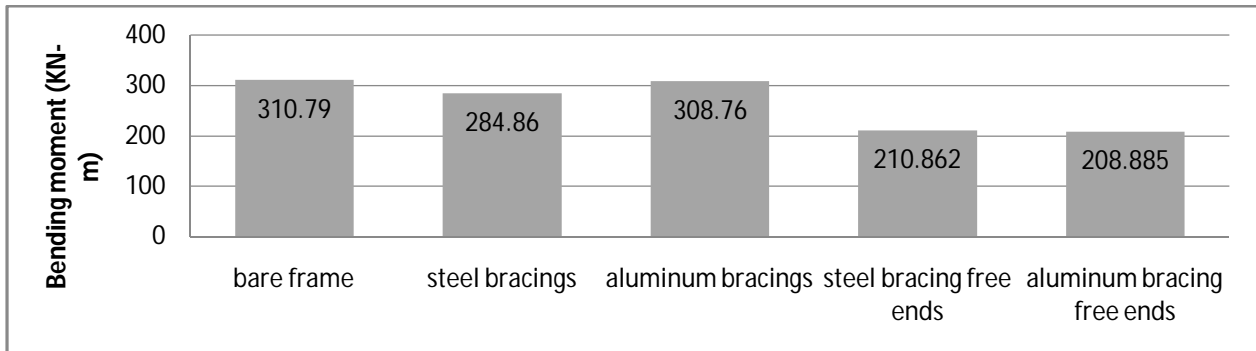


Figure 5.1

Aluminium bracing with shear link having a greater value as compare to steel bracing with shear link and also Steel bracing showing maximum value due to high unit weight of steel shown in figure 5.1.

### 5.2 Maximum Bending Moment in Y direction:

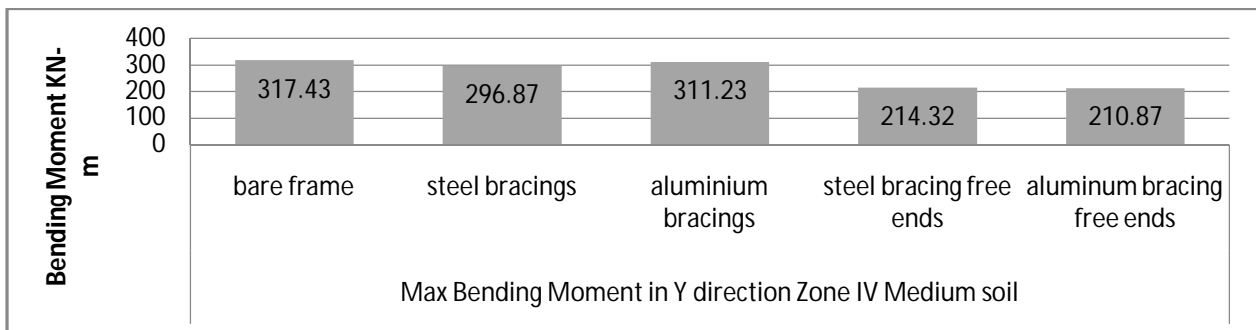


Figure 5.2

Aluminium bracings with shear link shows more precise value as compared to steel bracing with shear link which shows that use of aluminium can be more effective to resist Bending Moment in figure 5.2.

### 5.3 Axial force in due to EQ load:

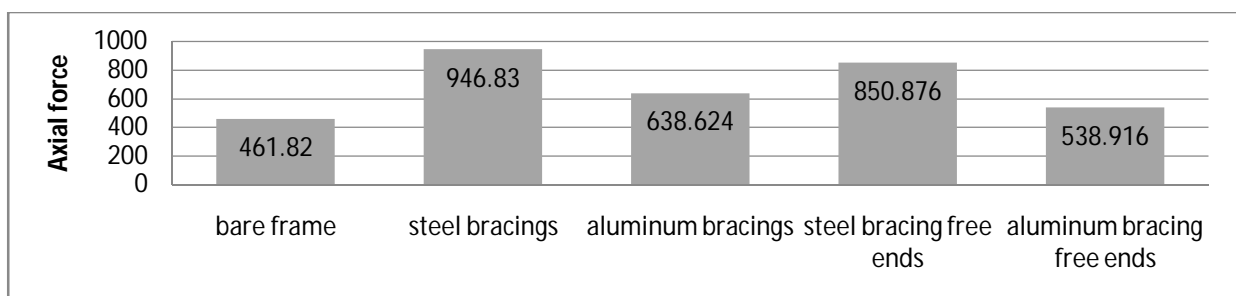


Figure 5.3

In comparison of steel and aluminium bracing with shear link cases results shows that aluminium case is showing lesser value which determines that it is more stable as shown in figure 5.3.

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## 5.4 Shear Force:

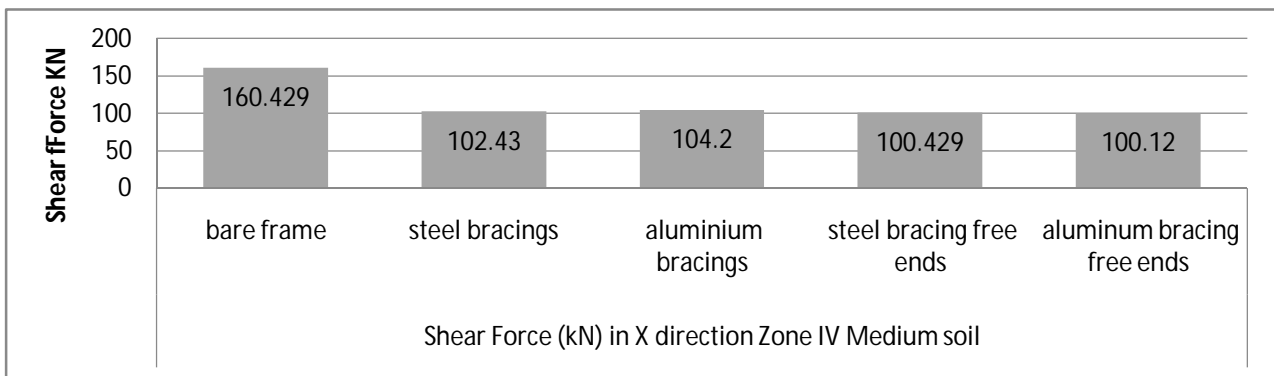


Figure 5.4

In comparison of shear link cases aluminium bracing system is proven more resistible to unbalances fore and will be more stable as shown in figure5.4.

## 5.5 Storey Drift:

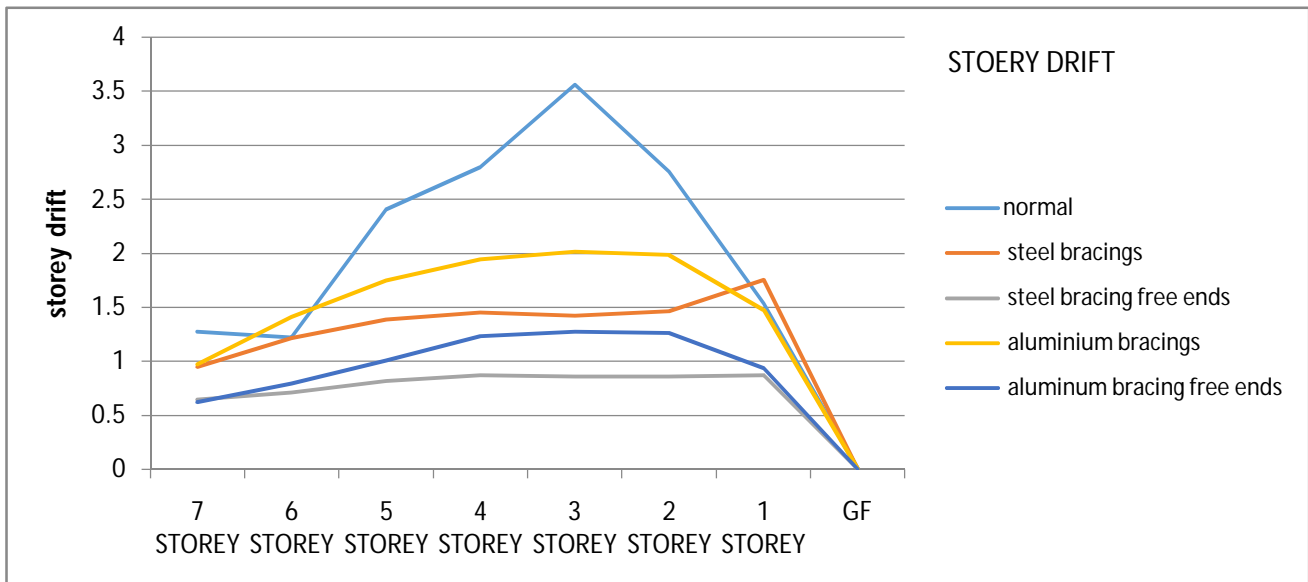


Figure 5.5

In steel and aluminium bracing with shear link case results shows that steel structure is providing least value of drift but aluminium structure value is relatively same as steel bracing with shear link case values as shown in figure5.5.

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## 5.6 Storey stiffness:

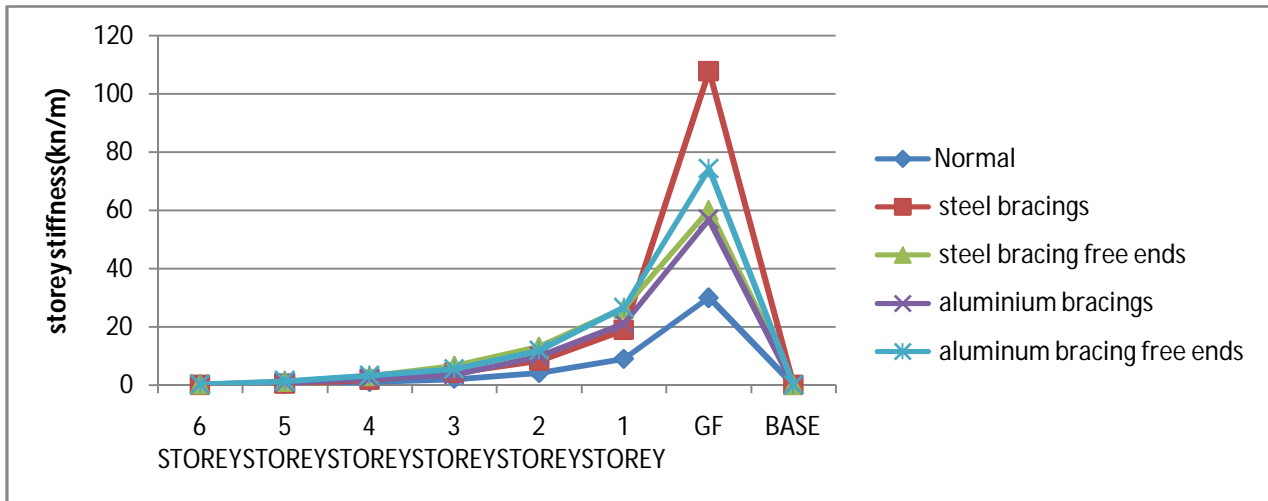


Figure 5.6

Aluminium bracing with shear link shows greater value at base compare to steel bracing with shear link. Result of both steel and aluminium marginally having same value shown in figure 5.6.

## 5.7 Storey displacement:

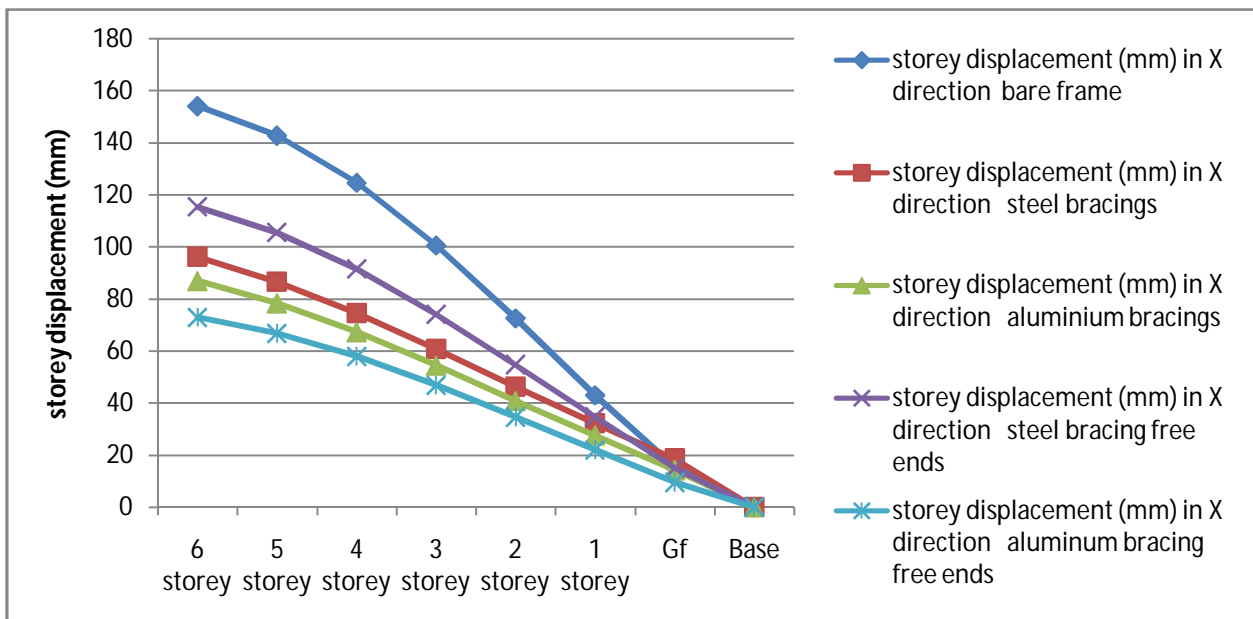


Figure 5.7

Aluminium bracing with shear link show less displacement in x directional as compare to steel displacement as shown in figure 5.7.



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## VI. CONCLUSION

From the present study it is seen that aluminium bracings with free ends is much efficient in comparison to steel bracing with free ends or other cases on parameter like Bending moment, shear force, storey displacement. Steel and aluminium gave nearly same result in case stiffness & drift whereas in case of axial force steel bracing system is more stable. Vertical shear links have fat and stable hysteresis loops. So aluminium can be performance better than steel in seismic zone.

### Future scope:

- (a) In this study rectangular structure have been provided. The study can be stretched out to different geometrical shapes.
- (b) In this study G + 6 symmetrical structures has been considered. The study can be extended to more tall structures.
- (c) This study performs seismic load analysis and in further study wind load analysis can be included.

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