



Study of Axial Force in Columns of Coupled Building of different shapes

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Abstract: Present study describes the effect of connecting Sky Bridge on axial force in corner columns, internal columns and central columns of structurally coupled tall buildings. To study the effect of structural coupling on the structural response of two high rise buildings, Response Spectrum is carried out using STAAD PRO v8i software. Frame structural system is adopted for the building having just beams and columns, each of the two buildings is analysed for different shapes in plan like square, rectangle & C shape with dimension of grid of beams and column as 5m x 5m. Zone III & damping coefficient 5% is considered in the analyses. The two buildings are connected with one sky bridge, two sky bridges and three sky bridges, with length 5m. The bridge is located at different levels. Due to presence of connecting bridge the structural response is modified.

Key Words: Sky Bridge, Tall building, Coupled Building, Response Spectrum and STAAD PRO v8i.

I. INTRODUCTION

As the globalization and urbanization increases worldwide the need of construction of buildings will become common. As to accommodate increasing population of the world tall buildings or high rise buildings will be required i.e. vertical development will be required which will save the land. These trends will increase the construction of tall buildings in close proximity to each other, which during earthquake can cause pounding of the structures.

As tall buildings are susceptible to seismic pounding there is a need to provide additional safety to the structure. Tall buildings should also be safeguard against fire and should provide efficient way of evacuation, as this can be learned from the disastrous event of 11th September and the World Trade Centre towers collapse case.

The main three recommendations for the safety in tall buildings are:

- Improvement of fire proofing to structure and fabric.
- Improvement of evacuation systems.
- Improvement of structural systems especially with respect to progressive collapse.
- Improvement of structural systems against pounding of the structures.

To tackle the problem efficiently we need to find out a way which will provide all the safety measures required in the above points. One possible way of improving safety is to provide dampers or Sky Bridge between the buildings. It will provide a evacuation way at a level other than the ground level, especially during any emergency in tall building. This concept is used in many buildings like Petronas Tower.

In view of this responsibilities and the increasing demand of the tall buildings due to globalization and population explosion, this analysis project study on the consequences of inclusion of Sky Bridge in adjoining building towers under earthquake effect (response spectrum). This project is aimed to examine the feasibility of Sky Bridge in providing lateral stiffness to the frame building and thus the possibility to eliminate the need to construct shear or core wall in building up to 20 stories and thus providing an economic way to increase lateral stiffness of the buildings of different shapes.

On the whole, the proposed project aims at studying the earth quake effect (response spectrum) on a 20 storeys building of different shapes of merely frame system without combination of other structural system such as shear wall, core wall etc. Also, the behaviour of the sky bridge under earthquake effect from various directions are monitored and analysed. Next, with the inclusion of the sky bridge the behaviour of the building structure under earthquake effect was studied. The effect arises from the various configurations of the sky bridge, different shapes of the building as well as under various load conditions are also analysed. All these study would lead to achieve goal of this research which is the study of response of coupled building of different shapes.

II. PROBLEM FORMULATION

This section defines the procedure of formulation of the problem. For each plan considered in the study, the grid of beams is taken as 5m x 5m constant. Storey height is taken as 3.3m and 20 stories building is considered. For the seismic analysis the parameters considered are Zone III, Damping ratio 0.05, Medium Soil, SMRF building and Importance

factor as 1. In general, the frame system considered in the analysis composed of beams and columns only. On the other hand, secondary elements such as slabs, staircase and brick wall could be modelled as bracing to frame structure; however this was not carried out due to the limitation of software STAAD PRO.

The shapes considered in the study are:

1. Square shape plan - (25m x 25m)
2. Rectangle shape plan - (20m x 30m)
3. C shape plan - (20m x 40m)

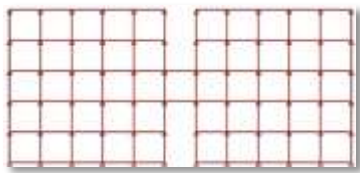


Figure 1. Square Shape Plan

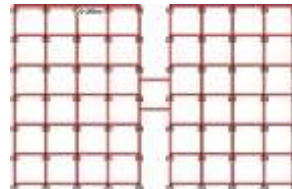


Figure 2. Rectangle Shape Plan

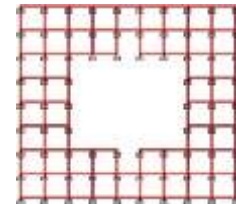


Figure 3. C Shape Plan

The parameters which are common to all buildings are stated below:-

- Height of building : 66 m (constant), 20 storeys
- Height of each storey : 3.3 m (constant)
- Length of each bay(in X-direction): 5 m
- Length of each bay(in Z-direction): 5 m
- Location of service bridge varies without shear wall as :
 - ✓ Single Bridge provided at 5th, 10th & 15th floor
 - ✓ Double Bridge provided at 5th & 10th, 5th & 15th, 10th & 15th floors.
 - ✓ Triple Bridge provided at 5th, 10th & 15th floors.
- Grade of steel: Fe-415
- Density of RCC: 25 kN/ m³
- Density of wall: 20 kN/ m³
- Live load: 4 kN/ m²
- Slab thickness: 150 mm
- Wall thickness:
 - ✓ 230 mm (external wall)
 - ✓ 100 mm (internal wall)
 - ✓ 230 mm (parapet wall)

2.1. Loads Considered

Different design loads for analysis of all buildings have been calculated as below:

Slab thickness is 150 mm

Density =25 kN /m³

Floor load:

DL = 0.15×25
 =3.75 kN /m²

FF = 1.00 kN/m²

LL =4.00 kN/m²

Wall load:

Height of storey =3.3 m

Height of wall =3.3-0.45
 =2.85 m

Density =20 kN /m³

Load for external wall
 =13.11 kN / m

Load for internal wall
 =5.7 kN / m

For top floor

Height of parapet wall = 1 m

Thickness =0.23 m

Load for parapet wall
 =4.60 kN /m

III. RESULTS AND DISCUSSION

The results considered are maximum values from the envelope of columns at the ground floor i.e. not for a particular column. The values are compared after coming to the safe design for each building which is carried out by trial and error method.

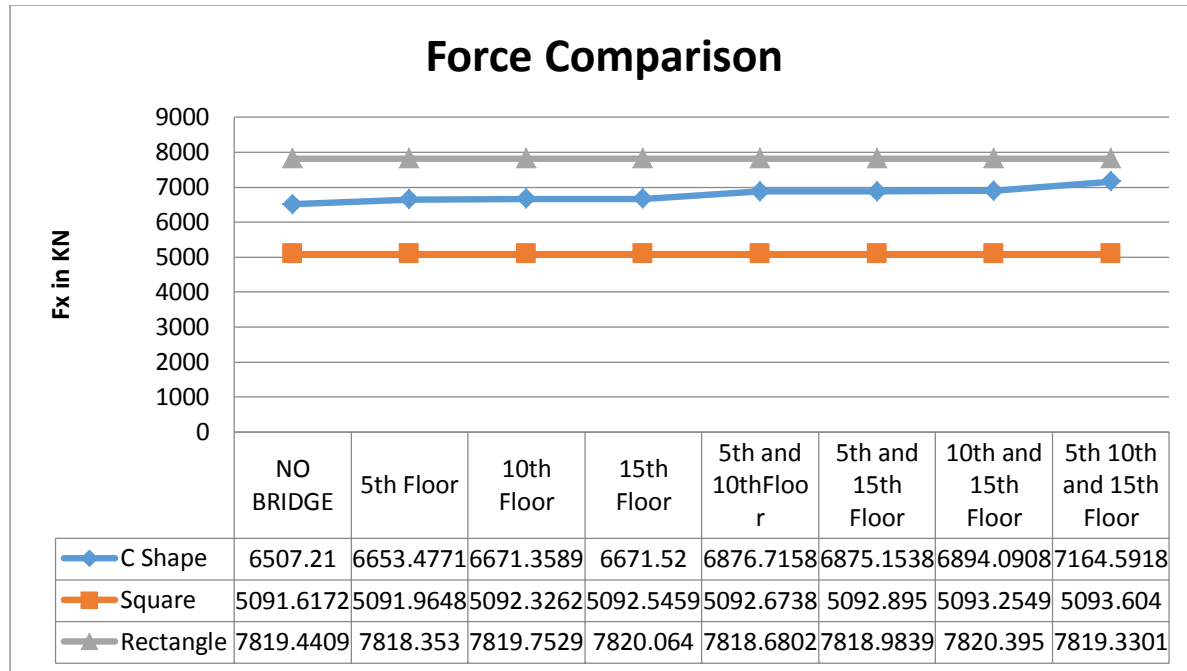


Figure 4. Comparative Graph of Axial Force in Corner Column

From the graph shown in figure 4, it can be seen that axial force in Square shape is minimum compared to the Rectangle shape building and C shape building and there is difference in force of at most 35%. This change in force is due to the change in shape of plan which had created irregularity.

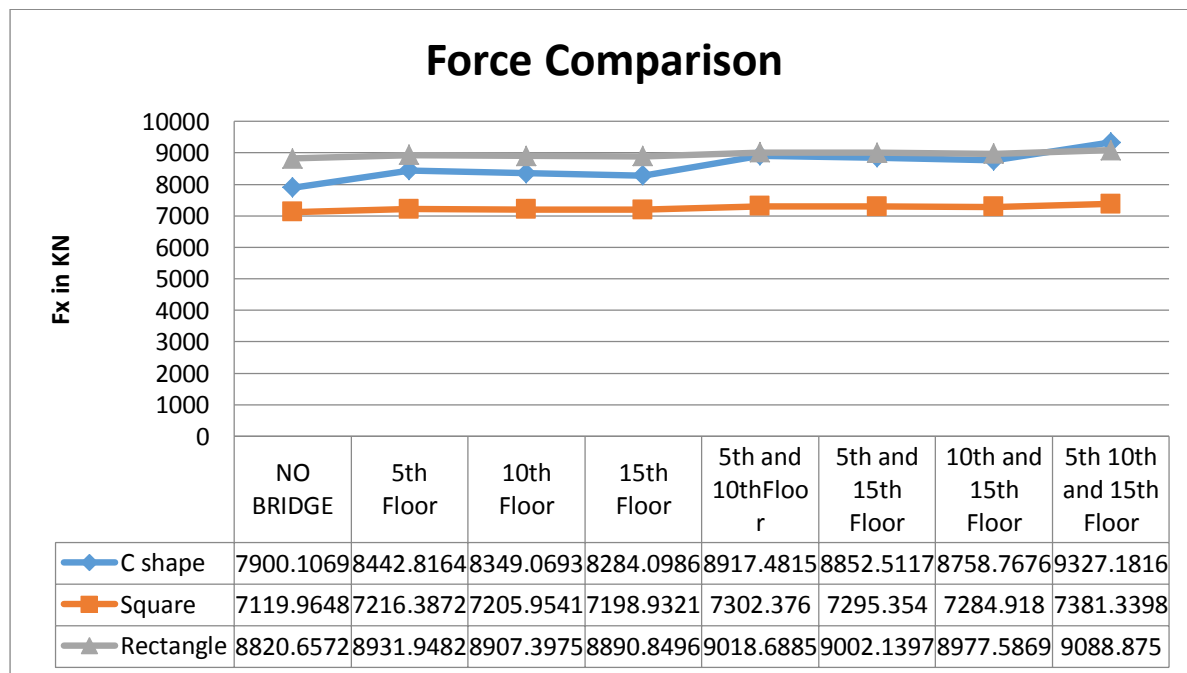


Figure 5. Comparative Graph of Axial Force in Outer Middle Column

From the graph shown in figure 5, it can be seen that axial force in Square shape is minimum compared to the Rectangle shape building and C shape building and there is difference in force of at most 21%.

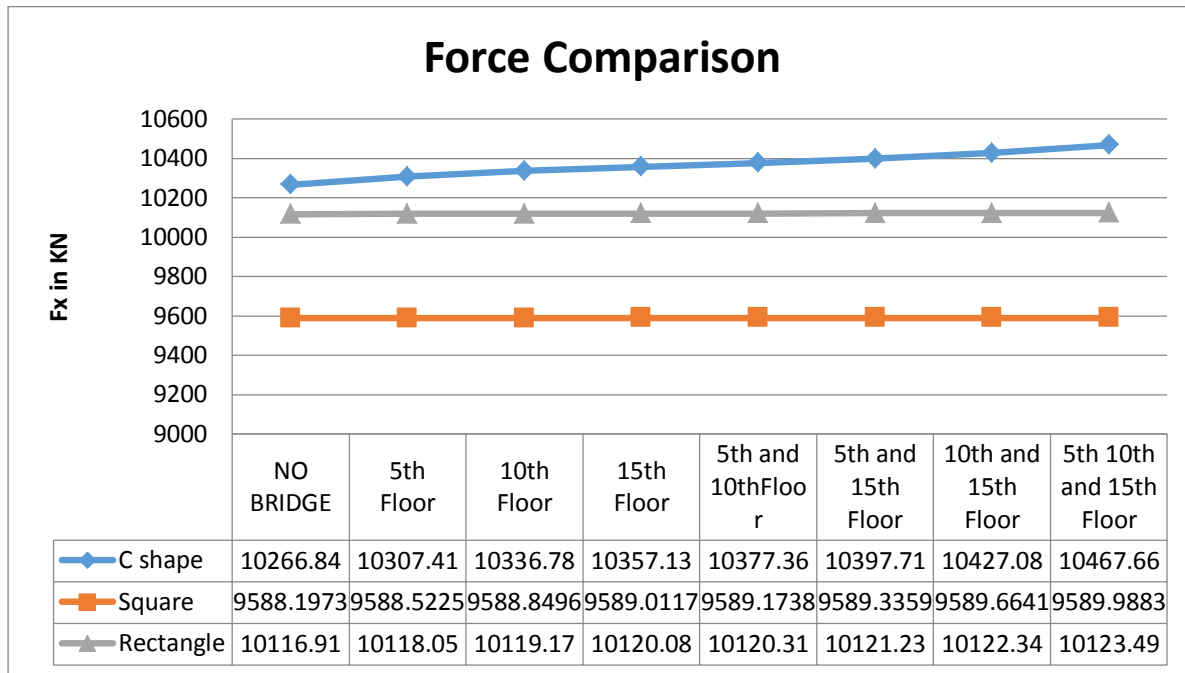


Figure 6. Comparative Graph of Axial Force in Central Column

From the graph shown in figure 6, it can be seen that axial force in Square shape is minimum compared to the Rectangle shape building and C shape building and there is difference in force of at most 9%.

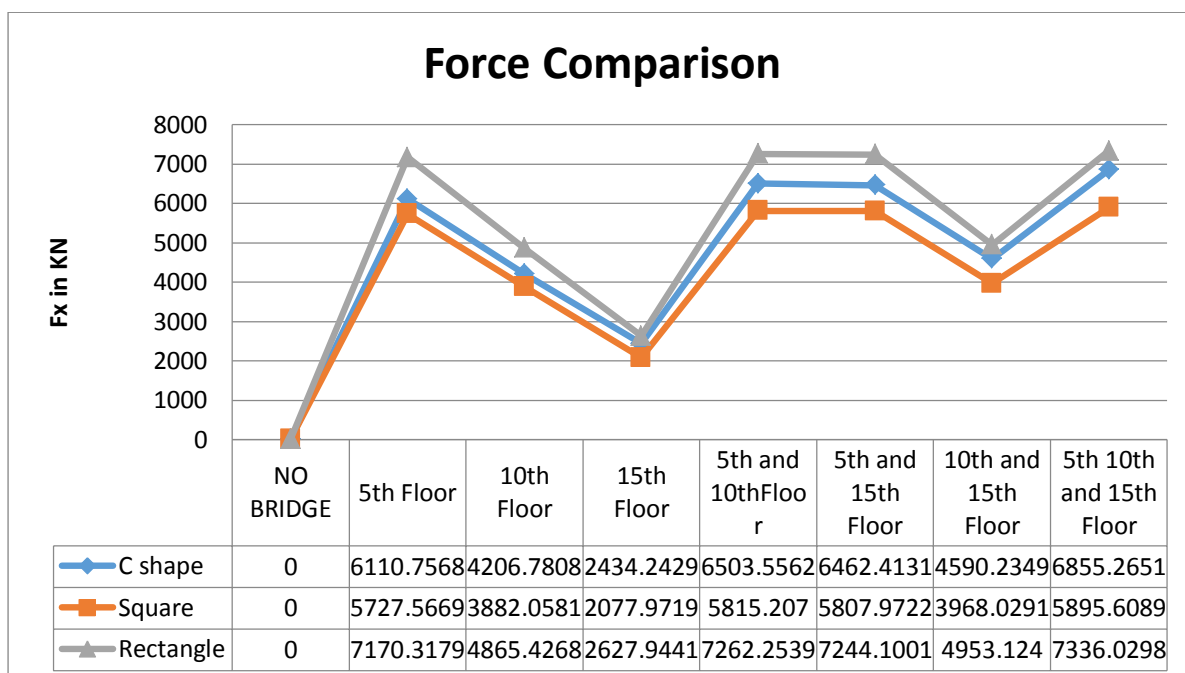


Figure 7. Comparison of Axial Force in Column at Junction of Bridge and Building

From the graph shown in figure 7, it can be concluded that axial force in the column at the junction varies largely when the location of the bridge is changed this can be due to the change in stiffness and irregularity of the structure. The maximum axial force is observed in the rectangle shape building while minimum in the square shape building. For all the shape when bridge is provided at 15th floor alone the axial force is reduced as compared to the other case in which the bridge is located at the other floors case which is due to the reduced cantilever portion of the building.

IV. CONCLUSION

The main focus of this study is to understand the behaviour of coupled building on elements in terms of axial forces in columns. Comparative results for coupled building of different shapes are as under:

- ✓ For all the cases the axial forces seem to be linear that is it does not change much with the change in location of the sky bridge.
- ✓ When the axial force in column is compared in columns at the junction of building and bridge, it was observed that the minimum force is seen when the bridge is provided at the 15th floor compared to the other cases. This is because of the reduction in the cantilever portion of the building.
- ✓ From the force comparison it was found that the square shape building will provide the most economic sections for the design.

V. REFERENCES

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