

Opening Effect of Core Type Shear Wall used in Multistoried Structures: A Technical approach in Structural Engineering

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Abstract— The reduction of the overall budget of the project leads to the cost effective one and there should be such criteria of reduction of the cost in different manner. To make economic structure without losing the stiffness criteria, the work has been performed in two stages. The former one is building with single shear wall core and the latter one is building with dual core shear wall; the entire work has performed with four different phases. In first phase total 5 buildings that are modeled with different openings in single core types shear wall and then second phase performs the analysis procedures of the same. The third phases have total 6 buildings that are modeled with different openings in dual core types shear wall and then fourth phase performs the analysis procedures of the same. The result analysis has been performed and then conclusions are drawn. Building with 25% opening area in single core type shear wall and 50% opening area in dual core type shear wall performs well to reduce the cost of the project.

Keywords— Deduction Area, Earthquake Effects, Opening Area, Response spectrum, Shear Wall, Wall Area Reduction, Wall Deduction Ratio.

I. INTRODUCTION

Shear wall is a firm and stiff member, is a structural component used generally around the lift areas. Shear wall has constructed from foundation base to the top of the structure. These walls have the ability to resist the lateral forces along with the uplift forces due to the pull of wind. It has to resist the force that aim to push the walls over. The shear walls are connected with column components; thereby transfer the entire horizontal and vertical loads throughout itself. The shear walls do not need extra finishing or plastering when construction is going on.

II. OBJECTIVES OF THE CURRENT STUDY

The main purpose is to find the optimum building case to counteract earthquake forces and analysis is done using software STAAD Pro. So for this, different loads applied and parametric values obtained are considered and the point of comparison on different building models is as follows:

1. Use of response spectrum method in with and without opening dual configuration multistoried structure.

2. To take 10 different buildings, (5 for Single Core + 6 for Dual Core) comparing them among each heads by using Response Spectrum Method of dynamic analysis using Staad pro software.
3. To calculate maximum displacement and then comparing all the 5 single core cases and 6 dual core cases.
4. To compare base shear in both X and Z direction and then comparison have performed on all the 5 single core cases and 6 dual core cases.
5. To explore the possibilities of overall structural resistance by minimal use of shear wall area.
6. To determine maximum Axial Forces in column and then comparison have performed on all the 5 single core cases and 6 dual core cases.
7. To evaluate maximum Torsional Moments in beams along X and Z directions and then comparison have performed on all the 5 single core cases and 6 dual core cases.

To obtain the best building with opening threshold criteria, all buildings are thoroughly observed and compared their parametric values.

III. PROCEDURE AND 3D MODELING OF THE STRUCTURE

As per criteria for earthquake resistance design of structures, a commercial building (G+20) with plinth area 625 sq. m. for single core and 750 sq. m. for dual core has taken for analysis. A total of five different cases have been chosen for parametric analysis for single core type shear wall and total six different cases have been chosen for parametric analysis for dual core type shear wall, its description shown below with its own abbreviations. Various input parameters of buildings are shown in Table 1 with earthquake input parameters taken respectively.

M 30 grade of concrete with Fe 415 grade of steel is used in the entire analysis procedure. Dead loads, Live loads, Response spectrum loads are applied on the structure with various load combinations. Figure 1 and figure 2 shows floor plan and the entire sectional 3D views of the single core building. Figure 3 and figure 4 shows the typical floor plan and entire sectional 3D views of the dual core building. After then, the comparative result of various parameters has shown with graphical representation of each core case.

Table 1: Input Parameters Used

Constraint	Assumed data for all buildings
Soil type	Medium Soil
Seismic zone	III
Response reduction factor (ordinary shear wall with SMRF)	4
Importance factor (For all semi commercial building)	1.2
Damping ratio	5%
Fundamental natural period of vibration (T_a)	$0.09 \cdot h / (d)^{0.5}$
Plinth area of building (For Single Core)	625 sq. m
Plinth area of building (For Dual Core)	750 sq. m
Floors configuration	G + 20
Height of building	77 m
Floor to floor height	3.5 m
Depth of foundation	3.5 m
Beam sizes	450 mm X 600 mm
Column sizes	550 mm X 650 mm
Slab thickness	170 mm (0.17 m)

Shear wall thickness	270 mm (0.27 m)
Material properties	M 30 Concrete Fe 415 grade steel

Different building model cases selected for analysis using Staad Pro software

When Single Core is used:-

Table 2: List of buildings framed with assigned abbreviation for Single Core Shear Wall

S. No.	Buildings framed for analysis when Single Core Type Shear Wall used	Abbreviation
1.	Building with 100 % shear wall area used	Core 1
2.	Building with 90 % shear wall area used	Core 2
3.	Building with 87.5 % shear wall area used	Core 3
4.	Building with 83.33 % shear wall area used	Core 4
5.	Building with 75 % shear wall area used	Core 5

When Dual Core is used:-

Table 3: List of buildings framed when dual core is used with assigned abbreviation

S. No.	Buildings framed for analysis when Dual Core Type Shear Wall used	Abbreviation
1.	Building with 100 % shear wall area used	Dual Core 1
2.	Building with 90 % shear wall area used	Dual Core 2
3.	Building with 87.5 % shear wall area used	Dual Core 3
4.	Building with 83.33 % shear wall area used	Dual Core 4
5.	Building with 75 % shear wall area used	Dual Core 5
6.	Building with 50 % shear wall area used	Dual Core 6

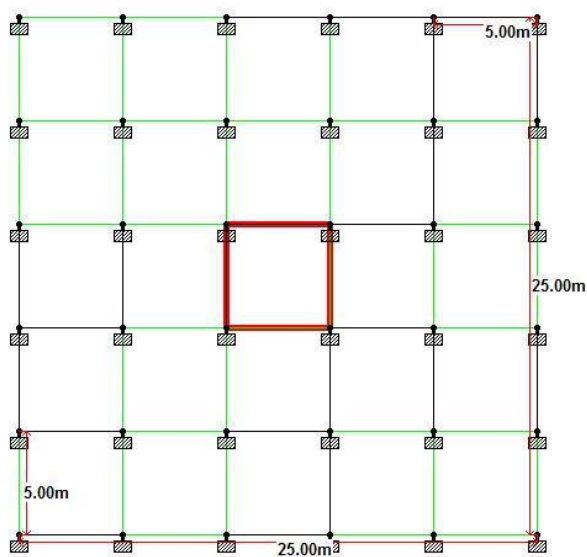


Fig. 1: Typical floor plan of single core

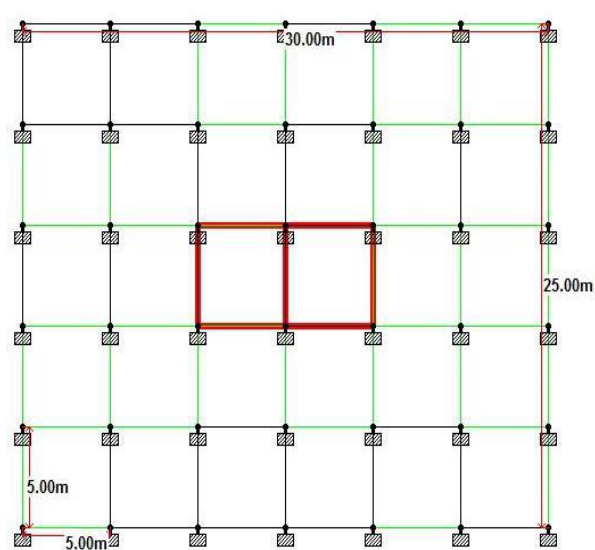


Fig. 3: Typical floor plan of Dual Core

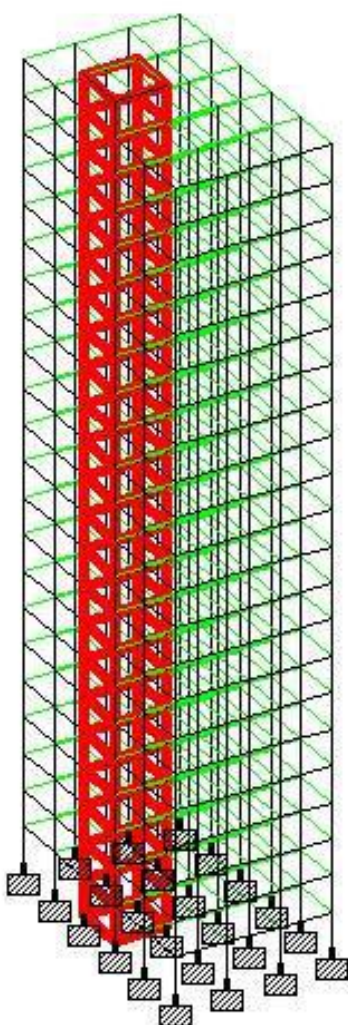


Fig. 2: Sectional 3D view of Single Core

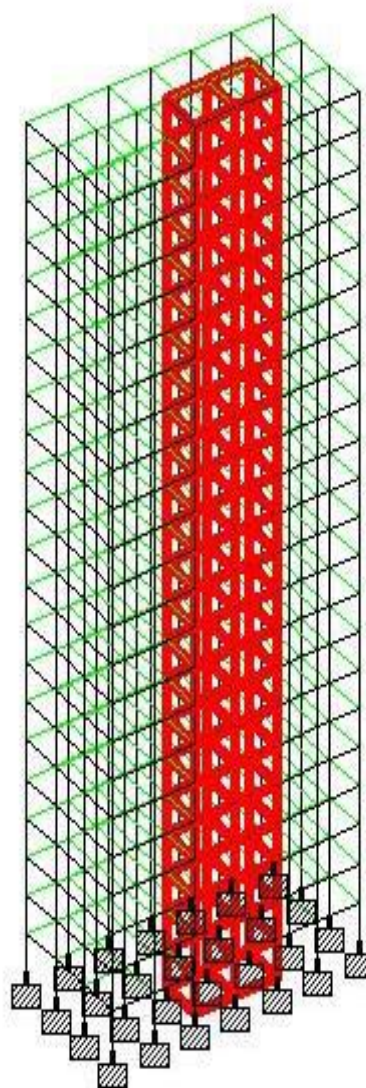


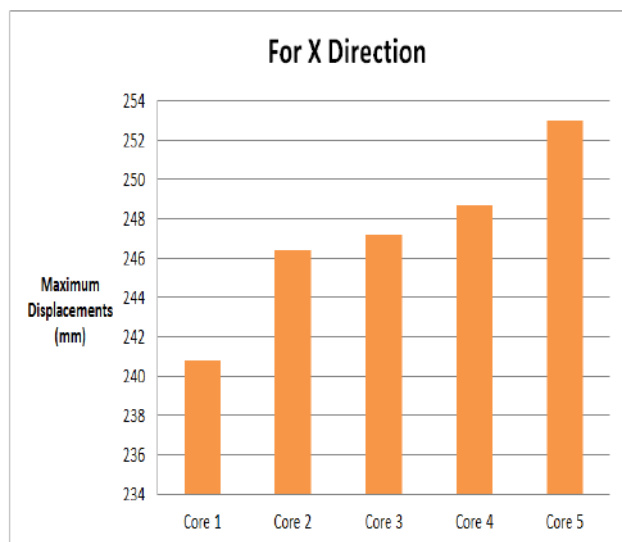
Fig. 4: Sectional 3D view of Dual Core

IV. RESULTS ANALYSIS

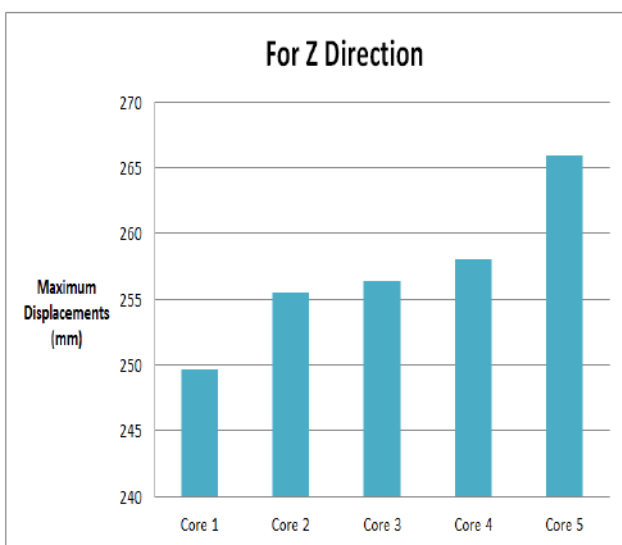
To reduce the overall cost and to reduce the weight of the structure, For the stability of the structure by changing the grade of concrete in columns at different pairs, parameters such as the nodal displacement in both X and Z directions, base shear in both X and Z directions, column axial forces, and last but not the least beam torsion values in both X and Z directions.

The above parameters obtained by the application of loads and their combinations on various cases of the multistory building as per Indian Standard 1893: 2016 code of practice.

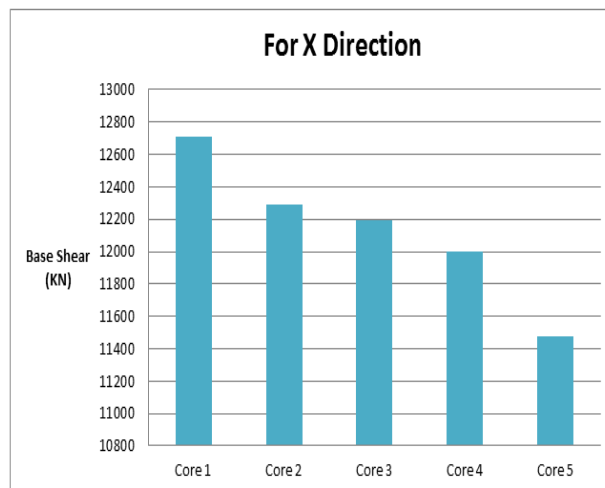
Result of each parameter and for both single and dual core has discussed with its graphical form below:-



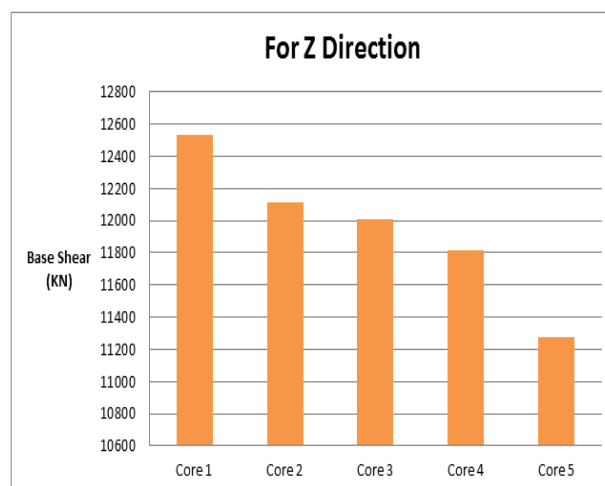
Graph 1: Graphical Representation of Maximum Displacement in X direction for all Single Core Cases



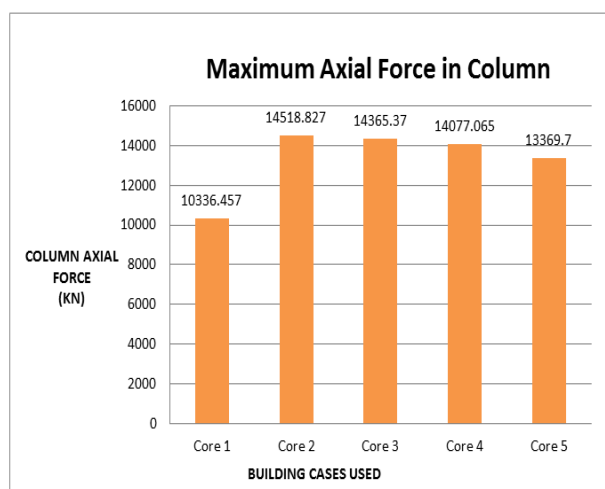
Graph 2: Graphical Representation of Maximum Displacement in Z direction for all Single Core Cases



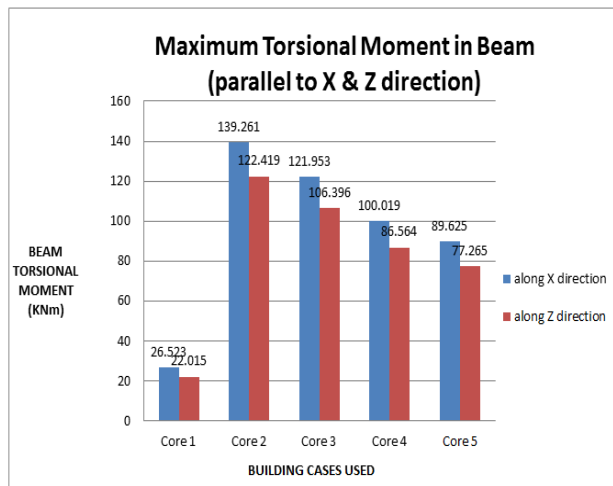
Graph 3: Graphical Representation of Base Shear in X direction for all Single Core Cases



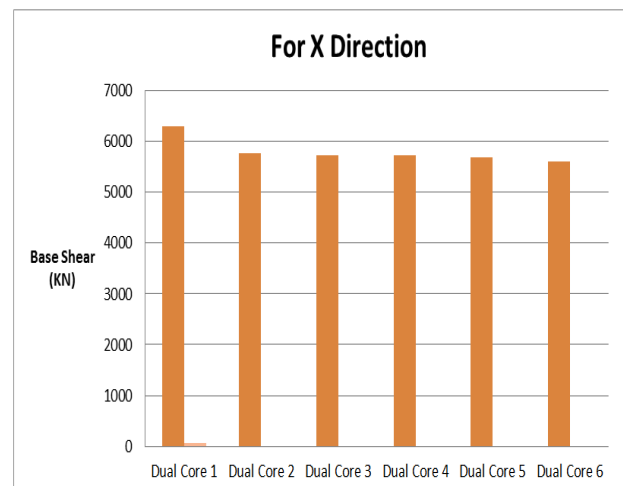
Graph 4: Graphical Representation of Base Shear in Z direction for all Single Core Cases



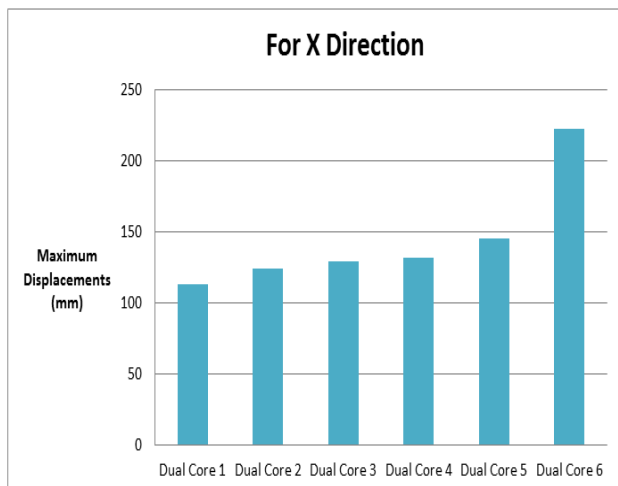
Graph 5: Graphical Representation of Maximum Axial Forces in Column for all Single Core Cases



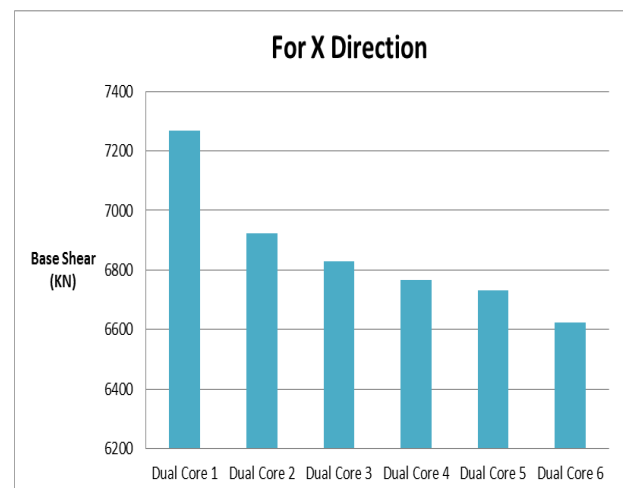
Graph 6: Graphical Representation of Maximum Torsional Moment in beams along X and Z direction for all Single Core Cases



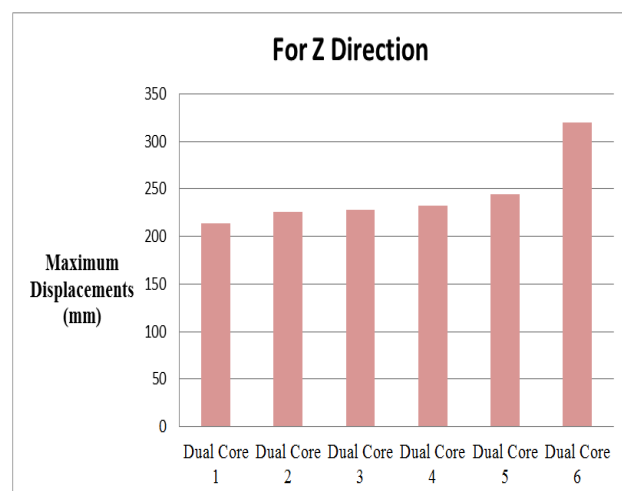
Graph 9: Graphical Representation of Base Shear in X direction for all Dual Core Cases



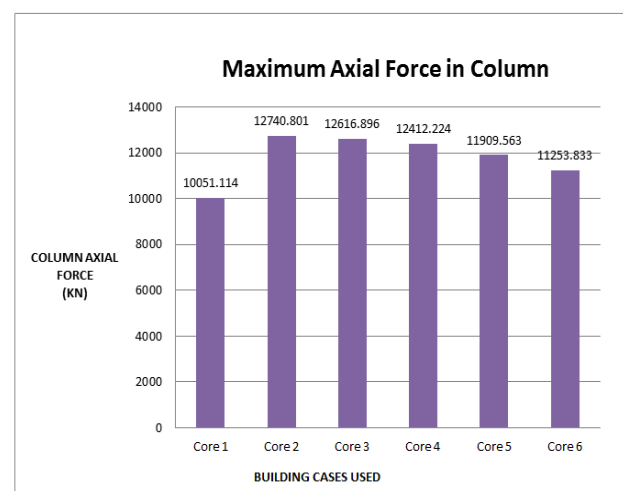
Graph 7: Graphical Representation of Maximum Displacement in X direction for all Dual Core Cases



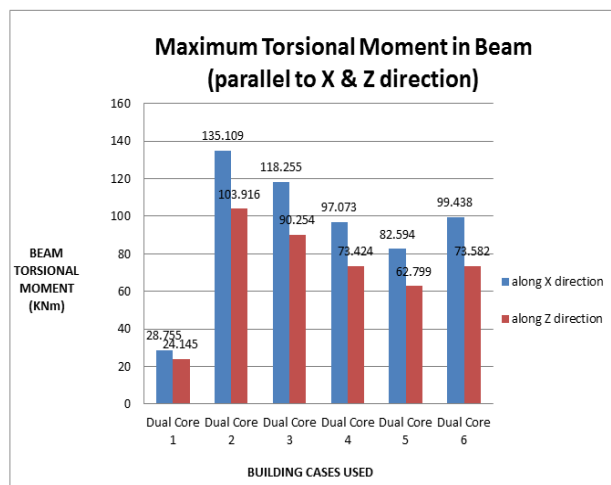
Graph 10: Graphical Representation of Base Shear in Z direction for all Dual Core Cases



Graph 8: Graphical Representation of Maximum Displacement in Z direction for all Dual Core Cases



Graph 11: Graphical Representation of Maximum Axial Forces in Column for all Dual Core Cases



Graph 12: Graphical Representation of Maximum Torsional Moment in beams along X and Z direction for all Dual Core Cases

V. CONCLUSIONS

Conclusions evolved by analyzing the result data of various parameters for all five Single Core are as follows:-

1. Maximum displacement in X direction and Z direction increases due to reduction in Shear Wall and when the opening crosses 10%, there is an increase in displacements for single core cases.
2. Base shear values decreases as the weight of the structure decreases since there is an increase in opening area percentage. For this, in both X and Z directions, building core case 5 shows the best parametric values at 25 % shear wall opening.
3. Values of Maximum Axial forces in column first increases from 0% to 10 % opening area and then the values constantly decreases and hence building core case 5 is economical among all.
4. Torsion in beam shows limiting parametric values up to building core case 5 when there will be deduction in shear wall area.

Conclusions evolved by analyzing the result data of various parameters for all six Dual Core Cases are as follows:-

1. Maximum displacement in X direction and Z direction increases due to reduction in Shear Wall and when the opening crosses 10%, there is an increase in displacements for dual core cases.
2. Base shear values decreases as the weight of the structure decreases since there is an increase in opening area percentage. For this, in both X and Z

directions, building dual core case 6 shows the best parametric values at 50 % shear wall opening.

3. Values of Maximum Axial forces in column first increases from 0% to 10 % opening area and then the values constantly decreases and hence building core case 6 is economical among all with 50% opening area.
4. Torsion in beam shows limiting parametric values under dual core case 2 when there will be deduction in shear wall area.

Due to Seismic effects, for single core structures, building core case 5 shows best parametric values among all. Similarly, for dual core structures, building core case 6 shows best parametric values among all.

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