Comparative study of Conventional and Staggered Opening Shear Wall in Tall buildings by ETAB software

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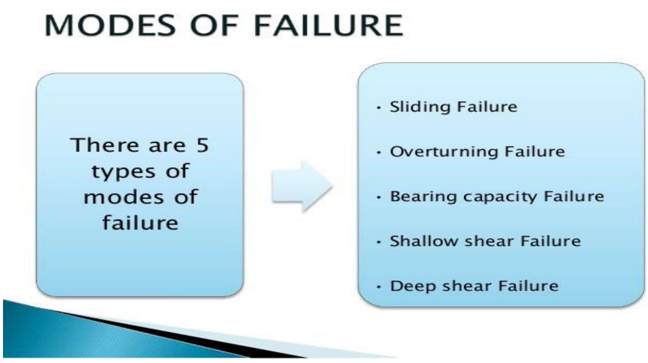
Abstract -In present days the shear walls are more important in the construction of high rise buildings.Shear wall is a structure considered to be one, whose resistance to horizontal loading is provided entirely by them.Failure of shear walls depends on a openings, reinforcement and the openings layout.The walls with staggered openings developed a ductile failure, whereas the ones with regular openings developed a brittle failure; and the shear walls with staggered openings are more rigid and needed less reinforcement.Hence study of this staggered shear panels in tall buildings is necessary and important in analysis of multystoried structures. Present work consists comparative analysis of conventional and staggered opening shear wall by static and dynamic analysis method of earthquake. Results are obtained by Etabs Software. And Proved here that staggered opening shear wall is advantageous than conventional opening shear wall.

***Key Words*:**Staggered opening, conventional opening, Etabs,Dynamic analysis

1. INTRODUCTION

Tall reinforced concrete buildings are subjected to lateralloads due to wind and earthquake. In order to resist these lateral loads, shear walls are provided in the framed structure asa lateral load resisting element.Earthquake in general had a long history of deadly devastations in the past. Basically the response of the structure due to ground motion is an essential factor to analyze and design any earthquake resistant structure. The loads or forces which a structure subjected to earthquake motions are called upon to resist, the damages induced by the motion of the ground on which it rests.Shear walls possess sufficientstrength and stiffness under any loading conditions. The importance of shear wall in mitigating the damage to reinforcedconcrete structures is well documented in the literature Shear walls are generally classified on the basisof aspect ratio (height/width ratio). Shear walls with aspectratio between 1 and 3 are generally considered to be of squattype and shear walls with aspect ratio greater than 3 are consideredto be of slender type.



Shear walls are generally provide in between columns. If column is not available then boundary elements should be provide in shear wall. These boundary elements may be width equal to wall web's width or it may be more than that. Shear walls with boundary elements have substantially higher bending strength and horizontal shear force carrying capacity, and are therefore less susceptible to earthquake damage than walls without boundary elements. Steel reinforcement bars are to be provided in walls in regularly spaced vertical and horizontal grids. Shear walls provide large strength and stiffness to buildings in the direction of their orientation, due to high strength & stiffness provided by shear wall, there will be significantly reduction in the lateral sway of the building and there by reduces damage to structure and its contents under large lateral load may be due to earthquake or wind. The size and location of shear walls in the configuration of building is extremely important. They must be symmetrically arranged in plan to reduce the effect of twisting forces in the buildings.In general, the structural responseof shear walls depends strongly on the type of loading,aspect ratio of shear wall, and size and location of the openingsin the shear walls. Squat shear walls generally fail in shearmode whereas slender shear walls fail in a flexural mode.

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The presence of openings in shear walls makes the behaviour of shear wall slightly vulnerable under dynamic loadingconditions.

2.MODEL DESCRIPTION

For this study, 3-D model is being prepared for the frame static analysis and dynamic analysis Of the building in ETABS version 16.0.2and floor height of 2.9 m was modeled with conventional opening, with vertical opening and with staggered opening in shear wall, using the finite element software ETABS. Typical floor plan with dimensions 27.27m × 57m was used. Models are prepared for conventional opening at periphery and center and staggered openings at periphery and center. The thickness of the shear wall was taken as 450 mm. The size of beams and columns were adopted as 230mm x 450 mm. The thickness of slab was taken as 150 mm and it was also represented as a shell element. Elevations of the building with vertical and staggered openings in shear wall are shown in Fig. 1 and Fig. 2 respectively. The size of the openings in both the cases were maintained as 1 m × 1 m. The earthquake load and load combinations were applied as per IS 1893 – 2002 and the seismic analysis was done by response spectrum method. Seismic zone II was taken for analysis. The shear wall was designed using limit state method and was detailed as per IS 456 – 2000 and IS 13920 – 1993 respectively.

Codes used for analysis of the structure:

- R.C.C. design : IS 456: 2000
- Earthquake design : IS1893: 2016
- Code for Dead load : IS875: Part 1
- Code for Live load : IS875: Part 2

The basic parameters considered for the Analysis and design:-

- Slab depth: 150 mm thick :Assumed
- Live load in office area: 3 kN/sqm :As per IS 875 Part 2
- Live load in Balcony area:3kN/sq m : As per IS 875 Part 2
- Live load in passage area : 3 kN/sq m : As per IS 875 Part 2
- Live load in urinals : 3 kN/sq m : As per IS 875 Part 2
- Floor finish load : 1.5 kN/ sq m : As per IS 875 Part 1
- Wall thickness : 150 mm thick wall : Assumed
- Stair case loading : 3 kN/sq m : As per IS 875 Part 2
- Lift shaft : 450 mm thick shear wall : Assumed

3. RESULTS AND DISCUSSION

3.1 Time Period: The response of a structure can be defined as a combination of many mode shapes, resulting due to the vibratory motion of the building. But for seismic analysis, the first mode or the fundamental time period is the most significant, which is the inherent property of the building

SR.NO	MODE	Staggered opening at periphery	Staggered opening at center
1.	MODE 01	3.51	3.28
2.	MODE 02	3.27	2.76
3	MODE 03	2.75	2.15

Table1. Time Period For conventional Opening At Periphery And Centre

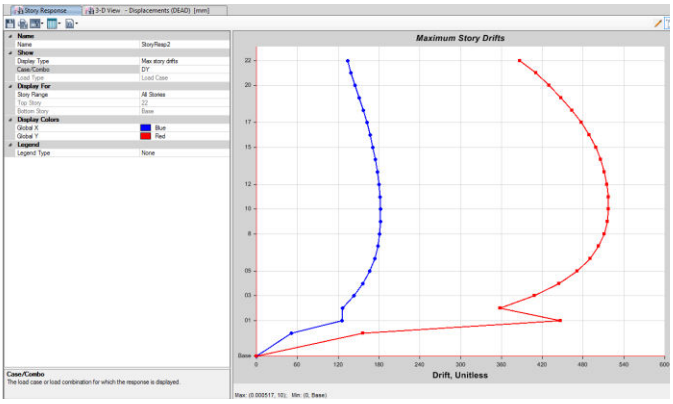
Table2.TIME PERIOD FOR STAGGERED OPENING AT PERIPHERI AND CENTRE

SR.NO	MODE	Staggered opening at periphery	Staggered opening at center
1.	MODE 01	3.51	3.28
2.	MODE 02	3.27	2.76
3	MODE 03	2.75	2.15

3.2 Base shear: Story shear is defined as the sum of design lateral forces at all levels above the story under consideration.

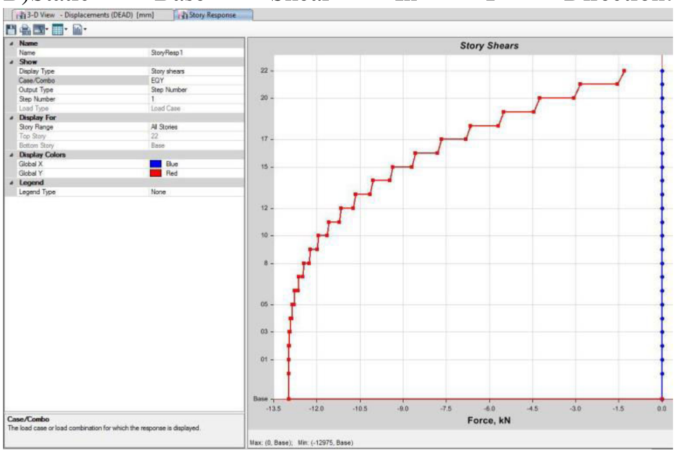
Normal Opening In Shear Wall At Periphery Of The Building

A) Static Base Shear Inx Direction



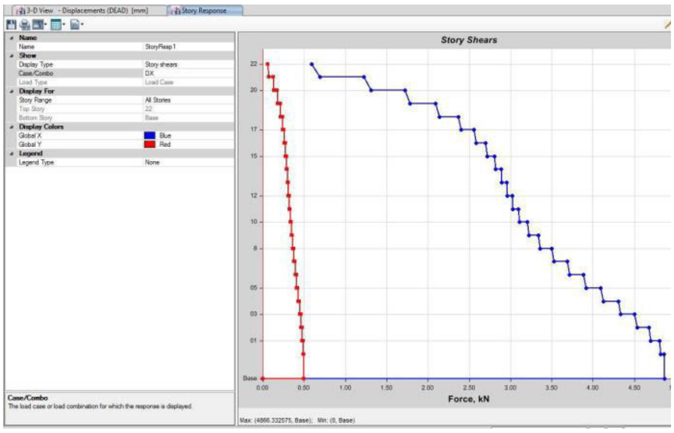
GRAPH: 01

B)Static Base Shear In Y Direction:



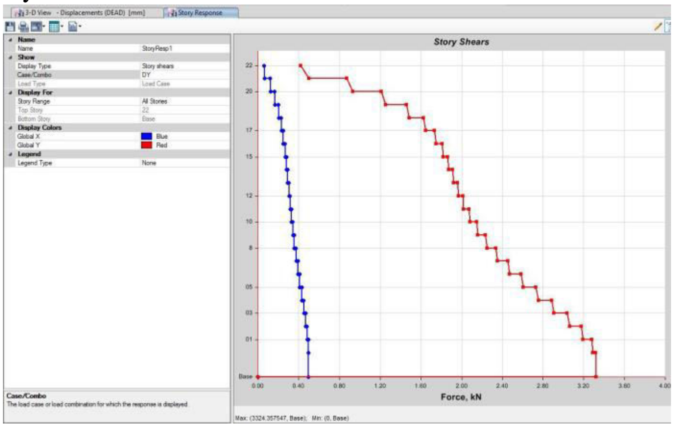
GRAPH: 02

Dynamic Base Shear In X Direction:



GRAPH: 03

Dynamic Base Shear In Y Direction:

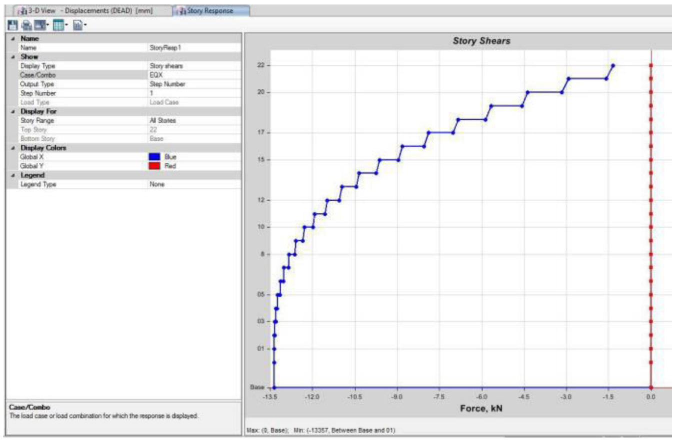


GRAPH: 04

Staggered Opening In Shear Wall At Periphery Of The Building

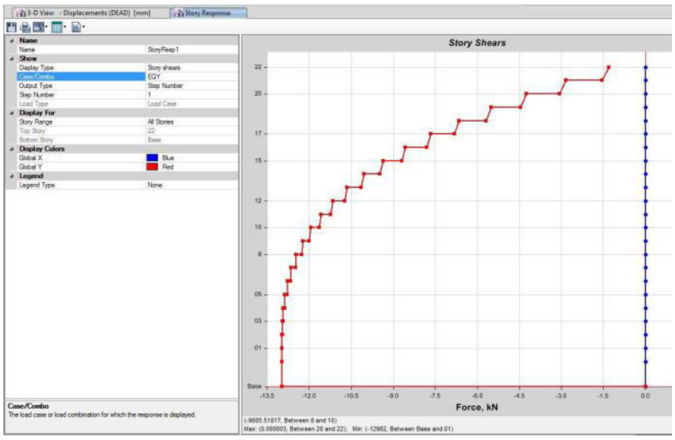
A) Base Shear Details:-

Static Base Shear In X Direction:



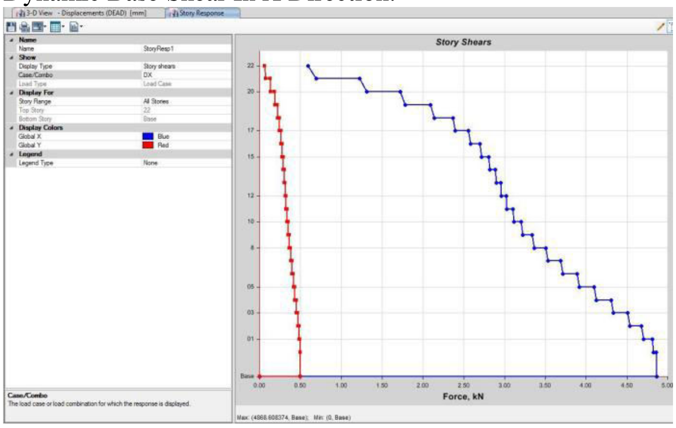
GRAPH: 05

Static Base Shear In Y Direction:



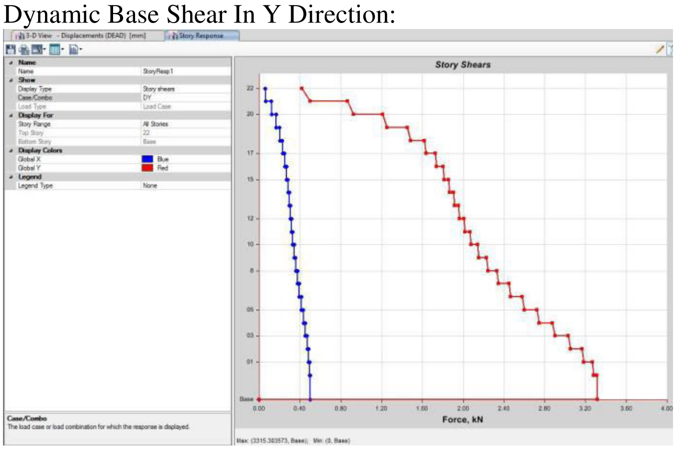
GRAPH: 06

Dynamic Base Shear In X Direction:



GRAPH: 07

Dynamic Base Shear In Y Direction:

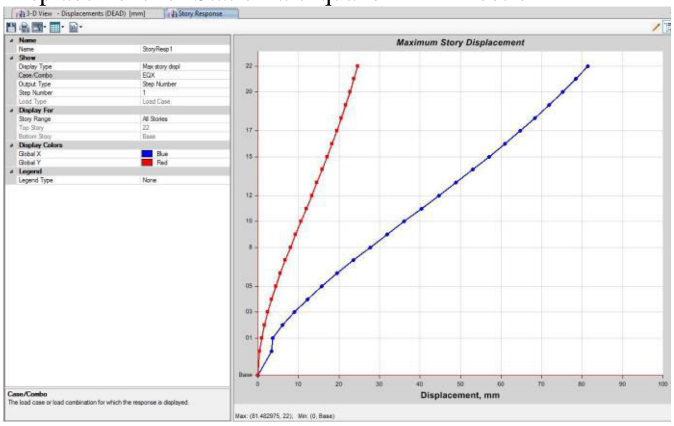


GRAPH: 08

3.2Displacement Details:-The displacement refers to the distance that points on the ground are moved from their initial locations by the seismic waves.

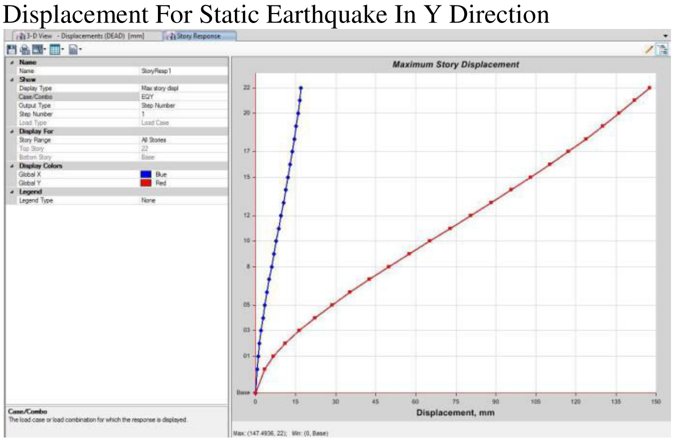
Normal Opening In Shear Wall At Periphery Of The Building

Displacement for Static Earthquake in X Direction



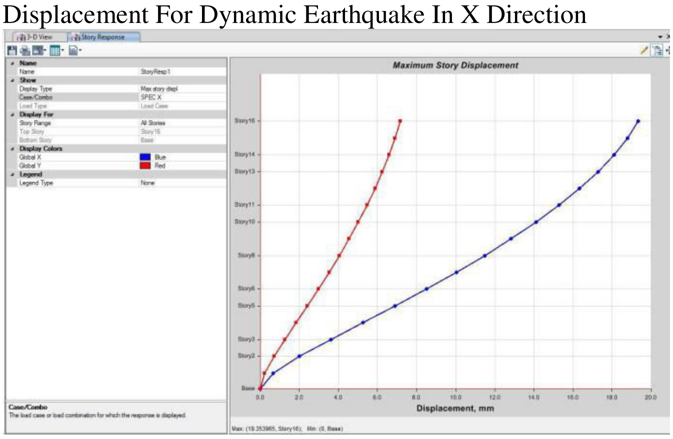
GRAPH: 09

Displacement For Static Earthquake In Y Direction



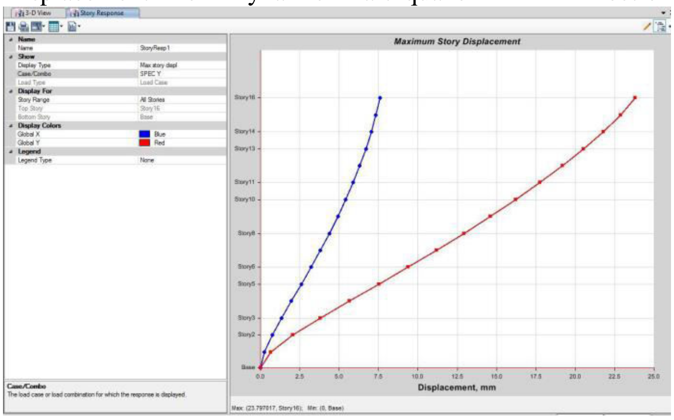
GRAPH: 10

Displacement For Dynamic Earthquake In X Direction



GRAPH: 11

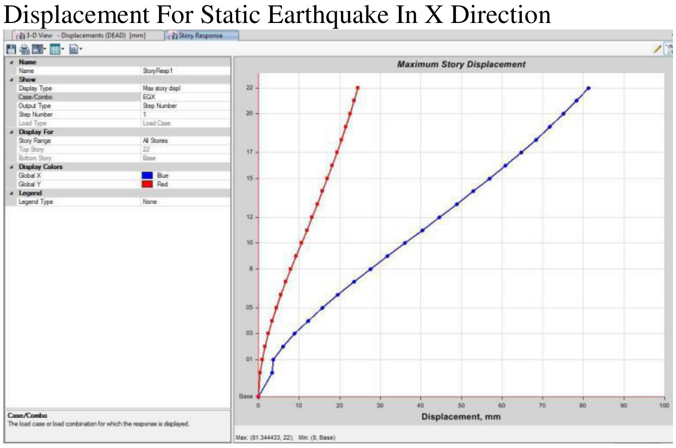
Displacement For Dynamic Earthquake In Y Direction



GRAPH: 12

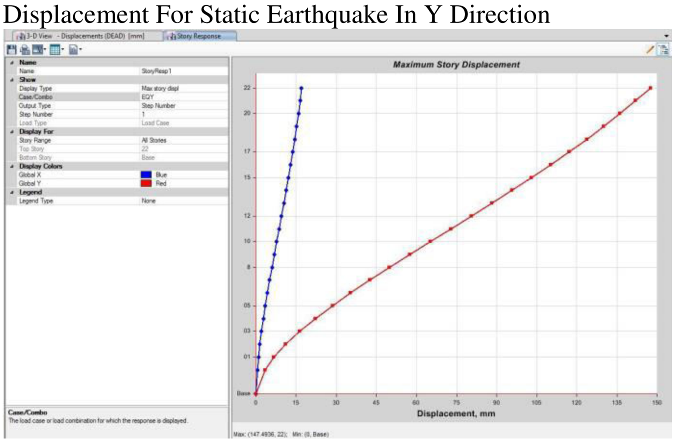
Staggered Opening In Shear Wall At Periphery Of The Building

Displacement For Static Earthquake In X Direction



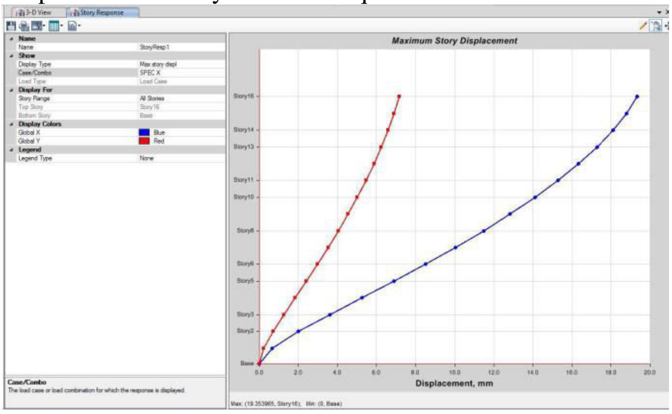
GRAPH: 13

Displacement For Static Earthquake In Y Direction



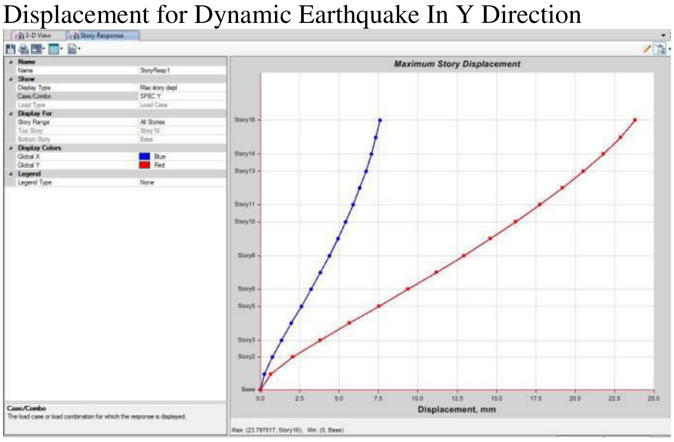
GRAPH: 14

Displacement for Dynamic Earthquake in X Direction



GRAPH: 15

Displacement for Dynamic Earthquake In Y Direction

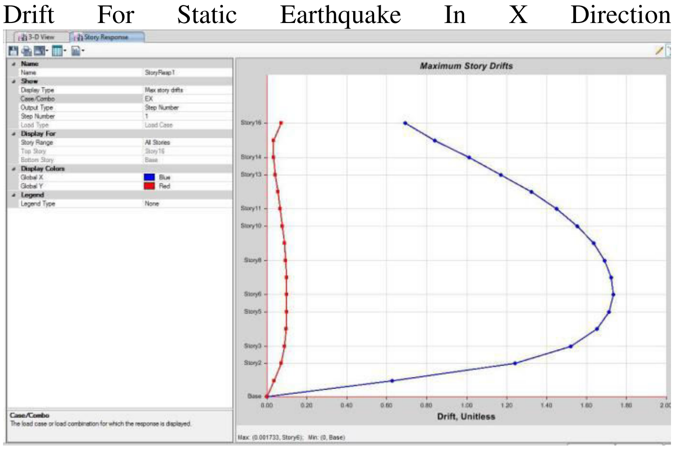


GRAPH: 16

3.4Drift Details: Story drift is defined as the displacement of one level relative to the other level above or below. Drift can also vary according to each direction.

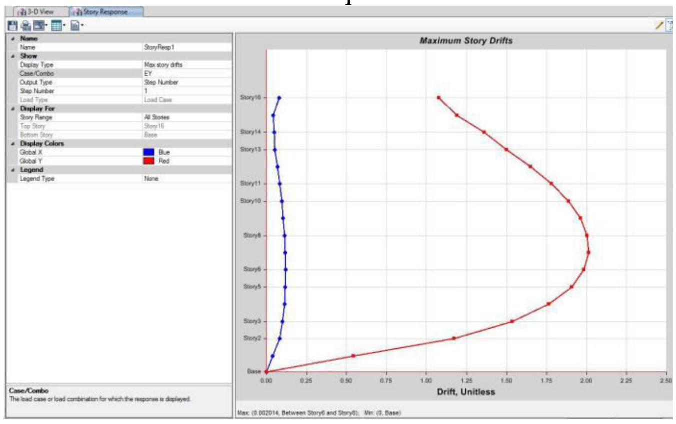
Normal Opening in Shear Wall at Periphery of the Building

Drift For Static Earthquake In X Direction



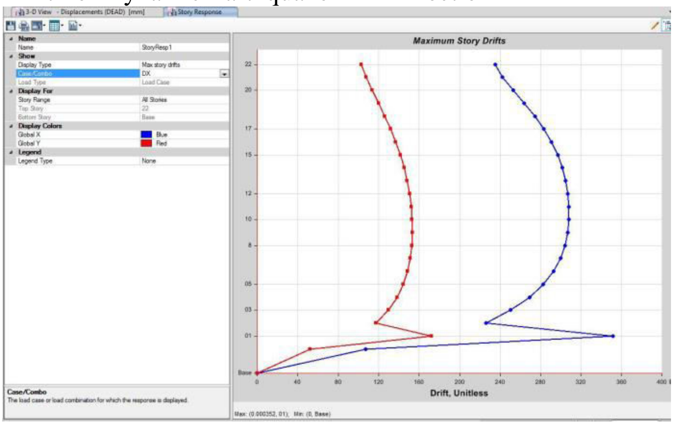
GRAPH: 17

Drift For Static Earthquake In Y Direction



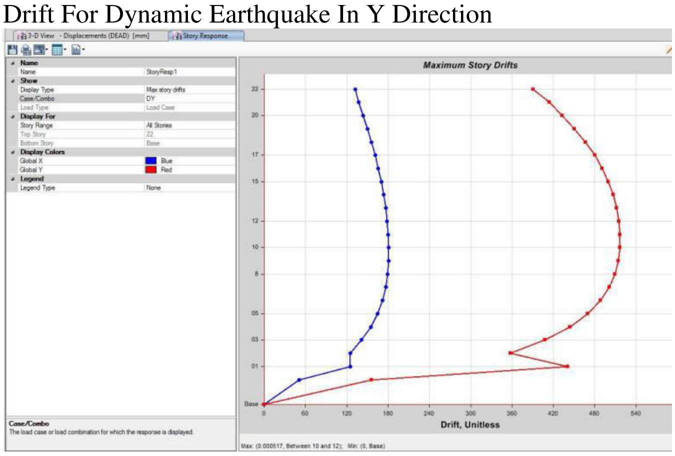
GRAPH: 18

Drift For Dynamic Earthquake In X Direction



GRAPH: 19

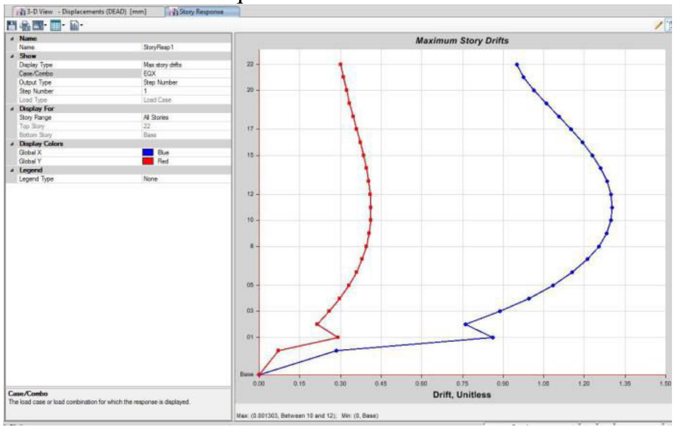
Drift For Dynamic Earthquake In Y Direction



GRAPH: 20

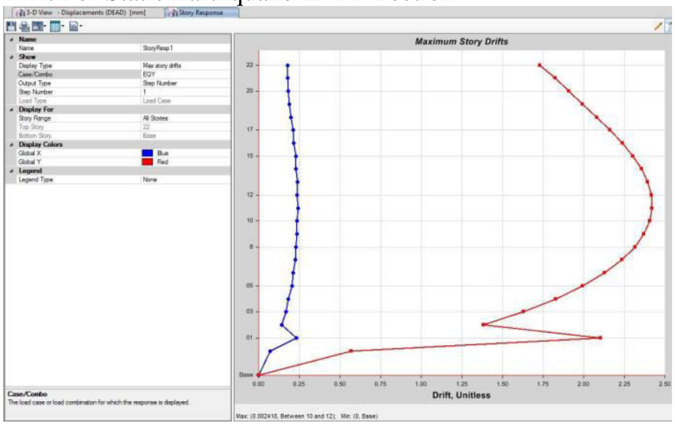
Staggered Opening in Shear Wall At Periphery Of The Building

Drift For Static Earthquake In X Direction



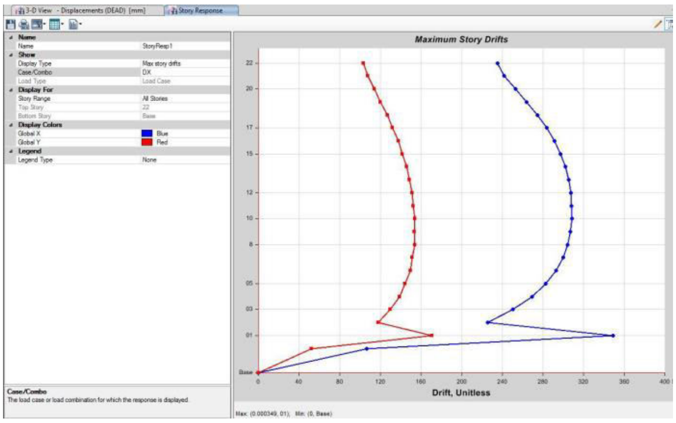
GRAPH: 21

Drift For Static Earthquake in Y Direction



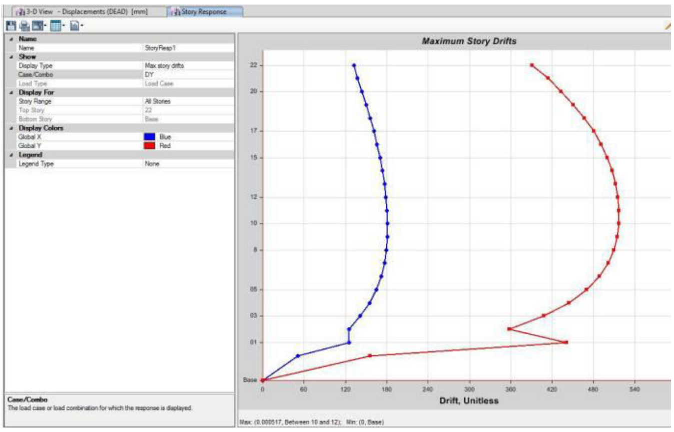
GRAPH: 22

Drift For Dynamic Earthquake in X Direction



GRAPH: 23

Drift For Dynamic Earthquake In Y Direction



GRAPH: 24

4. CONCLUSIONS

This study concludes that the time period, displacement, drift, base shear, and the overall seismic response of the structure is affected by the location of openings and sizes of openings in shear wall. The analysis led to the following conclusions.

1. Staggered openings in shear wall proved to be highly advantageous than conventional opening shear wall and they were found to provide better lateral resistance than shear walls with vertical openings.
2. Shear wall is advantageous at center.
3. Width of wall also affects the seismic behavior of staggered shear wall.

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