

STUDY ON INFLUENCE OF POSITIONS OF CORE WALL FOR STRUCTURES WITH STEP BACK CONFIGURATION

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Abstract - Advancement of population growth and urbanization has widely recognized change of enormous number of multistoried structures which has led to disappearance of level land for improvement. So there is a requirement for construction on sloped ground. Structures constructed on slopes are not quite the same as in plane land. When influenced by seismic tremor, they are sensitive to extreme damage as they might be unpredictable and unsymmetrical in level and torsionally coupled. It is hard to counteract seismic tremors yet; impact can be decreased by safe design.

In multi storied structures, core wall are generally used for encompassing the lift rooms and are to be established correctly. Henceforth in the present review, an effort is made to examine the outcomes of position of core walls on level ground and inclined ground. Using ETABS, a steel building model with G+ 20 storeys is developed and a time history method with Zone V using medium soil condition is done. Perfect position of core wall is appropriately determined and seismic reaction parameters are inspected.

Key Words: Buildings on slopes, Core wall, Torsion, Displacements,...

1. INTRODUCTION

Urbanization and economic expansion in hilly areas has increased land improvement and brought about increment in population rise excessively which has resulted in rise in interest for multi storied structures. Due to seismic tremor, sloped structures act unique in relation to those in plane ground when subjected to horizontal loads. Focal points of mass and rigidity do not concur on different floors as these structures have varied mass and stiffness.

Meanwhile, tremor seen in Sikkim and north eastern parts of India is indicative that structures on sloping ground are prone to high level of demolition but they have been intended for security of occupiers against normal risk. Subsequently while building the structures on hilly areas, attention ought to be kept for making these structure seismic safe.

Structures on sloped ground have stiff columns on hill side which attracts excessive amount of horizontal forces and is accountable to damage. Amid tremor, these structures evolve extremely large twisting moment. Short and Long column of proportionate area moves on a level ground with same magnitude.

Various researches on the sloping ground have been studied. Effort have been made on understanding the performance of buildings by making use of a constant angle of the slope and then comparing with the plain ground Birajdar et al (2004)[1] studied three dissimilar structural configurations with one building model on level ground and other two building on sloped ground with sloping angle maintained at 20 degree were assessed through response spectrum method and twisting impacts were comprised. Sloped buildings with varying slopes are also examined. In sloped structures, columns on the peak side are stiff deriving immense forces revealing short column effect. It is also identified that shearing performance in step back and set & step back buildings are comparatively on higher end when distinguished with setback configuration Kiran et al (2017)[2] reviewed on G+12 storey building with dissimilar sloping angles by performing linear static & response spectrum. It was observed as the sloping angle increases the base shear and storey drifts rises when compared with lower sloping angles. Research is also conducted by varying the storey heights for a uniform sloping angle. Birajdar et al (2004) [1] varied the storey heights from four to eleven using an angle of slope of 20 degree. It is established that the displacements & time period upsurges with rise in the number of floor level.

Shear walls are the elements incorporated in structures for minimizing the unnecessary displacements by absorbing the seismic forces. Shear walls are provided as a core type for encompassing the lifts & staircases. Positioning of core walls will affect the performance of structures amid an earthquake. Rupali Gaud et al (2016) [4] inspected the suitable position of lift core at many places and the operating of structures for various zones of seismic regions. were assessed. Lift cores are put at the middle and about the edges and its enactment during a tremor is examined by equivalent static method. From the consequence of placing the lift core, it was observed as, the lift core improves the buildings

resistance to seismic forces and also lift core at middle are desirable than edges. Investigations have been done for different shapes of shear walls placed for a sloped building. Sandip Doijad et al (2015) [5] observed for various arrangement of shear walls resting on level ground for different sloping angles varying as 9, 18, 27 degrees. Buildings were studied for response spectrum method and observed that insertion of shear wall in building diminishes displacements along level and inclined ground and base shear intensifies in x & y direction.

2. OBJECTIVES OF THE STUDY

- The earthquake action of steel structure with step back configuration are examined
- To inspect the consequence of several positioning of core walls in steel structure for step back building.
- To identify providing of core wall at satisfactory position for bearing the lateral loads proficiently.
- To evaluate many parameters of the analysis like time period, twisting moments etc.

3. MODELLING

From the study, a step back steel structure is developed in ETABS software. Step back building bearing 30.96 degree sloping angle is employed and time history method of examination is done with a structure found in zone V with medium soil.

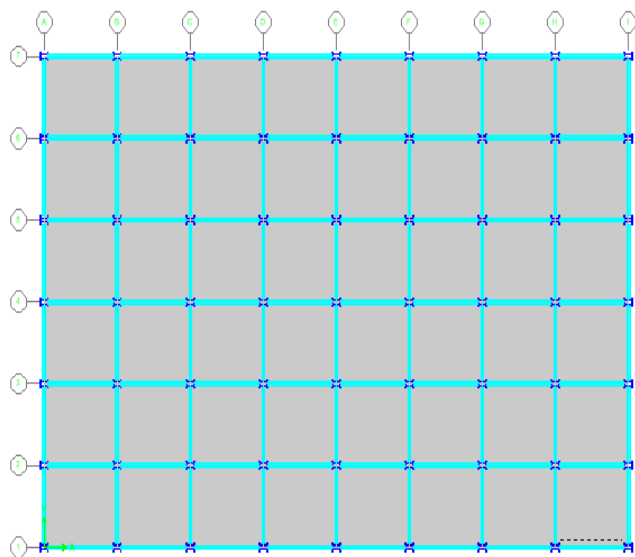


Figure 3.1: A plain view of steel step back building

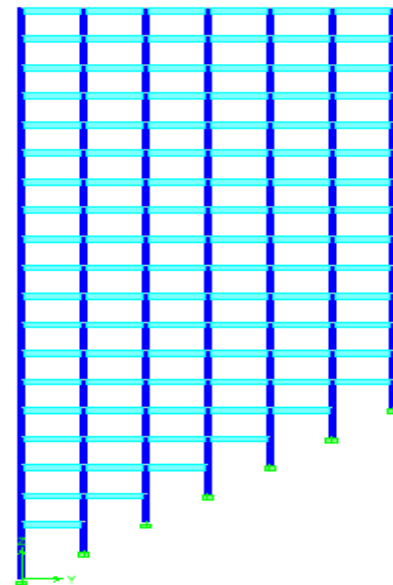


Figure 3.2: Elevation of set & step back structure

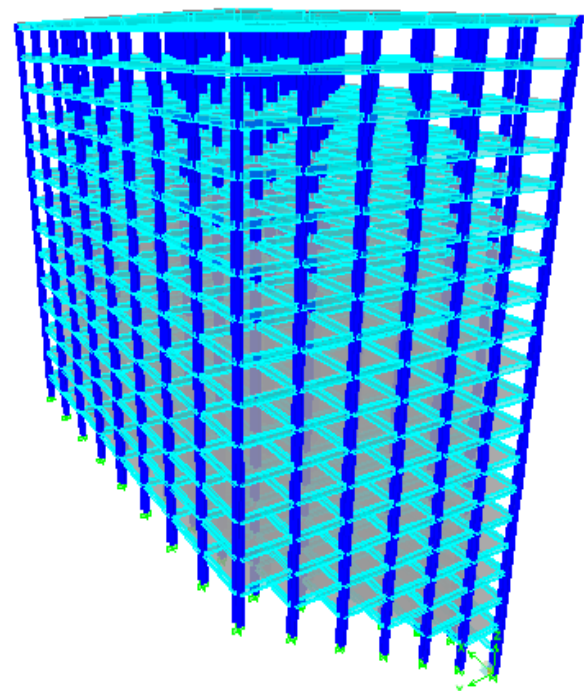


Figure 3.3: A 3D view of step back building

3.1 Locating core walls

To inspect the proper shape & position of core wall for step back, core walls aligned in C & U shape are assessed for various situations in the building and its twisting reaction in the building accompanied by displacements are valued. Listed below are the different positions of core walls on step back structures.

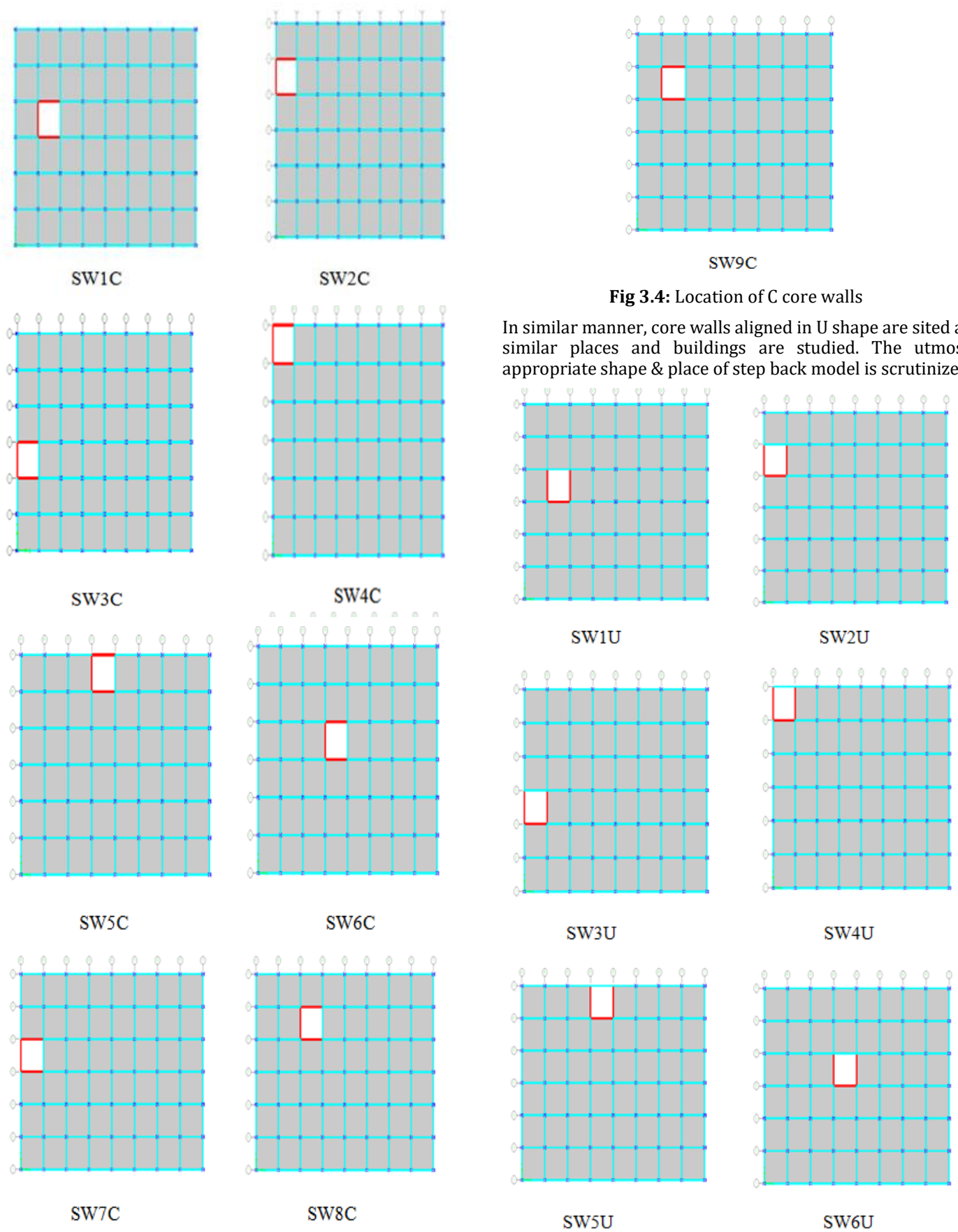


Fig 3.4: Location of C core walls

In similar manner, core walls aligned in U shape are sited at similar places and buildings are studied. The utmost appropriate shape & place of step back model is scrutinized

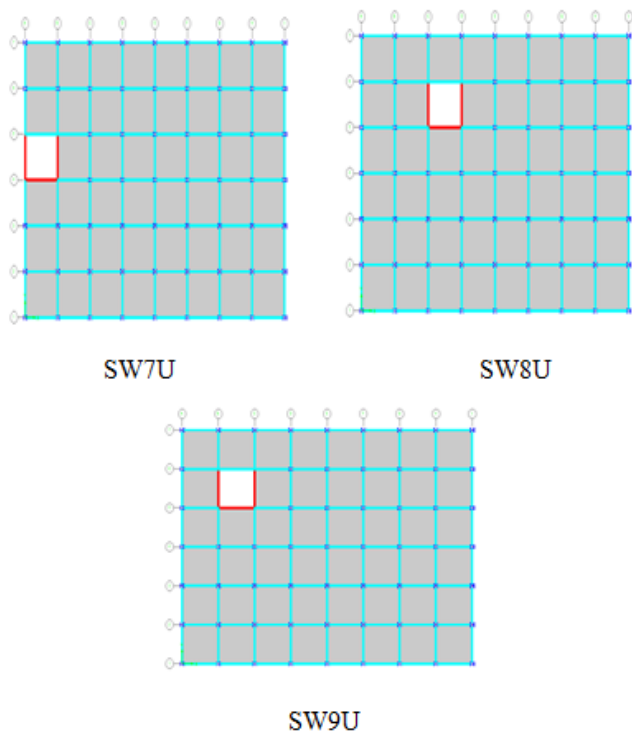


Fig 3.5: U core walls placed at different positions

3.2 Material & Geometric Properties

Various properties used for the developing of the step back structures-

Table 3.1: Details of various properties used

Plan Dimension	48m x 30m
Floor to floor height	3m
Number of storey	G+20
Width of bay along x direction	6m
Width of bay along y direction	5m
Type of structural steel	Fe340
Grade of concrete	M30
Column size	Built-up
Beam size	ISMB600
Deck thickness	200mm
Live load	4 kN/m ²
Floor finishes	1.5kN/m ²
Seismic zone, Z	V
Importance factor, I	1
Response reduction factor, R	5
Soil type	Medium
Shear wall thickness	300mm

4. RESULTS AND DISCUSSIONS

Results obtained are developed in form of graphs for evaluating purposes and below are the results drawn

4.1 Displacements

It is sighted from examining the various location of core walls that sw7c imparts fewer displacements nearly 5.18% & and 64.80% smaller than bare models in x & y direction respectively. Henceforth of many positions evaluated sw7c has the least displacement and can be considered suitable.

Table 4.1 Maximum displacement along x and Y direction for step buildings

POSITION	MAX UX m	MAX UY m
bare	0.0275	0.0287
sw1c	0.0637	0.031
sw1u	0.0914	0.0289
sw2c	0.052	0.0263
sw2u	0.0599	0.0236
sw3c	0.0449	0.0227
sw3u	0.0813	0.0339
sw4c	0.0434	0.0319
sw4u	0.1131	0.0426
sw5c	0.0393	0.053
sw5u	0.07	0.218
sw6c	0.0994	0.0476
sw6u	0.0841	0.1401
sw7c	0.0259	0.0101
sw7u	0.0683	0.017
sw8c	0.0565	0.0376
sw8u	0.092	0.0507
sw9c	0.0411	0.0249
sw9u	0.0835	0.03085

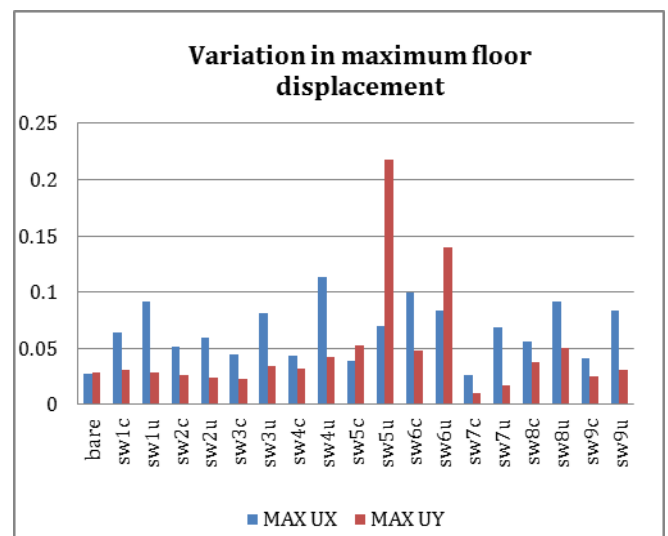


Fig 4.1: Maximum displacements along x & y direction for step back structures

4.2 Torsion

Examining altogether the location of core walls aligned in C & U shape, sw7c produces 74% less significant torsion and 1.55% more twisting moment than bare model for seismic loads in x & y direction respectively. So sw7c is suggested as right position for step back buildings

proven as an applicable position for step back structures. Besides sw5u, sw9u, sw6c and sw7u are few significant positions considered for complete study

Henceforth a complete investigation is prepared for these 5 positions chiefly sw5u, sw9u, sw6c, sw7c & sw7u.

Table 4.2 Torsional response of step back structures

POSITION	MAX TORSION X kN-m	MAX TORSION Y kN-m
bare	0.788	1.349
sw1c	2.309	2.857
sw1u	2.38	4.099
sw2c	1.344	3.348
sw2u	1.231	2.456
sw3c	1.336	3.277
sw3u	1.937	1.76
sw4c	0.997	2.534
sw4u	1.753	1.764
sw5c	2.036	0.522
sw5u	0.361	0.361
sw6c	1.365	0.995
sw6u	3.505	0.719
sw7c	1.336	3.271
sw7u	1.451	2.198
sw8c	0.886	2.907
sw8u	1.252	1.139
sw9c	1.412	2.478
sw9u	1.056	6.44

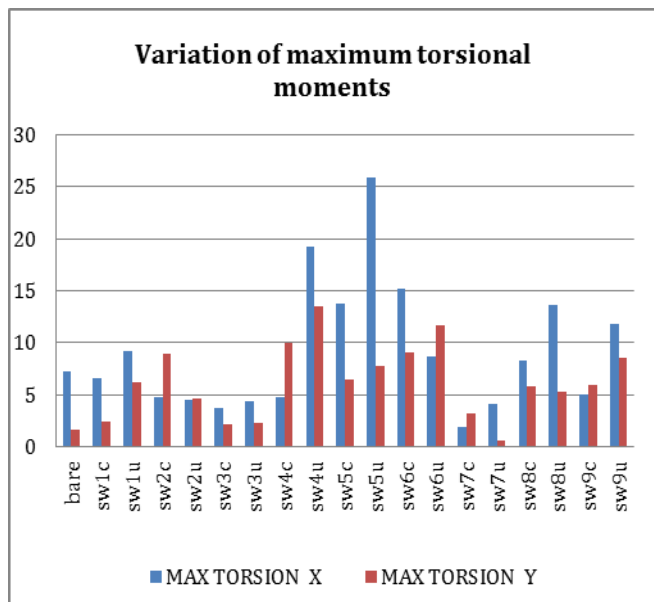
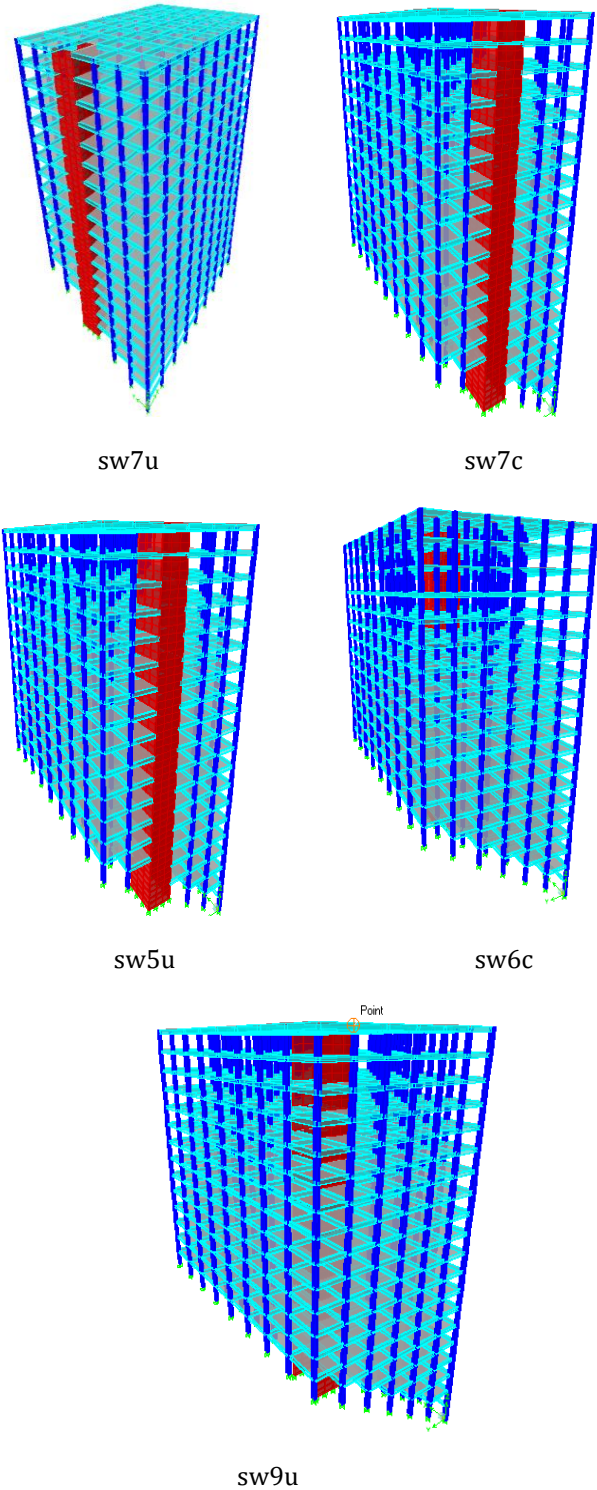


Fig 4.2 Maximum torsion in step back structures

Viewing the torsional moments & displacements for many shapes & positions of core wall, it is observed that sw7c is

4.3 Examining core wall positions

4.3.1 Displacements at different storeys for step back structures

The maximum displacements are commonly seen at top floors. The bare model has 25.68mm & 28.69 mm along x and y direction. In contrast with the buildings with core walls, position sw7c has smaller displacements from rest positions of core wall which is 0.7% more in x direction & 64.5% lesser displacements when compared with bare model displacements for x & y direction.

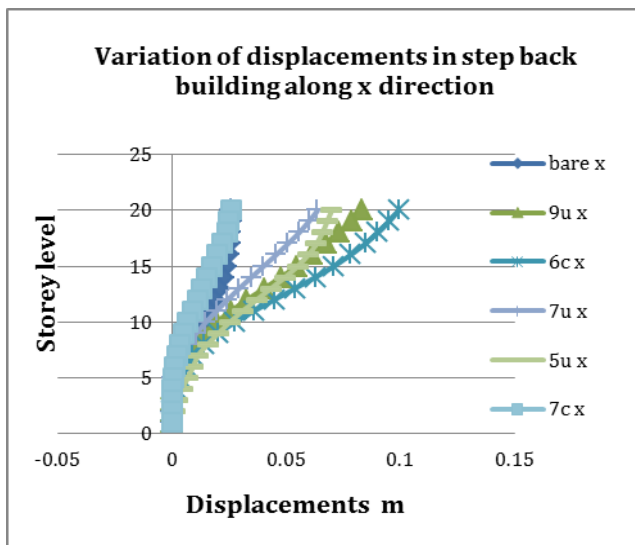


Fig 4.3: Displacements along x direction

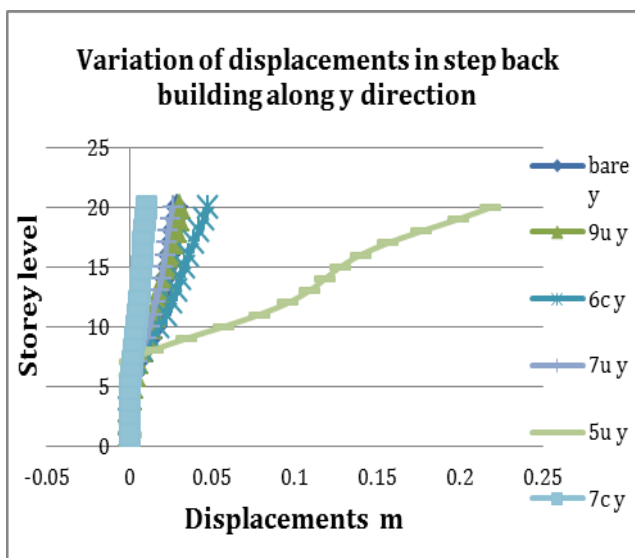


Fig 4.4: Displacements along y direction

4.3.2 Natural time period

The building lacking with incorporation of core wall has displayed higher values for time period implying more likely

to damage. Presence of the core walls has seen reduction in time period by 26.4% -65.76% in contrast with bare model suggesting that the decrease in time period helps in improving the structure to handle more seismic input frequencies

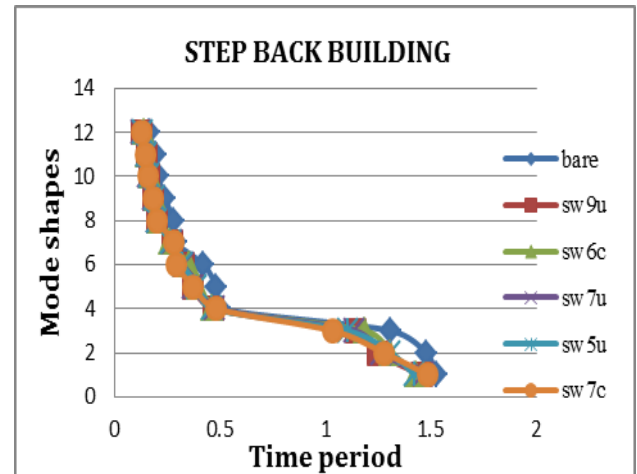


Fig 4.5: Time period variation.

4.3.3 Variation of torsion in step back structures

In step back buildings, it is seen that the maximum column twisting are commonly seen at hill side and the columns c7 & c66 in bare models have twisting moments of 7.3kN-m and 1.28kN-m for seismic load in x & y direction. Among many positions, sw7c has about 74% lesser values & 1.5% more values for seismic loads in x & y direction when related with bare models. Since this produces the least torsion in columns this position is treated appropriate

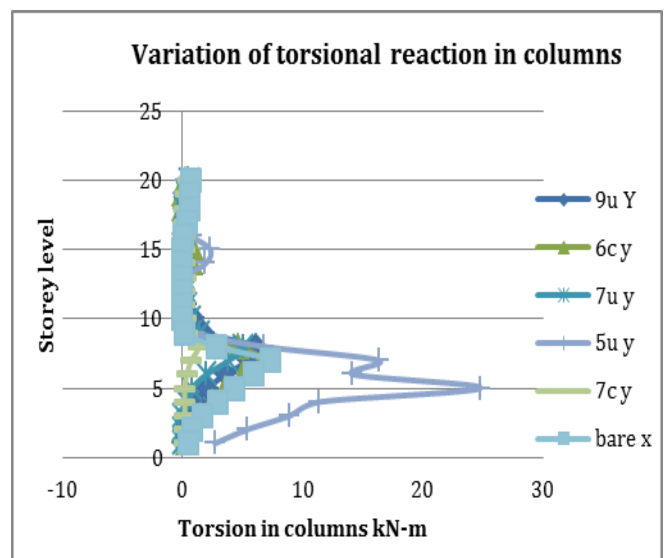


Fig 4.6: Torsion in columns for seismic load x direction

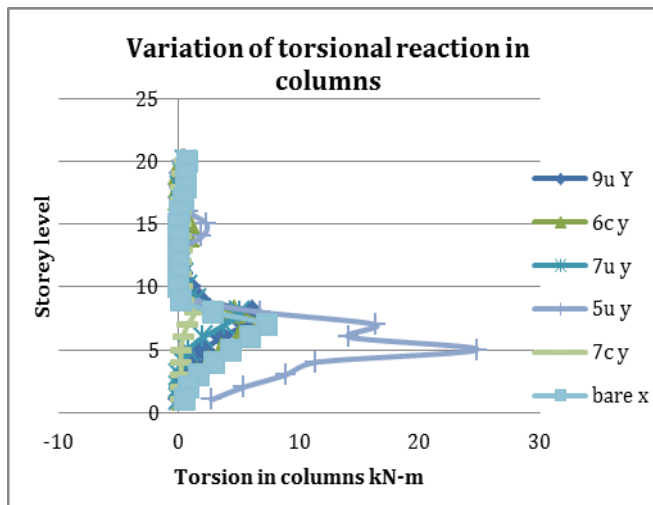


Fig 4.7: Torsion in columns for seismic load y direction

5. CONCLUSIONS

- A step back building encompasses changing length of columns, greater torsion is felt on the columns positioned on hill side of inclined ground, were shorter columns pulls more seismic forces leads to short column effect.
- Looking through time period outcomes of several models, it is noticeable that comprising core walls in structures diminishes the fundamental time period of buildings consecutively increasing the stiffness of structure to draw a high level of input frequencies of seismic tremor. In existence of core walls, structures have displayed a time period by 26.28%-65.71%.
- Displacement results exhibits sw7c produced a slightly higher value of 0.69 % in x direction & 64.48% smaller values in y direction than bare models. And so sw7c is treated as suitable location.
- Torsion results shows that, maximum torsional moments are seen in columns on upper side of sloping ground. Maximum values for bare model are encountered for columns c7 and c66 located on the higher slope end. While locating the suitable location of core wall it was seen that sw7c with column c66 exhibited lesser values of torsion than bare models. Hence sw7c is considered better.
- Finally it is inferred as sw7c is epitome position for core walls for step back buildings.

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