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# Analysis of G+10Multi-storey Building using ETABS

[1]sanjay Sankar Tudu, [2]soumyakanta Behera,
*Gandhi Institute of Excellent Technocrats, Bhubaneswar, India*
*Gurukula Institute of Technology, Bhubaneswar, Odisha, India*

**ABSTRACT:**
Asthehorizontalexpansionsofcitiesarelimitedandthequickincrementofpopulation,constructionof atall buildingis essential thesedays. Therefore itisimportant toanalysisthis tallbuildingunder the earthquake load. The building should able to withstand is gravity load i.e. self-weight of the structure,static load, imposed load and wall load. Apart from this vertical load, the building is additionally exposed tolateral load which is caused by earthquake or wind. The most common structure of the buildings is to frame andframe is considered as rigid in a multi-storey building. Generally, only the frame is not sufficient to take thehorizontal as well as lateral load. So the shear wall is the most common suitable structural element in muti-storeybuilding. This paper investigatedthe behaviour of amulti-storeybuildingunder seismicforcesforvariousshearwallthicknessandshearwallswithdifferentaperturewidths.Astudyofthe multi-storyframeofG + 10 stories was carried out. The investigation will be carried out in seismic zones II using ETABS, and thefindings will be compared. It evaluates numerous scenarios with and without shear wall apertures to establishthebase shear,displacementinXandYdirections,storey driftand time period.
**Keywords:**Shearwall,Slabopenings,Seismicanalysis, Multi-storeybuilding,Modelling,Analysis,ETABS.

## I. INTRODUCTION

Shear walls are one of the greatest structure features for resisting lateral/horizontal stresses induced bywind and earthquake in high-rise or multi-story buildings. Shear walls are often employed in high-rise buildingsto prevent failure and to improve the response of the multi-story structures to lateral stresses.Shear walls arevertical elements of the horizontal force resisting system; they can resist forces directed along the length of thewall. Once shear walls designed and constructed properly, they will have the strength and stiffness to resist thehorizontalforces[1].
At the point when shear wall is arranged in the proper position, it can be very efficient to restrainlaterals loads from wind or earthquake. Shear walls are ordinarily light-outlined or supported wooden walls witha reinforced masonry wall, reinforced concrete wall, or steel plates. Shear walls are very important structuralelements used in a multi-storey building in a high seismic zone because they offer high resistance to earthquakeload. In combination with shear walls and frame, it provides the required solidarity and stiffness to withstand thelateral loads in tall buildings. Most of the case the shear walls are a lot stiffer than the frames and in this way themajorityofthe lateral loadshastakenbythe shearwalls.

AdvantagesofShearWallsinRCBuildings:
- Shearwallresisthorizontallateralforceandprovideearthquakeresistance.
- Itresistlateralloadwhichpossessverylargein-planestiffness.
- Forcontrollingdeflectionshear wallsareveryuseful.
- Shear wallreducestheearthquakedamagestonon-structuralaswellasstructuraldamages.
- Itiseasytoconstructi.e.reinforcementdetailing.
- Providingpropershearwallsdesignnotonlygiveadequatesafetybutalsoprovidegreatamountofprotectionagainstcostlynon-structural damageduringmoderateearthquake [2].

### 1.1 FunctionofShearWalls

- Shearwallsoughttogivethesignificantlateralstrength toopposehorizontalearthquakeforces.Atthepointwhenthe shearwallisverysolid,theycanmovethese forcesto theestablishment.

- Tostayawayfromtheoverthetopsideinfluencesoftherooftoporfloorshearwallalsoactaslateralstiffness.
- When the shear wall is adequately inflexible, it will attempt to keep away from the floor or roof outliningindividualsmovingfromtheir backing.
- Also,thebuildings whicharerigidenoughwill getlessdamagetothenon-structural.
- Shear walls have provided tremendous stiffness and strength to structure towards their direction, whichdecreased lateral sway of the construction and it will lessen the harms of the design. Since shear walls haveconveyed atremendoushorizontalforce,theoverturningimpactsonthem willbeenormous [3].

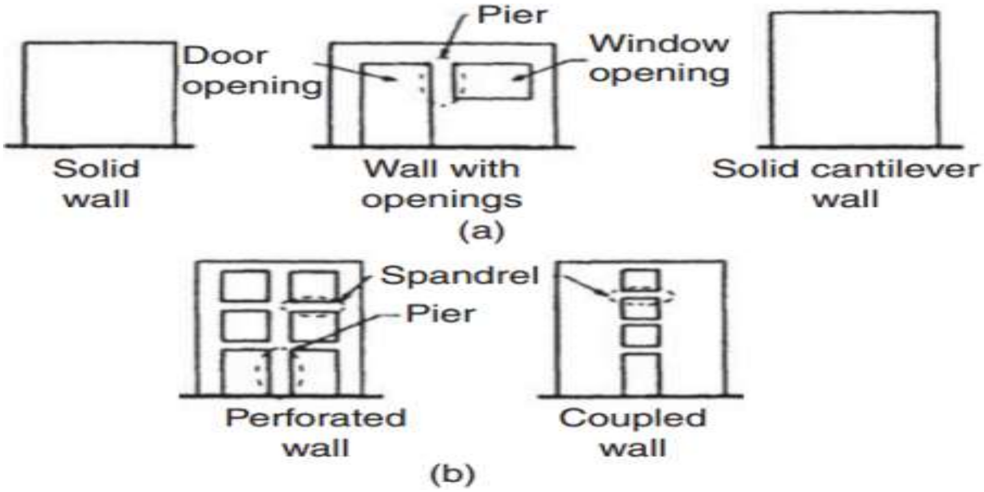



**Figure1:DifferenttypesofShearwalls**

### 1.2 ObjectiveoftheStudy

Themainobjectivesofthis studyare:

i. Tocarryoutthemodelling&analysisofG+10multi-storeybuildingframeusingETABS.
ii. Tostudythebehaviourofstructure withdifferent shear wallsthickness.
iii. ToanalysisthestructureunderseismiczoneIV.
iv. Tostudytheresultofbaseshear,lateraldisplacementinXandYdirectionofbuildingwithandwithoutshear.

## II. METHODOLOGY

In this present study the behaviour of amulti-storey frameunderseismic pressures was explored in this paperfor varied shear wall thicknesses. An investigation of the multi-storey frame of G + 10 storeys was performed.Thestudywillbeperformed usingETABSinseismiczonesIV, and the resultwillbe discussed.

**Table1: Casesconsideredforanalysis**

| **Description** | | **Model** | **Shearwallthickness** |
|---|---|---|---|
| Withoutshearwall | | Model1 | - |
| Shear wall withdifferent thicknesswith6mx6 mopening | **CASE 1** | Model2 | 150mm |
| | | Model3 | 200mm |
| | | Model4 | 250mm |
| | | Model5 | 300mm |
| Slab openings to thecenter with 250mmshearwallthickness | **CASE 2** | **Model** | **Slabopeningsize** |
| | | Model4 | 6m x6m |
| | | Model4A | 4.5mx4.5m |
| | | Model4B | 3m x3m |

### 2.1 StructuralParameters

The different structural parameters are considered for the analysis of the structure, below table shows thedifferentparametersconsideredfor analysis.

**Table2:StructuralParametersofbuilding**

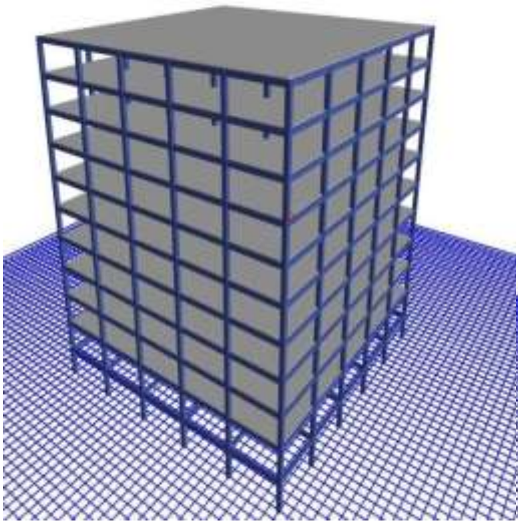
| **Parameters** | **Description** |
|---|---|
| Sizeofcolumn | 500x500mm |

| | |
|---|---|
| Sizeofbeam | 300x600mm |
| Slabthickness | 150mm |

| | |
|---|---|
| Storeyheight | 3m |
| Totalheight | 33m |
| Baysnumber | 5no. inX&Ydirection |
| Spanc/clength | 6m |
| Mainwallthickness | 200mm |
| Partitionwallthickness | 100 m |
| Parapetwallheight | 1m |
| Liveload | 2kN/m$^2$ |
| Finishload | 1.5kN/m$^2$ |
| Roofload | 3kN/m$^2$ |
| Brickdensity | 20kN/m$^3$ |
| Gradeofconcreteandsteel | M40&Fe500 |
| Seismiczonefactor(Z) | 0.24 |
| Responsereductionfactor(R) | 5 |
| Importantfactor(I) | 1 |
| Soiltype | Medium(II) |

## 2.2 ModellinginETABS

First, choose the appropriate units and lay out the grid system according to the design. Draw theproposed buildings center line diagram by supplying reference points and sketching the lines. Modelling entailsdefining materials characteristics, frame section, area objects, and lastly arranging the aforementioned attributestoformastructure.Materialpropertiesshouldbeestablishedbasedonthegradeofconcretei.e.whenconcreteisutilizedat theM40site;thefollowingquantitiesmustbedefined.



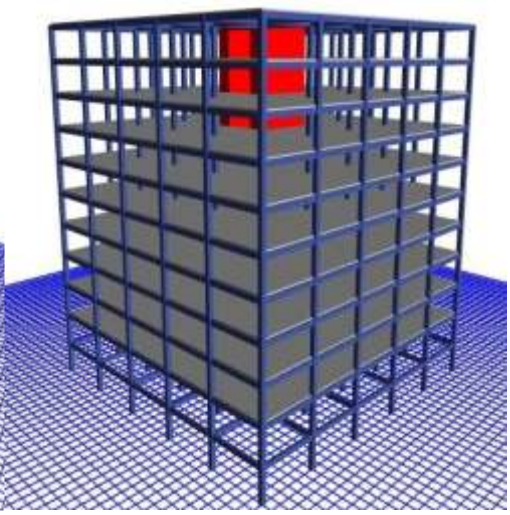


**Figure2: BuildingwithoutshearwallFigure3:Building withshearwallatcenter**

## 2.3 LOADCALCULATIONANDASSIGNING

The load which has to be assign is frame load and shell load. Frame loads are those which will apply atthe beam of the structure i.e. main wall,partition wall and parapet wall.And shell load are those floor finish,rooffinish,typicalliveloadwhichareassignedineach floorwithreferenceto ISCodeprovisions.

### 2.3.1 Calculationofwallload

Wallloadwillbecalculatedpermeterlength.
Data,floorheight=3m
Main wall thickness = 0.2 mPartition wall thickness = 0.1 mHeight of parapet walls = 1 mBeamdepth= 0.6m
Densityofbrick masonry=20 kN/m$^3$
(a) Mainwallload:

h = floor height – beam depthh=3– 0.6=2.4 m
weight=volumexdensity

=1 x2.4 x0.2x20= 9.6kN/m
(b) Partitionwallload:weight=volumexdensity
=1 x2.4 x0.1x20 = 4.8kN/m
(c) Parapet wall load:weight=volumexdensity
=1 x1 x0.2x20 = 4.8 kN/m

- Thecalculationforall wallsineachfloorhastobecalculatedandassigned.
- Theassignedwallloadhasshowninthefigurebelow.

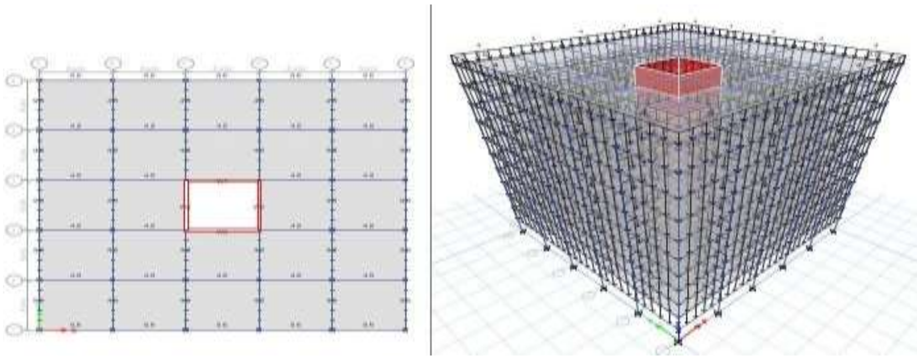


**Figure4:Wallloadpatternwithopeningatcenter**

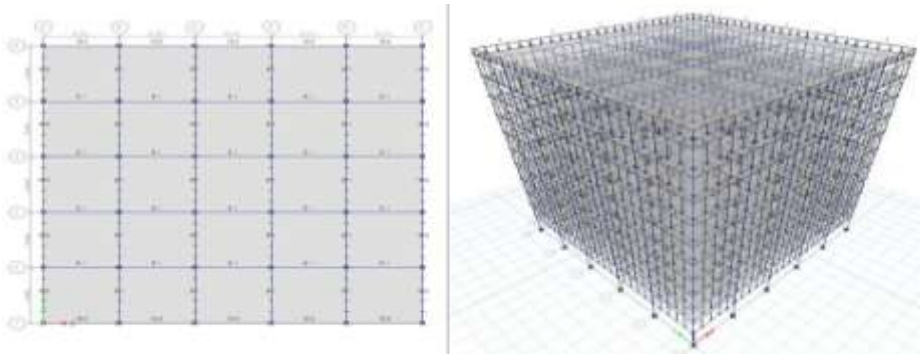


**Figure5:Wallloadpatternwithoutopening**

## III. RESULT ANDDISCUSSION

The analytical investigation of G + 10 structures is carried out in seismic zone IV by using IS 875 and IS1893:2002withETABSsoftware.Thebehaviourofamulti-storeyframeunderseismicpressurewasexploredinthisworkforvariedshearwallthicknessandslabopenings.

**(i) Case1**

The building without shear wall, 150 mm shear wall, 200 mm shear wall, 250 mm shear wall, 300 mmshear is analyzed for case 1 under the seismic zone IV, and by different iterations the structure with 250mmshear wall is considered.The percentage of shear taken by the shear wall is gradually increased as the thicknessofshearwall increases.

**Table3:BaseShear,shearcalculationundercase1**

| **Models** | **TotalBaseShear kN** | **Shear taken by shearwall kN** | **Sheartakenbycolumn kN** | **Shear taken by shearwall** inpercentage(%) |
|---|---|---|---|---|
| 1 | 6346 | 0 | 6346 | 0 |
| 2 | 6211 | 5032 | 1179 | 81 |
| 3 | 6273 | 5302 | 971 | 85 |

| | | | | |
|---|---|---|---|---|
| 4 | 6335 | 5503 | 832 | 87 |
| 5 | 6397 | 5666 | 731 | 89 |

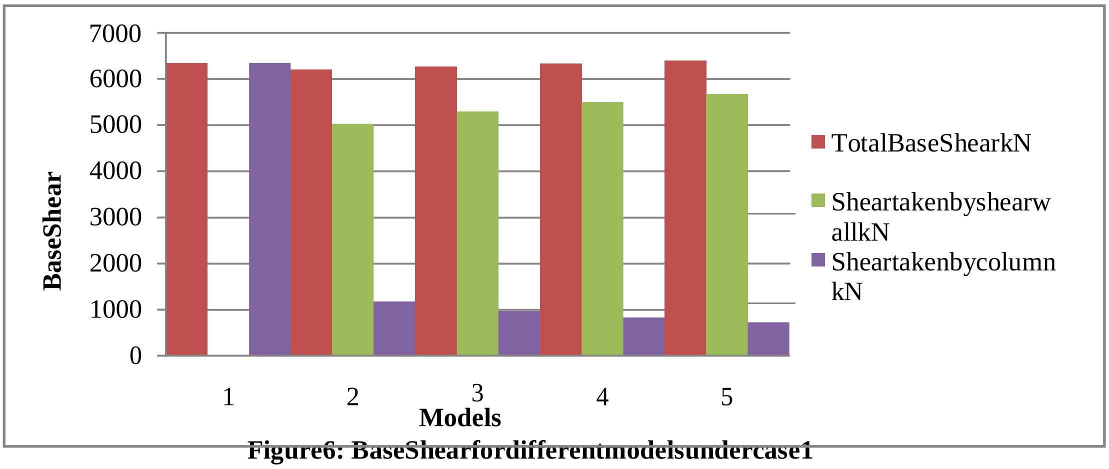



**Figure6: BaseShearfordifferentmodelsundercase1**

The storey wise displacement of G + 10 structure is analyzed for the model without shear wall and withdifferent shear wall thickness. The displacement of the model without shear shear wall i.e. Model 1 is muchhigher compare tothe others.

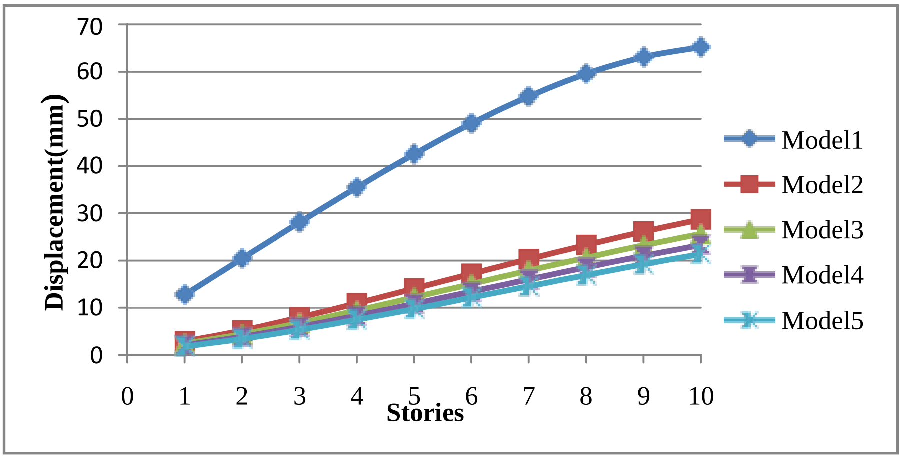



**Figure7:Displacementforeachstoreyfordifferentmodels undercase1**

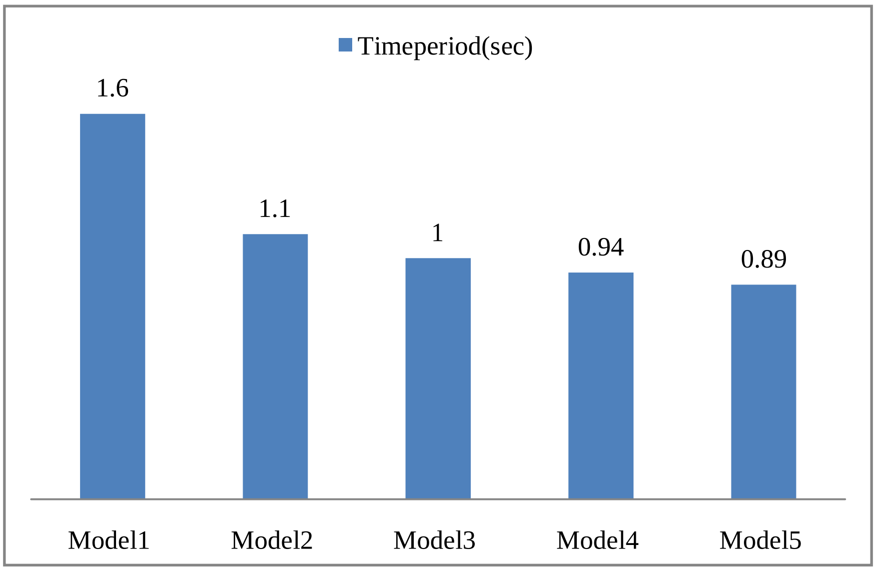



**Figure8:Timeperiodfordifferent modelsundercase1**

**(ii) Case2**

The model 4 in case 2 is subcategorised into model 4A, 4B with opening of 4.5 x 4.5m, 3m x 3mrespectively and comparedwith model 4 where total base shear, shear taken by the shearwall and shear takenbythe columniscalculatedand comparedaccordingly.

**Table4:Baseshear,shearcalculationundercase2**

| **Models** | **Total BaseShearkN** | **Shear taken by shearwallkN** | **Sheartakenbycolumn kN** | **Shear taken by shearwall**percentage(%) |
|---|---|---|---|---|
| 4 | 6335 | 5503 | 832 | 87 |
| 4A | 6395 | 5085 | 1310 | 80 |
| 4B | 6360 | 4143 | 2217 | 65 |

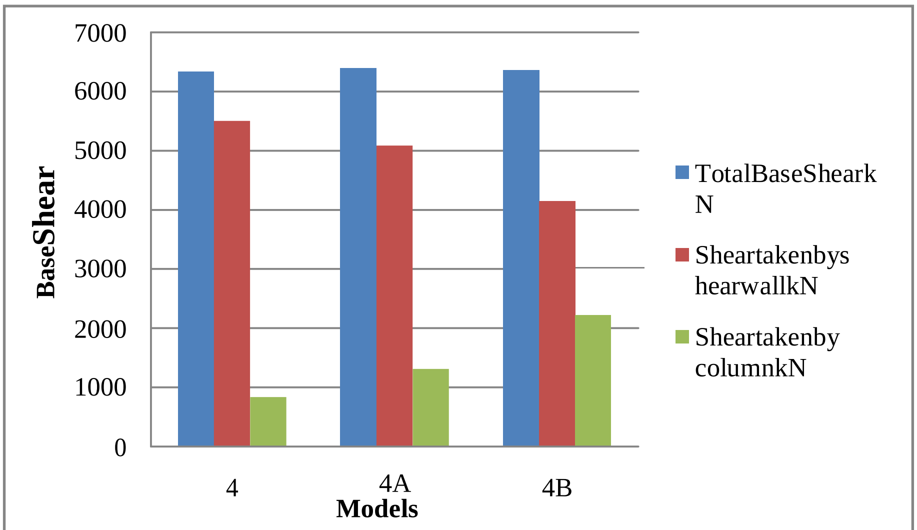



**Figure9: BaseShearforModel4,4A,4B undercase2**

The storey wise displacement of G + 10 structure is analysed for the model 4, 4A, 4B. The displacementformodel 4Bismore comparedto model 4whichisshowninfigure 10.



mm)

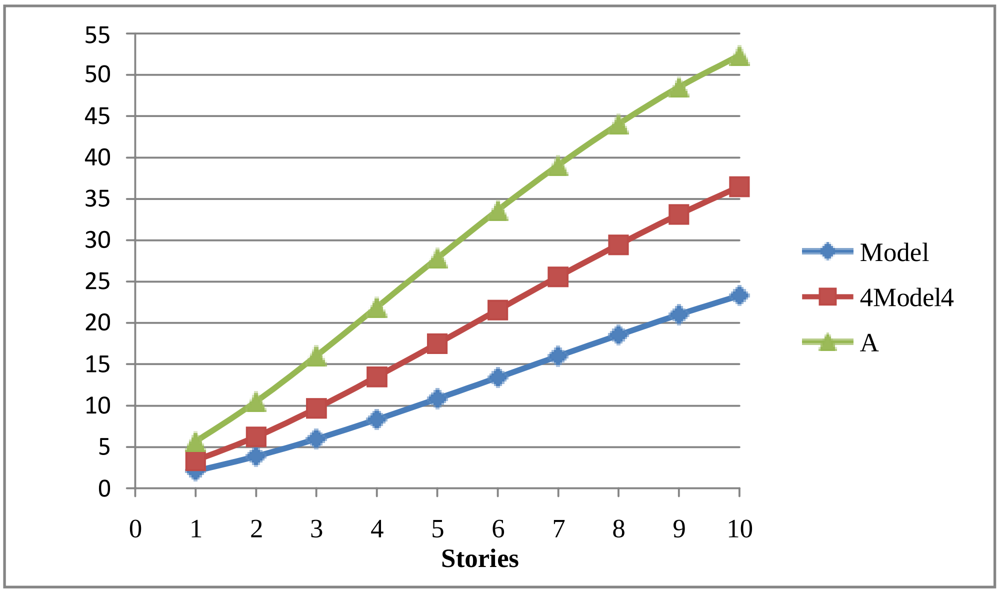



**Figure10:DisplacementforModel4,4Aand4B undercase2**

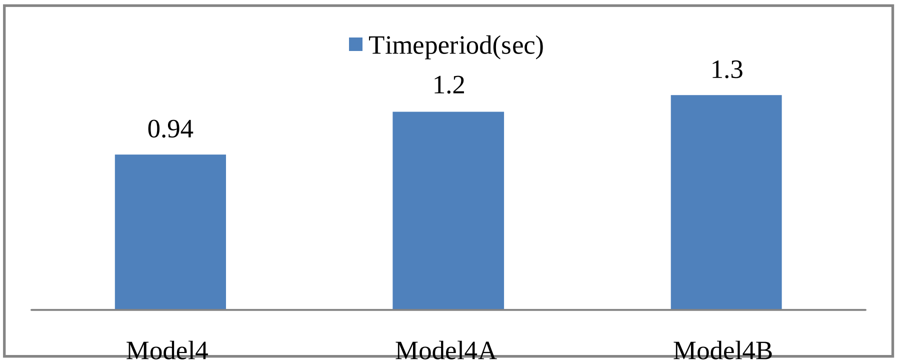



**Figure11:TimeperiodforModel4,4Aand4B undercase2**

## IV. CONCLUSION

In this work, the behaviour of a frame with and without a shear wall with fluctuating section anddifferent slab openings size was explored in an uncovered edge framework in the center of the structure. Shearwallservea significantcapacityinimprovingdevelopmentexecutionunderlateralpressure.

From the result for case 1 i.e. shear wall of various thickness size the model 4 is considered the mostsuitable thickness of shear wall i.e. 250 mm thickness and compare to frame without shear wall the base shear isidentically same. And the percentage of shear taken by the shear wall is gradually increased as thickness of theshear wall increase. The maximum lateral displacement for the model 1 in zone IV is 2.3 to 3 times higher thantheothermodel.The period graduallydecreasedastheshearwallthicknessincreases.

In case 2 the provision of different opening size of slab is analyzed, in this the model 4 is consideredmost suitable in the analysis. While comparing the three models, shear taken by the shear wall decreased from87% to 65% as the opening size is decreased. Also lateral displacement of model 4B is much higher compare tomodel 4, it is known that as the opening size decreased the displacement got higher. In this case time period isincreased asthe openingsize isreduces.

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