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Analysis of G + 10 Multi-storey Building using ETABS

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ABSTRACT: *As the horizontal expansions of cities are limited and the quick increment of population, construction of a tall building is essential these days. Therefore it is important to analysis this tall building under 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 to lateral load which is caused by earthquake or wind. The most common structure of the buildings is to frame and frame is considered as rigid in a multi-storey building. Generally, only the frame is not sufficient to take the horizontal as well as lateral load. So the shear wall is the most common suitable structural element in muti-storey building. This paper investigated the behaviour of a multi-storey building under seismic forces for various shear wall thickness and shear walls with different aperture widths. A study of the multi-story frame of G + 10 stories was carried out. The investigation will be carried out in seismic zones II using ETABS, and the findings will be compared. It evaluates numerous scenarios with and without shear wall apertures to establish the base shear, displacement in X and Y directions, storey drift and time period.*

Keywords:*Shear wall, Slab openings, Seismic analysis, Multi-storey building, Modelling, Analysis, ETABS.*

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I. INTRODUCTION

Shear walls are one of the greatest structure features for resisting lateral/horizontal stresses induced by wind and earthquake in high-rise or multi-story buildings. Shear walls are often employed in high-rise buildings to prevent failure and to improve the response of the multi-story structures to lateral stresses.Shear walls are vertical elements of the horizontal force resisting system; they can resist forces directed along the length of the wall. Once shear walls designed and constructed properly, they will have the strength and stiffness to resist the horizontal forces [1].

At the point when shear wall is arranged in the proper position, it can be very efficient to restrain laterals loads from wind or earthquake. Shear walls are ordinarily light-outlined or supported wooden walls with a reinforced masonry wall, reinforced concrete wall, or steel plates. Shear walls are very important structural elements used in a multi-storey building in a high seismic zone because they offer high resistance to earthquake load. In combination with shear walls and frame, it provides the required solidarity and stiffness to withstand the lateral loads in tall buildings. Most of the case the shear walls are a lot stiffer than the frames and in this way the majority of the lateral loads has taken by the shear walls.

Advantages of Shear Walls in RC Buildings:

- Shear wall resist horizontal lateral force and provide earthquake resistance.
- It resist lateral load which possess very large in-plane stiffness.
- For controlling deflection shear walls are very useful.
- Shear wall reduces the earthquake damages to non-structural as well as structural damages.
- It is easy to construct i.e. reinforcement detailing.
- Providing proper shear walls design not only give adequate safety but also provide great amount of protection against costly non-structural damage during moderate earthquake [2].

1.1 Function of Shear Walls

- Shear walls ought to give the significant lateral strength to oppose horizontal earthquake forces. At the point when the shear wall is very solid, they can move these forces to the establishment.
- To stay away from the over the top side influences of the rooftop or floor shear wall also act as lateral stiffness.

- When the shear wall is adequately inflexible, it will attempt to keep away from the floor or roof outlining individuals moving from their backing.
- Also, the buildings which are rigid enough will get less damage to the non-structural.
- Shear walls have provided tremendous stiffness and strength to structure towards their direction, which decreased lateral sway of the construction and it will lessen the harms of the design. Since shear walls have conveyed a tremendous horizontal force, the overturning impacts on them will be enormous [3].

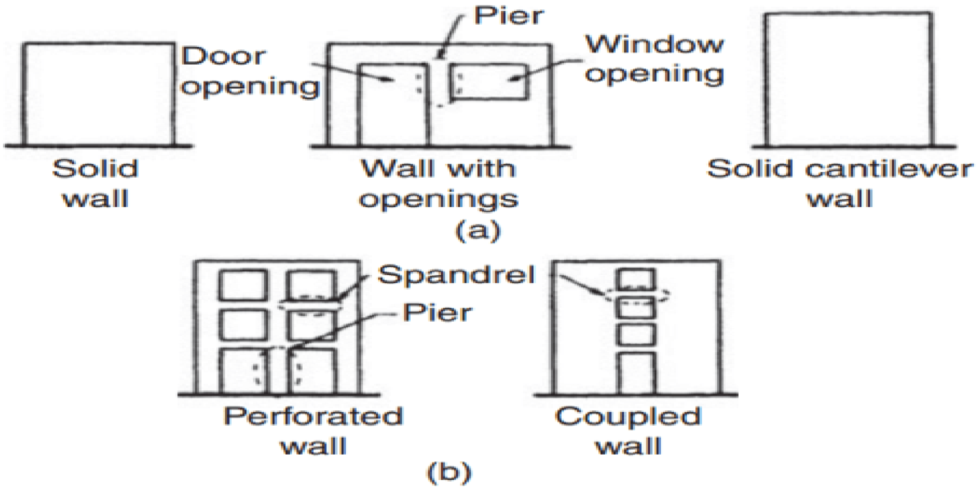

Figure 1: Different types of Shear walls

1.2 Objective of the Study

The main objectives of this study are:

i. To carry out the modelling & analysis of G + 10 multi-storey building frame using ETABS.
ii. To study the behaviour of structure with different shear walls thickness.
iii. To analysis the structure under seismic zone IV.
iv. To study the result of base shear, lateral displacement in X and Y direction of building with and without shear.

II. METHODOLOGY

In this present study the behaviour of a multi-storey frame under seismic pressures was explored in this paper for varied shear wall thicknesses. An investigation of the multi-storey frame of G + 10 storeys was performed. The study will be performed using ETABS in seismic zones IV, and the result will be discussed.

Table 1: Cases considered for analysis

Description		Model	Shear wall thickness
Without shear wall		Model 1	-
Shear wall with different thickness with 6m x 6m opening	CASE 1	Model 2	150mm
		Model 3	200mm
		Model 4	250mm
		Model 5	300mm
Slab openings to the center with 250mm shear wall thickness	CASE 2	**Model**	**Slab opening size**
		Model 4	6m x 6m
		Model 4A	4.5m x 4.5m
		Model 4B	3m x 3m

2.1 Structural Parameters

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

Table 2: Structural Parameters of building

Parameters	Description
Size of column	500 x 500 mm
Size of beam	300 x 600 mm
Slab thickness	150 mm

Storey height	3 m
Total height	33 m
Bays number	5 no. in X & Y direction
Span c/c length	6 m
Main wall thickness	200 mm
Partition wall thickness	100 m
Parapet wall height	1 m
Live load	2 kN/m^2
Finish load	1.5 kN/m^2
Roof load	3 kN/m^2
Brick density	20 kN/m^3
Grade of concrete and steel	M40 & Fe500
Seismic zone factor(Z)	0.24
Response reduction factor(R)	5
Important factor(I)	1
Soil type	Medium (II)

2.2 Modelling in ETABS

First, choose the appropriate units and lay out the grid system according to the design. Draw the proposed buildings center line diagram by supplying reference points and sketching the lines. Modelling entails defining materials characteristics, frame section, area objects, and lastly arranging the aforementioned attributes to form a structure. Material properties should be established based on the grade of concrete i.e. when concrete is utilized at the M40 site; the following quantities must be defined.

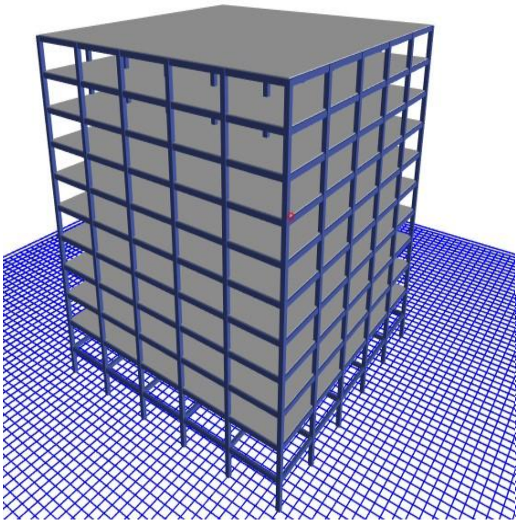
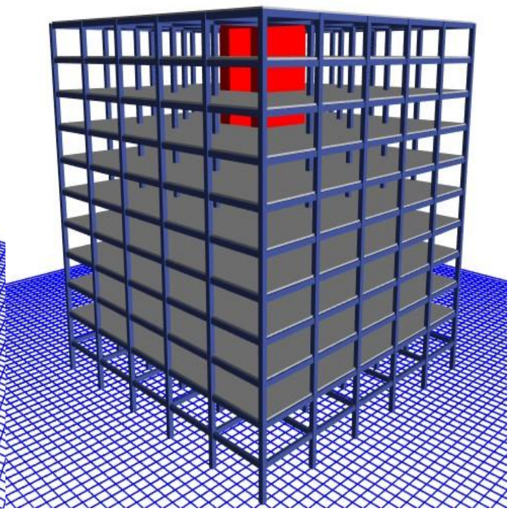

Figure 2: Building without shear wallFigure 3: Building with shear wall at center

2.3 LOAD CALCULATION AND ASSIGNING

The load which has to be assign is frame load and shell load. Frame loads are those which will apply at the beam of the structure i.e. main wall, partition wall and parapet wall. And shell load are those floor finish, roof finish, typical live load which are assigned in each floor with reference to IS Code provisions.

2.3.1 Calculation of wall load

Wall load will be calculated per meter length.

Data, floor height = 3 m

Main wall thickness = 0.2 m

Partition wall thickness = 0.1 m

Height of parapet walls = 1 m

Beam depth = 0.6 m

Density of brick masonry = 20 kN/m^3

(a) Main wall load:

h = floor height – beam depth

h = 3 – 0.6 = 2.4 m

weight = volume x density

= 1 x 2.4 x 0.2 x 20 = 9.6 kN/m

(b) Partition wall load:

weight = volume x density

= 1 x 2.4 x 0.1 x 20 = 4.8 kN/m

(c) Parapet wall load:

weight = volume x density

= 1 x 1 x 0.2 x 20 = 4.8 kN/m

- The calculation for all walls in each floor has to be calculated and assigned.
- The assigned wall load has shown in the figure below.

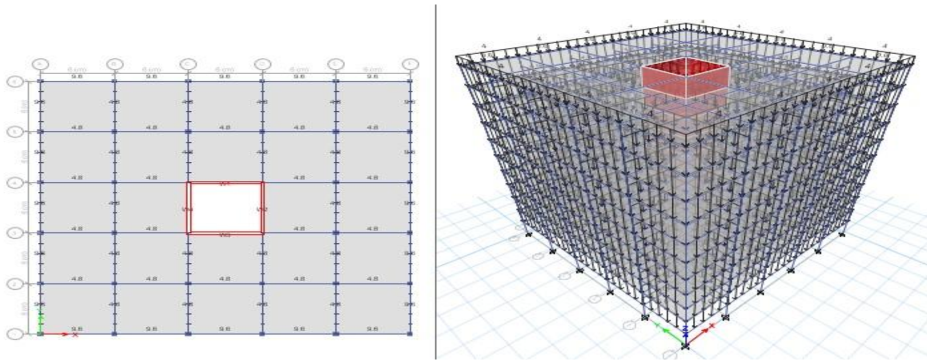

Figure 4: Wall load pattern with opening at center

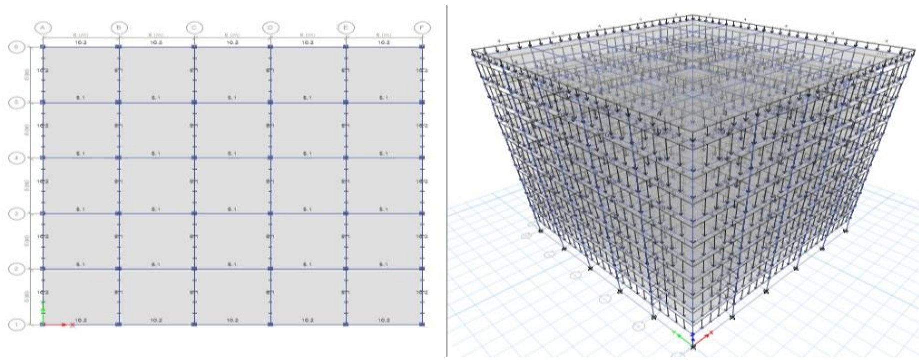

Figure 5: Wall load pattern without opening

III. RESULT AND DISCUSSION

The analytical investigation of G + 10 structures is carried out in seismic zone IV by using IS 875 and IS 1893:2002 with ETABS software. The behaviour of a multi-storey frame under seismic pressure was explored in this work for varied shear wall thickness and slab openings.

(i) Case 1

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

Table 3: Base Shear, shear calculation under case 1

Models	**Total Base Shear kN**	**Shear taken by shear wall kN**	**Shear taken by column kN**	**Shear taken by shear wall** in percentage (%)
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

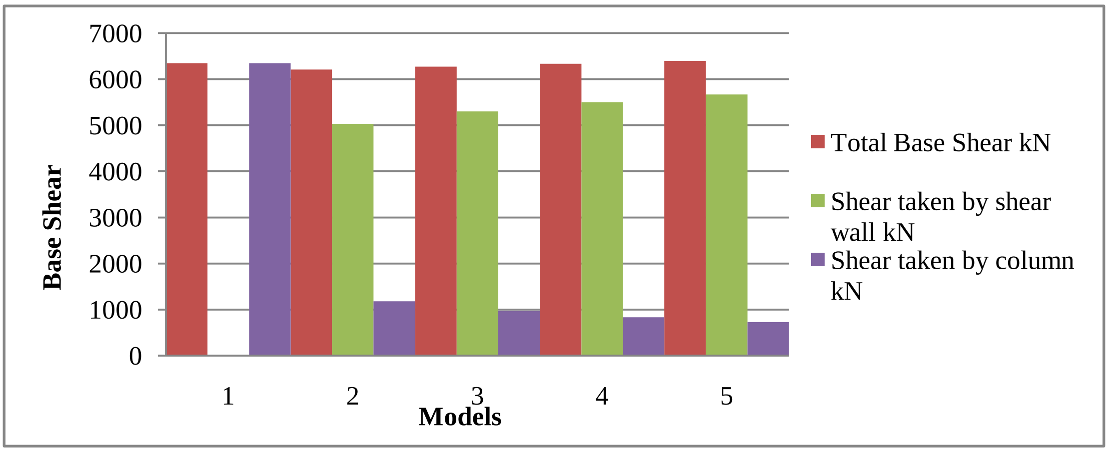

Figure 6: Base Shear for different models under case 1

The storey wise displacement of G + 10 structure is analyzed for the model without shear wall and with different shear wall thickness. The displacement of the model without shear shear wall i.e. Model 1 is much higher compare to the others.

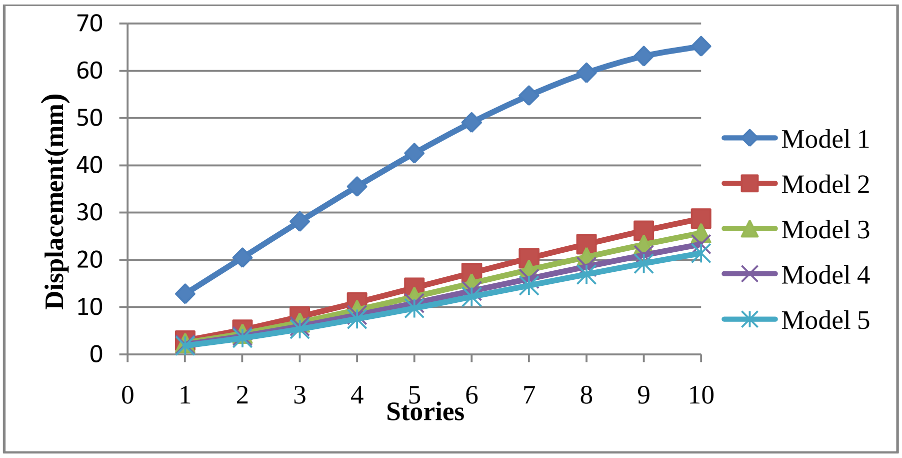

Figure 7: Displacement for each storey for different models under case 1

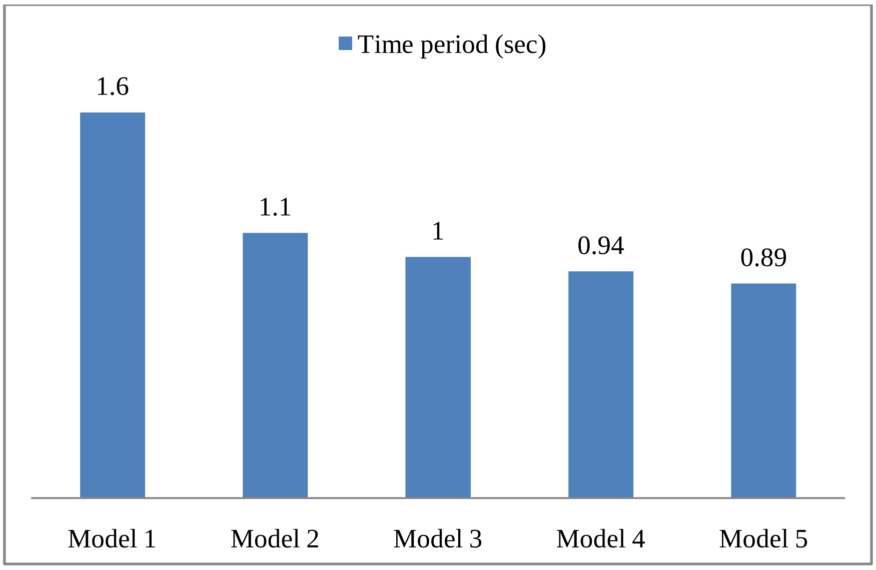

Figure 8: Time period for different models under case 1

(ii) Case 2

The model 4 in case 2 is subcategorised into model 4A, 4B with opening of 4.5 x 4.5m, 3m x 3m respectively and compared with model 4 where total base shear, shear taken by the shear wall and shear taken by the column is calculated and compared accordingly.

Table 4: Base shear, shear calculation under case 2

Models	Total Base Shear kN	Shear taken by shear wall kN	Shear taken by column kN	Shear taken by shear wall percentage(%)
4	6335	5503	832	87
4A	6395	5085	1310	80
4B	6360	4143	2217	65

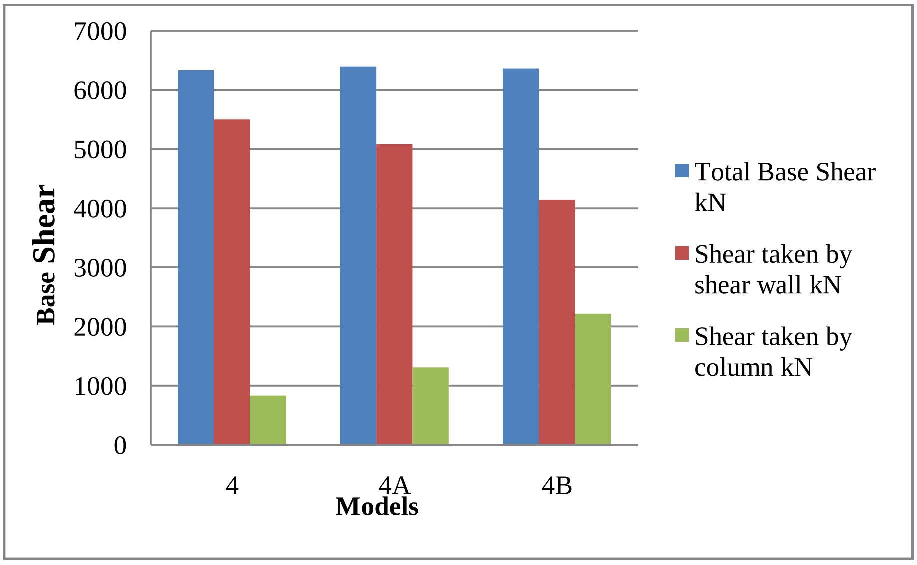

Figure 9: Base Shear for Model 4, 4A, 4B under case 2

The storey wise displacement of G + 10 structure is analysed for the model 4, 4A, 4B. The displacement for model 4B is more compared to model 4 which is shown in figure 10.

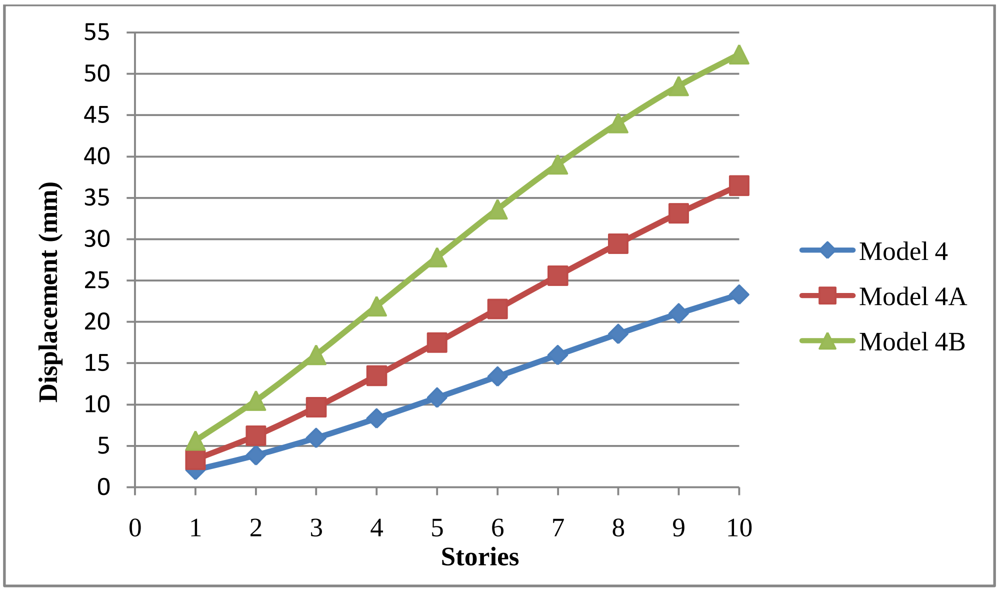

Figure 10: Displacement for Model 4, 4A and 4B under case 2

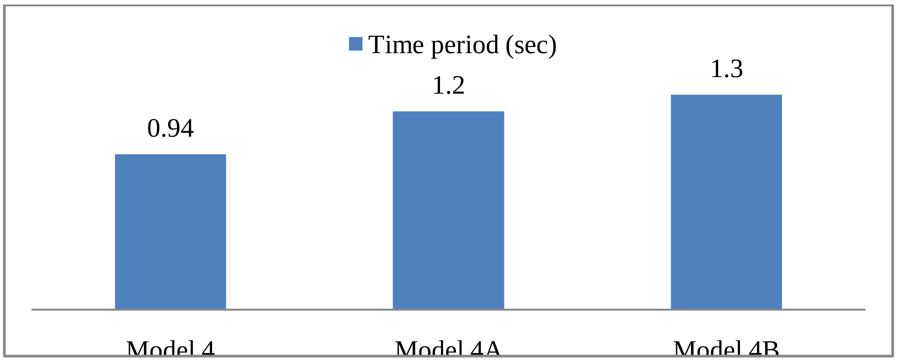

Figure 11: Time period for Model 4, 4A and 4B under case 2

IV. CONCLUSION

In this work, the behaviour of a frame with and without a shear wall with fluctuating section and different slab openings size was explored in an uncovered edge framework in the center of the structure. Shear wall serve a significant capacity in improving development execution under lateral pressure.

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

In case 2 the provision of different opening size of slab is analyzed, in this the model 4 is considered most suitable in the analysis. While comparing the three models, shear taken by the shear wall decreased from 87% to 65% as the opening size is decreased. Also lateral displacement of model 4B is much higher compare to model 4, it is known that as the opening size decreased the displacement got higher. In this case time period is increased as the opening size is reduces.

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