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Analysis of Elevated Water Tank with Different Staging Configuration for Wind Load

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ABSTRACT: Liquid storage tanks are important structures in water, oil and gas industrialists, and their behavior during an earthquake is more important than the economic value of the tanks and their contents. It is important that utilities remain in operation after the earthquake to meet emergency requirements, such as fire water or meet public requirements as a source of water supply. For these reasons, serviceability becomes a major design factor in most of these structures. A good understanding of the seismic behavior of these structures is necessary to achieve safety objectives, while containing construction and maintenance costs. It is observed that the Story Drift at top of container is maximum with the value of the 0.3 mm. In the case of Model II: Elevated water tank with staging with X type bracings while it goes on decreasing with the minimum value of the model- Model VI: Elevated water tank with Staging with shear wall at central portion having the value of 0.1 mm. the other models gives the value of story drift at top of container ranging from the 0.1 to 0.3 mm.

KEYWORDS: Elevated water tank, Analysis, Comparison of forces

I. INTRODUCTION

Over ground water pads of various shapes can be used as service tanks, as a balancing tank in water supply schemes and to replenish tanks for various purposes. Reinforced concrete water towers have clear advantages, because they are not affected by climate change, are airtight, provide greater rigidity and are acceptable for all forms.

These tanks are supported by a production that may consist of brick walls, an R.C.C tower, or an R.C.C column connected to each other. The walls are exposed to water pressure from the inside. The base is exposed to water weight, wall weight and roof weight. The installation must carry the entire load of entire tanks with water and be subjected to wind loads. The parameters of water tanks include the general design of tanks, the choice of materials for construction, as well as the following:

- i. Location of water tanks (indoors, outdoors, above ground or underground) determines color and design characteristics.
- ii. The volume of the water tank will need to be maintained to meet the design requirements.
- iii. Purpose for which water tanks, human consumption or industrial will be used identifies concerns about materials that have no side effects on humans.
- iv. The temperature of the area where the water will be stored can cause concerns about freezing and heat supply.
- v. Supply pressure requirements, internal pressure range from 35-60 PSI, demand for a given GPM (gallon per minute) of the set flow requirements.
- vi. How water should be delivered to the place of use, to the water tank and beyond, i.e. pumps, gravity or tank.
- vii. Considerations for wind and earthquake design allow you to develop water tank parameters to survive seismic and strong wind events.
- viii. Reverse flow prevention is a reverse valve mechanism that allows a single direction of water flow.
- ix. Chemical injection systems for algae, bacteria and virus control allow for the long term water storage.
- x. Algae in water tanks can be mitigated by removing sunlight from access to stored water.

II. REVIEW OF LITERATURE

Shakib, H. etc. [7] studied this document, the study is conducted on a round elevated RCC tank with M-20 concrete and steel and SMRF Fe-415 are considered for analysis. Raised water tank with a capacity of 50,000 liters and a capacity of



100,000 liters with a height of 12 m. For the study take into account 16 m, 20 m, 24 m, 28 m, taking into account the height of 4 m of each panel.

Dhruvit H Chevli et al. [12] For the same capacity, the same geometry, the same height, with the same staging system, in the same zone, with the same coefficient of importance and the coefficient of reduction of the reaction; the reaction of the equivalent static method to the dynamic method differs significantly. He also notes that even if we consider two cases of the same tank capacity, a change in the geometric features of the container may show a significant change in the response of the increased water tank. At the same time, a static response shows higher scale values than a dynamic response. This happens through different periods of time.

M.C.Arun Prasad and Mrs. V.Preetha [13] For static analysis, the interaction of water structure shows, as well as water, and the structure achieves a choice simultaneously through assumptions, that the water sticks to the tank and acts as a structure itself, and structure, and water has the same rigidity, while in dynamic analysis we considered two models of mass, which show two different stiffnesses as for water, and for the structure, so, time selection for both components is different, so, the main time periods are different as for static, and for dynamic analysis. But the secondary period of time in dynamic analysis is greater than both main time periods, because the water in the upper region (Convective region) remains in the undamped state (strawing condition) for some time.

III. METHODOLOGY

The different parameters considered in the ETABS software are mentioned as follows in the table 1 in terms of the dimensions of structural member in the case of Wind Load case.

Table 1: Water tank data for different parameters for Wind load case

Parameters	Dimension
Size of top slab	120 mm thk.
Size of bottom slab	200 mm thk.
Size of Roof beam	250x400 mm
Size of Base Slab beam	250x900 mm
Size of column	550 mm Dia
Size of braces	250x500 mm
Size of ground beam	250x400 mm
Diameter of tank	20.2 m inner
Height of tank	5 m
Height of staging	26 m
Number of columns	24
Wind Speed	44 m/s
Terrain Category	II
Importance factor	1.0

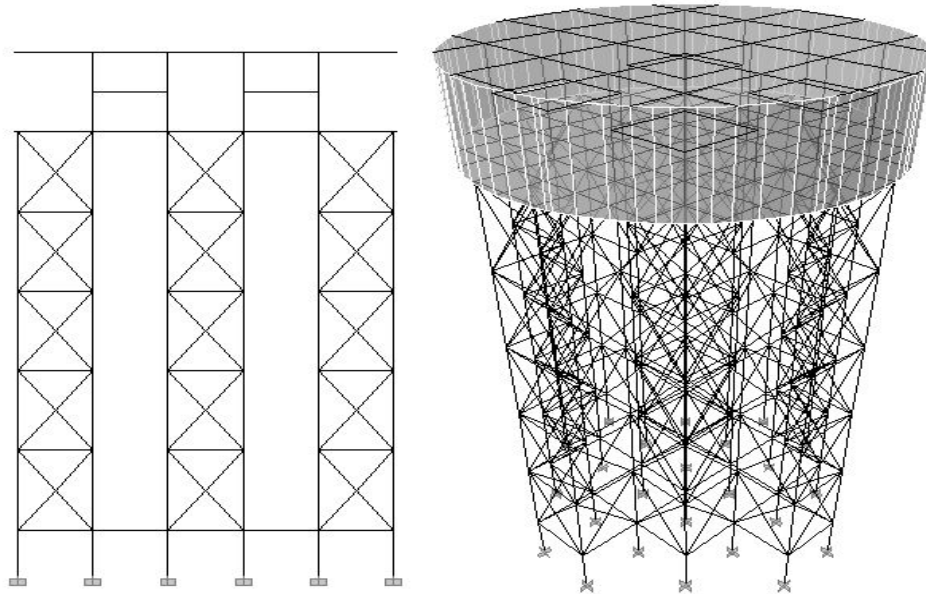


Figure 1: Elevation of the model-II

The above figure gives the elevation of the water tank with the staging configuration considered in the ETABS software for the model-II.

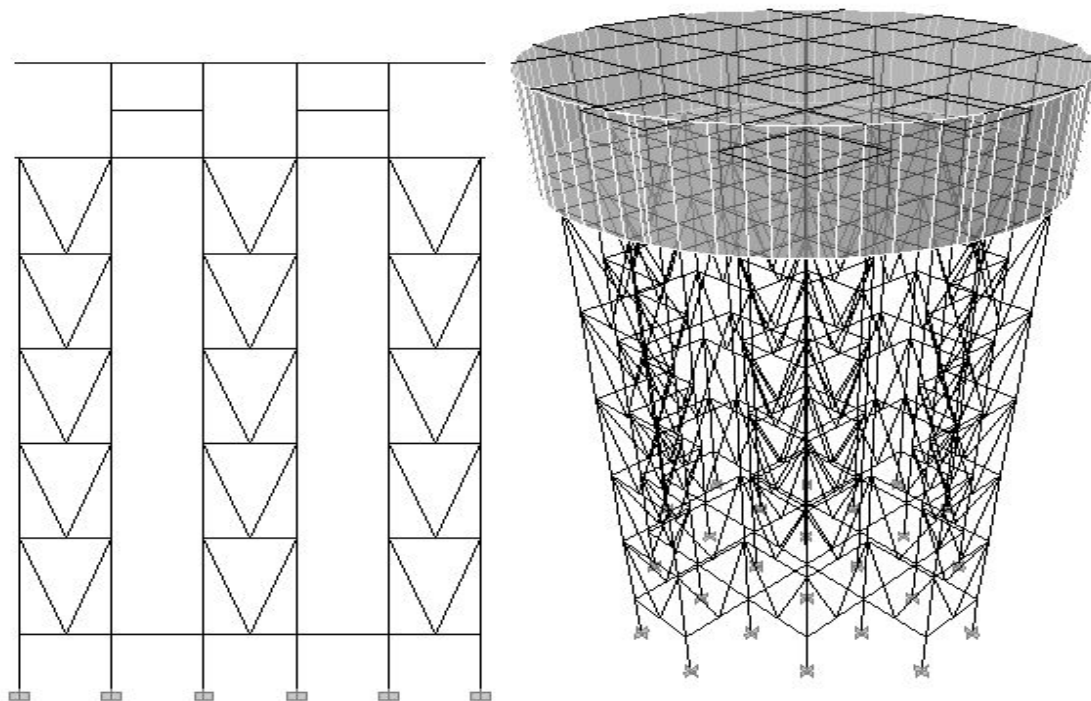


Figure 2: Elevation of the model-III

The above figure gives the elevation of the water tank with the staging configuration considered in the ETABS software for the model-III



IV. RESULTS

The results obtained in the ETABS software are in terms of the lateral displacement, story drift, shear force, bending moment, axial load and the time period for the models which are modeled and analyzed for the case of Wind load case

Table 2: Lateral Displacement for all models for Wind load case

Models	Lateral Displacement
Model- I	24.339
Model- II	2.775
Model- III	4.559
Model-IV	4.047
Model- V	4.111
Model-VI	5.429
Model-VII	5.227
Model-VIII	1.943

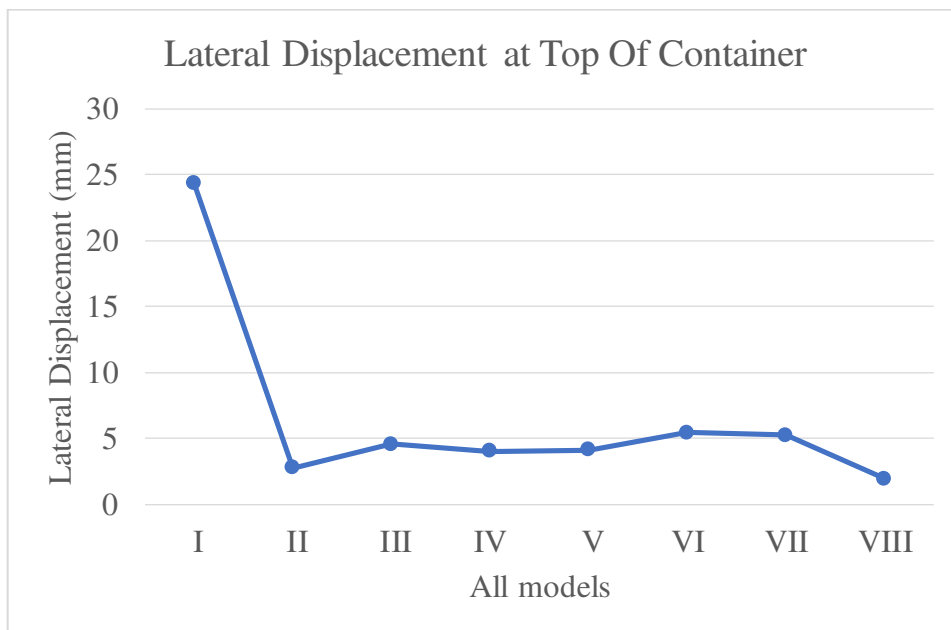


Figure 3:Lateral displacement for all models for Wind load case

The above graph gives the lateral displacement for all the models as obtained in the ETABS software, it is observed that the model-I (Elevated water tank with Staging with Conventional Horizontal Bracings) gives the maximum displacement as compared to other models. It is observed that the lateral displacement is maximum with the value of the 24 mm in the case of model-I while it goes on decreasing with the minimum value of the Model VIII: Elevated water tank with Staging with C type Shear Wall at Peripheral Portion having the value of 2 mm. The other models gives the value of lateral displacement ranging from the 2.5 to 5.0 mm.



Table 3: First Mode time period for all models for Wind load case

Models	Time Period
Model- I	2.00
Model- II	0.677
Model- III	0.868
Model-IV	0.818
Model- V	0.824
Model-VI	0.962
Model-VII	0.957
Model-VIII	0.586

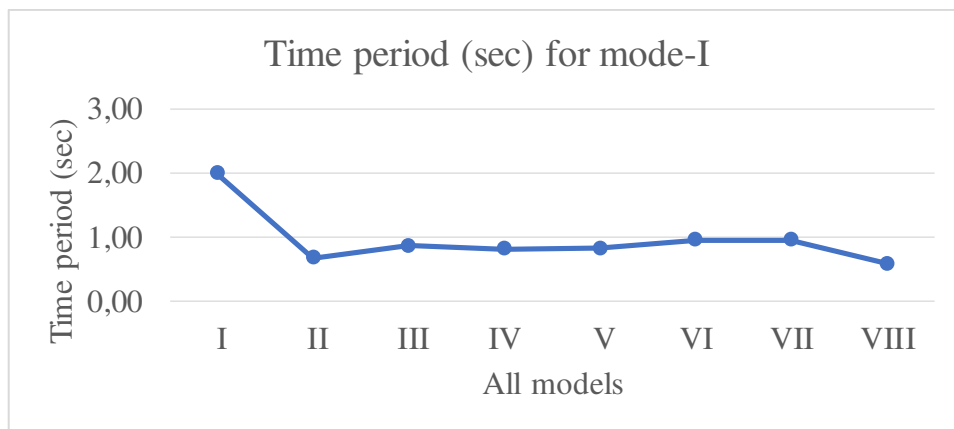


Figure 4: First mode time period for all models for Wind load case

The above graph gives the First Mode time period for all the models as obtained in the ETABS software, it is observed that the model-I (Elevated water tank with Staging with Conventional Horizontal Bracings) gives maximum the First Mode time period as compared to other models. It is observed that the First Mode time period is maximum with the value of the 2.0 sec in the case of model-I (Elevated water tank with Staging with Conventional Horizontal Bracings) while it goes on decreasing with the minimum value of the Model VIII: Elevated water tank with Staging with C type Shear Wall at Peripheral Portion having the value of 0.5 sec. the other models give the value of First Mode time period ranging from the 0.5 to 1.0 sec.

Table 4: Story drift at top of container for all models for Wind load case

Models	Story Drift
Model- I	0.3068
Model- II	0.2132
Model- III	0.2756
Model-IV	0.2184
Model- V	0.2496
Model-VI	0.0884
Model-VII	0.1404
Model-VIII	0.1196

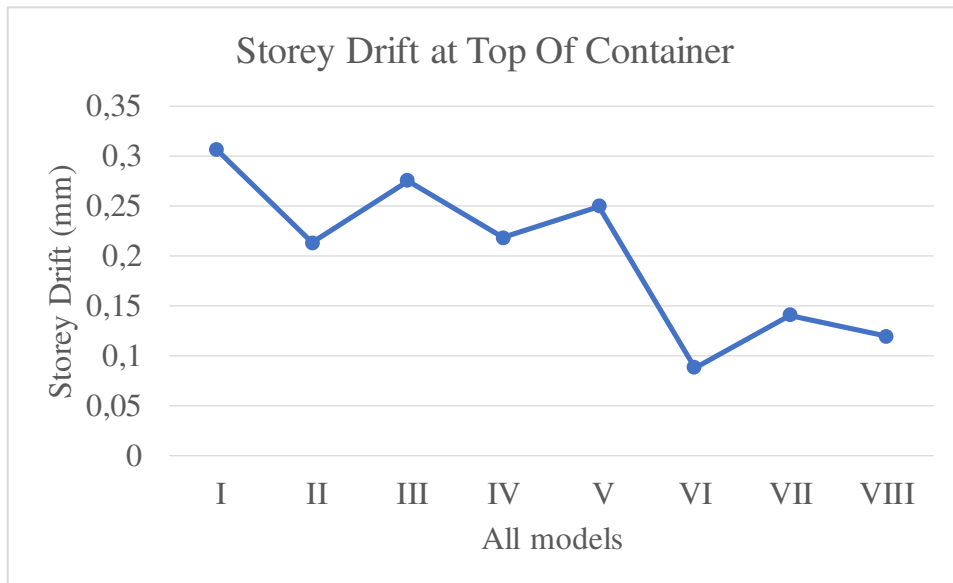


Figure 5: Story drift at top of container for all models for Wind load case

The above graph gives the story drift for all the models as obtained in the ETABS software, it is observed that the Model I: Elevated water tank with Staging with Conventional Horizontal Bracings gives maximum the story drift as compared to other models. It is observed that the story drift at top of container is maximum with the value of the 0.3 mm in the case of Model II: Elevated water tank with staging with X type Bracings while it goes on decreasing with the minimum value of the model- Model VI: Elevated water tank with staging with shear wall at central portion having the value of 0.1 mm. the other models gives the value of story drift at top of container ranging from the 0.1 to 0.3 mm.

Table 5: Max SF in column at top of container for all models for wind load case

Models	Max SF In Column
Model I	26.07
Model II	201.22
Model III	115.38
Model IV	127.31
Model V	93.98
Model VI	180.67
Model VII	52.40
Model VIII	158.30

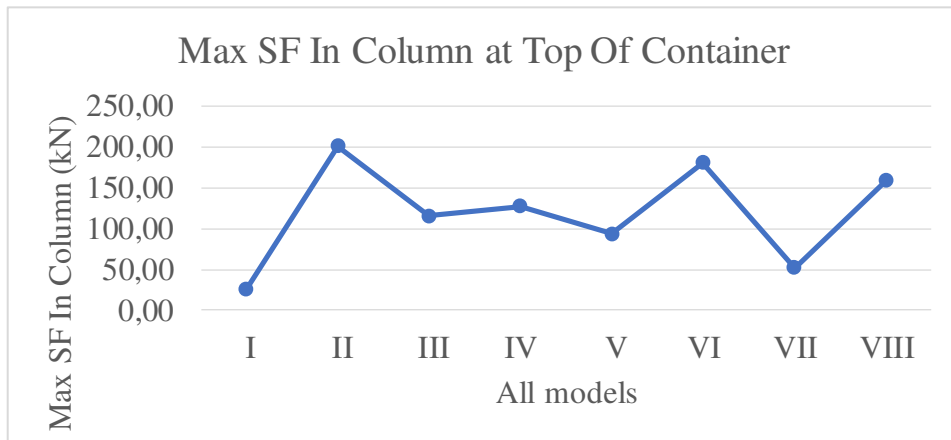


Figure 6: Max SF in column at top of container for all models for Wind load case

The above graph gives the Max SF for all the models as obtained in the ETABS software, it is observed that the Model II: Elevated water tank with Staging with X type Bracings gives maximum the Max SF as compared to other models. It is observed that the Max SF in column at top of container is maximum with the value of the 201kN in the case of Model VI: Elevated water tank with staging with shear wall at central portion while it goes on decreasing with the minimum value of the Model I: Elevated water tank with staging with conventional horizontal bracings having the value of 26 kN. The other models gives the value of Max SF in column at top of container ranging from the 52-201kN.

Table 6: Max BM in column at top of container for all models for Wind load case

Models	Max BM In Column
Model- I	70.04
Model- II	365.68
Model- III	218.79
Model-IV	237.47
Model- V	175.59
Model-VI	75.26
Model-VII	61.13
Model-VIII	100.84

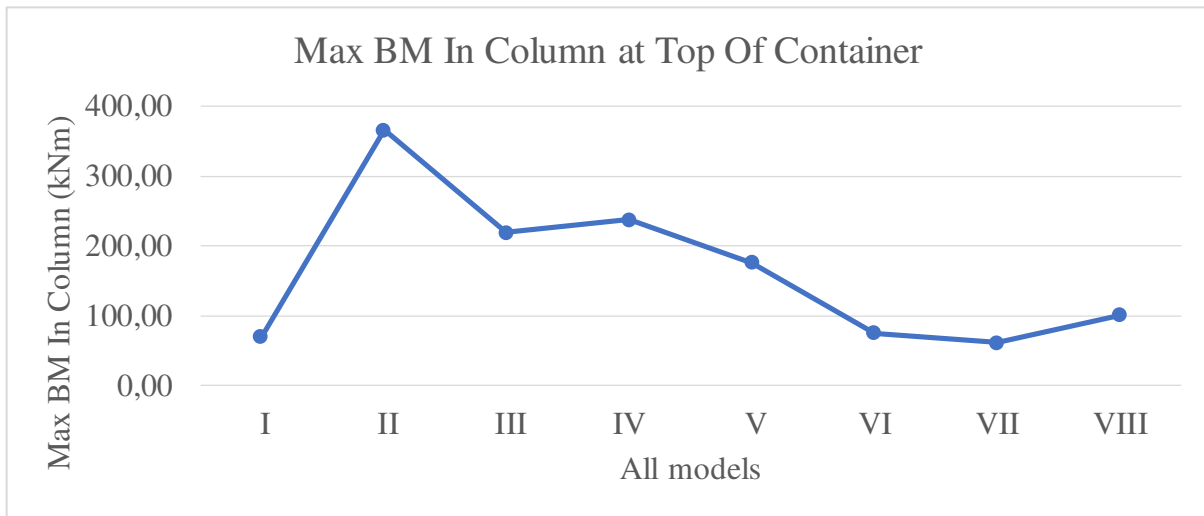


Figure 7: Max BM in column at top of container for all models for Wind load case

The above graph gives the Max BM for all the models as obtained in the ETABS software, it is observed that the Model II: Elevated water tank with Staging with X type Bracings gives maximum the Max BM as compared to other models. It is observed that the Max BM in column at top of container is maximum with the value of the 366kNm in the case of Model II: Elevated water tank with Staging with X type Bracings while it goes on decreasing with the minimum value of the Model VII: Elevated water tank with Staging with Shear Wall at Peripheral Portion having the value of 61 kNm. The other models gives the value of Max BM in column at top of container ranging from the 70 to 237kNm.

Table 7: Max Axial Load in column at top of container for all models for Wind load case

Models	Max Axial Load In Column
Mod I	1986.50
Mod II	2061.12
Mod III	2061.45
Mod IV	2051.50
Mod V	2040.60
Mod VI	1832.94
Mod VII	1994.66
Mod VIII	1725.86

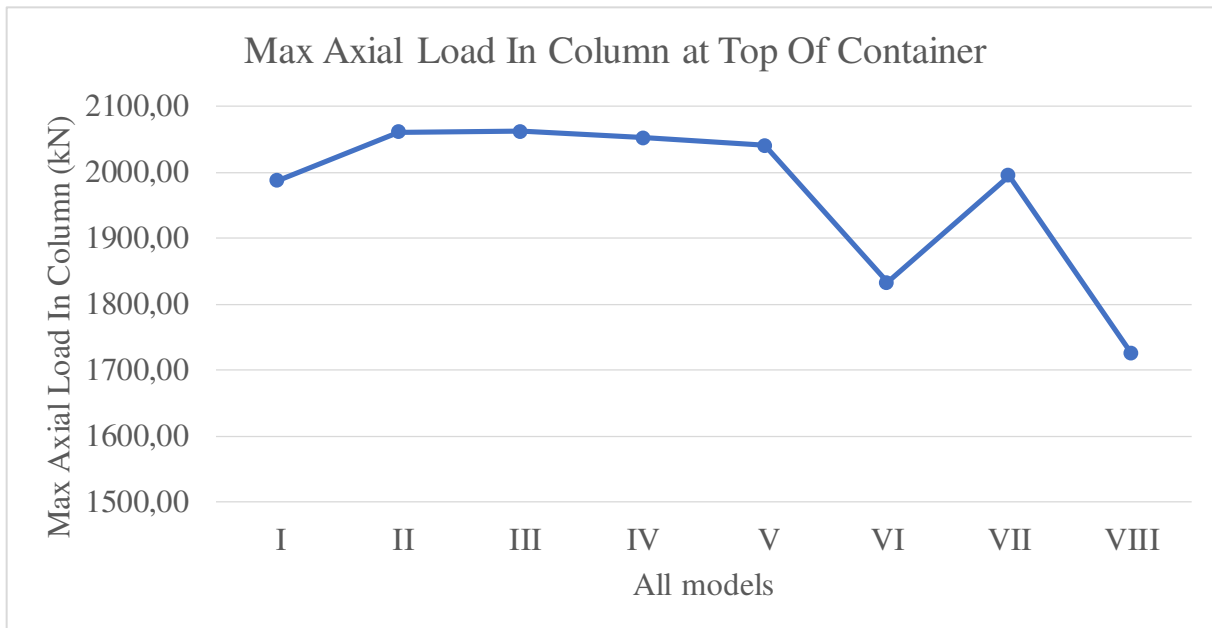


Figure 8: Max Axial load in column at top of container for all models for Wind load case

The above graph gives the Max axial load for all the models as obtained in the ETABS software, it is observed that the Model II: Elevated water tank with Staging with X type Bracings gives maximum the Max Axial Load as compared to other models. It is observed that the Max Axial Load at top of container is maximum with the value of the 2061kN in the case of Model II: Elevated water tank with Staging with X type bracings while it goes on decreasing with the minimum value of the Model VIII: Elevated water tank with Staging with C type shear wall at peripheral portion having the value of 1726kN. The other models gives the value of Max Axial Load at top of container ranging from the 1832 to 2061kN.

V. CONCLUSION

The conclusions from the above models are as follows:

- i. Minimum value of story drift is obtained in the case of the model-VI (Staging with Shear Wall at Central Portion).
- ii. The maximum base shear obtained in the model-VIII (Staging with C type Shear Wall at Peripheral Portion) as compared to other models.
- iii. The minimum value of the shear force is obtained in the case of model-I (Staging with Conventional Horizontal Bracings).
- iv. From the above results it is observed that the model-VIII (Staging with C type Shear Wall at Peripheral Portion) gives the good results as compared to other models.

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