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Comparative Analysis of multi storey Steel Setback Building with Steel Plate Shear Walls and Bracings

Bhushan Vijay Dhamodkar , Prof. Ganesh P. Deshmukh

Department of Civil Engineering,PankajLaddhad Institute of Technology & Management Studies, Buldana, (M.S), India-443001

ABSTRACT:

The high yield and ultimate strength result in slender sections. Being ductile the steel structures give sufficient advance warning before failure by way of excessive deformations. These properties of steel are of very much vital in case of the seismic resistant design. The models are to be analyzed using STAAD-PRO software, the models includes the setback building- Steel in Earthquake zone-II without shear wall or bracings, setback building- Steel in Earthquake zone-II with shear wall, setback building- Steel in Earthquake zone-II with bracings and the same models are also analysed for the earthquake zone-III. The results obtained are in terms of the storey displacement, storey drift, time period and storey shear for all the models.

Keywords: Setback building, shear wall, bracings and seismic

1. General

Over the past few decades, global attention and interest have grown in the use of steel plate sliding walls (SPSW) to build side load systems. Advantages of using SPSW in a building are a resisting lateral force system that violates stable hysteretic characteristics, high ability to absorb plastic energy and increased rigidity, strength and plasticity [1]. A significant number of experimental and analytical studies were conducted to establish methods for the analysis and design of such lateral resistance systems; however, there is still a need for a common methodology for analysis and design. Compared to reinforced cement concrete (RCC), steel has some important physical properties, such as high strength per unit weight and plasticity [2].

High yields and ultimate strength lead to slender areas. Being plastic, steel structures give a sufficient prior warning before failure due to excessive deformation. These properties of steel are very important in the case of a seismically stable structure [3]. A steel shear wall is a system of lateral load resistance, consisting of vertical steel plates connected to the surrounding beams and columns and installed in one or more bays along the full height of the structure to form a cantilever wall. Sliding walls are vertical elements of a horizontal force that resists. The main role of the steel shear wall is to collect the lateral forces of the earthquake in the building and transfer these forces to the foundation. Web plates in steel shear walls are classified according to their ability to withstand bending [4].

1.*1 Purpose of erection of the wall of shear of steel plates.*

Sliding wall systems are one of the most commonly used side loads that resist in a high-rise building. The shear wall has high rigidity and plane strength, which can be used to simultaneously resist with a large horizontal load and maintain gravitational loads. Sliding walls designed to withstand the lateral loads of earthquakes and wind. The steel plate wall shear system has become an effective alternative to other side load-resistant systems, such as reinforced concrete walls, different types of spring frames, etc. [5]. SPSW is preferred because of the different advantages they have over other systems, primarily significant plasticity, and high initial rigidity, fast construction, light weight, provides more space inside due to the minimum thickness, which is another advantage for the architect and reduced seismic mass [6].

1.*2 Modeling of walls from the shear of steel plates*

This is the most popular way to model thin, non-compact sliding walls. It is based solely on the action of the diagonal tension field, developed immediately after the plate fastener [7]. This type of modeling is recommended by the Canadian code, CAN / CSA-S16-01 in the SPSW analysis and design procedure. In the analysis software, the steel plate on the wall panel should be replaced with a series of farm elements (pieces) or strips along the voltage field. There are two ways to model this method [8].

2. Literature Review

Ajamy, A. and others. [1] investigated that building steels and composite materials are widely used for structural applications and construction. Steel frames have often been used to build high-rise buildings, which should be paid close attention to withstand the applied external loads. An earthquake is the most significant natural disaster that makes steel frames vulnerable to failure. A large number of records have been recorded in the literature, reporting major structural damage and destruction due to high-demand earthquakes. It has been reported that when buildings located in a seismic-loaded region, some buildings are destroyed and some are resistant and intact, which has shown that they use a system that provides them with better seismic performance to remain stable.

AnojSurwase et al. [2] studied that there was always a real need to build a structure resistant to seismic loads caused by earthquakes to increase safety and reduce maintenance costs. Therefore, much attention was drawn to the study of the impact of various important parameters, such as architectural design, structural materials and soil conditions on the seismic stability of the building.

Ashwin G. Sony and others. [3] investigated that in recent decades the construction of seismic-resistant steel frame buildings has been converted into appropriate lateral resistance systems that provide plastic and elastic behavior in moderate earthquakes, despite the fact that they were expensive and uneconomical, was of great interest. One of the main problems to look out for is the vertical inequalities of the building, which are challenged in the structure in the form of different column heights on any floor, which leads to uneven rigidity. Structures with irregular horizontal and vertical layouts are more vulnerable to destruction than conventional structures.

BhosleAshwiniTanaji et al. [4] investigated that, in addition, many public, commercial and institutional buildings were designed with various structural planning violations due to architectural and aesthetic requirements. Designing buildings with uneven rigidity requires specific design considerations compared to the design of conventional buildings due to different seismic requirements. Structural elements can withstand a certain amount of rotation of the plastic hinge, except that it may fail. Linear static, nonlinear static (pushover), linear dynamic and nonlinear dynamic analysis can be used to assess the structural behavior of a building subject to seismic load.

Doctor. S. AND. Halkude et al [5] studied that it was recorded that the most accurate predictions of dynamic reactions of irregular structures subjected to strong dynamic loading can be obtained by nonlinear dynamic analysis, by which the development of plastic hinge is evaluated at the ends of structural elements.

H. Gaur et al. [6] presented a method of studying the seismic behavior of a multi-storey building, which is subject to strong ground movements at the previous stage of practical design. The accuracy of the method was assessed taking into account asymmetrical tall buildings with mass or rigidity of unevenness. Dynamic reactions of elastic multi-storey building systems were obtained by analyzing a simple (equivalent) single-storey system. The behavior of the building was also investigated in the aftermath of the elastic phase, given the strength depending on the rigidity of the various stands and gaps.

3. METHODOLOGY

The following models are modelled using STAAD-PRO software.

i. Model-I: Setback building – Earthquake zone-II (without bracing & shear wall)
ii. Model-II: Setback building – Earthquake zone-II (with bracing)
iii. Model-III: Setback building – Earthquake zone-II (with shear wall)
iv. Model-IV: Setback building – Earthquake zone-III (without bracing & shear wall)
v. Model-V: Setback building – Earthquake zone-II (with bracing)

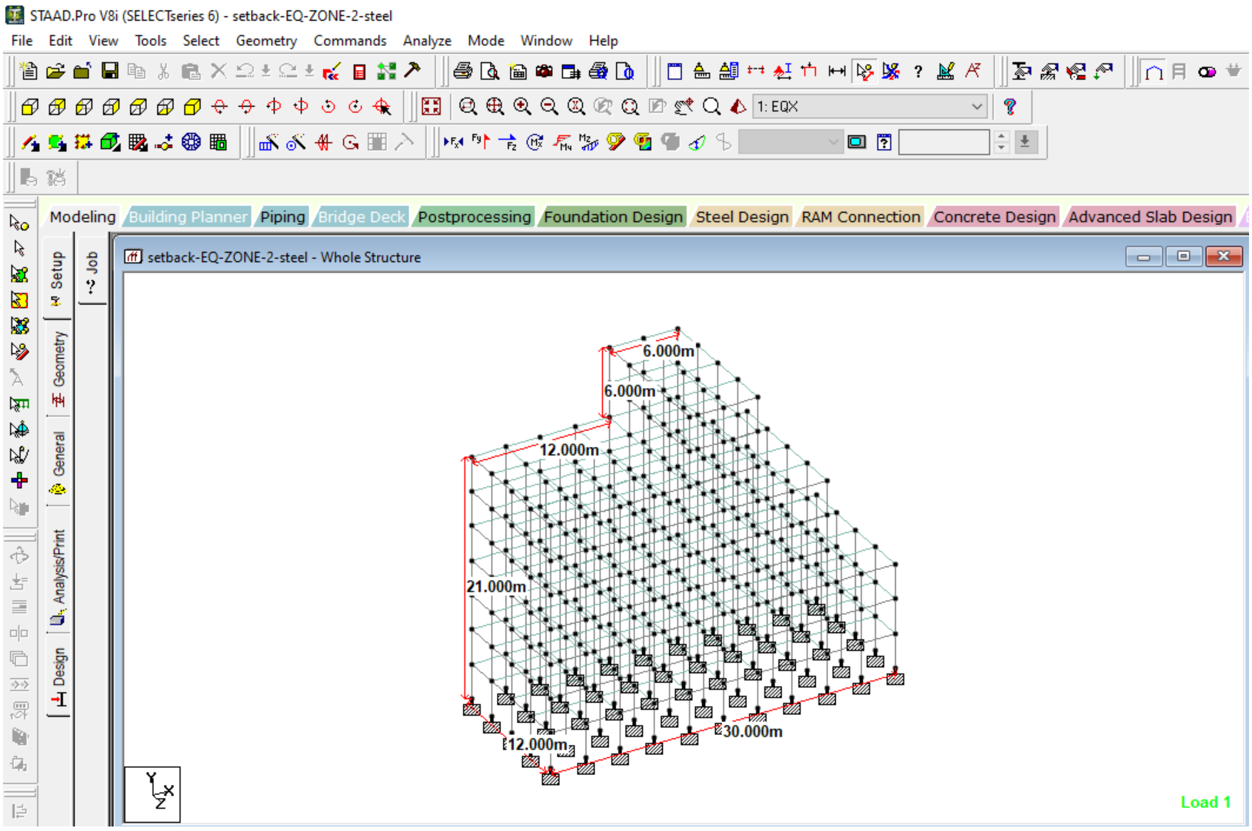

Fig.1: Dimensions of the setback building

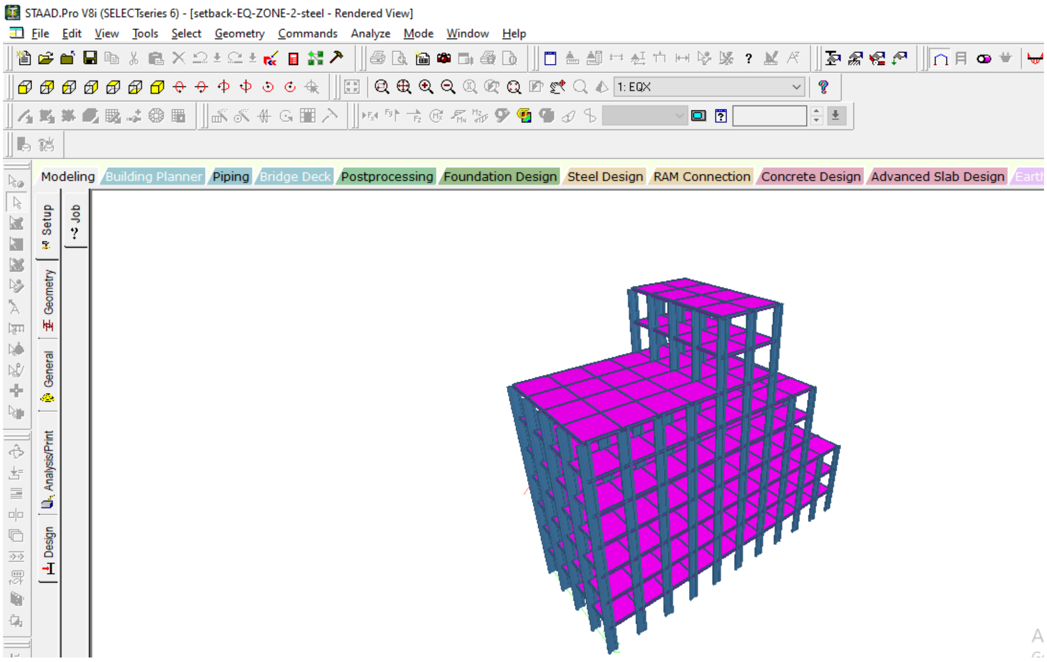

Fig.2: 3D-view of the setback building

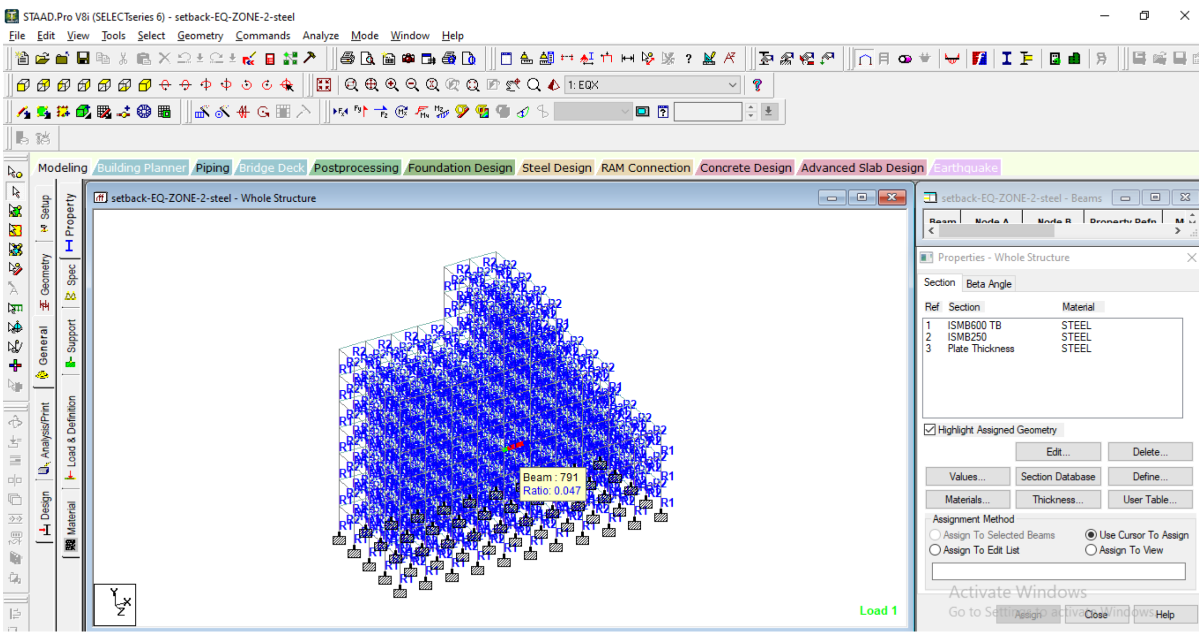

Fig.3:Property assignment of the setback building

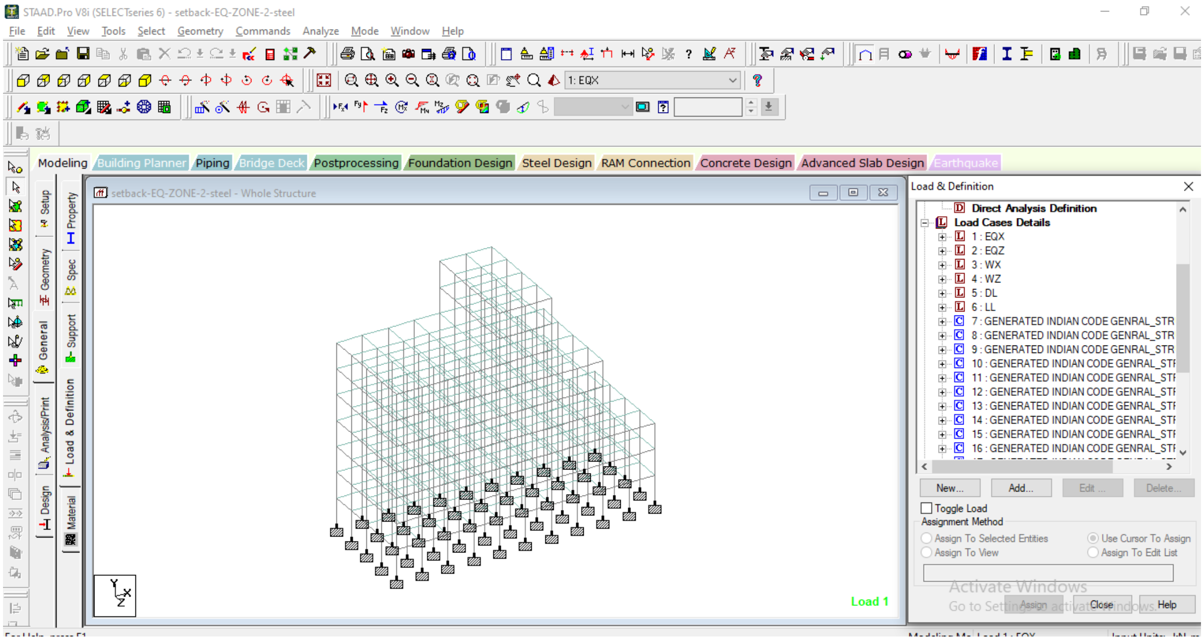

Fig.4:Load assignment to the setback building

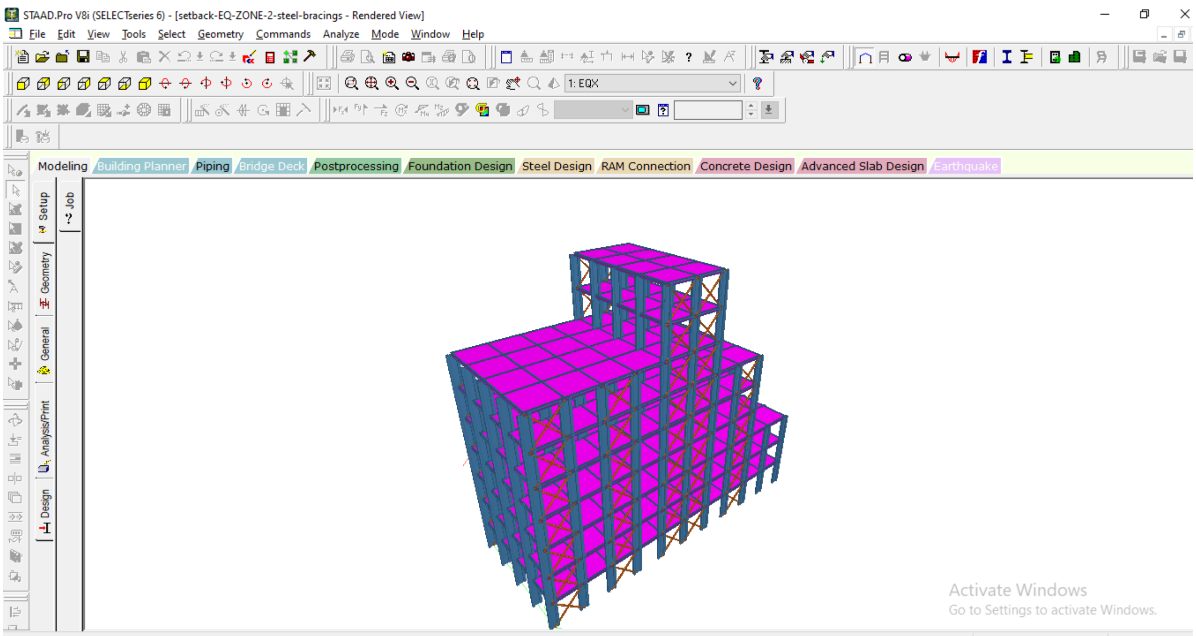

Fig.5:3D view of the setback building with the bracings

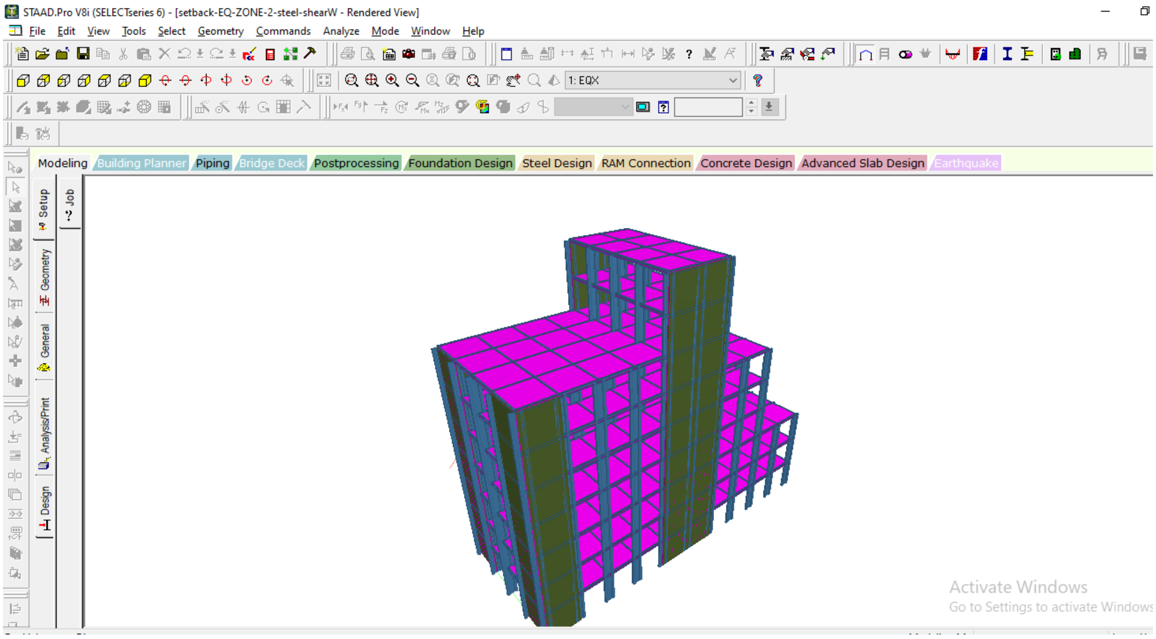
Fig.6:3D view of the setback building with the shear walls

4. RESULTS

The results obtained in the STAAD-PRO in terms of the displacement, reactions, beam forces, plate stresses for the all models as follows.

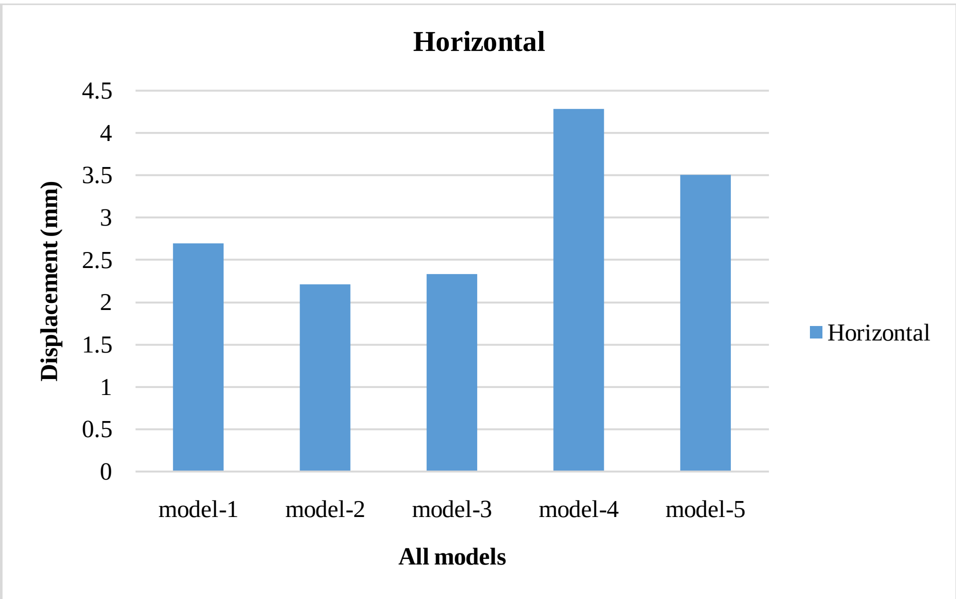

Fig.7:Horizontal Displacement for all models of the setback building

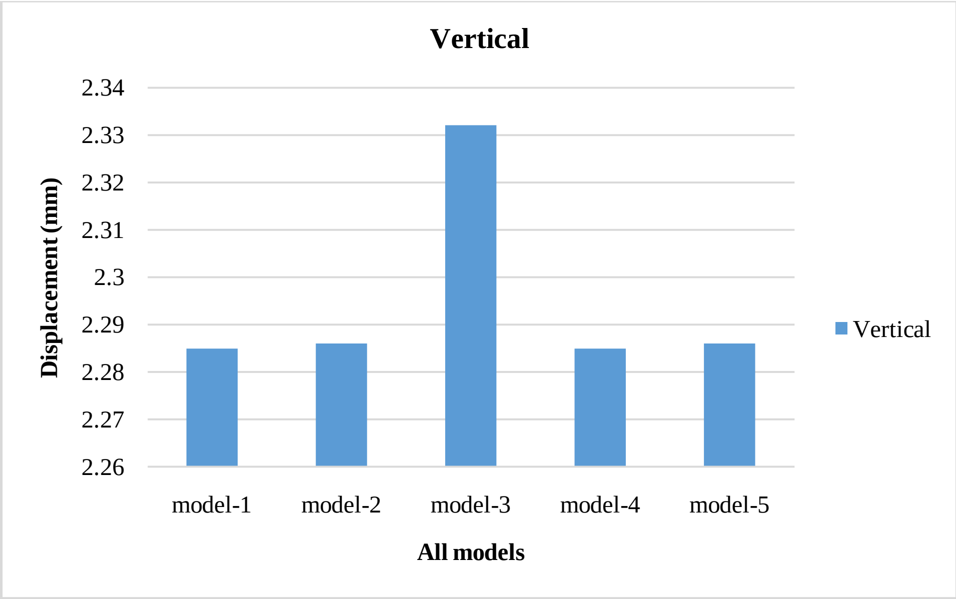

Fig.8:Vertical Displacement for all models of the setback building

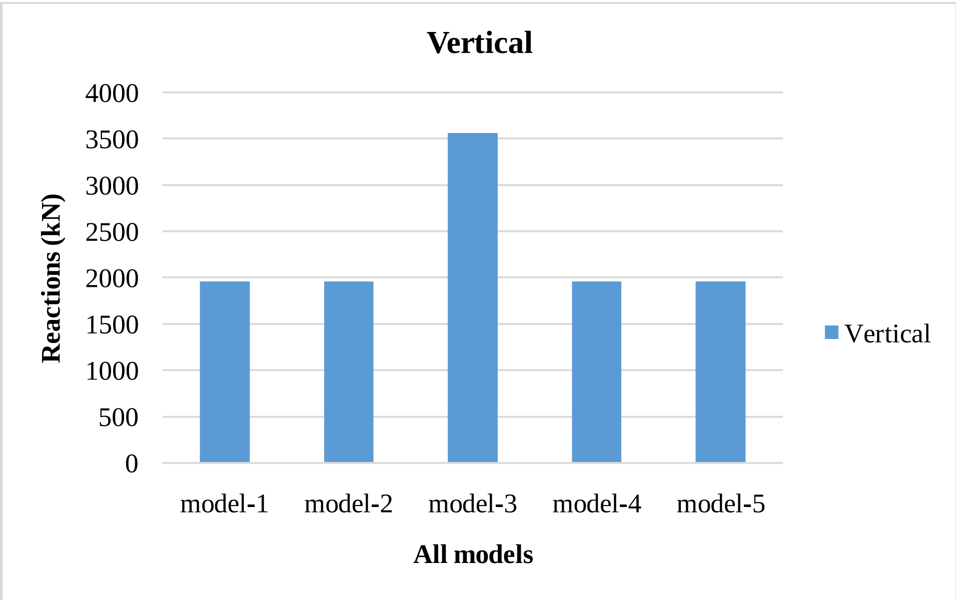

Fig.9:Vertical reactions for all models of the setback building

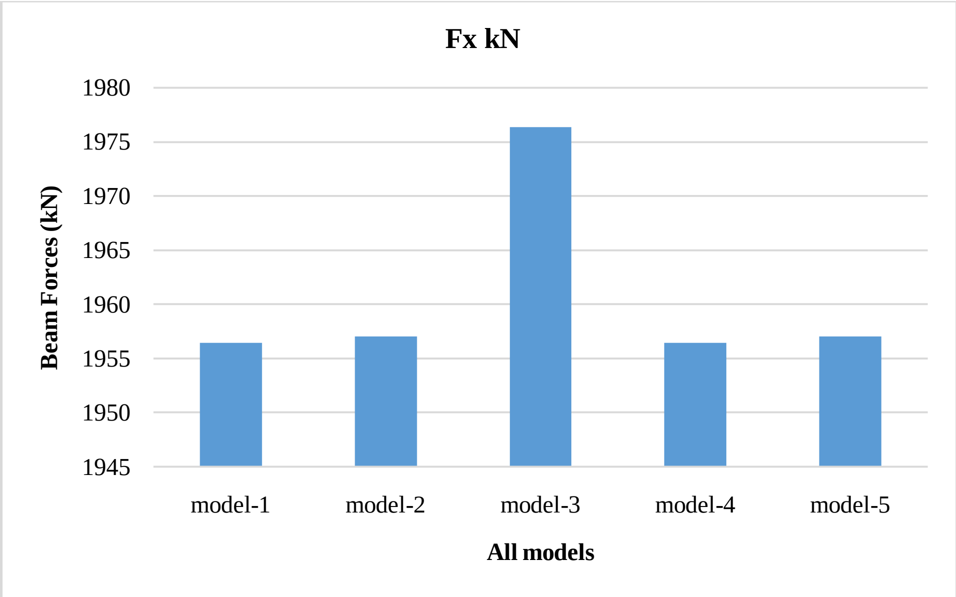

Fig.10:Beam Forces (Fx) for all models of the setback building

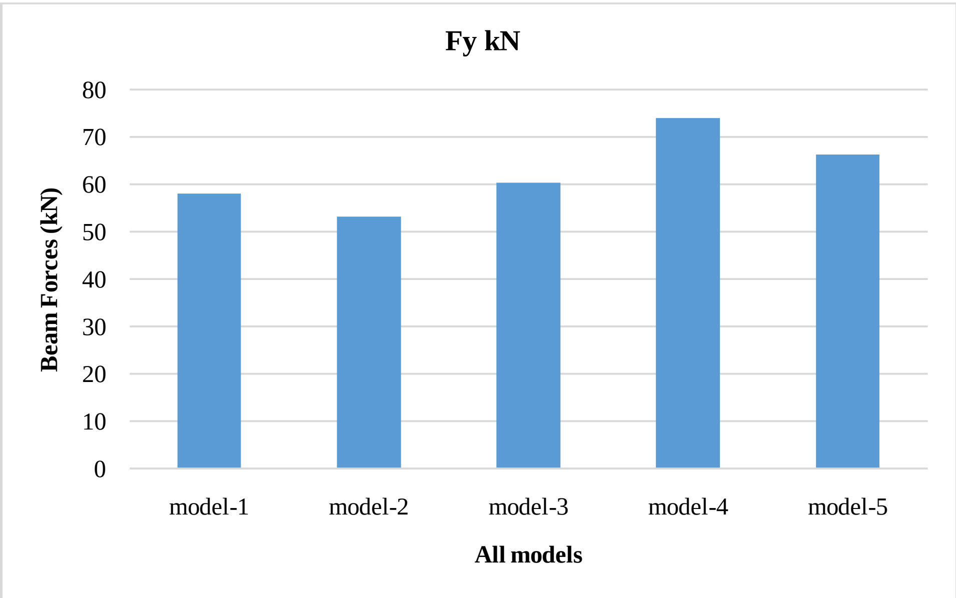

Fig.11:Beam Forces (Fy) for all models of the setback building

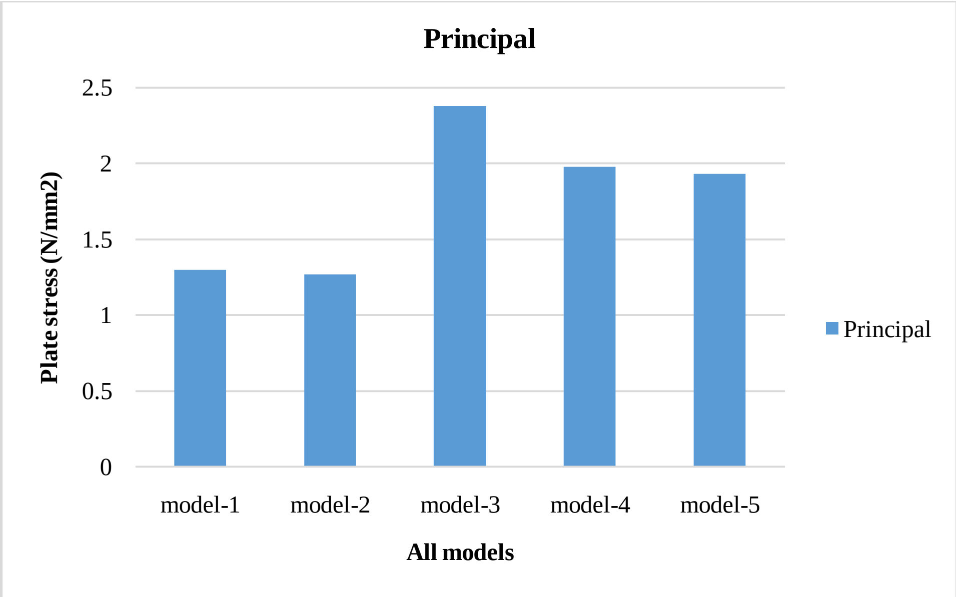

Fig.12:Principal Top stress for all models of the setback building

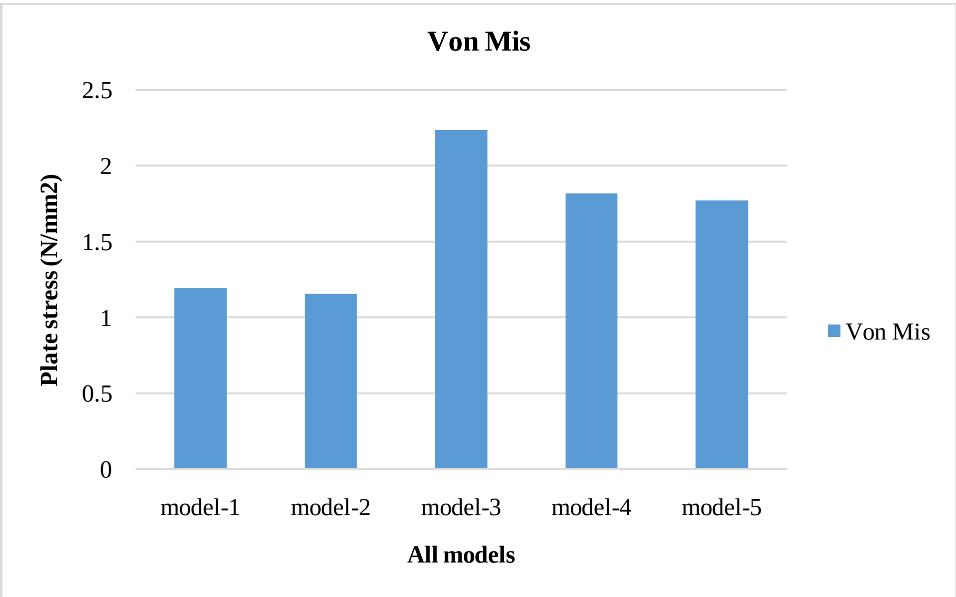

Fig.13:Von-Mis Top stress for all models of the setback building

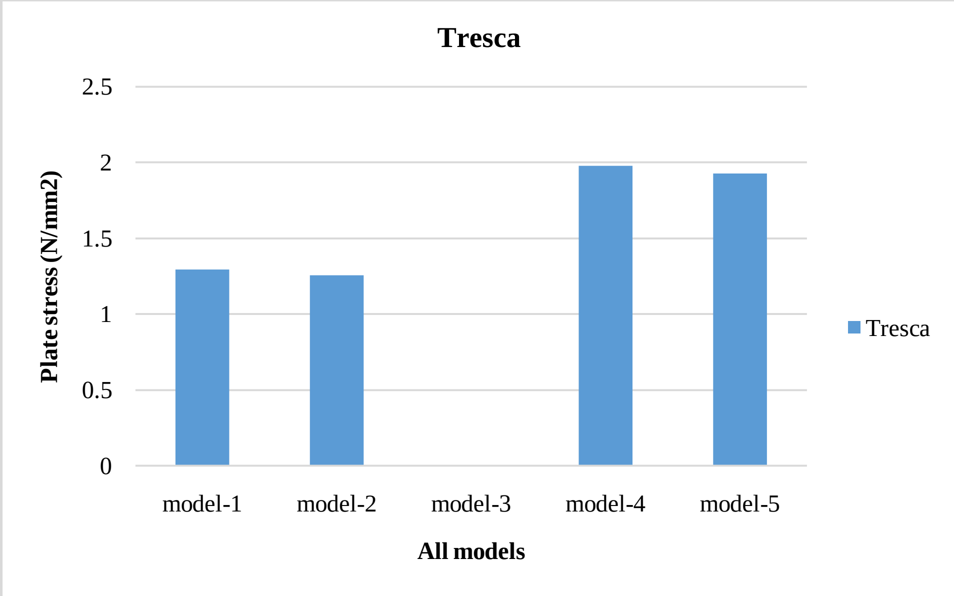

Fig.14:Tresca-bottom stress for all models of the setback building

5. Conclusions:

From the above results following conclusions can be made:

i. The maximum displacement is found to be for the model-4 (i.e. the model in the Earthquake zone-III) of the setback building
ii. The maximum reactions is found for the model-3 of the setback building as the shear walls are provided in the building
iii. The maximum beam forces is found for the model-3 of the setback building as the shear walls are provided in the building
iv. The minimum principal stress are found in the model-2 as the setback building is provided with the beacings.

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