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Seismic Analysis (Zone v) of RCC Building (G+5) with Shear Walls Using Staad. Pro Software

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ABSTRACT- An upright component of a seismic force-resisting structure called a shear wall is made to protect against in-plane lateral forces, which are often caused by wind and seismic loads. The design of shear walls is governed by the international residential code and the international building code in many countries. A shear wall may withstand loads that are equal to the wall's plane. The diaphragm shear is transferred to shear walls and other vertical components of the seismic force-resisting system via collectors, sometimes referred to as drag members. In this study, we have chosen Seismic analysis (zone v) of RCC building (G+5) with shear walls using STAAD. Pro software The multistory building (G+5) is the subject of analysis. The STAAD. Pro, Designing and Analysis software is used to develop the 3D model of Shear wall and Building. Giving it constraints that are based on the acting seismic force and wind loads on buildings rendered the nodes weak, so we added a shear wall to reinforce that nodes. Following the inclusion of the building's shear wall and analysis using STAAD. Pro in standard format. After analyzing the effect & shear wall's position on the building & comparing results with old building design without shear wall, it was determined that the addition & location of shear walls in multistory structures strengthens the structure's weak points and enables it to withstand lateral loads, wind loads, and earthquake loads.

KEYWORDS-Multistory Structure, Seismic Force, STAAD. Pro, Shear-Wall.

I. INTRODUCTION

Because of its advantages of economic effectiveness and rapid development, reinforced cement concrete (RCC) material has been widely used in foundation innovations such as pressure-driven structures and asphalt. As a distinct type of concrete, RCC differs from ordinary concrete in that it uses more fly slag rather than water to replace Portland concrete, for example. Bulldozers are used to disseminate and clean the RCC mixture; vibratory rollers are then used to crush it into a layered structure. RCC has been used to build large structures such as tarmac for airport terminals and dams. These buildings may be subjected to a variety of burdens during the course of their administration, such as impact and effect loads. It is crucial to learn about the dynamic mechanical characteristics of RCC materials in this way. RCC also features bedding surfaces. The mechanical characteristics of the layered RCC are influenced by the presence of bedding surfaces and tiny-scale splits at interfaces and progress layers. It is also necessary to look at how the sheet material surface affects the dynamic compressive conductivity of RCC material in this way.

The bulldozer spreads the reinforced cement concrete (RCC), a specific kind of concrete material, and the vibratory roller compacts it into a layered structure, resulting in the numerous horizontal construction joints. As a result, interlayers are always present in layered RCC created by the large-scale, subsequent building of hydraulic structures and pavements. According to reports, the interlayer's thickness ranges from 0.5 to 2.0 cm, and this thickness has a big impact on how the RCC constructions behave mechanically and physically.[1] The regulation of vibratory compaction, interlayer shear behavior, temperature field, and temperature control, among other things, have received increased attention in recent research on RCC materials. Additionally, it is becoming increasingly clear how the bonding interlayer affects the functionality of static structures. On the basis of experimental research and theoretical analysis, for instance, the gradual change in Young's modulus and interlayer viscosity of layered RCC has been extensively examined. The effect of joints in rock masses on wave propagation has been studied via a number of studies using different experimental approaches.[2] A lot of effort has been made to use a variety of theoretical methodologies in addition to experimental studies to characterize the propagation mechanisms of stress waves across interlayers. In order to create a continuous medium analysis for joints in rock masses so that its mechanical behavior may be predicted using a typical elementary volume, the similar medium technique is recommended. It treats the discontinuity as a whole. When describing the rock masses with joints in an elastic continuum medium, this technique often ignores the nonlinear deformation behavior under different levels of stress waves. When compared to the existing elastic continuum medium techniques, it has been shown that the comparable visco elastic medium methodology can successfully predict the stress waves propagating through jointed rock masses. Additionally, it is feasible to theoretically explore the dispersion and attenuation of stress waves as well as their frequency dependence for jointed rock masses by solving a specific stress wave propagation equation. All of these may be utilized as references to understand the stress wave propagation rules across the interlayer in RCC masses.

A. BUILDING MODELING

The idea for this research is modelled after a five-story structure with 3.5-meter stories. These structures were designed in accordance with the Indian code of training in the analysis of structures with and without shear walls with the purpose of optimising the placement of shear walls in multi-story buildings in seismic zone V. The floor functions as stiff characteristics at the base of these structures, which are meant to be static. The dimensions of the structural element portions are square and rectangular. Buildings are designed to have story heights that continue up from the bottom level. The STAAD PRO V8i software shows the buildings. By placing shear walls both inside and outside of the structure, five distinct models were analysed. Models are examined for analysis and optimisation of the shear wall's location in the multistory building. Multistory building preliminary data is shown in Table no. 1

B. OBJECTIVE

The proposed work has the following objectives:

- To design and study a multi-storey building (G+5) 3D frame using STAAD Pro.
- To study primary factors that determine a buildings seismic performance.
- To study and perform seismic analysis on a multi-storey building prior to its construction using STAAD Pro.
- To determine the impacts of adding shear walls at different positions for the strength increase and comparing results with old building design

II. LITERATURE REVIEW

M.D. Goel et al. Investigating the crucial column on the ground level of the building and its behaviour in the event of an intentional blast is the major goal of the current effort. Studies are conducted based on the selected building model to examine the crucial column at the bottom level and the route where the most significant behaviour changes in terms of shear reaction at nodes and axial force occur after the abrupt loss of a vertical support component. With the use of STAAD Pro, the research of progressive collapse initiation on a typical reinforced concrete frame is carried out when one essential column is removed. The investigation's findings lead to the following conclusions:

1. Deletion of the corner column created an issue more serious than eliminating the column at the middle of the bay of its exterior in the event of joint displacement.
2. The column in the middle of the transverse bay (in the direction of Z) is more important than any of column in structure because it will cause the greatest alterations when it is removed.
3.When the comparision is made longitudinally (in the direction of X) positioned adjoining column, the reaction transmitted to the adjoining column following the deletion of column is predominantly pronounced in the transverse (in the direction of Z) located adjoining column.
4. The longitudinal (X-direction) neighboring column receives more axial force than the transverse (in the direction of Z) adjoining column.[3]

P. P. Chandrika et al. conducted a seismic study of a 10 story RCC building with & without a shear wall and compared to four models. Changes in the placement of the shear wall have been shown to have an impact on the attraction of forces, and it has also been found that dimensionally big shear walls are associated with the largest amount of horizontal force. They also said that if shear walls are in suitable places, displacements are reduced to some extent. Therefore, dimensionally huge shear walls are ineffective for buildings of 10 floors or less.[4]

Amita Baghel et al. A) Maximum node displacement was recorded at nodes 71 and 23 on the top level of the construction. With Model IV, the smallest node displacement (in the x and z directions) has been seen. Therefore, the (Model-IV) stance is ideal for situation.

B) Maximum Response: The Model IV is significantly better compared to the competition, as evidenced by the maximum response data for all x and z orientations with nodal numbers 51 and 3 respectively. Thus, the Model IV is the ideal stance for the situation.[5]

Kanchan Rana et al. A shear wall was used to analyse the behaviour of an RC structure at various sites, and conclusions can be inferred by this research

- Model-3 has very low storey driftng in both the X and Z directions, while Model-1 exhibits the most storey drift at storey 2.
- Model-2 has the highest peak storey shear, while Model-1 has the lowest.
- Software analysis creates the structure to the designer's specifications. Figure.1: Phases of the Research
- STAAD Pro software, which can also be utilized for the study of structural strength and economic areas of profit, makes structure comparison and creation easy. As a result, the general conclusion points out that the Model-3 is the most efficient site out of all the places.[6]

Jeetendra Chajlani et al. Three distinct sets of concrete cylinders' final strengths were investigated. In SET I, the P1, P2, & P3 cylinders of concrete were tested. In SET II, three concrete cylinders, labeled S1, S2, and S3, are put to the test. In SET III, all three cylinders of concrete (N1, N2, and N3) are examined.

The cylinders of concrete P1, S1, & N1 that were employed as the control were shown to have a lower load-bearing capability when compared with externally reinforced beams composed of FRP sheets.

Cylinders of concrete in SET 1 P2 and P3 are reinforced using a single warp of FRP sheet and a sheet of double FRP warp, respectively, on the complete dimensions of the cylinders of concrete. Cylinders of concrete in SET II, S2 and S3 are reinforced by a single FRP sheet warp and a double FRP sheet warp, respectively, on the complete diameters of the concrete cylinders. Cylinders of concrete in SET III, N2 and N3 are reinforced using a single warp of FRP sheet and a double warped sheet of FRP, respectively, on complete dimensions of the cylinders of concrete.[7]

Ketan Patel et al. According to deflection standards, the maximum allowable displacement for a structure with 30 stories is 180 mm; nevertheless, the displacement of top story of the RCC building marked as 179.6 mm, which is quite close to the allowable limit. Therefore, it can be argued that with this geometric frame construction, RCC will not be practical over 30 stories.

For a 30-story CFT building, the percentage decrease in time was 26.2% and 3.5%; however, for a 20-Story Steel & RCC construction, the reduction in time was 25.5 and 17.8%.

In contrast to RCC and steel structures, the 20-story CFT structure's load-bearing capability rose by 19.1% and 27.3%, respectively. However, compared to RCC and steel buildings, the 30-story CFT structure's load-bearing capability increased by 22.8% and 11.8%, respectively.

The current work demonstrates how steel tube columns filled with concrete have continually been used for construction of high rise buildings because these offer significant cost savings over traditional steel structures. Additionally, performance results were better than those of RCC and steel buildings.[8]

Chang-Hai Zhai et al. The present investigation presents the findings of the preliminary seismic examinations of an RCC under seismic sequence excitations. Following the study, two horizontal seismic input components are taken into account in suitable three-dimensional finite element models. The contrasting result of the findings in terms of speed, displacements, as well as overall damage shows the necessity for incorporating aftershock impacts for the design of NPP buildings and associated structural elements.

(a)The conventional reaction range, which is primarily relies on single-design quakes, should be further assessed & defined since the occurrence of many earthquakes cannot be disregarded.

(b)Greater acceleration needs are needed for many earthquakes than for a single seismic event. This quality is crucial and considered for the facilities of acceleration-sensitive, that are crucial for shielding the environment from radioactive release. According to the findings, seismic sequences can result in an increase in maximum absolute accelerations of up to 21.2% when compared to major shocks.

(c) Compared to single seismic occurrences, seismic sequences result in higher displacement requirements. It is discovered that at the SS eigenvector level, consecutive ground movements can result in a displacement of the top to its max, increase of up to 30.0%. Due to substantial main shock-aftershock impacts, it might be wise to reevaluate the RCC's conventional seismic design, which is essentially predicated on a single earthquake.

(d) Local and worldwide structural damage caused by seismic sequences is plainly more severe than damage caused by a single ground motion. The damage index of global as well as the local damage index are proposed as constraints under primary shocks for the reason to protect the RCC against significant effects during frequent earthquakes. The tensional force for the localised damage At the SSE intensity stage, damages & compressive damages are anticipated to reach, respectively, 0.53 and 0.16 or less for the A zone of the RCC. Similar to this, In order to avoid the RCC from sustaining more damage, it is recommended that damage sipation energy be less or equal to 0.33 MJ.[9]

III. PROBLEM FORMULATION

RCC stands for Reinforced Cement Concrete, which combines plain concrete with steel bars for added strength. Steel reinforcement improves the quality of concrete and prevents unexpected collapses. Shear walls, like reinforced solid dividers, are used to enhance the structure's stability. Shear walls are crucial in earthquake-prone and high-rise buildings, providing strength and stability. The shape and position of shear walls impact the structure's behavior, often located at closures or without apertures. Typically enclosing stairwells and elevator shafts, shear walls are structural elements that remain constant throughout the entire building.

A. Methodology

1) STAAD. Pro

STAAD. Pro, a software developed by Research Engineers International in 1997 and later acquired by Bentley Systems, is widely used for structural design and analysis worldwide. It covers various building regulations and allows structural engineers to design reliable infrastructure. The software considers changing loads like wind and earthquakes through finite element analysis. Physical modelling in STAAD-PRO simplifies the representation of structures, with surfaces and beams positioned realistically. The software's post-processing provides results such as stress, displacement, shear force, and bending moment. By ensuring that forces and moments are within acceptable limits, engineers can confidently construct the designed structures.

B. Finite Element Analysis

The competitiveness of evolving sectors relies on delivering goods quickly. Finite Element Analysis (FEA) was initially developed by R. Courant in 1943 and has since evolved due to PC advancements. FEA provides precise results and has reduced reliance on expensive centralized computers. The traditional product development process requires extensive testing, making it costly. FEA effectively analyzes complex physical issues, reducing the need for initial model testing. The Finite Element Method (FEM) helps understand flexibility and research problems in various fields. FEM improves construction quality, reduces costs, and considers stress and strain distribution. FEM software has enhanced design accuracy and accelerated product development. R. Courant's work on FEA used numerical analysis and minimization for vibration structures. Figure no. 1 shows FEA flowchart

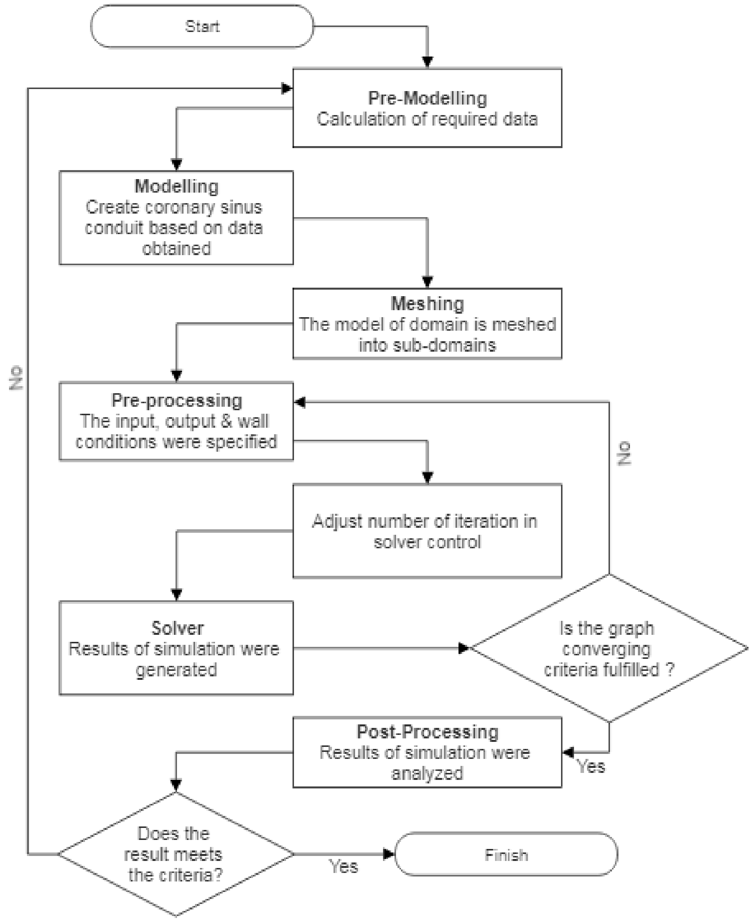

Figure 1: Flowchart of Finite Element Analysis

FEA innovation improves the conventional approach. Bolts are optimized using FEA. FEA forms networks using hubs and includes material characteristics. Hubs are distributed based on anticipated stress levels. Hub thickness varies according to pressure. Works resemble a network of vectors.

IV. PROPOSED WORK

A. Structure Analysis

Structural analysis examines shear wall behavior under loading. Shear walls enhance a building's capacity to withstand lateral loads and minimize earthquake damage. By applying loads and analyzing an existing design, shear walls can be optimized for maximum node displacement and weak areas. They resist lateral loads and provide strength and stiffness. STAAD. Pro facilitates the determination of shear walls positions.

B. Loading Consideration

The Live (LL) & Dead Load (DL) and acting on the structure are defined by IS 875 (Part 2) (1987) & IS 875 (Part 1) (1987), respectively. According to the IS 1893 (Part 1) (2002) methodology, seismic load (SL).

Dead load (DL):

- Weight of the building itself
- Floor weight
- Wall loads

Live load (LL):

3.8 KN/sq. is taken into consideration for floor load

SL: Zone: V (Z=0.36)

Rock/ soil type: Medium Soil

Soil site factor: 2

Response reduction factor: 5

Damping: 5%

Importance factor: 1

The below map in Figure no. 2 shows different Seismic zones of India as per geological map.

Figure 2: Different Seismic zones of India

Table 1: Multistory building preliminary data

G+5	No of Storey's
20m*20m	Size of plan
4m*4m	Size of Each Grid
450mm*450mm	Column Dimensions
350mm*350mm	Beam Dimensions
120mm	Thickness of slab
200mm	Thickness of Shear wall
3m	Plinth beam height
20.5m	Overall Structure Height
3.5m	Floor to Floor Height
Fixed	Type of Support

3D Model sample according to above parameters is shown in Figure no. 3.

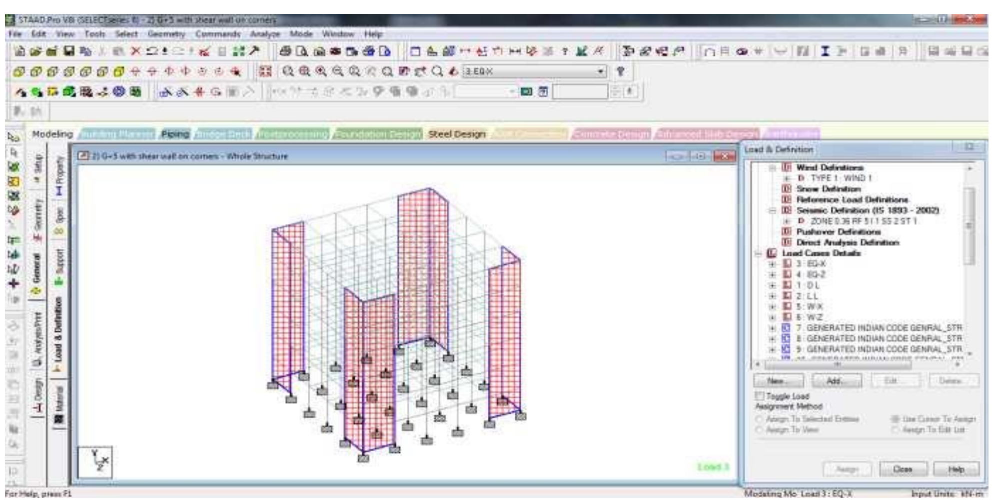

Figure 3: 3D Model sample

C. Creating Model in Staad. Pro

1) STEP- 1

Open the STAAD. Pro V8i Software
Then select New Project from the menu.
Next, choose the STAAD. Pro units that you wish to work in, as shown in Figure no. 4

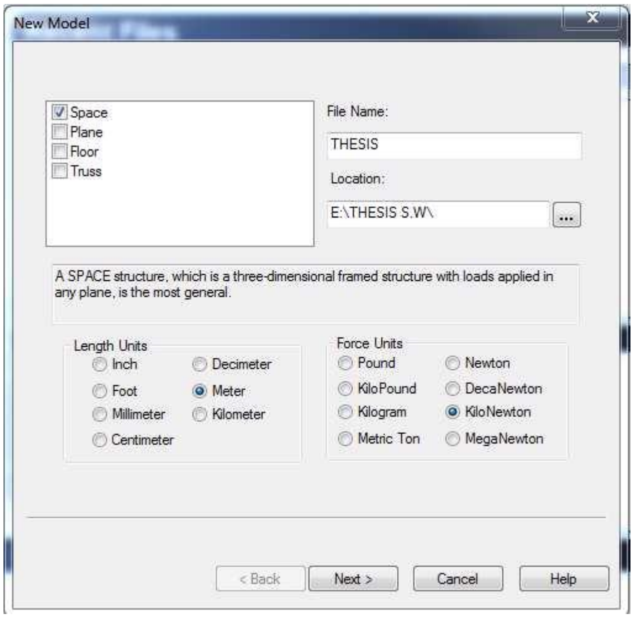

Figure 4: Creating Model

The STAAD. Pro Workspace then becomes accessible.

2) STEP 2

Select Geometry from the menu. After that, choose Run Structure Wizard. Following that, select Frame Models**,** then Bay Frame**,** and then enter the parameter you wish to include in the structure, as shown in Figure no. 5

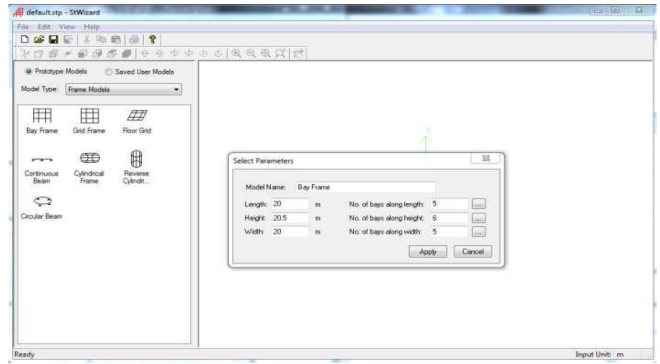

Figure 5: Dimensions of Structure

The multi-story building's frame model is then generated in STAAD. Pro, as shown in Figure no. 6

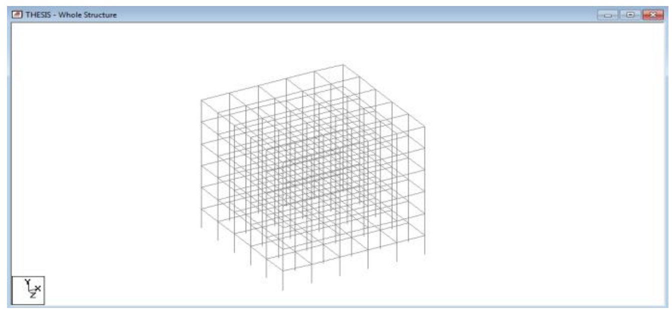

Figure 6: Structure according to defined dimensions

3) Support

Providing fixed support to the structure as shown in Figure no. 7. For providing fixed support firstly, Choose all of the structure's bottom nodes. Select the support option under General**,** then click on Create. Add Fixed End Support to the structure, then assign it to each selected bottom nodes.

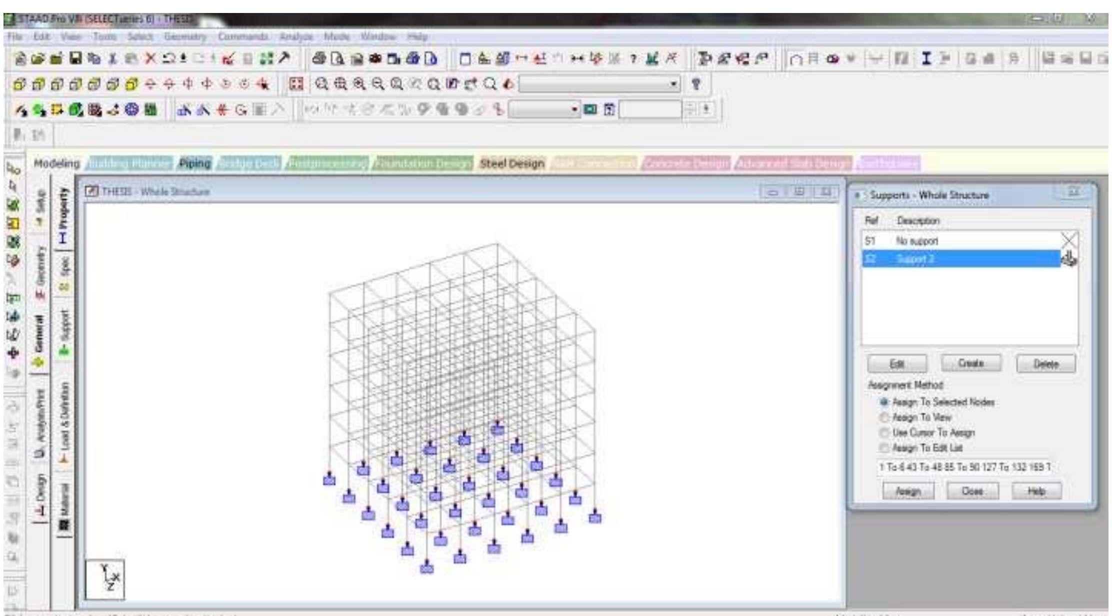

Figure 7: Structure with Fixed Supports

4) Property

The following steps are to assign these properties to the structure that is shown below and then send the properties shown in Table no. 2 to the frame model of the multistory building that we created as shown in Figure no. 8:

Table 2: Column and Beam Properties

.45m*.45m	Size columns
.35mm*.35m	Size of beams

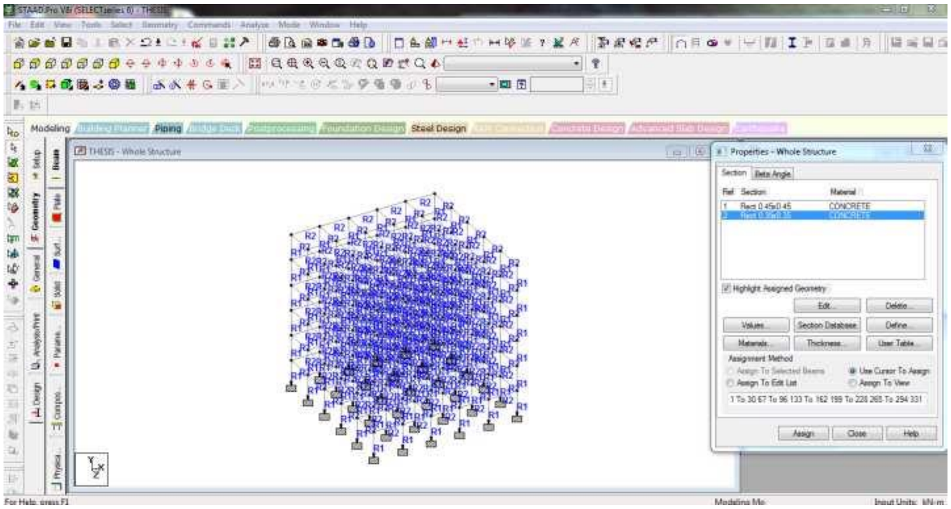

Figure 8: Column and Beam Properties

- Choose the option for selecting the columns, and then click on the beam that is parallel to the Y direction.
- By using the cursor, assign the chosen columns and that property.
- Repeat it, keeping in mind the beam part.

To begin constructing a slab, first choose the option to choose and then click on the choice of a beam parallel to the X-direction. Next, repeat the process and choose the direction in the Z-direction as well. When you construct a slab and then click to fill the floor grids, the structure will be given plates.

5) Slab Property

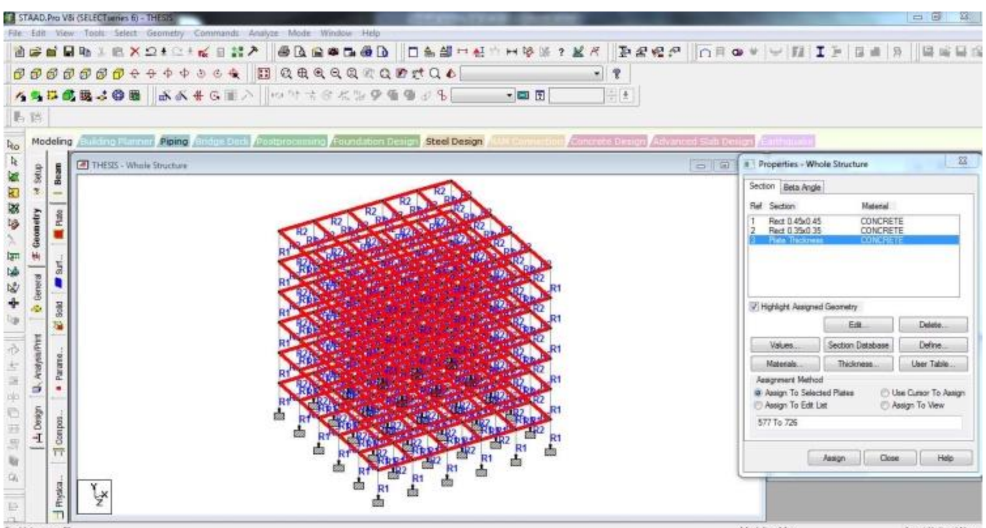

Figure 9: Slab properties

Add the slab's property to the structure after adding the slab's plates:
Slab depth: 120 mm; assign it by selecting all of the plates with the plate cursor and assigning it, as shown in Figure no. 9.

6) Loading Consideration

Live Load & Dead Load As per IS 875 (Part 2) (1987) & IS 875 (Part 1) (1987, respectively, these are the forces affecting the structure. Seismic load (SL): in accordance with IS 1893 (Part 1) (2002).

- Dead load(DL):
  - Structure's Self weight = -1 in y – direction
  - Floor Weight = -4kn/sq.m

  .12m {slab thickness} *25kn/m3{Density ofconcrete} +.050m {floor finish thickness} *20{Density of floor finish} = 4kn/sq.m

  iii)Wall loads

  a) Parapet weight (4”) = -3.5kn/m

  .114m{thickness}*1.219{height of wall} *20{density of brickwork} +.027{thickness of plaster} *22{density of plaster} *1.219m {height of plaster} =3.50kn/m

  b) Member weight (9”) = -13kn/m

  .23m {wall thickness} *2.4m {height of wall} *20{density of brickwork} +.027m {thickness of plaster} *22{density of plaster} *2.4m {height of plaster} =12.5kn/m or 13kn/m
- LL: Live load

  i) 3.8 KN/sq.m
- Seismic Loading consideration:

  IS 1893 – 2002/2015

  Z= 0.36

  City = Srinagar ZONE = V

  Response reduction = 5

  Importance factor = 1

  Type of soil = Medium

  Type of Structure = RC framed building

  Damping Ratio = 5%
- Wind Load

  Intensity – 3.9kn/m

  All these loading applied considerations are shown in Figure no.10
- Loads & definitions:

A. Step 1: Seismic Load

Go to the definitions in load page select and add seismic definition. Select type IS 1893-2002/2005.Now click generate & then

Use the following data

IS 1893 – 2002/2015

Z=0.36

Select City = Srinagar ZONE = V

Response reduction = 5

Importance factor = 1

Type of soil = Medium

Type of Structure = RC framed building

Damping Ratio = 5%

Now click on generate and add the load.

Then add the seismic parameters:

Selfweight factor 1; Add

Member weight; Add

Floor weight; Add

Then assign? Con to any single column. After that go to Staad editor.

Copy (dead load) member load, Paste in member weight & remove all Global direction (GY) & negative sign’s (-), Use numeric value only.

Now for floor weight= D. L+50% of L.L = 4+.5*3.8 = 5.9kn/sq.m (50% because of L.L >3kn/sq.m)

Now copy floor load & paste in floor weight deleting minus sign & cordinate axis (GY)

Then close staad editor & save changes

Now in load case details add sesmic load with tile

EQ-X for x direction

EQ-Z for z direction

Then close.

Now click on EQ-X for x direction, add direction as x and factor 1 in seismic loads likewise for EQ-Z.

Then open Staad editor, Cut and paste seismic loads (EQ-X, EQ-Z) above dead & live load

B. Dead Load

In the load case details, add a dead load.

Add Self weight = -1 in Y- direction

Select assign it to view

Then click on Dead Load & add member load, Uniform force & use the data

Member load (9") = -13kn/m, Parapet (4") -3.5kn/m

add it & Then apply it respectively on selected beams in the building by assigning it.

Floor Load:

Pressure = -4kn/m2

Range in Y- direction Minimum = 0 & Maximum = 20.5,

Shown in Figure no. 11

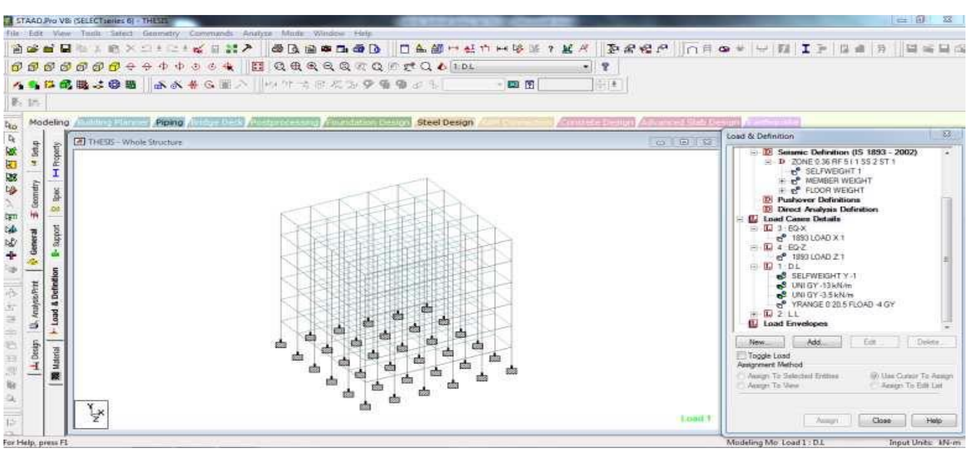

Figure 10: Loading Details

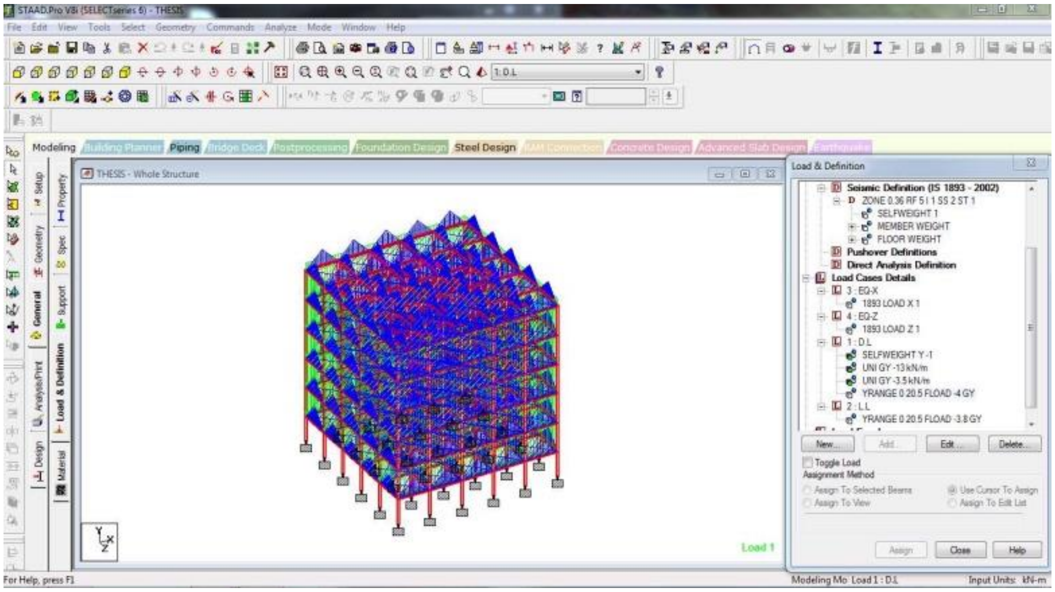

Figure 11: Dead Load

C. Live Load

The following load should be added once the live load has been added to the load case details:
Floor Load.
Pressure = -3.8kn/m2
Range in Y- direction Minimum = 0 & Maximum = 20.5, Shown in Figure no. 12.

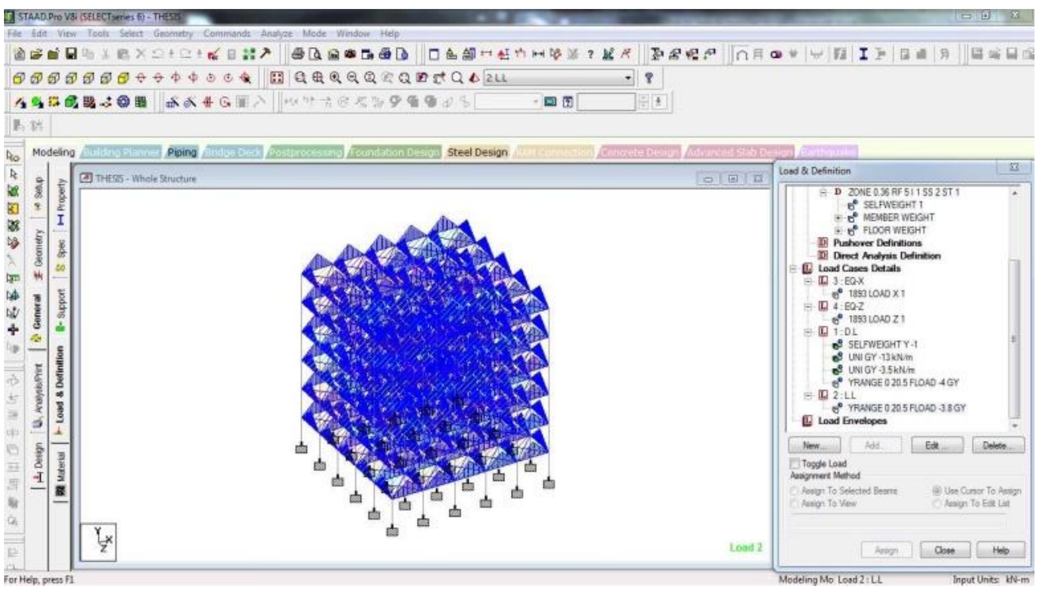

Figure 12: Live Load

D. Wind Load

Go to the definitions and add the wind load Definition. Select Type 1: Wind 1, click add
Add = Intensity – 3.9kn/m & Height of structure = 24 m, then add it
Add factor = 1 & close
Select the exposure factor & assign to view, Then assign
Now go to Load case details & Add Loading Type Wind Title W-X & add. Likewise, for Z Direction W-Z & add
Now select W-X, then add Select Wind load
X (windward face), Factor =1 Y-Range= 0 to 20.5 & add it
Again in X (windward face), but Factor = -1 Y-Range= 0 to 20.5 & add it, Then close it
Now select W-Z, then add Select Wind load
Z (windward face), Factor =1 Y-Range= 0 to 20.5 & add it
Again in Z (windward face), but Factor =-1 Y-Range= 0 to 20.5 & add it, then close it, as shown in Figure no. 13 below

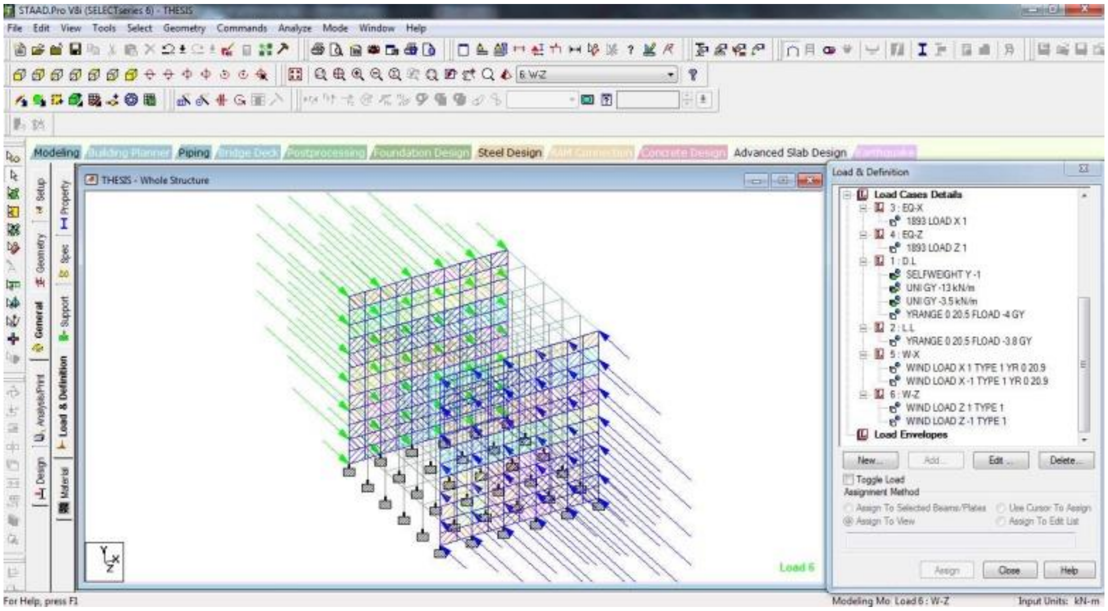

Figure 13: Wind Load

After all, loading, add load combination in Load case details then go to Auto combination of loads, select combination of load in accordance with Indian Code & generate loads, combination of Loads will be generated. Then click add & close

E. Design Parameters

Choosing IS 456 Concrete Design Code.
Selecting the parameters:
Clear cover
Compressive strength (F_c) of concrete
Yield strength (F_y main) of main reinforcement steel
Defining parameters:
Clear cover = 25 mm
Compressive strength (F_c) of concrete = 25000 Kn/m^2
Yield strength (F_y main) of main reinforcement steel= 415000 Kn/m^2
F_y sec =415000 Kn/m^2
Adding Design Commands:
Beam design
Column design
Slab / Element design
Take off
Assign to component respectively by selecting particular component.

F. Analysis

After adding all the loads, going to the option analysis and print, marking the option for all, and then adding it, as shown in Figure no. 14.

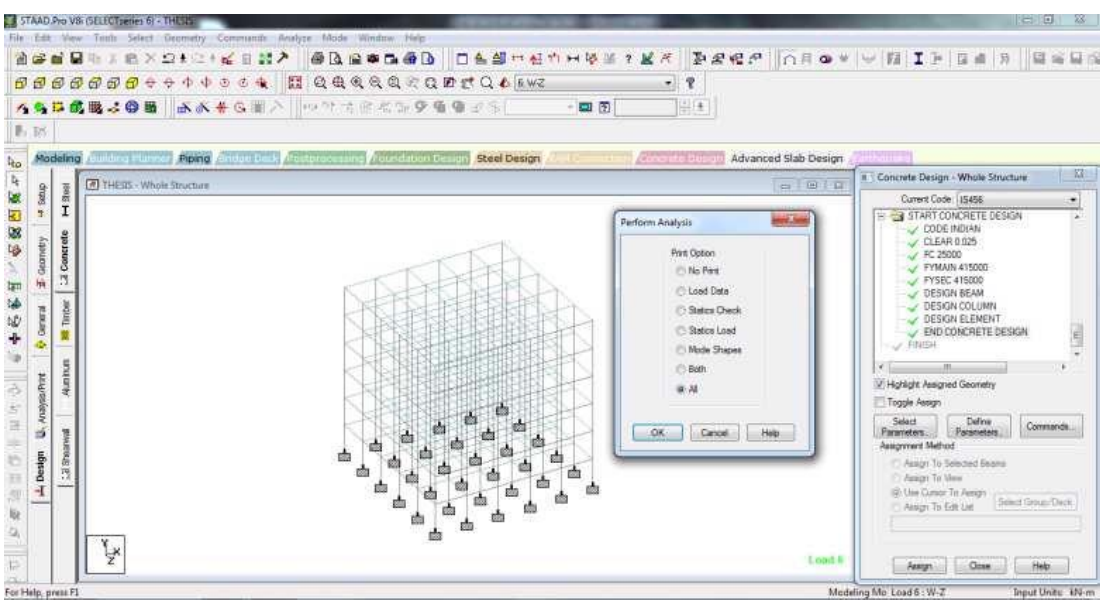

Figure 14: Analysis of Model without shear wall

For analysis go to analyze & run command. As Shown in Figure no. 15

G. Post –Processing

Following post-processing. Then navigate to nodes, choose displacement, and check to write down either the maximum or minimum displacement that occurs as a result of the structure's loading circumstances. As seen in Figure no. 16,

After being aware of the weak structural nodes. On weak nodes that were at the structure's corners and edges, we built the shear walls. Return to modelling and designing the shear wall on the weak points of the structure after that.

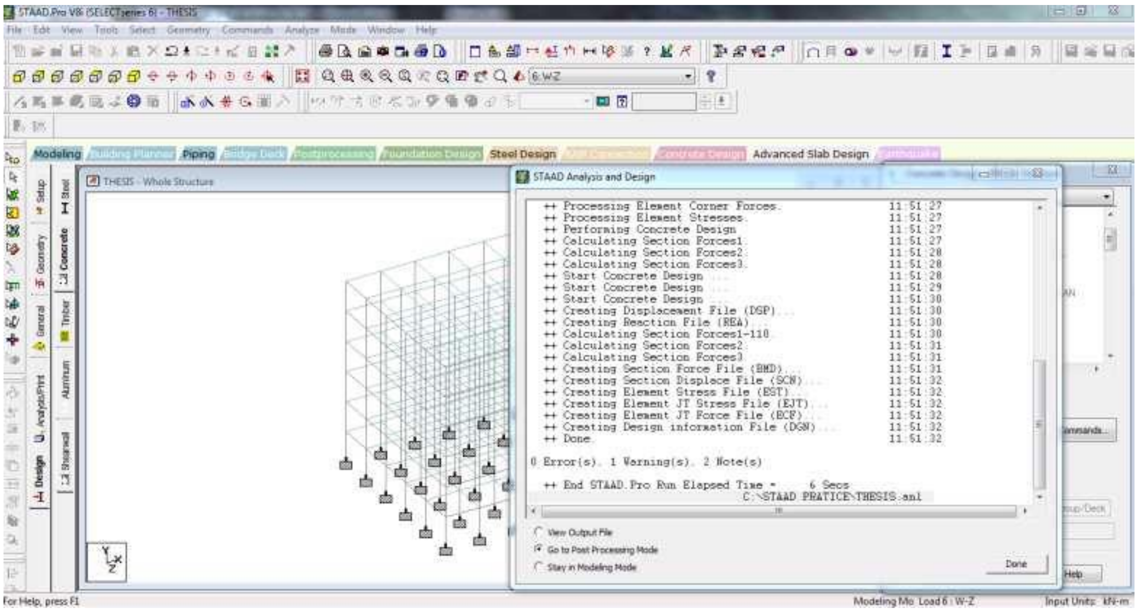

Figure 15: Analysis and Print Command

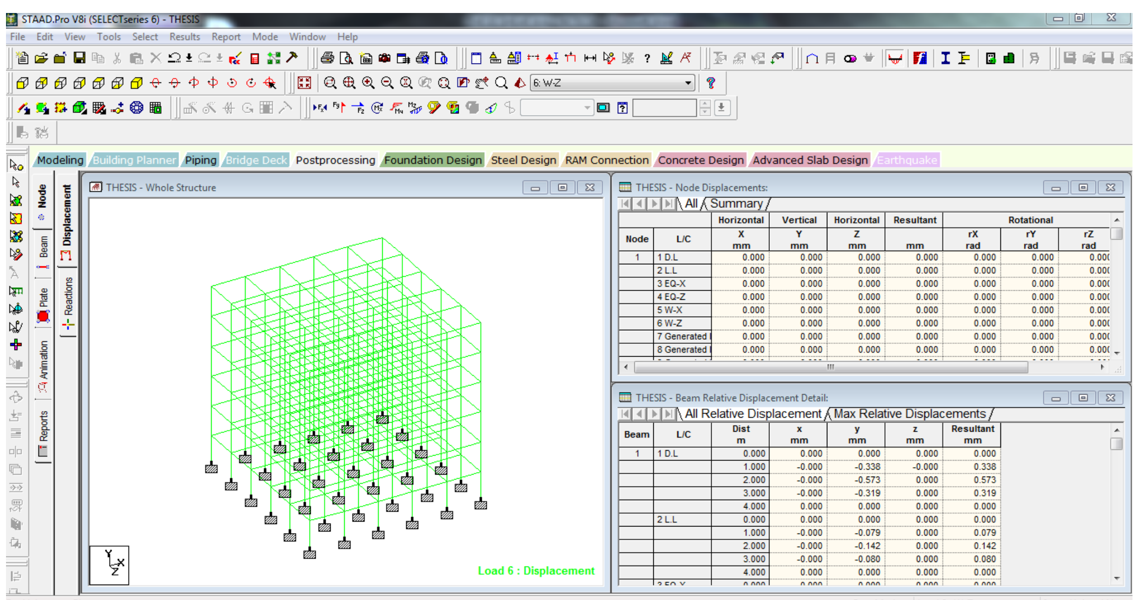

Figure 16: Post Processing of Model

H. Design of Shear Wall

Creating the panel of shear wall. Designing shear wall on the weaker nodes and then add it to those nodes. then pick the shear wall design in the design stage. Go to the option to add surface after choosing the design, then add it by choosing the nodes. We will add shear walls to the building's corners, inner corners, periphery & intermediate, since they are where the weaker nodes are often found. By adding it to the building's corners, inner corners, periphery & intermediate, the strength of the structure will be increased. Like the Model with Shear wall on Corners & alternatively on periphery can be seen in Figure no. 17 & Figure no. 18 respectively. While the model with Designed shear wall at different positions can be seen in Figure no. 20, Figure no. 21, Figure no. 22, Figure no. 23.

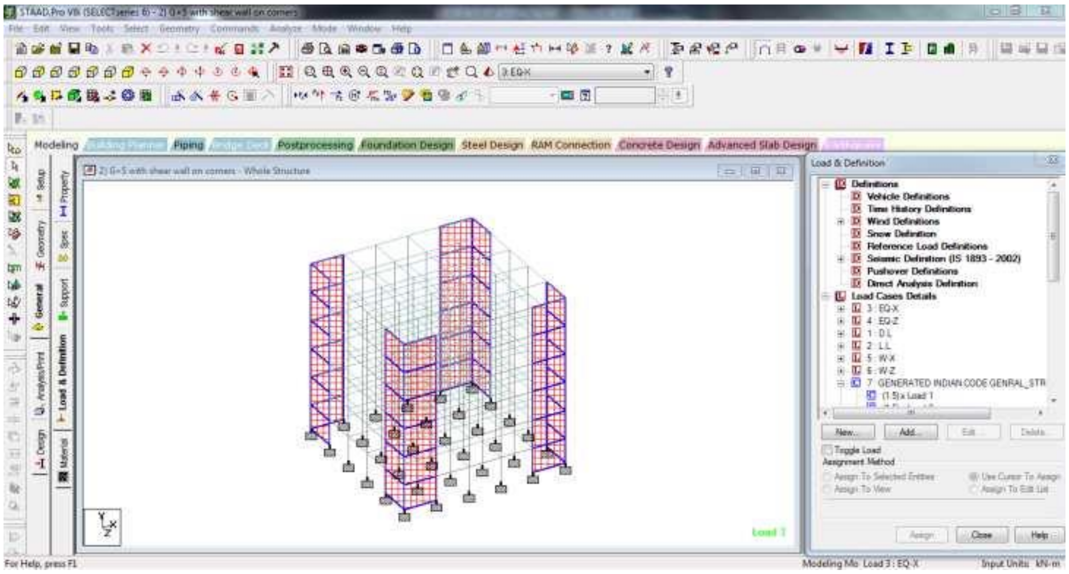

Figure 17: Model with shear wall on corners

After adding the surfaces, pick the option in the shear wall panel dialogue box. Figure no. 19 illustrates how

1) STEP 1

Create panel: In this, all surfaces are picked out individually and added using the create panel function. By choosing the surface and giving it the name "wall," like in Figure no. 19, After creating a panel, it will appear in a building and be visualised as in Figure no. 18. We will generate each one individually after adding the panel type to the full surface and giving it a wall type. Having added it

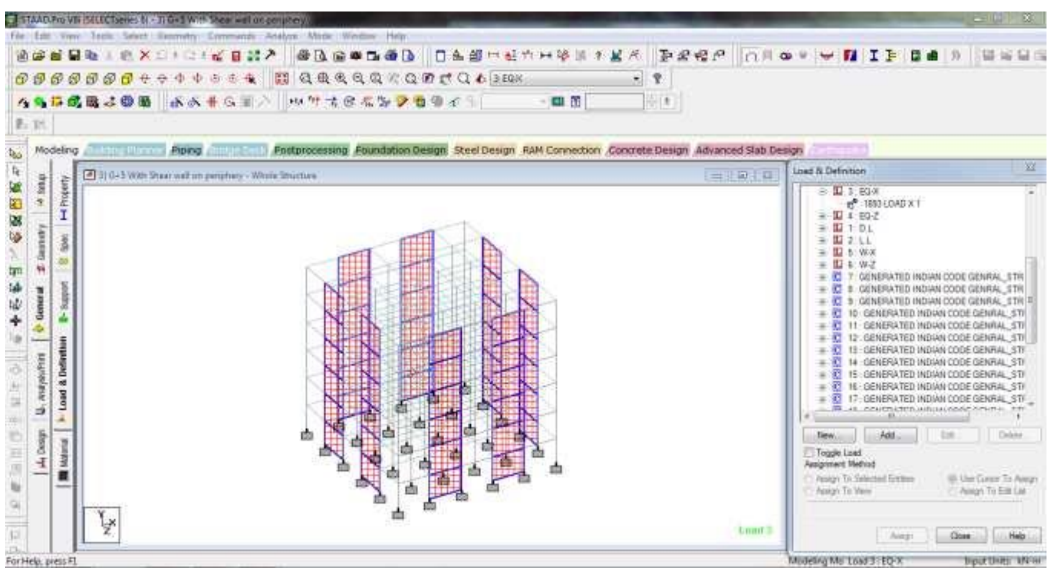

Figure 18: Model with shear wall alternatively on periphery

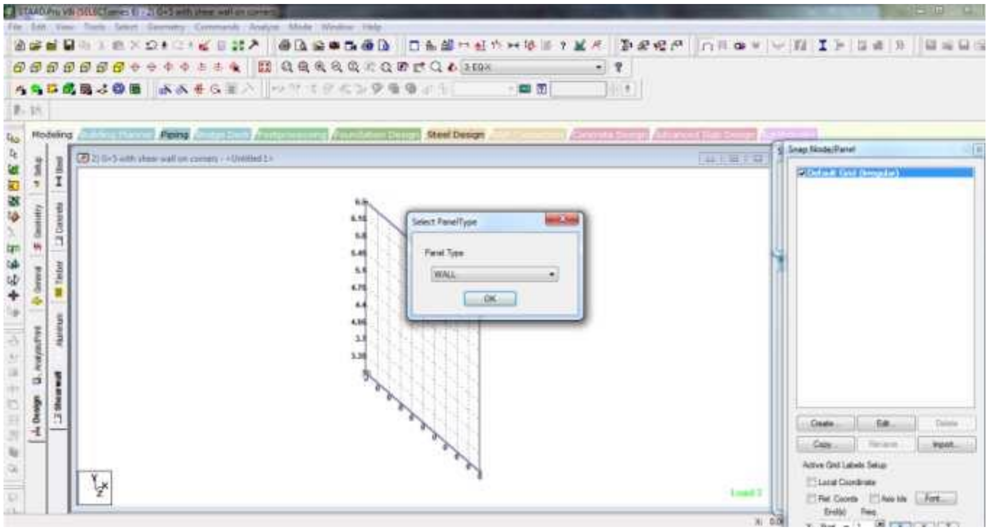

Figure 19: Shear wall addition

Add the entire shear wall panel in the model.
Select the Design code of IS 456
Select the parameters:
Clear cover
Compressive strength (F_c) of concrete
Yield strength (F_y main) of main reinforcement steel
Two-layer reinforcement

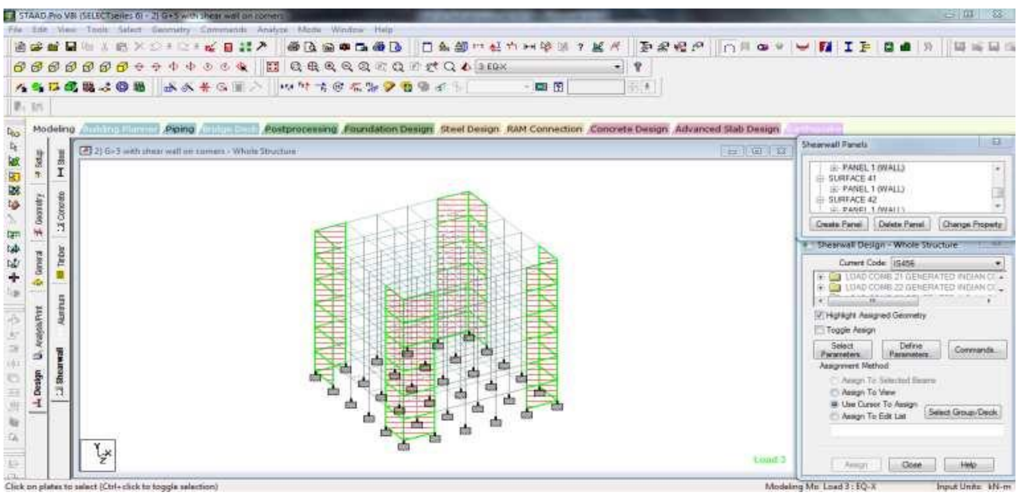

Figure 20: Shear wall design on corners

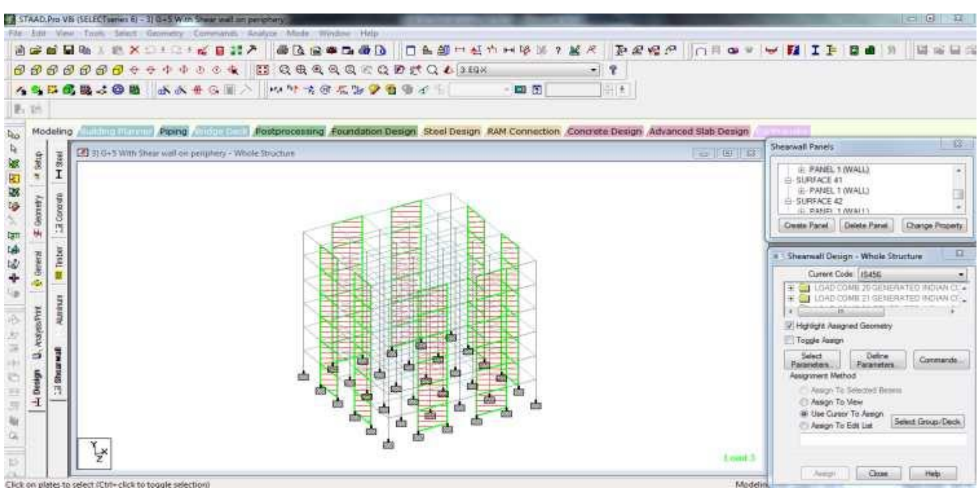

Figure 21: Shear wall design alternatively on periphery

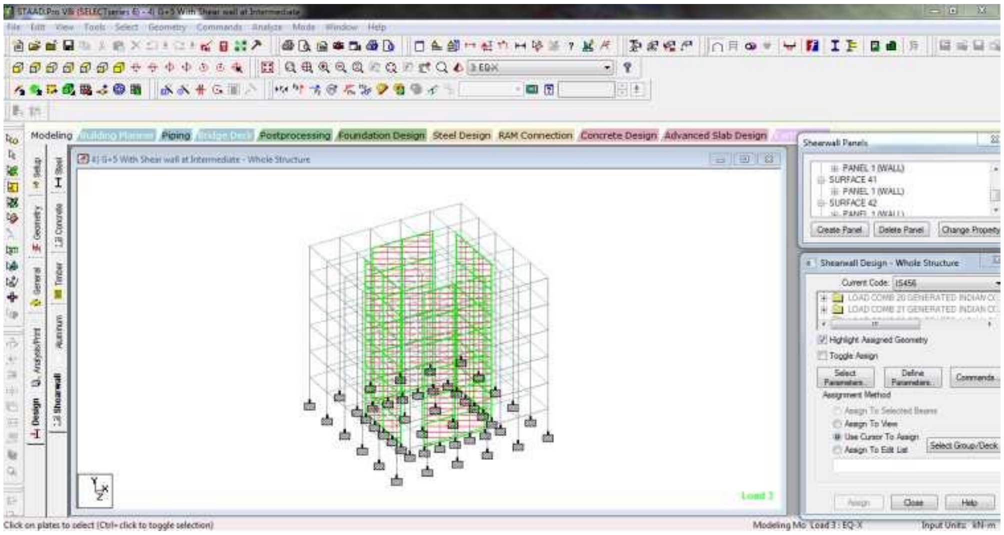

Figure 22: Shear wall design at intermediate

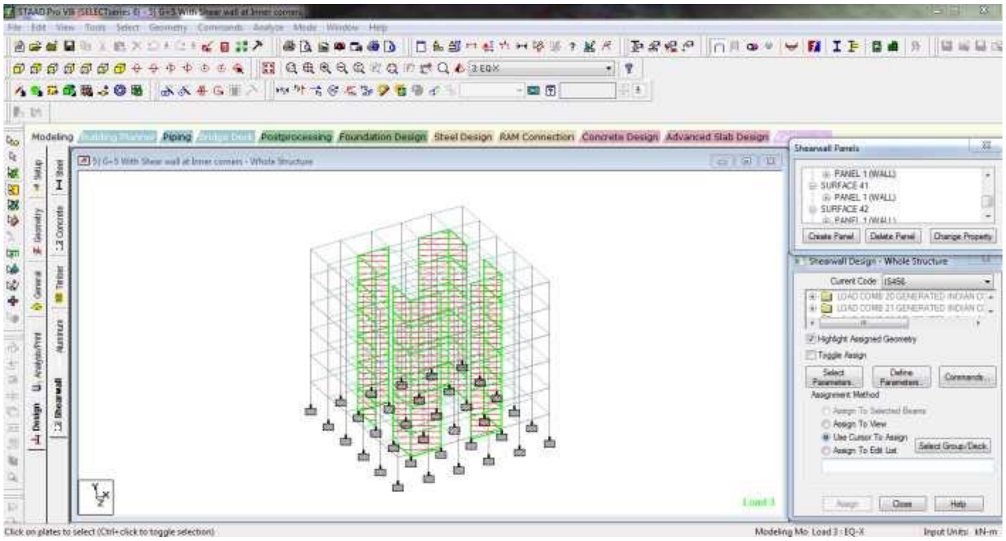

Figure 23: Shear wall design at inner corners

2) STEP 2

Define parameters:

Clear cover = 25 mm

Compressive strength (Fc) of concrete = 25000 Kn/m^2

Main reinforcement steel's Yield strength (Fy main) = 415000 Kn/m^2

Two-layer reinforcement

3) STEP 3

Add Command

Design the shear wall

4) Shear Wall Positions

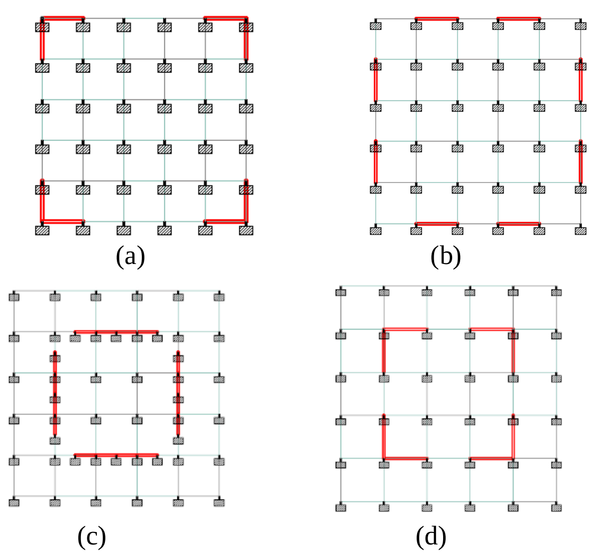

Figure 24: Shear Wall Positions

In Figure no. 24 (a) The position of Shear walls is taken on the corners of the walls.

In Figure no. 24 (b) The position of Shear walls is taken taken alternatively on periphery of wall.

In Figure no. 24 (b) The position of Shear walls is at Intermediate

In Figure no. 24 (b) The position of Shear walls is taken on inner corners of the walls.

V. RESULTS AND DISCUSSION

A. Structure Analysis

STAAD.Pro aids in solving complex construction problems and making design decisions. It incorporates FEA tools for automation and parameterization. It provides accurate results for displacement, deflection, loading, bending moment, and shear force. Shear walls improve structural performance under dynamic loads. Shape and positioning of shear walls impact structure behavior. RC walls are preferred for taller buildings. The study focuses on overstrength and better-than-expected performance of wall structures.

1) Node Displacement

For particular applications, nodes will include nodal (vector) degrees of freedom that might include translations, rotations, as well as higher-order derivatives of displacements. Nodes moved from their original positions as a result of the response, forces, and weights acting on them. The elements will be dragged when the nodes move in a specific way that is determined by the element formulation. These findings demonstrate the behaviour of shear walls and how they strengthen multistory buildings so that they can carry and withstand lateral moments, earthquake loads, and wind loads. As a result, there are some differences between buildings with and without shear walls.

2) Node Displacement in Structure Without Shear Walls

When structure under loading conditions without a shear wall, some nodes may move, and the values for these nodes' displacements are provided in Table no 3:

Table 3: Node Displacement without shear wall

1} G+5 Without Shear Wall - Node Displacements:

All | Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	rY rad	rZ rad
Max X	163	20 GENERAT	**58.796**	-2.204	0.002	58.837	0.000	0.000	-0.001
Min X	168	22 GENERAT	**-58.796**	-2.204	0.002	58.837	0.000	-0.000	0.001
Max Y	205	3 EQ-X	39.191	**0.575**	0.001	39.195	0.000	-0.000	-0.001
Min Y	124	7 GENERATE	-0.003	**-4.993**	0.003	4.993	-0.000	0.000	-0.000
Max Z	40	21 GENERAT	0.002	-2.204	**58.796**	58.837	0.001	-0.000	-0.000
Min Z	250	23 GENERAT	0.002	-2.204	**-58.796**	58.837	-0.001	0.000	-0.000
Max rX	18	21 GENERAT	-0.002	-0.787	18.545	18.562	**0.003**	0.000	0.000
Min rX	228	23 GENERAT	-0.002	-0.787	-18.545	18.562	**-0.003**	-0.000	0.000
Max rY	223	16 GENERAT	0.062	-1.215	0.013	1.216	-0.000	**0.000**	-0.000
Min rY	228	16 GENERAT	-0.062	-1.215	0.013	1.216	-0.000	**-0.000**	0.000
Max rZ	228	22 GENERAT	-18.545	-0.787	-0.002	18.562	-0.000	0.000	**0.003**
Min rZ	223	20 GENERAT	18.545	-0.787	-0.002	18.562	-0.000	-0.000	**-0.003**
Max Rs	168	20 GENERAT	58.779	-3.925	-0.006	**58.910**	0.000	0.000	-0.001

The following Table 3 shows how the displacement of nodes in the building without shear walls has changed as a result of the building's lack of a shear wall, with increased node displacement when compared with the same structure with shear walls.

When a load is applied to a structure without a shear wall, certain nodes may move, but this impact may be minimized by adding a shear wall to the building. The node displacement values that result with addition of shear wall on corners is shown in Table 4.

3) Node Displacement with Shear Wall on Corners

Table 4: Node Displacement in nodes with shear walls on corners

2} G+5 with shear wall on corners - Node Displacements:

All | Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	rY rad	rZ rad
Max X	163	20 GENERAT	**16.260**	-2.639	-0.046	16.473	-0.000	-0.000	-0.001
Min X	168	22 GENERAT	**-16.260**	-2.639	-0.046	16.473	-0.000	0.000	0.001
Max Y	251	3 EQ-X	10.728	**1.603**	0.019	10.848	-0.000	-0.000	-0.000
Min Y	166	7 GENERATE	-0.007	**-4.998**	-0.007	4.998	0.000	-0.000	-0.000
Max Z	40	21 GENERAT	-0.046	-2.639	**16.260**	16.473	0.001	0.000	0.000
Min Z	250	23 GENERAT	-0.046	-2.639	**-16.260**	16.473	-0.001	-0.000	0.000
Max rX	42	21 GENERAT	-0.187	-0.215	16.097	16.100	**0.001**	0.000	0.000
Min rX	252	23 GENERAT	-0.187	-0.215	-16.097	16.100	**-0.001**	-0.000	0.000
Max rY	241	27 GENERAT	0.148	0.339	-12.886	12.891	-0.001	**0.000**	-0.000
Min rY	241	21 GENERAT	-0.150	-2.426	12.888	13.115	0.001	**-0.000**	-0.000
Max rZ	252	22 GENERAT	-16.097	-0.215	-0.187	16.100	-0.000	0.000	**0.001**
Min rZ	247	20 GENERAT	16.097	-0.215	-0.187	16.100	-0.000	-0.000	**-0.001**
Max Rs	164	20 GENERAT	16.259	-3.490	-0.017	**16.630**	-0.000	-0.000	-0.000

When the load is applied to the structure, there are nodal displacements that happen in the building with shear walls alternatively on periphery, is shown in Table no. 5.

Table 5: Node Displacement in nodes with shear walls

3} G+5 With Shear wall on periphery - Node Displacements:

All / Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	Rotational rY rad	Rotational rZ rad
Max X	163	20 GENERAT	19.829	-1.501	-0.020	19.886	-0.000	-0.000	-0.001
Min X	168	22 GENERAT	-19.829	-1.501	-0.020	19.886	-0.000	0.000	0.001
Max Y	242	3 EQ-X	10.580	1.488	-0.012	10.684	-0.000	-0.000	-0.001
Min Y	124	7 GENERATE	-0.004	-5.005	0.004	5.005	-0.000	-0.000	-0.000
Max Z	40	21 GENERAT	-0.020	-1.501	19.829	19.886	0.001	0.000	0.000
Min Z	250	23 GENERAT	-0.020	-1.501	-19.829	19.886	-0.001	-0.000	0.000
Max rX	28	21 GENERAT	-0.018	-1.350	11.842	11.919	0.001	0.000	0.000
Min rX	238	23 GENERAT	-0.018	-1.350	-11.842	11.919	-0.001	-0.000	0.000
Max rY	235	16 GENERAT	0.053	-1.901	0.014	1.902	-0.000	0.000	-0.000
Min rY	30	17 GENERAT	0.014	-1.901	0.053	1.902	0.000	-0.000	0.000
Max rZ	156	22 GENERAT	-11.842	-1.350	-0.018	11.919	-0.000	0.000	0.001
Min rZ	151	20 GENERAT	11.842	-1.350	-0.018	11.919	-0.000	-0.000	-0.001
Max Rs	251	20 GENERAT	19.767	-3.906	0.009	20.150	-0.000	0.000	-0.001

When the load is applied to the structure, the nodal displacements that happen in the structure having shear.

Table 6: Node Displacement in nodes with shear walls at Intermediate

5} G+5 With Shear wall at Inner corners - Node Displacements:

All / Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	Rotational rY rad	Rotational rZ rad
Max X	165	20 GENERAT	14.651	-3.277	-0.001	15.013	-0.000	0.000	-0.001
Min X	166	22 GENERAT	-14.651	-3.277	-0.001	15.013	-0.000	-0.000	0.001
Max Y	202	3 EQ-X	7.881	1.428	0.002	8.009	-0.000	0.000	-0.000
Min Y	124	7 GENERATE	-0.002	-4.586	0.002	4.586	0.000	-0.000	0.000
Max Z	124	21 GENERAT	-0.001	-3.277	14.651	15.013	0.001	-0.000	0.000
Min Z	166	23 GENERAT	-0.001	-3.277	-14.651	15.013	-0.001	0.000	0.000
Max rX	36	21 GENERAT	-0.003	-1.965	11.846	12.008	0.001	-0.000	0.000
Min rX	246	23 GENERAT	-0.003	-1.965	-11.846	12.008	-0.001	0.000	0.000
Max rY	235	16 GENERAT	0.056	-1.999	0.018	1.999	-0.000	0.000	-0.000
Min rY	235	18 GENERAT	-0.065	-1.998	-0.009	1.999	-0.000	-0.000	-0.000
Max rZ	246	22 GENERAT	-11.846	-1.965	-0.003	12.008	-0.000	-0.000	0.001
Min rZ	241	20 GENERAT	11.846	-1.965	-0.003	12.008	-0.000	0.000	-0.001
Max Rs	208	22 GENERAT	-14.630	-3.898	-0.007	15.140	0.000	-0.000	0.000

Inner corners**:**

When the load is applied to the structure, there are nodal displacements that happen in the structure with shear walls at inner corners as shown in Table no. 6. Which demonstrates that buildings with shear walls alternatively on periphery have the most displacement of nodes because of position of those walls on the structure, which will result in more node displacement as comparison to structures with shear walls in rest of cases, which have less displacement. However, shear walls in structure at intermediate have least displacement of nodes

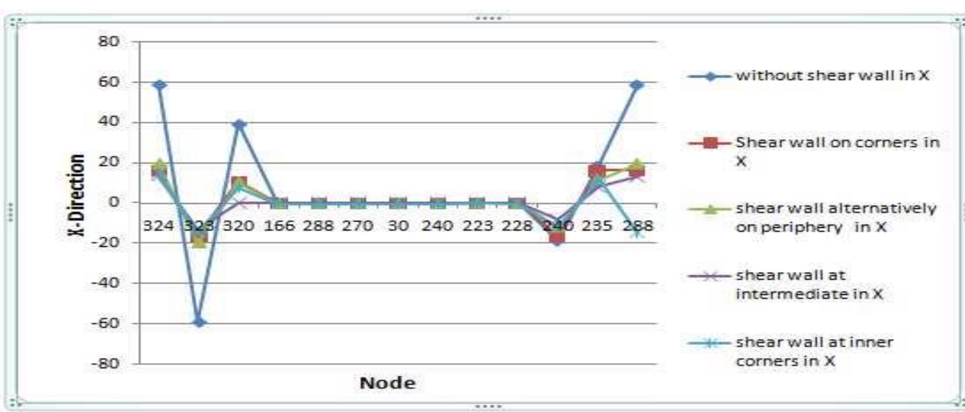

Figure 25: Comparison of node displacement in X- direction

The structure with shear walls at intermediate has the least displacement in this graph's X-direction, while the building without shear walls has the most displacement, as can be seen from Figure 25.

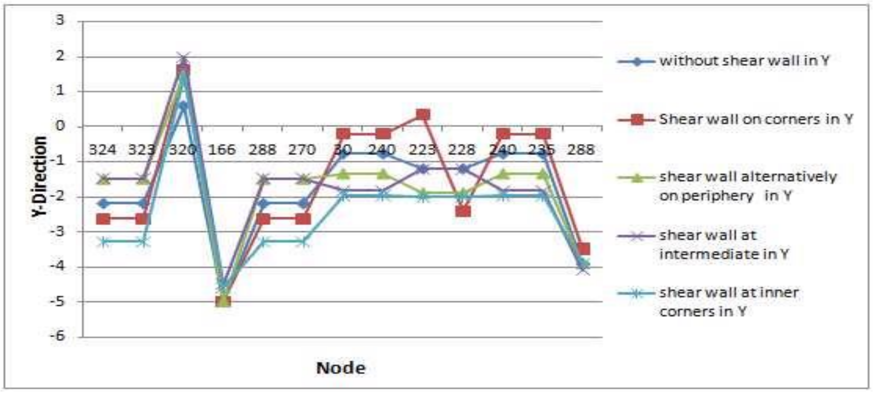

Figure 26: Comparison of node displacement in Y- direction

The structure having shear walls on the inner corners has the smallest displacement, while the structure without shear walls as well as the structure having shear walls on corners have the maximum displacement in the Y-direction, which can be seen from Figure 26
.

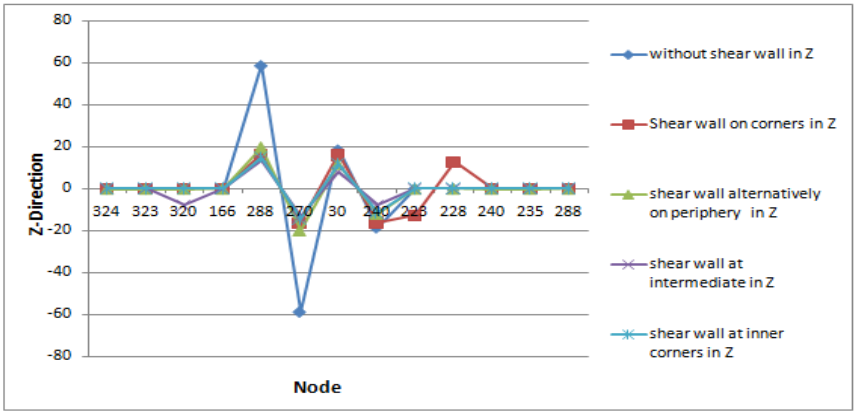

Figure 27: Comparison of node displacement in Z

A. Direction

According to this graph, the structure having shear walls at intermediate & the structure having shear walls at inner corners have the least displacement in the direction of Z, while the structure without shear walls has the most displacement followed by structure having shear wall at corners as seen from Figure 27

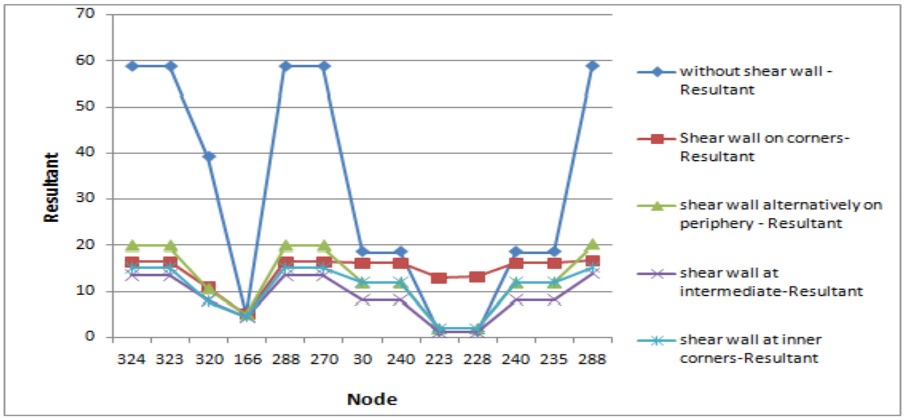

Figure 28: Comparison of Resultant node displacement.

As can be seen from a comparison of the buildings in the Figure 28, the structure having shear wall at intermediate is having least displacement of nodes than other structures, which have higher displacement. Structure lacking shear walls is having the most displacement, also structures without shear walls had most displacement overall

VI. CONCLUSIONS

Without shear walls, shear walls on the corners, shear walls on periphery alternatively, shear walls at intermediate & at inner corners, the optimization of shear wall placement in a multistory structure is examined. From this study, conclusions may be drawn.

STAAD. Pro is utilized to locate the shear wall in a multistory structure by showing the effect of forces or loads on the structure without & having shear walls at various positions throughout the structures. End of this paragraph demonstrates that the structure with shear walls at the intermediate location had the least amount of displacement when contrasted with structures without shear walls and structures with shear walls at other positions. Following are conclusions based on the findings:

- The displacements of nodes in the X, Z, and Y dimensions demonstrate that the load-bearing capability of the frame model significantly rises in the event upon addition of shear wall
- The building was significantly impacted by the shear wall's position, which reduced the impact of loading and displacement.
- Because the structure has a shear wall, the axial stress on the columns during an earthquake is decreased by 45%. Buildings without shear walls exhibit a significant decrease.
- Shear walls are undoubtedly a useful method for reducing lateral stresses, but their location must be carefully considered.
- Using STAAD. Pro, a building can be simply compared and created, and its strengths and economic profit points may be examined.

Therefore, the overall conclusion sheds light on effect & the optimizing shear walls location in multistory structure, stating that shear walls at the intermediate is overall effective location of shear walls compared to building without & with shear walls at other positions. Shear walls at the intermediate have the least load. It aids in bearing and lessens the impact of loads and displacement on the building.

VII. FUTURE SCOPE

By examining buildings without & with shear walls, nodal displacement in the building's structure was employed in the present research to assess the impacts of shear wall optimization. While under load. Therefore, this study may also be continued by considering hydrostatic loads while designing floors.

- When considering hydrostatic pressure, a building can be a Dam.
- The combination of above shear wall placement may serve more structural stability.
- Shear wall placement at different levels.
- Various building layouts will also be affected by other locations.

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