A

M.TECH.

MAJOR PROJECT

On

Wind Load Analysis Of High Rise Building With And Without Shear Wall And Its Comparisons

Submitted by:

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(2K15/STE/16)

M.Tech

(Structural Engineering)

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<u>CANDIDATE'S DECLARATION</u>

I hereby declare that the project work entitled **"Wind Load Analysis Of High Rise Building With And Without Shear Wall And Its Comparisons"** submitted to Department of Civil Engineering, DTU is a record of an original work done by **Raj Kumar Varma** under the guidance of **Dr. Ritu Raj**, Assistant Professor, Department of Civil Engineering, DTU, and this project work has not performed the basis for the award of any Degree or diploma/fellowship and similar project, if any.

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CERTIFICATE

This is to certify that the project entitled **"Wind Load Analysis Of High Rise Building With And Without Shear Wall And Its Comparisons"** submitted by **Raj Kumar Varma,** in partial fulfillment of the requirements for award of the degree of **MASTERS OF TECHNOLOGY (STRUCTURAL ENGINEERING)** to Delhi Technical University is the record of student's own work and was carried out under my supervision.

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. (**Raj Kumar Varma)**

ABSTRACT

Indian standard code IS 875(part-3)-1987 gives the specifications for wind load analysis on the different structures. The analysis is based on various steps provided for wind pressure intensity, wind load calculation by wind coefficients. Behavior of building by the wind pressure is dependent on the angle on which the wind is striking the structure.

Wind load is dangerous for the high rise building ,hence various techniques are used to reduce its effects. Shear wall is a good option for this, which is effected up to approximate 70 stories. It is expected in this study that a shear walled structure will show the better result and stability against normal building without shear wall.

This study compares the performance of buildings with and without shear wall in terms of deflection of at the different stories and various parameters. As a case study, a 40 storey building designed for Gravity loads(dead load +live load) as well as lateral load (wind load) as per IS:875(part-3)-1987 for wind zone IV is considered. This paper also provides other important conclusions on wind load design provisions and shear wall specifications.

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CHAPTER 1

INTRODUCTION

1.1 General

The necessity of high rise building in urban areas is to minimize the land requirements. The wind force acts on high rise building structure very high compared to low rise building. Worldwide as it's necessity has increased hence the various code are adopted in different country to analyse and design of high rise structure.

According national building code 2005 of India, the building of height more than 15 m is called high rise building.

Many techniques are used to minimize the wind effect on high rise building like Rigid frames, braced hinge frame, Shear wall /hinged frame, Outrigger Structures.

Shear wall / Rigid frame of the concrete shear wall and concrete frame is effective up to 70 stories. It creates shear wall-frame interaction that resist the lateral load by wind or earthquake.

The main objective of every structural system is to transfer gravity load to the foundation of building. Dead load and live load are the primary load created from the gravity effect. The lateral loads like wind or earthquake also affects the building other than this dead and live load. High stresses are developed due to these lateral loads and also these create sway movement and cause vibration in the structure. Therefore, the building must have sufficient strength and stiffness to encounter the vertical loads and lateral loads respectively.

1.2 Goal

Analysis of two 40 stories building with and without shear wall by the STADD-PRO software and their comparison.

There are two 40-stories tall building, and as the policy of construction of building is toward the vertical accommodation, so building would be helpful to approach this goal. The building has two transverse main walls with the angle of 90°.It seems that this kind of architectural configuration is due to aesthetic considerations.

1.2.1 Specific Objectives

The primary objective of this study is to analyse the building with and without shear wall and compare the results of deflection and other parameters. In the analysis frame elements were used instead of plane stress elements in analysis and modelling of shear walls to reduce the time requirements and to increase the performance of the building.

1.2.2 Experimental Study Plan

Dead load and live load have been taken as per IS 875 (Part 1) (1987) and IS 875 (Part 2) (1987) respectively. Wind load calculation has been done based on the IS 875 (Part 3) (1987). Analysis is being done by STAD-PRO by providing adequate material properties and dimension as per the required building standard.

1.2.3 Layout

This study report is summarized in total 6 chapters, each chapter deals with specific objective and divided according to specific work area. Chapter 1 gives the general information and introduction about the work also about the objective and procedure. Chapter 2 is about the literature work, terms used in the study and work of the previous studies. Chapter 3 deals with the methodology adopted for analyzing the structure and also about the detailing of the problem. Chapter 4 gives the modelling done in STAAD-PRO software and analysis separately of both buildings and about the results obtained from the analysis. Chapter 5 is about the comparisons of the results obtained from chapter 4 and a discussion is also made to discuss the results. Chapter 6 is concluded the whole study work.

CHAPTER 2

LITERATURE REVIEW

2.1 General

The elevator and the introduction of structural steel, towers and skyscrapers have continued to soar skyward, where they are buffeted in the wind's complex environment. Unfortunately, these advances in height are often accompanied by increased flexibility and a lack of sufficient inherent damping, increasing their susceptibility to the actions of wind. While major innovations in structural systems have permitted the increased lateral loads to be efficiently carried, the dynamic nature of wind is still a factor, causing discomfort to building occupants and posing serious serviceability issues. The next generation of tall buildings research has been devoted in part to the mitigation of such wind-induced motions via global design modifications to the structural system.

2.2 High Rise Building

Emporis Standards defines a high-rise as "A multi-story structure between 35–100 meters tall, or a building of unknown height from 12–39 floors." According to the building code of Hyderabad, India, a high-rise building is one with four floors or more, or 15 to 18 meters or more in height.

Three Generations of High-Rise Buildings:
Since the first appearance of high-rise buildings, there has been a transformation in their design and construction. This has culminated in glass, steel, and concrete structures in the international and postmodernist styles of architecture prevalent today.

First Generation

The exterior walls of these buildings consisted of stone or brick, although sometimes cast iron was added for decorative purposes. The columns were constructed of cast iron, often unprotected; steel and wrought iron was used for the beams; and the floors were made of wood. "In a fire, the floors tend to collapse, and the iron frame loses strength and implodes. " 38 Elevator shafts were often unenclosed. The only means of escape from a floor was through a single stairway usually protected at each level by a metal-plated wooden door. There were no standards for the protection of steel used in the construction of these high-rises.

Second Generation

The second generation of tall buildings, which includes the Metropolitan Life Building (1909), the Woolworth Building (1913), and the Empire State Building (1931), are frame structures, in which a skeleton of welded- or riveted-steel columns and beams, often encased in concrete, runs through the entire building. This type of construction makes for an extremely strong structure, but not such attractive floor space. The interiors are full of heavy, load-bearing columns and walls.

Third Generation

Buildings constructed from after World War II until today make up the most recent generation of high-rise buildings. Within this generation there are those of steel-framed construction (core construction and tube construction), reinforced concrete construction, and steel-framed reinforced concrete construction.

Techniques to reduce the effects of wind/earthquake load on high rise building:

2.3 Wind

Wind is essentially the large scale Horizontal movement of free air. It plays an important role in design of tall structures because it exerts loads on Building. Wind means the horizontal motion of air in the atmosphere.The response of structure to wind depends on the characteristics of the wind.

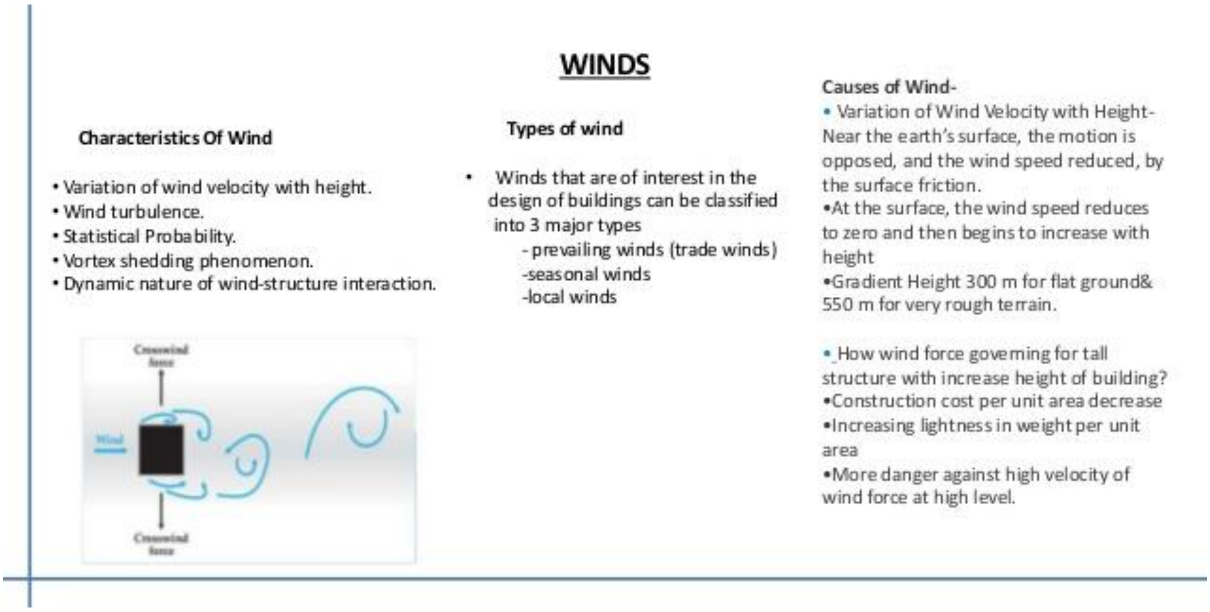


Fig 2.1- Wind (types, characteristics and cause)

2.3.1 Variation of wind velocity with height

Near the earth's surface, the motion is opposed and wind speed is reduced by the surface friction. At the surface wind speed reduces to zero and then begins to increase as the height increases and at some height (gradient height) ,the motion is to be considered to be free from earth's frictional influence and attains its gradient velocity.

Gradient Height- 300m for flat ground,

550m for very rough terrain.

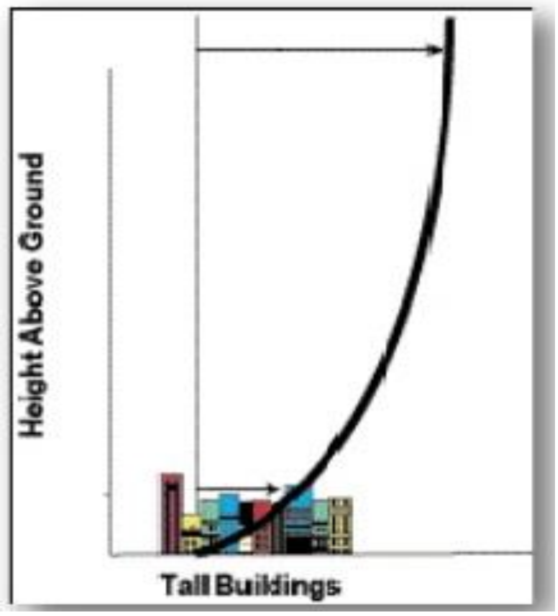


Fig 2.2-Wind behaviour

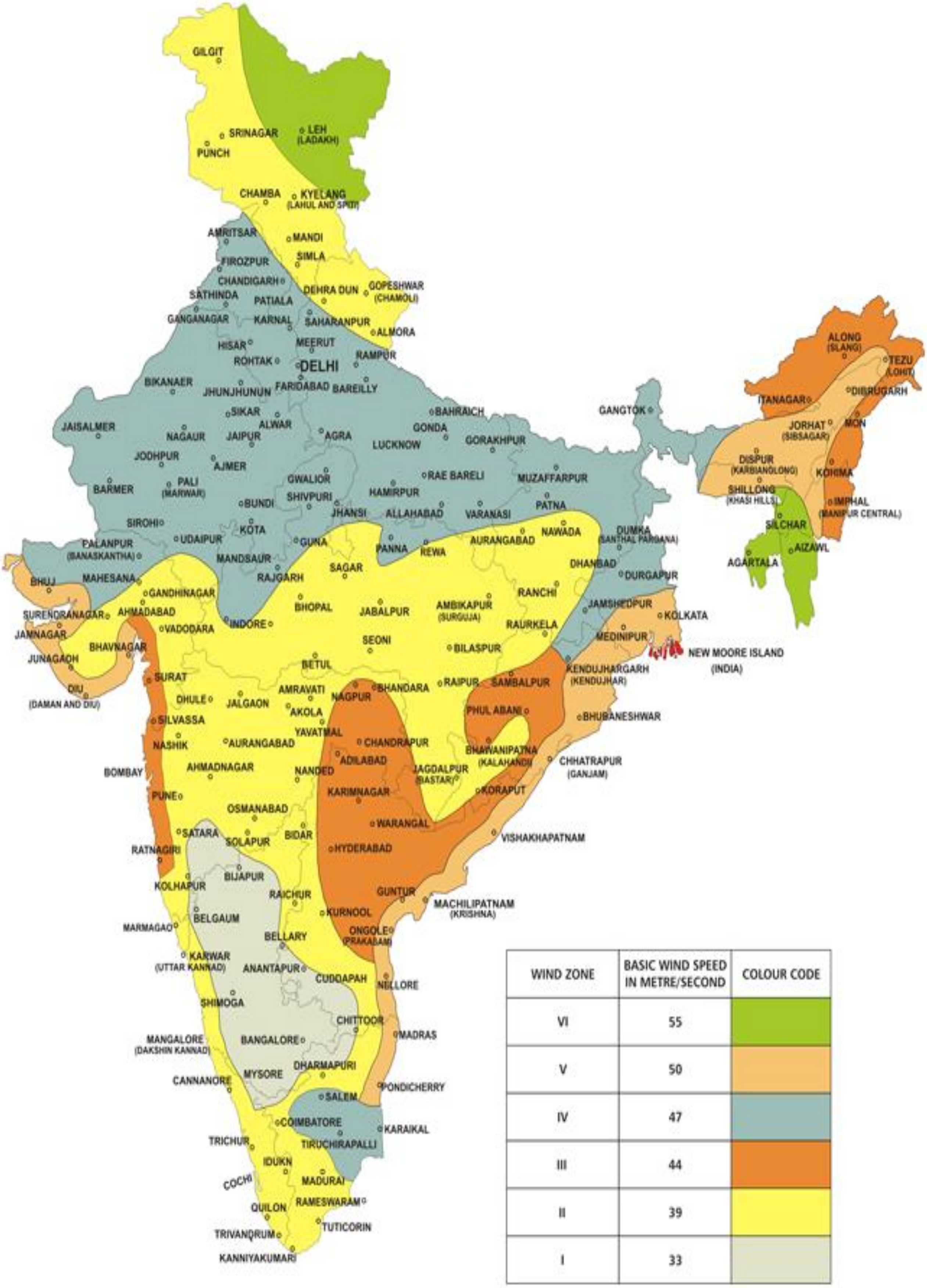
2.3.2 WIND ZONES IN INDIA

There are 6 wind zones in India as follows:

Table-2.1- Wind zones and Basic wind speed

ZONE	BASIC WIND SPEED
I	33
II	39
III	44
IV	47
V	50
VI	55

These zones are defined by the meteorological department of india as shown in map of India:



WIND ZONE	BASIC WIND SPEED IN METRE/SECOND	COLOUR CODE
VI	55	
V	50	
IV	47	
III	44	
II	39	
I	33	

Fig 2.3- Map of India showing the wind zones

2.3.3 Wind load on high rise building

Wind forces are studied on four main groups of building structures:-
i. Tall Buildings
ii. Low Buildings
iii. Equal-Sided Block Buildings
iv. Roofs and Cladding

Almost no investigations are made in the first two categories as the structure failures are rare, even the roofing and the cladding designs are not carefully designed, and localized wind pressures and suctions are receiving more attention. But as Tall buildings are flexible and are susceptible to vibrate at high wind speeds in all the three directions(x, y, and z) and even the building codes do not incorporate the expected maximum wind speed for the life of the building and does not consider the high local suctions which cause the first damage. Due to all these facts the Wind Load estimation for Tall Buildings are very much important. (**International Journal of Advances in Engineering & Technology, Sept. 2013).**

2.4 Shear Wall

In structural engineering a shear wall is a structural system composed of braced panels (also known as shear panels) to counter the effects of lateral loads acting on a structure, these are vertically oriented wide walls of width varies from 150 to 400mm in high rise building.

The most common shear wall is the concrete wall structure reinforced with both horizontal and vertical reinforcement (Figure 4). A reinforcement ratio is defined as the ratio of the gross concrete area for a section taken orthogonal to the reinforcement.

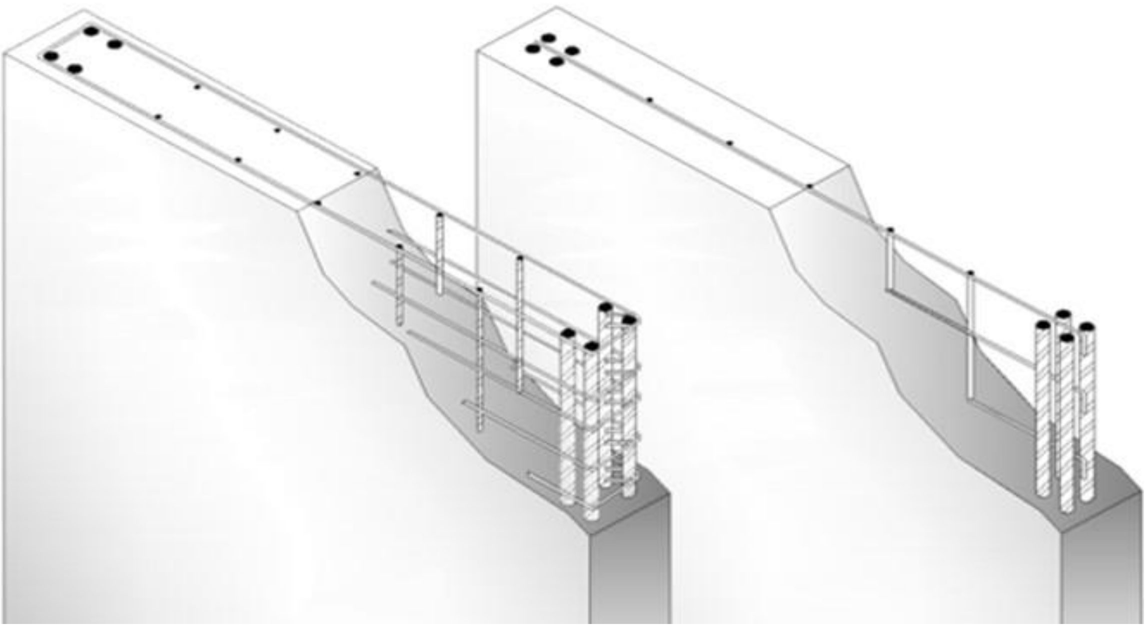


Fig 2.4-Reinforced concrete shear wall with both horizontal and vertical reinforcement

2.4.1 Types Of Shear Wall

Shear walls are classified into different types. They are coupled shear wall, core type shear wall, column support shear wall, frame wall with infill frame, rigid frame shear wall etc.

2.4.2 Functions of shear wall

- Shear wall mainly resists two types of forces: shear forces and uplift forces. To resist the horizontal earthquake/wind forces, shear wall should provide the necessary lateral strength and to prevent the roof or floor above from excessive side-sway, shear walls also should provide lateral stiffness.
- Shear wall transfers the wind / earthquake load to the bottom of foundation.

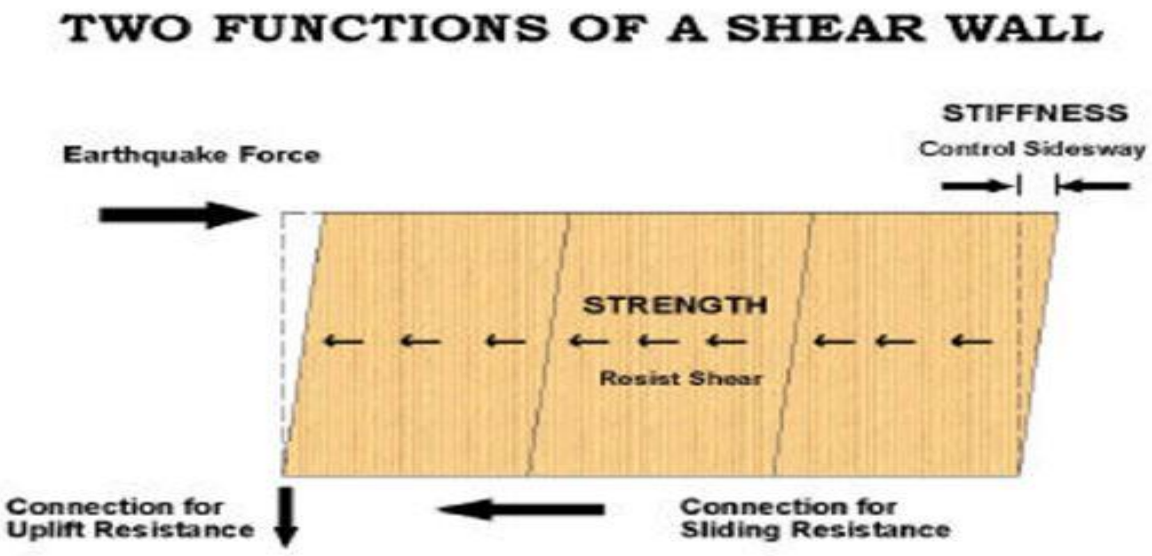


Fig 2.5- Functions of shear wall

2.4.3 Advantages of shear wall

- Effectively resists lateral loads by producing shear truss - frame interacting system.
- It provides large stiffness and strength.
- Symmetric location of shear wall along the perimeter of building is desirable.

2.4.4 Disadvantages of shear wall

- Interior planning limitations due to shear trusses.
- Unsymmetrical location of shear wall along the perimeter of building is not desirable.
- The opening provided in shear wall should be symmetrical.
- Shear wall is effective only when it is located along the perimeter not interior.

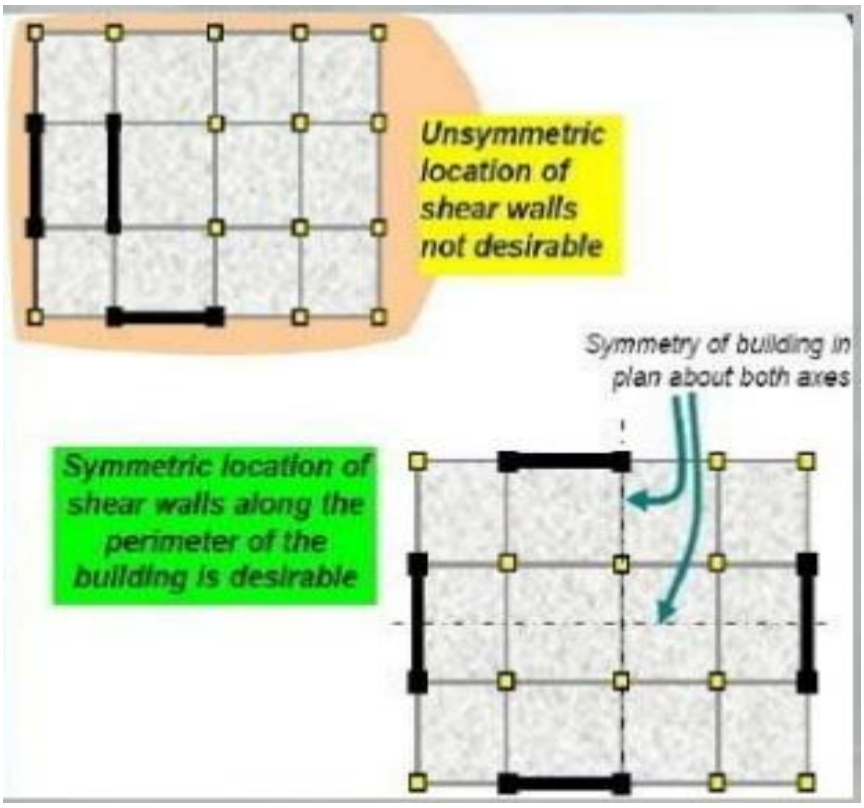


Fig 2.6- Location of shear wall

2.4.5 Deflection and its pattern with shear wall

Horizontal deflections in the planes of shear walls can be computed on the assumption that they act as cantilevers.

For a shear wall (Fig) the deflection in its plane induced by a load in its plane is the sum of the flexural deflection as a cantilever and the deflection due to shear. Thus, for a wall with solid rectangular cross section, the deflection at the top due to uniform load is

$$\delta = \frac{1.5wH}{Et}\left[\left(\frac{H}{L}\right)^3 + \frac{H}{L}\right]$$

where
w=uniform lateral load
H = height of the wall
E = modulus of elasticity of the wall material
t = wall thickness
L = length of wall

For a shear wall with a concentrated load P at the top, the deflection at the top is :

$$\delta_c = \frac{4P}{Et}\left[\left(\frac{H}{L}\right)^3 + 0.75\,\frac{H}{L}\right]$$

If the wall is fixed against rotation at the top, however, the deflection is

$$\delta_f = \frac{P}{Et}\left[\left(\frac{H}{L}\right)^3 + 3\,\frac{H}{L}\right]$$

Pattern →

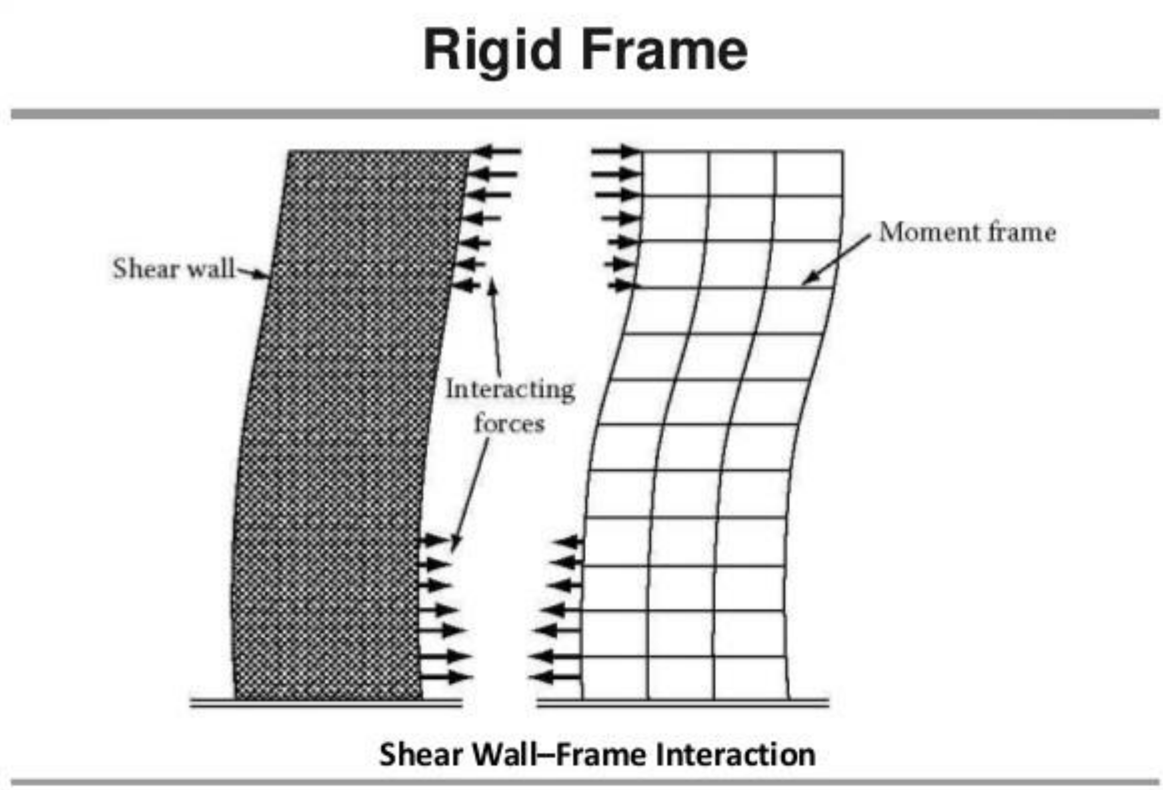


Fig 2.7- Shear wall–frame Interaction

2.5 Tall Building With Shear Wall

Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements (like glass windows and building contents). Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents.

Since shear walls carry large horizontal wind forces, the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear walls should be provided along preferably both length and width. However, if they are provided only along one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong wind actions.

Shear walls in buildings must be symmetrically located in plan to reduce illeffects of twist in buildings. They could be placed symmetrically along one or both directions in plan. Shear walls are more effective when located along exterior perimeter of the building –such a layout increases resistance of the building to twisting

Where shear walls are connected by a rigid diaphragm so that they must deflect equally under horizontal load, the proportion of total horizontal load at any story or level carried by a perpendicular shear wall is based on its relative rigidity or stiffness. The rigidity of a shear wall is inversely proportional to its deflection under unit horizontal load. The total deflection of the shear wall can be determined from the sum of the shear and moment deflections.

2.6 Wind load on high rise building with shear wall

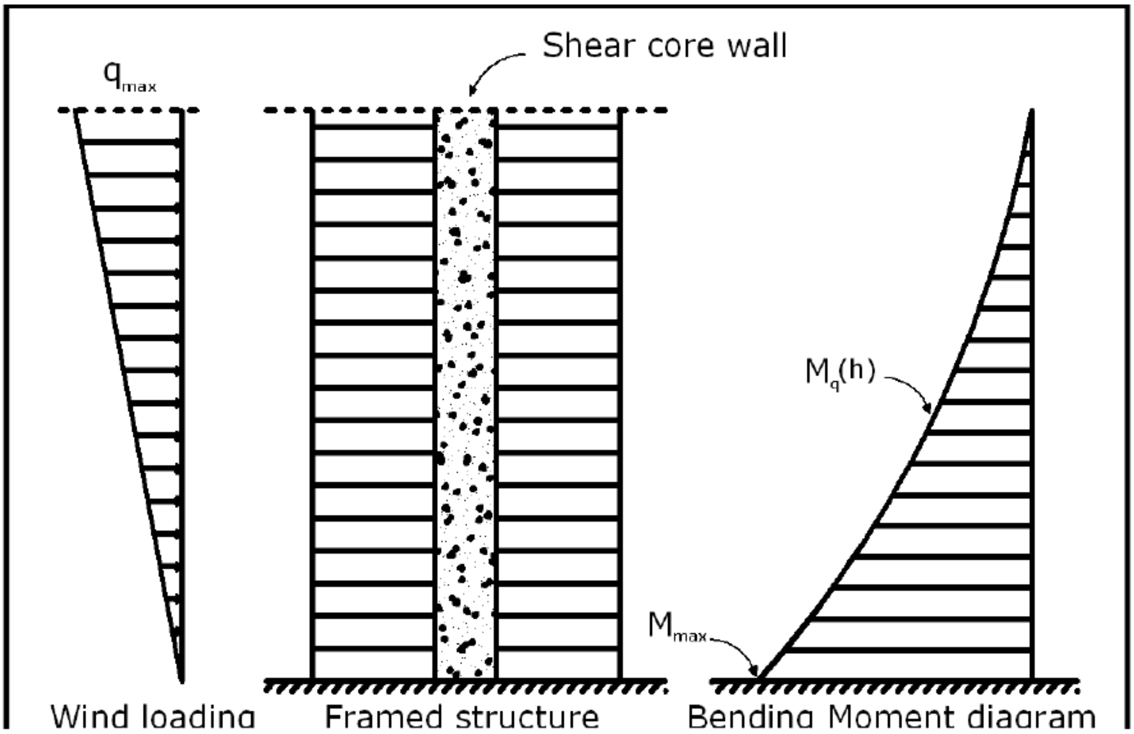


Fig 2.8- Structure with frame and shear core under wind loading (left) and the bending moment diagram of the concrete core (right)

2.7 Codal Provision

In the different countries, different codes are adopted to design shear wall structure system and wind load consideration and its specification. Some important code details are included for the current study, these are as follows:

2.7.1 AS/NZS 1170.2:2011

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee, BD-006, General Design Requirements and Loading on Structures, to supersede AS/NZS 1170.2:2002.
The objective of this Standard is to provide wind actions for use in the design of structures subject to wind action. It provides a detailed procedure for the determination of wind actions on structures, varying from those less sensitive to wind action to those for which dynamic response must be taken into consideration.
The objectives of this revision are to remove ambiguities, to incorporate recent research and experiences from recent severe wind events in Australia and New Zealand.

2.7.2 SEI/ASCE 7-02

This revision of the ASCE Standard Minimum Design Loads for Buildings and Other Structures is a replacement of ASCE 7 -98. This Standard provides requirements for dead, live, soil, flood, wind, snow, rain, ice, and earthquake loads, and their combinations that are suitable for inclusion in building codes and other documents.
Substantial changes were made to the wind, snow, earthquake, and ice provisions. In addition, substantial new material was added regarding the determination of flood loads. The structural loading requirements provided by this Standard are intended for use by architects, structural engineers, and those engaged in preparing and administering local building codes.

2.7.3 EN 1991-1-4:2005+A 1

EN 1991-1-4 gives guidance on the determination of natural wind actions for the structural design of building and civil engineering works for each of the loaded areas under consideration. This includes the whole structure or parts of the structure or elements attached to the structure, e. g. components, cladding units and their fixings, safety and noise barriers.
This part is intended to predict characteristic wind actions on land-based structures, their components and appendages.
Certain aspects necessary to determine wind actions on a structure are dependent on the location and on the availability and quality of meteorological data, the type of terrain, etc. These need to be provided in the National Annex and Annex A, through National choice by notes in the text as indicated.
Default values and methods are given in the main text, where the National Annex does not provide information.

2.7.4 IS 875(Part-3)-1987

This Part (Part 3) deals with wind load to be considered when designing buildings, structures and components thereof. In this revision, many important modifications have been made from those covered in the 1964 version of IS :875
This standard gives wind forces and their effects (static and dynamic) that should he taken into account when designing buildings, structures and components thereof.

2.7.5 IS 456-2000

This standard was first published in 1953 under the title ‘Code of practice for plain and reinforced concrete for general building construction’ and subsequently revised in 1957. The code was further revised in 1964 and published under modified title ‘Code of practice for plain and reinforced concrete’, thus enlarging the scope of use of this code to structures other than general building construction also. The third revision was published in 1978, and it included limit state approach to design. This is the fourth revision of the standard. This revision was taken up with a view to keeping abreast with the rapid development in the field of concrete technology and to bring in further modifications/improvements in the light of experience gained while using the earlier version of the standard.

2.7.6 IS 1893(Part-1)-2002

Part 1 contains provisions that are general in nature and applicable to all structures. Also, it contains provisions that are specific to buildings only. Unless stated otherwise, the provisions in Parts 2 to 5 shall be read necessarily in conjunction with the general provisions in Part 1.

2.7.7 IS 13920-1993

Whilst the common methods of design and construction have been covered in this code, special systems of design and construction of any plain or reinforced concrete structure not covered by this code may be permitted on production of satisfactory evidence regarding their adequacy for seismic performance by analysis or tests or both.

CHAPTER 3

METHODOLOGY

3.1 Aim of the work

Analysis is being done by STAD-PRO by providing adequate material properties and dimension as per the required building standard.

The aim of the project is to briefly know about the shear wall concepts and structural concepts through computer aid STAAD-PRO software and the previous study and theory. Briefly I have gone through following points through out of the project work-

- Understanding of design and detailing concept.
- Main objective i.e. using STAAD-Pro software for the analysis of wind load and shear wall.
- Learning of analysis and design methodology which can be very useful in the field.
- Understanding of wind load design concept on the building.
- Approach for professional practice in the field of structural engineering.

3.2 Methodology Of The Work

- The whole analysis is done by the STAAD-PRO.V8i software, in which pressure intensity at different height of the building is predefined for the American code ASCE-07, but not for any other code. This analysis is done on the basis of Indian standard code IS-875(part-3) for which the intensity values were calculated through the codal provisions as:

Clause 5.3

5.3 Design Wind Speed (V_z) — The basic wind speed (V_b) for any site shall be obtained from Fig. 1 and shall be modified to include the following effects to get design wind velocity at any height (V_z) for the chosen structure:

a) Risk level;

b) Terrain roughness, height and size of structure; and

c) Local topography.

It can be mathematically expressed as follows:

$$V_z = V_b\, k_1\, k_2\, k_3$$

where

V_z = design wind speed at any height z in m/s;

k_1 = probability factor (risk coefficient) (*see* **5.3.1**);

k_2 = terrain, height and structure size factor (*see* **5.3.2**); and

k_3 = topography factor (*see* **5.3.3**).

clause 5.3.1

5.3.1 *Risk Coefficient* (*k_1 Factor*) — Figure 1 gives basic wind speeds for terrain Category 2 as applicable at 10 m above ground level based on 50 years mean return period. The suggested life period to be assumed in design and the corresponding k_1 factors for different class of structures for the purpose of design is given in Table 1. In the design of all buildings and structures, a regional basic wind speed having a mean return period of 50 years shall be used except as specified in the note of Table 1.

TABLE-3.1 K_1 Factor Value

TABLE 1 RISK COEFFICIENTS FOR DIFFERENT CLASSES OF STRUCTURES IN DIFFERENT WIND SPEED ZONES

(*Clause* 5.3.1)

Class of Structure	Mean Probable Design Life of Structure in Years	k_1 Factor for Basic Wind Speed (m/s) of 33	39	44	47	50	55
All general buildings and structures	50	1·0	1·0	1·0	1·0	1·0	1·0
Temporary sheds, structures such as those used during construction operations (for example, formwork and falsework), structures during construction stages and boundary walls	5	0·82	0·76	0·73	0·71	0·70	0·67
Buildings and structures presenting a low degree of hazard to life and property in the event of failure, such as isolated towers in wooded areas, farm buildings other than residential buildings	25	0·94	0·92	0·91	0·90	0·90	0·89
Important buildings and structures such as hospitals communication buildings / towers, power plant structures	100	1·05	1·06	1·07	1·07	1·08	1·08

Clause 5.3.2

From IS-875(part-3),

TABLE- 3.2 K_2 Factor Value

TABLE 2 k_2 FACTORS TO OBTAIN DESIGN WIND SPEED VARIATION WITH HEIGHT IN DIFFERENT TERRAINS FOR DIFFERENT CLASSES OF BUILDINGS/STRUCTURES

(*Clause* 5.3.2.2)

HEIGHT	TERRAIN CATEGORY 1 CLASS			TERRAIN CATEGORY 2 CLASS			TERRAIN CATEGORY 3 CLASS			TERRAIN CATEGORY 4 CLASS		
m	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
10	1·05	1·03	0·99	1·00	0·98	0·93	0·91	0·88	0·82	0·80	0·76	0·67
15	1·09	1·07	1·03	1·05	1·02	0·97	0·97	0·94	0·87	0·80	0·76	0·67
20	1·12	1·10	1·06	1·07	1·05	1·00	1·01	0·98	0·91	0·80	0·76	0·67
30	1·15	1·13	1·09	1·12	1·10	1·04	1·06	1·03	0·96	0·97	0·93	0·83
50	1·20	1·18	1·14	1·17	1·15	1·10	1·12	1·09	1·02	1·10	1·05	0·95
100	1·26	1·24	1·20	1·24	1·22	1·17	1·20	1·17	1·10	1·20	1·15	1·05
150	1·30	1·28	1·24	1·28	1·25	1·21	1·24	1·21	1·15	1·24	1·20	1·10
200	1·32	1·30	1·26	1·30	1·28	1·24	1·27	1·24	1·18	1·27	1·22	1·13
250	1·34	1·32	1·28	1·32	1·31	1·26	1·29	1·26	1·20	1·28	1·24	1·16
300	1·35	1·34	1·30	1·34	1 32	1·28	1·31	1·28	1·22	1·30	1·26	1·17
350	1·37	1·35	1·31	1·36	1·34	1·29	1·32	1·30	1·24	1·31	1·27	1·19
400	1·38	1·36	1·32	1·37	1·35	1·30	1·34	1·31	1·25	1·32	1·28	1·20
450	1·39	1·37	1·33	1·38	1·36	1·31	1·35	1·32	1·26	1·33	1·29	1·21
500	1·40	1·38	1·34	1·39	1·37	1·32	1·36	1·33	1·28	1·34	1·30	1·22

NOTE 1 — *See* **5.3.2.2** for definitions of Class A, Class B and Class C structures.

NOTE 2 — Intermediate values may be obtained by linear interpolation, if desired. It is permissible to assume constant wind speed between 2 heights for simplicity.

Clause 5.3.3

5.3.3 *Topography* (k_3 *Factor*) — The basic wind speed V_b given in Fig. 1 takes account of the general level of site above sea level. This does not allow for local topographic features such as hills, valleys, cliffs, escarpments, or ridges which can significantly affect wind speed in their vicinity. The effect of topography is to accelerate wind near the summits of hills or crests of cliffs, escarpments or ridges and decelerate the wind in valleys or near the foot of cliffs, steep escarpments, or ridges.

Clause 5.3.3.1

5.3.3.1 The effect of topography will be significant at a site when the upwind slope (θ) is greater than about 3°, and below that, the value of k_3 may be taken to be equal to 1·0. The value of k_3 is confined in the range of 1·0 to 1·36 for slopes greater than 3°. A method of evaluating the value of k_3 for values greater than 1·0 is given in Appendix C. It may be noted that the value of k_3 varies with height above ground level, at a maximum near the ground, and reducing to 1·0 at higher levels.

Clause 5.4

5.4 Design Wind Pressure — The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity:

$$p_z = 0.6\, V_z^2$$

Where, p_z = wind pressure in N/m^2
V_z= design wind speed in m/s

3.3 Building Details

- In this work following building details are to be considered:

  No. of stories=40

  Length=24m, each bay @4m

  Height=120m, each bay @3m

  Width=24m, each bay @4m

  Live Load; Area load= 2.5Kn/m^2

  Location – Delhi

  Wind zone –IV

  wind speed =47m/s

  Wind Load; as per the IS-875(Part-3)

  Concrete grade M30

  Steel grade Fe415

- Risk coefficient ,k_1=1.07(considered to be an important building with design life = 100 years)
- Terrain Coefficient, k_2= as per the table-2 [Building is to be considered in terrain type-3{surrounding structures are the height of between 10m to 25m} and class-B {glazing or roofing type of structural components having its maximum dimension(horizontal or vertical) between 20 to 50m]
- Topography Factor, k_3=1.0(upwind slope is assumed to be less than 3°)
- For the given structures ,wind pressure is calculated separately(manually) and these values were added in the analysis by staad-pro by providing 80%exposure to the wind.

- To see the effect of wind , a separate envelope of wind load in +X direction was added in the modeling.

- Concrete design as per the IS-800 ,was added in modeling to perform concrete design.

- A comparative analysis is also done after obtaining all results of both buildings ie; with shear wall and without shear wall.

CHAPTER-4

MODELLING AND ANALYSIS

4.1 Pressure Intensity Value Calculation

From the previous chapter of methodology from the IS-875(part-3) , the intensity values were calculated for the analysis by STAAD-PRO.

TABLE- 4.1 Intensity vs Height Table

HEIGHT	k1	k2	k3	Vb(m/s)	k1*k2*k3	Vz=k1*k2*k3*Vb(m/s)	Pz=0.6*Vz^2(N/m^2)
3	1.07	0.84	1	47	0.8988	42.2436	1070.713045
6	1.07	0.85	1	47	0.9095	42.7465	1096.357957
9	1.07	0.87	1	47	0.9309	43.7523	1148.558253
12	1.07	0.9	1	47	0.963	45.261	1229.134873
15	1.07	0.94	1	47	1.0058	47.2726	1340.819226
18	1.07	0.96	1	47	1.0272	48.2784	1398.482344
21	1.07	0.99	1	47	1.0593	49.7871	1487.253196
24	1.07	1.01	1	47	1.0807	50.7929	1547.951214
27	1.07	1.02	1	47	1.0914	51.2958	1578.755459
30	1.07	1.03	1	47	1.1021	51.7987	1609.863193
33	1.07	1.04	1	47	1.1128	52.3016	1641.274418
36	1.07	1.05	1	47	1.1235	52.8045	1672.989132
39	1.07	1.06	1	47	1.1342	53.3074	1705.007337
42	1.07	1.07	1	47	1.1449	53.8103	1737.329032
45	1.07	1.07	1	47	1.1449	53.8103	1737.329032
48	1.07	1.08	1	47	1.1556	54.3132	1769.954217
51	1.07	1.09	1	47	1.1663	54.8161	1802.882892
54	1.07	1.09	1	47	1.1663	54.8161	1802.882892
57	1.07	1.1	1	47	1.177	55.319	1836.115057
60	1.07	1.1	1	47	1.177	55.319	1836.115057
63	1.07	1.11	1	47	1.1877	55.8219	1869.650712
66	1.07	1.12	1	47	1.1984	56.3248	1903.489857
69	1.07	1.12	1	47	1.1984	56.3248	1903.489857
72	1.07	1.13	1	47	1.2091	56.8277	1937.632492
75	1.07	1.14	1	47	1.2198	57.3306	1972.078618
78	1.07	1.14	1	47	1.2198	57.3306	1972.078618
81	1.07	1.14	1	47	1.2198	57.3306	1972.078618
84	1.07	1.15	1	47	1.2305	57.8335	2006.828233
87	1.07	1.15	1	47	1.2305	57.8335	2006.828233
90	1.07	1.16	1	47	1.2412	58.3364	2041.881339
93	1.07	1.16	1	47	1.2412	58.3364	2041.881339
96	1.07	1.17	1	47	1.2519	58.8393	2077.237935
99	1.07	1.17	1	47	1.2519	58.8393	2077.237935
102	1.07	1.17	1	47	1.2519	58.8393	2077.237935
105	1.07	1.18	1	47	1.2626	59.3422	2112.898021
108	1.07	1.18	1	47	1.2626	59.3422	2112.898021
111	1.07	1.18	1	47	1.2626	59.3422	2112.898021
114	1.07	1.19	1	47	1.2733	59.8451	2148.861596
117	1.07	1.19	1	47	1.2733	59.8451	2148.861596
120	1.07	1.19	1	47	1.2733	59.8451	2148.861596

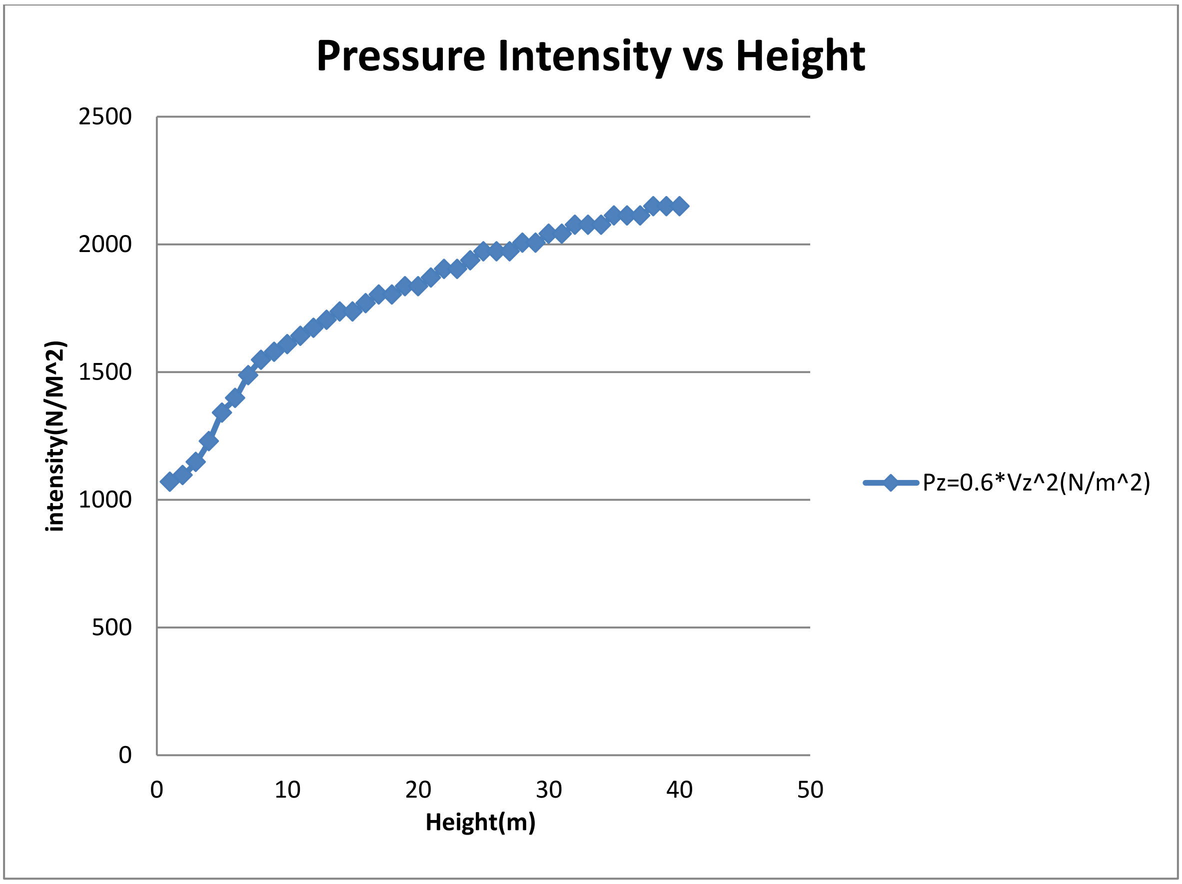


Fig4.1: Graph of Intensity vs Height of Building

- In staad-pro software ,indian standard code is not provided so the intensity values were calculated as per the specifications given in IS-875(Part-3).
- In the design , exposure factor is to be taken as 0.8(considering 80% face of building is exposed to wind).

4.2 ANALYSIS OF HIGH RISE BUILDING WITHOUT SHEAR WALL

4.2.1 Modeling Using Staad-Pro

In modeling following points were added:

- Preparation of the model by considering the given dimension.
- Defined property of section and thickness of the surface plate.
- Given the loading details of live load, dead load and wind load.
- Defined wind definition in load definitions as per IS-875(part-3).
- For design of concrete, IS-456 is adopted, in this f_c=30000Kn/m^2 and f_y=415000Kn/m^2 is given for the concrete and steel respectively.

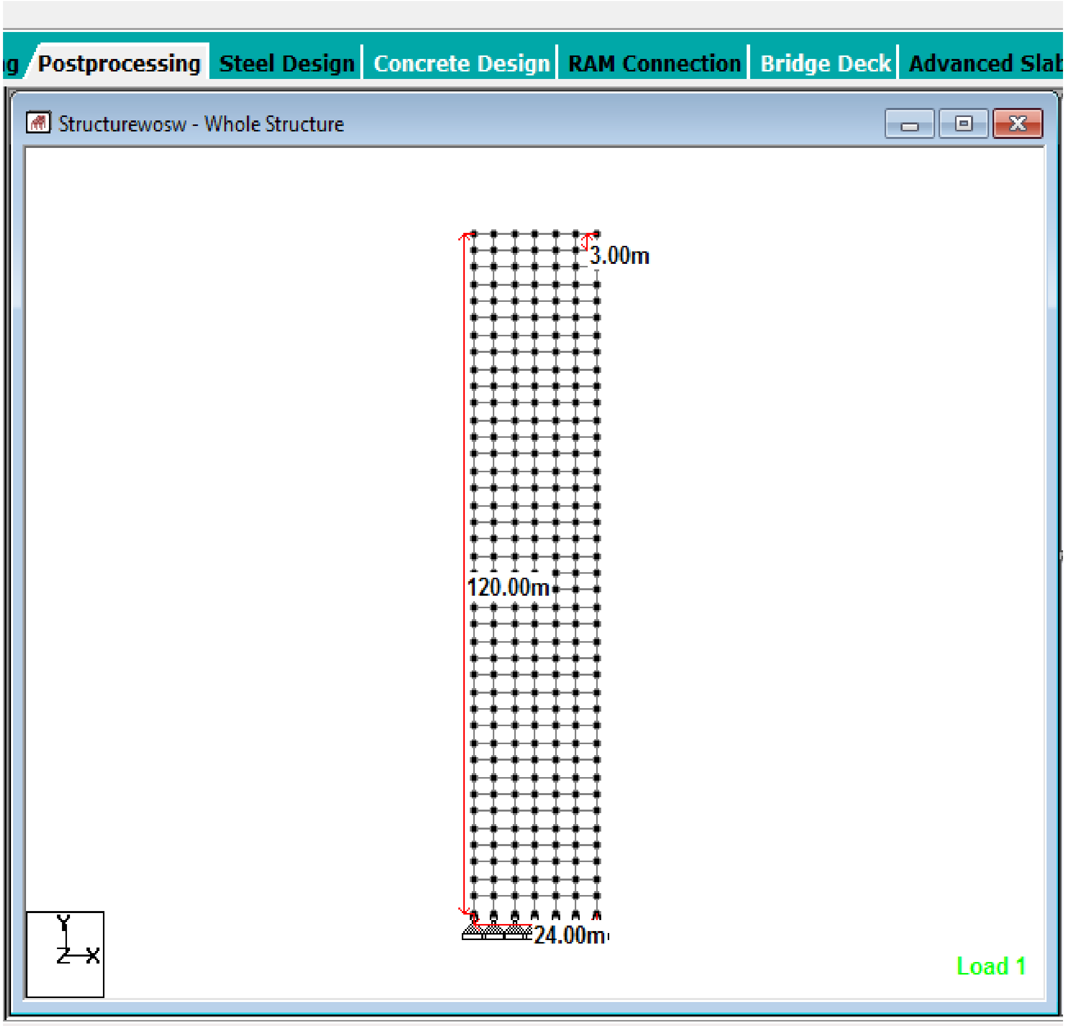


Fig4.2 : Front view of the building

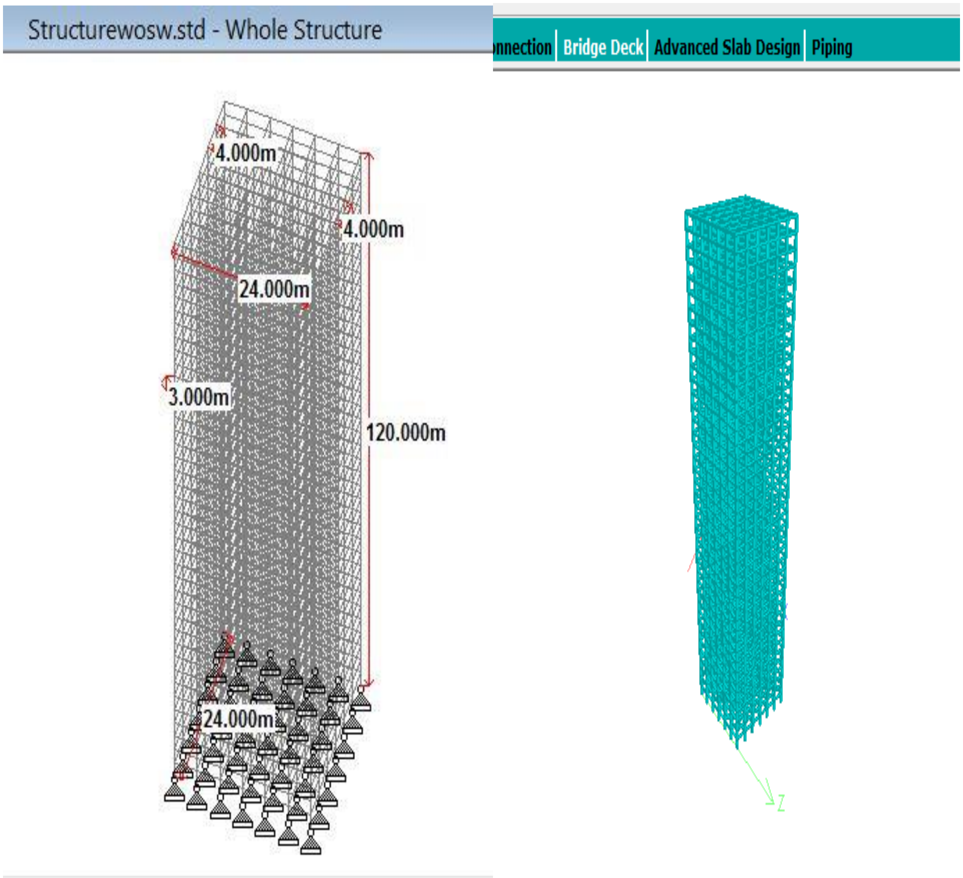


Fig4.3 : 3D Model of building without shear wall

4.2.3 Analysis

After completing the modeling , to analyze the building following points were added in staad-pro analysis-

- Added joint displacement to the analysis.
- Added member forces to analyse results.
- Added support reactions.
- Before running the analysis; print joint displacement, print member forces, print support reactions all were assigned to view.

4.2.4 Results From The Analysis

Following results were obtained from the analysis.

4.2.4.1 Beam Design Results

In the given structure there were 5320 beams to be designed , here I am showing one beam design result from the STAAD-PRO OUTPUT file.

DESIGN RESULTS OF BEAM (2)

CONCRETE GRADE- M30
STEEL GRADE- Fe415 (Main and secondary)
LENGTH OF THE BEAM: 4m
SIZE OF THE BEAM: 0.4m X 0.5m
COVER PROVIDED: 25.0 mm

SUMMARY OF REINFORCEMENT AREA (mm^2)

SECTION	0m	1m	2m	3m	4m
TOP REINFORCEMENT	1324.81 (mm^2)	610.32 (mm^2)	385.06 (mm^2)	611.61 (mm^2)	1326.82 (mm^2)
BOTTOM REINFORCEMENT	1325.93 (mm^2)	385.06 (mm^2)	385.06 (mm^2)	611.28 (mm^2)	1325.93 (mm^2)

SUMMARY OF PROVIDED REINFORCEMENT AREA

SECTION	0m	1m	2m	3m	4m
TOP REINFORCEMENT	17-10í 2 layers	8-10í 1 layer	5-10í 1 layer	8-10í 1 layer	17-10í 2 layers
BOTTOM REINFORCEMENT	17-10í 2 layers	5-10í 1 layer	5-10í 1 layer	8-10í 1 layer	17-10í 2 layers
SHEAR REINFORCEMENT(@C/C)	2legged8í 200 mm	2legged8í 200 mm	2legged8í 200 mm	2legged8í 200 mm	2legged8í 200 mm

SHEAR DESIGN RESULTS AT EFFECTIVE DEPTH ,DISTANCE d FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 809.7 mm AWAY FROM START SUPPORT
V_Y = -98.98 M_X = -0.00 LD=3
Provide 2Legged8í at the spacing 200 mm center to center.

SHEAR DESIGN RESULTS AT 809.7 mm AWAY FROM END SUPPORT
VY = -98.98 MX = -0.00 LD=3
Provide 2Legged8í at the spacing 200 mm center to center

4.2.4.2 Column Design Results

One column design is being shown here out of all from STAAD-PRO OUTPUT file.

DESIGN RESULTS OF COLUMN NO.241

- CONCRETE GRADE- M30
- STEEL GRADE- Fe415 (Main and secondary)
- LENGTH OF THE COLUMN: 4m
- C/S OF THE COLUMN: 0.4m X 0.5m
- COVER PROVIDED: 25.0 mm

- GUIDING LOAD CASE:5
- END JOINT: 8
- THE COLUMN IS A TENSION COLUMN.

REQUIRED STEEL AREA : 6822.06 mm^2
REQUIRED CONCRETE AREA : 343177.94 mm^2.

MAIN REINFORCEMENT : Provide 36 - 16 dia. (2.07%, 7238.23 mm^2.)
(distributed uniformly and equally)
TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties at the 255 mm center to center.

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
P_{uz} = 6756.27 M_{uz} 1 =357.21 M_{uy} 1= 243.79

INTERACTION RATIO = 0.93 (as per Clause 39.6, IS-456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
WORST LOAD CASE: 5
END JOINT: 8 P_{uz}= 6880.18 M_{uz}= 404.62 M_{uy}= 275.86 IR=0.83

4.2.4.3 Quantity Of Concrete

The quantity of concrete used in the structure is being shown here as calculated by the analysis by STAAD-PRO. These are from STAAD-PRO OUTPUT file.

CONCRETE TAKE OFF : (FOR BEAMS AND COLUMNS DESIGNED ABOVE)
NOTE:

- Concrete quantity represents the volume of concrete used in design of beams, columns and other components.
- Reinforcing steel quantity represents the reinforcing steel required in design of beams and columns but reinforcement in plates are not included here.

TOTAL QUANTITY(VOLUME) OF CONCRETE USED IN STRUCTURE = 4745.9 M^3

BAR DIA (in mm)	WEIGHT (in New)
8	653125
10	603074
12	1570773
16	158154
20	189321
25	46932
TOTAL =	3221378

4.2.4.4 Reaction Load, Deflection, Slope Results By The Wind Load In Direction +X

As calculated by STAAD-PRO analysis and results are in STAAD-PRO OUTPUT.

CENTER OF THE FORCE BASED ON X FORCES ONLY (METERIAL).

→Non-Global directions forces will not validate the results.

X = 0.000000000E+00
Y = 0.650918136E+02
Z = 0.119999999E+02

SUMMARY (LOADING 3) OF TOTAL APPLIED LOAD
TOTAL FORCE IN -X = 4179.73KN
TOTAL FORCE IN -Y = 0.00
TOTAL FORCE IN -Z = 0.00

SUMMATION OF THE MOMENTS ACTING AROUND THE ORIGIN
M_X= 0.00 M_Y= 50156.81KN.M M_Z= -272066.47KN.M

SUMMARY (LOADING 3) OF TOTAL REACTION LOAD
TOTAL FORCE IN -X = -4179.73
TOTAL FORCE IN -Y = -0.00
TOTAL FORCE IN -Z = 0.00

SUMMATION OF THE MOMENTS ACTING AROUND THE ORIGIN
M_X= 0.00 M_Y= -50156.81 KN.M M_Z= 272066.47KN.M

MAXIMUM DISPLACEMENTS (CM /RADIANS) FOR LOAD CASE 3

MAXIMUMS (VALUE)	AT NODE
X = 1.42211E+01	1142
Y = -5.97659E-01	1967
Z = -4.42144E-04	1961

RX= -5.98014E-07 1723
RY= -2.97674E-05 1674
RZ= -2.91148E-03 865

4.2.4.5 Results (STAAD-PRO)

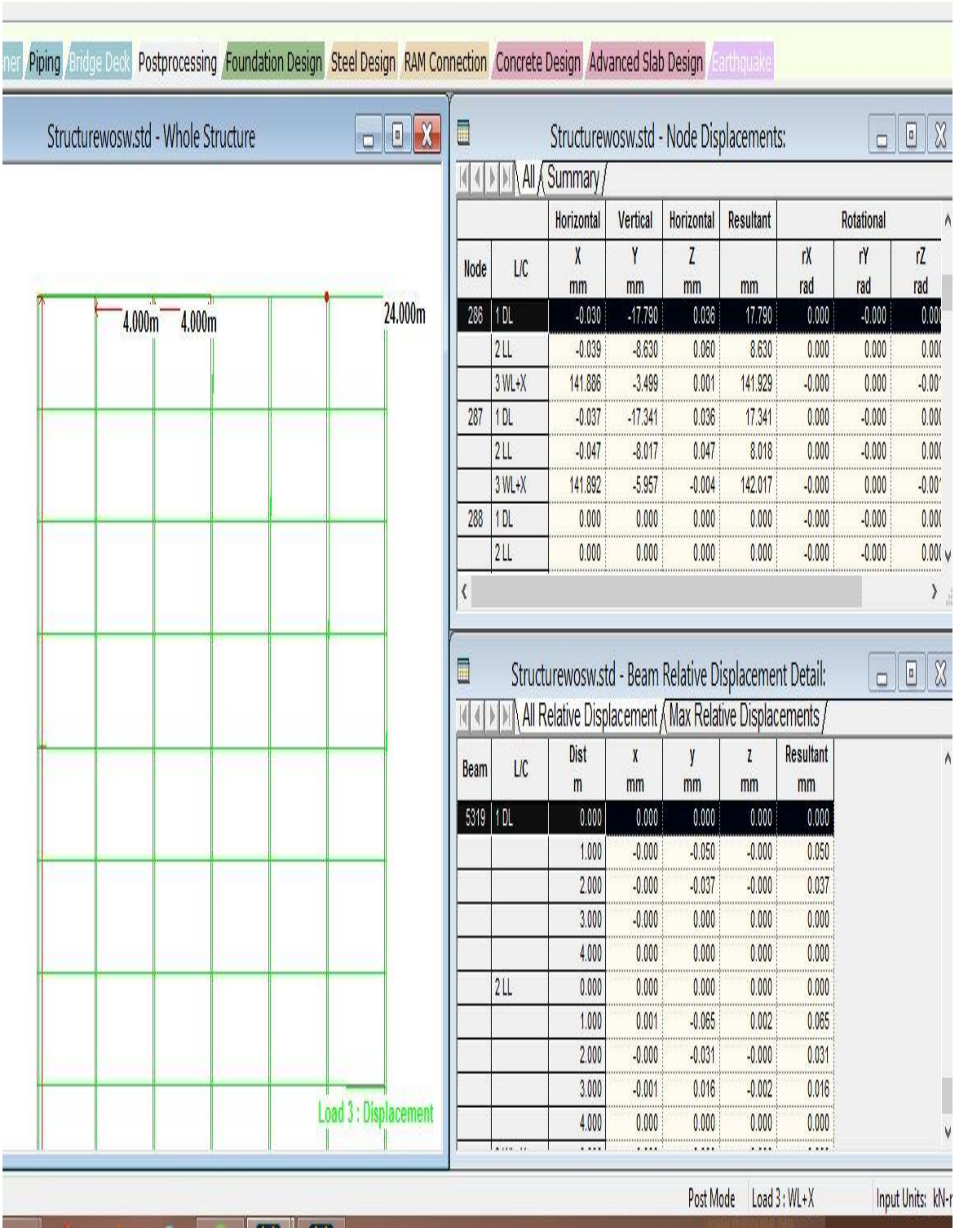
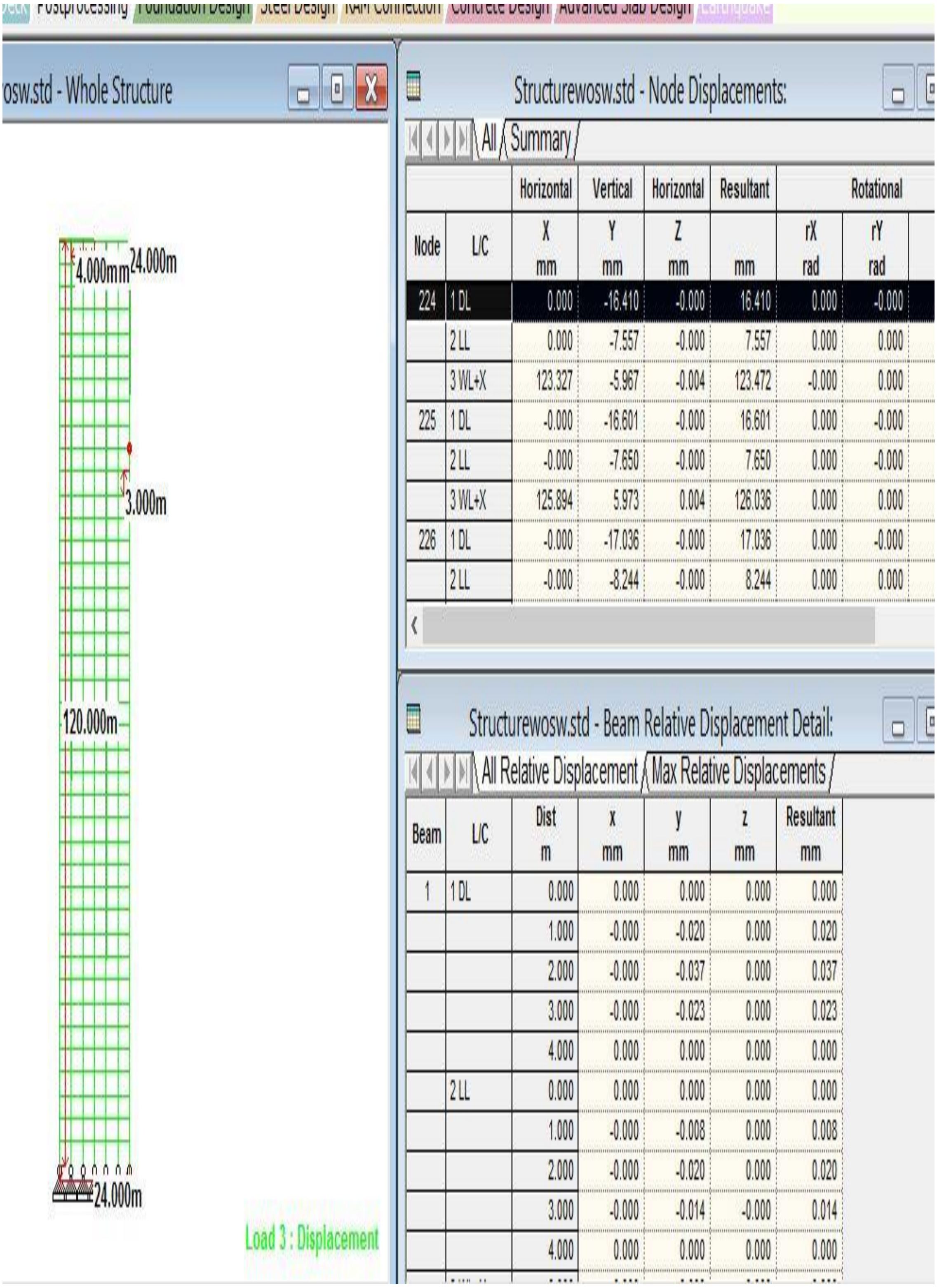


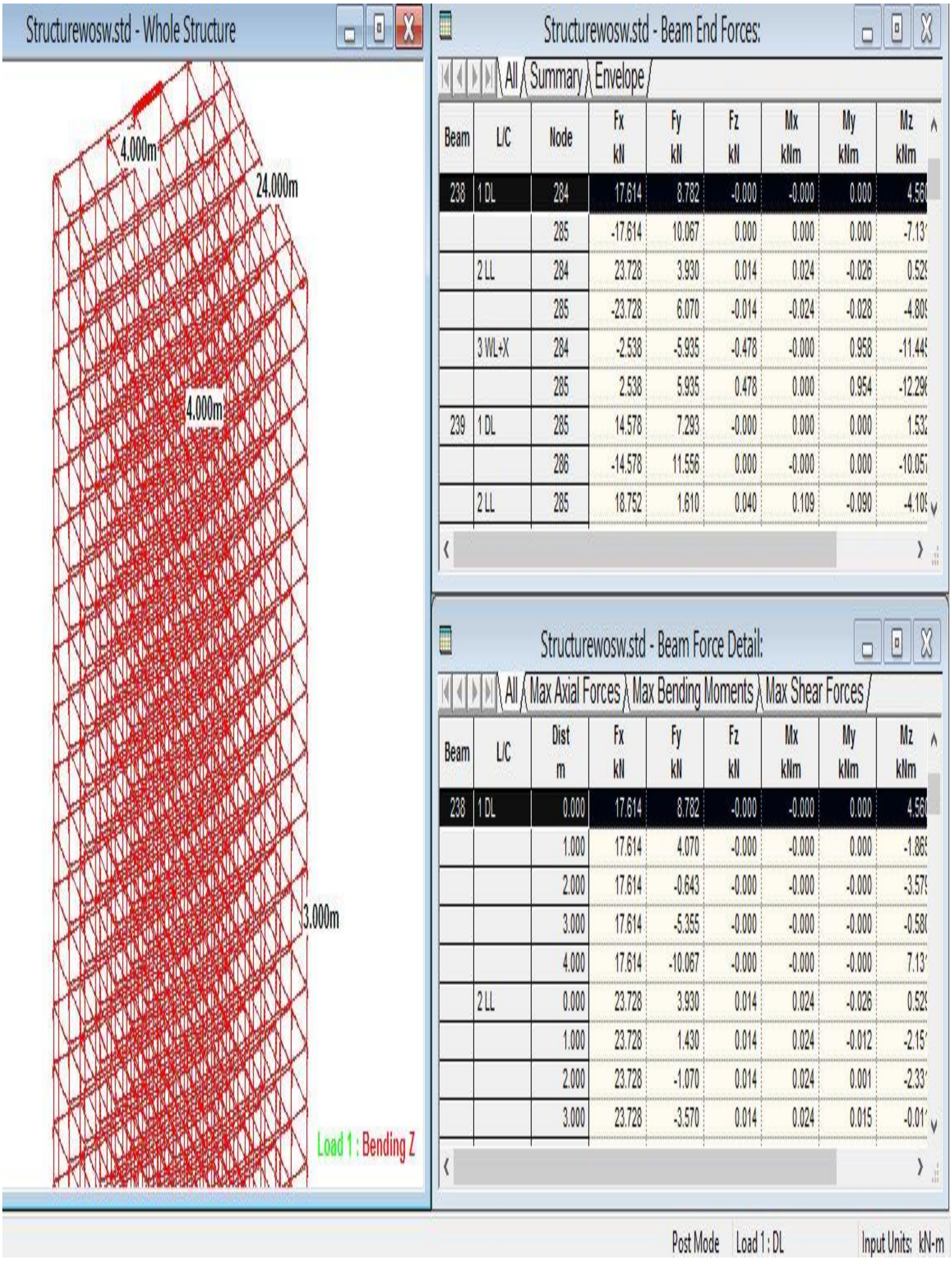
Fig4.4: Deflected shape



		Horizontal	Vertical	Horizontal	Resultant	Rotational	
Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad
224	1 DL	0.000	-16.410	-0.000	16.410	0.000	-0.000
	2 LL	0.000	-7.557	-0.000	7.557	0.000	0.000
	3 WL+X	123.327	-5.967	-0.004	123.472	-0.000	0.000
225	1 DL	-0.000	-16.601	-0.000	16.601	0.000	-0.000
	2 LL	-0.000	-7.650	-0.000	7.650	0.000	-0.000
	3 WL+X	125.894	5.973	0.004	126.036	0.000	0.000
226	1 DL	-0.000	-17.036	-0.000	17.036	0.000	-0.000
	2 LL	-0.000	-8.244	-0.000	8.244	0.000	0.000

Beam	L/C	Dist m	x mm	y mm	z mm	Resultant mm
1	1 DL	0.000	0.000	0.000	0.000	0.000
		1.000	-0.000	-0.020	0.000	0.020
		2.000	-0.000	-0.037	0.000	0.037
		3.000	-0.000	-0.023	0.000	0.023
		4.000	0.000	0.000	0.000	0.000
	2 LL	0.000	0.000	0.000	0.000	0.000
		1.000	-0.000	-0.008	0.000	0.008
		2.000	-0.000	-0.020	0.000	0.020
		3.000	-0.000	-0.014	-0.000	0.014
		4.000	0.000	0.000	0.000	0.000

Fig4.5: Deflection Result of a node(224) in envelope1(DL+LL+WL)



Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
238	1 DL	284	17.614	8.782	-0.000	-0.000	0.000	4.56
		285	-17.614	10.067	0.000	0.000	0.000	-7.13
	2 LL	284	23.728	3.930	0.014	0.024	-0.026	0.52
		285	-23.728	6.070	-0.014	-0.024	-0.028	-4.80
	3 WL+X	284	-2.538	-5.935	-0.478	-0.000	0.958	-11.44
		285	2.538	5.935	0.478	0.000	0.954	-12.29
239	1 DL	285	14.578	7.293	-0.000	0.000	0.000	1.53
		286	-14.578	11.556	0.000	-0.000	0.000	-10.05
	2 LL	285	18.752	1.610	0.040	0.109	-0.090	-4.10

Beam	L/C	Dist m	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
238	1 DL	0.000	17.614	8.782	-0.000	-0.000	0.000	4.56
		1.000	17.614	4.070	-0.000	-0.000	0.000	-1.86
		2.000	17.614	-0.643	-0.000	-0.000	-0.000	-3.57
		3.000	17.614	-5.355	-0.000	-0.000	-0.000	-0.58
		4.000	17.614	-10.067	-0.000	-0.000	-0.000	7.13
	2 LL	0.000	23.728	3.930	0.014	0.024	-0.026	0.52
		1.000	23.728	1.430	0.014	0.024	-0.012	-2.15
		2.000	23.728	-1.070	0.014	0.024	0.001	-2.33
		3.000	23.728	-3.570	0.014	0.024	0.015	-0.01

Fig4.6 : Moment Diagram of the building

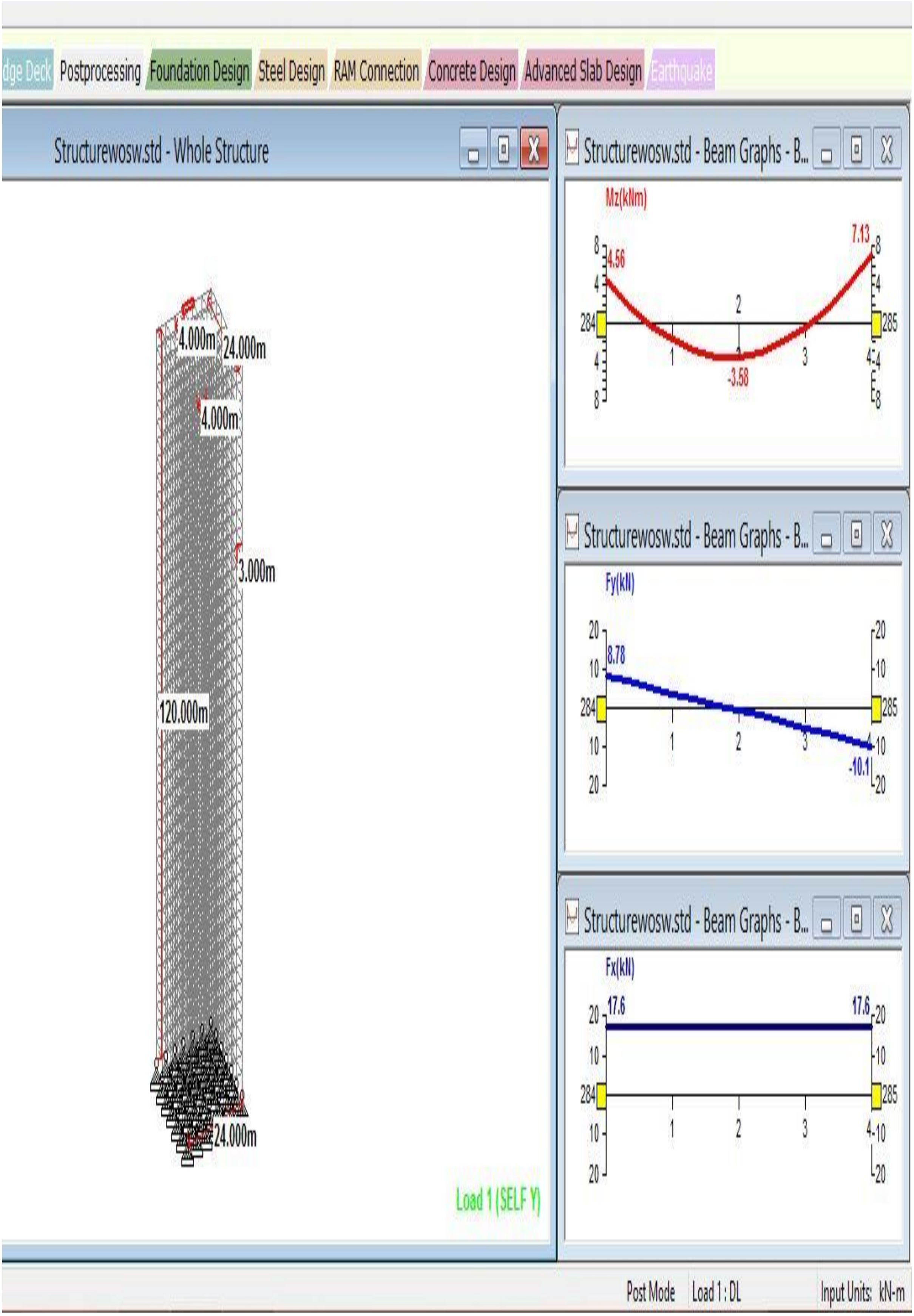


Fig4.7 : Beam Results Graph (Beam No. 238)

4.2.4.6 Report File By Stad Pro

Software licensed to	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref		
	By	Date 12-Jun-17	Chd
Client	File Structurewosw.std	Date/Time 12-jun-2017 14:02	

Job Information

	Engineer	Checked	Approved
Name:			
Date:	12-Jun-2017		

Structure Type	SPACE FRAME

Number of Nodes	2009	Highest Node	2009
Number of Elements	5320	Highest Beam	5320

Number of Basic Load Cases	6
Number of Combination Load Cases	0

Primary Load Cases

Number	Name	Type
1	DL	Dead
2	LL	Live
3	WL+X	Wind
4	WL-X	Wind
5	WL+Z	Wind
6	WL-Z	Wind

Combination Load Cases

There is no data of this type.

Wind Load Definition : Type 1

Intensity (N/mm²)	Height (m)
0.001	3.000
0.001	12.000
0.001	21.000
0.002	30.000
0.002	39.000
0.002	48.000
0.002	57.000
0.002	66.000
0.002	75.000
0.002	84.000
0.002	93.000
0.002	102.000
0.002	111.000
0.002	120.000

Exposure Factor	Range	Nodes / Height Range (m)
0.800	Nodes	1 - 2009

1 DL : Selfweight

Direction	Factor	Assigned Geometry
Y	-1.000	ALL

2 LL : Area Loads

Load (N/mm²)	Beams
-0.003	1 - 5320

4 WL-X : Wind Loading

Direction	Type	Factor
X	1	-1.000

5 WL+Z : Wind Loading

Direction	Type	Factor
Z	1	1.000

6 WL-Z : Wind Loading

Direction	Type	Factor
Z	1	-1.000

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	DL
Primary	2	LL
Primary	3	WL+X
Primary	4	WL-X
Primary	5	WL+Z
Primary	6	WL-Z

Supports

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN'm/deg)	rY (kN'm/deg)	rZ (kN'm/deg)
1	Fixed	Fixed	Fixed	-	-	-
2	Fixed	Fixed	Fixed	-	-	-
3	Fixed	Fixed	Fixed	-	-	-
4	Fixed	Fixed	Fixed	-	-	-
5	Fixed	Fixed	Fixed	-	-	-
6	Fixed	Fixed	Fixed	-	-	-
7	Fixed	Fixed	Fixed	-	-	-
288	Fixed	Fixed	Fixed	-	-	-
289	Fixed	Fixed	Fixed	-	-	-
290	Fixed	Fixed	Fixed	-	-	-
291	Fixed	Fixed	Fixed	-	-	-
292	Fixed	Fixed	Fixed	-	-	-
293	Fixed	Fixed	Fixed	-	-	-
294	Fixed	Fixed	Fixed	-	-	-
575	Fixed	Fixed	Fixed	-	-	-
576	Fixed	Fixed	Fixed	-	-	-

4.2.5 Analysis Of High Rise Building With Shear Wall

4.2.5.1 Modeling Using Staad-Pro

In modeling following points were added:

- Preparation of the model by considering the given dimension.
- Added surfaces on all 4 side as shear wall.
- Defined property of section and thickness of the surface plate.
- Given the loading details of live load, dead load and wind load.
- Defined wind definition in load definitions as per IS-875(part-3).
- For design of concrete, IS-456 is adopted, in this f_c=30000Kn/m^2 and f_y=415000Kn/m^2 is given for the concrete and steel respectively.
- For design of shear wall, IS-456 is adopted, in this also f_c=30000Kn/m^2 and f_y=415000Kn/m^2 is given for the concrete and steel respectively.

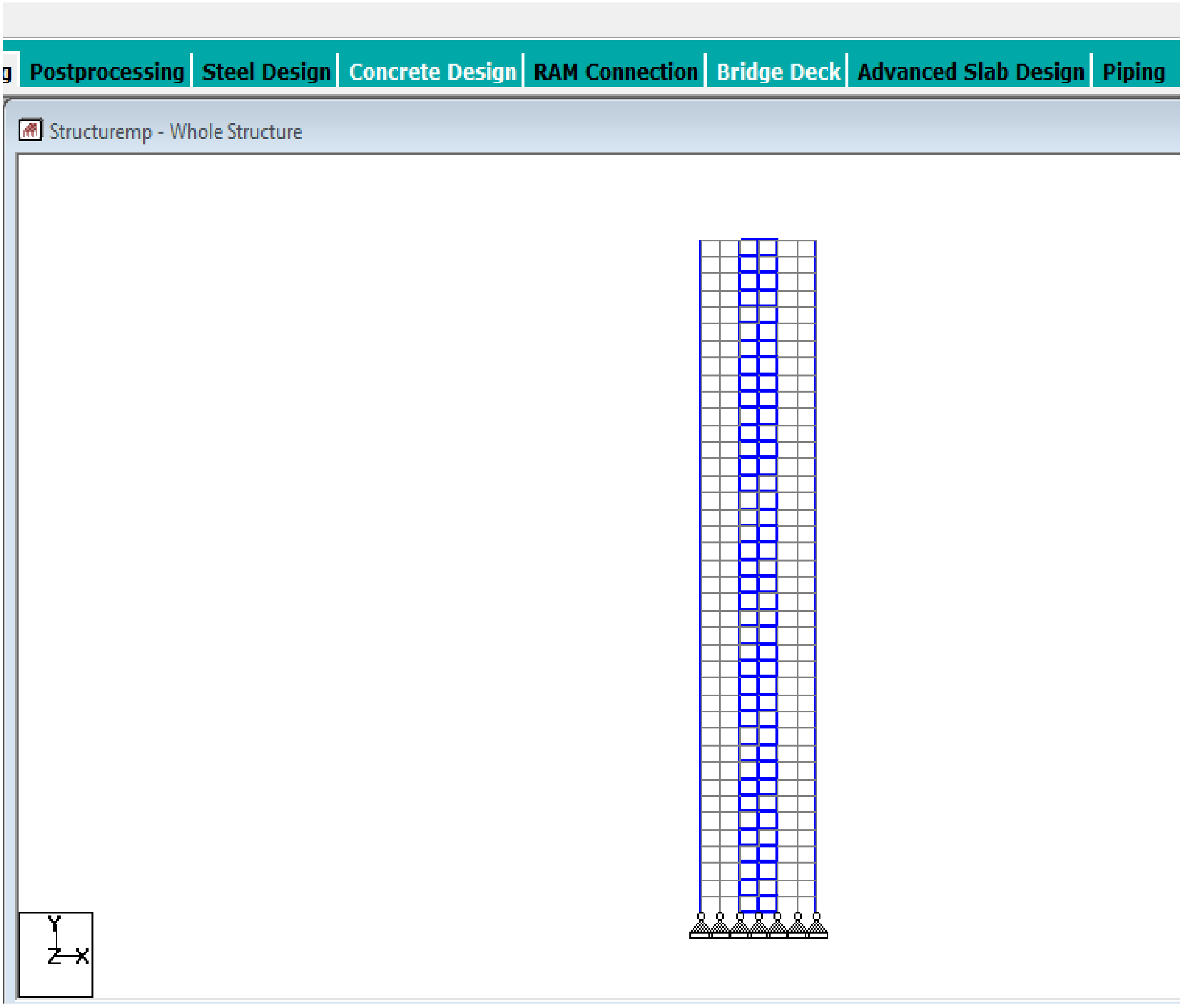


Fig4.8 : Front View Of The Building With Shear Wall

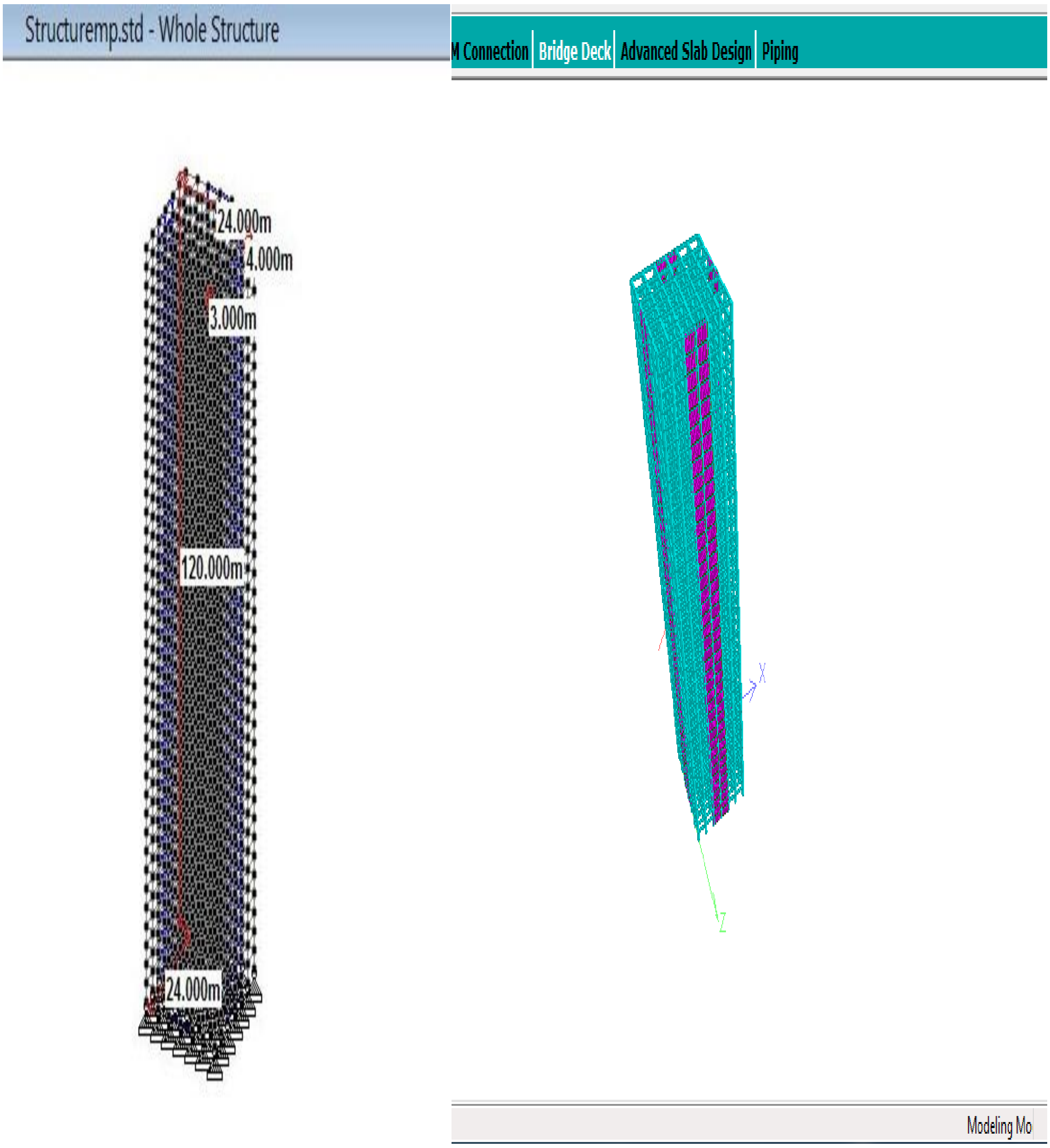


Fig4.9 : 3D view of building

4.2.5.2 Analysis

After completing the modeling , to analyze the building following points were added in staad-pro analysis-

- Added joint displacement to the analysis.
- Added member forces to analyse results.
- Added support reactions.

Before running the analysis; print joint displacement, print member forces, print support reactions all were assigned to view.

4.2.5.3 Results

SUMMARY FOR LOAD CASE NO.3 FOR STATIC , REACTION ,EQUILIBRIUM
LOAD TYPE - WIND
TITLE - WL+X

CENTER OF FORCE BASED ON X FORCES ONLY (METERIAL).
→Non-Global directions forces will not validate the results.

X = 0.000000000E+00
Y = 0.650918136E+02
Z = 0.119999999E+02

SUMMARY (LOADING 3) OF TOTAL APPLIED LOAD
TOTAL FORCE IN -X = 4179.73KN
TOTAL FORCE IN -Y = 0.00
TOTAL FORCE IN -Z = 0.00

SUMMATION OF THE MOMENTS ACTING AROUND THE ORIGIN -
MX= 0.00 MY= 50156.81KN.M MZ= -272066.47KN.M

SUMMARY (LOADING 3) OF TOTAL REACTION LOAD
TOTAL FORCE IN -X = -4179.73KN
TOTAL FORCE IN -Y = -0.00
TOTAL FORCE IN -Z = -0.00

SUMMATION OF THE MOMENTS ACTING AROUND THE ORIGIN-
MX= -0.00 MY= -50156.81KN.M MZ= 272066.46KN.M

MAXIMUM DISPLACEMENTS (CM /RADIANS) FOR LOAD CASE 3

MAXIMUMS	AT NODE
X = 8.86777E+00	32783
Y = -4.70191E-01	287
Z = -4.77485E-03	1751
RX= 7.50930E-04	2354
RY= -2.66218E-04	1464
RZ= -2.94655E-03	2010

4.2.5.4 Results (STAAD-PRO)

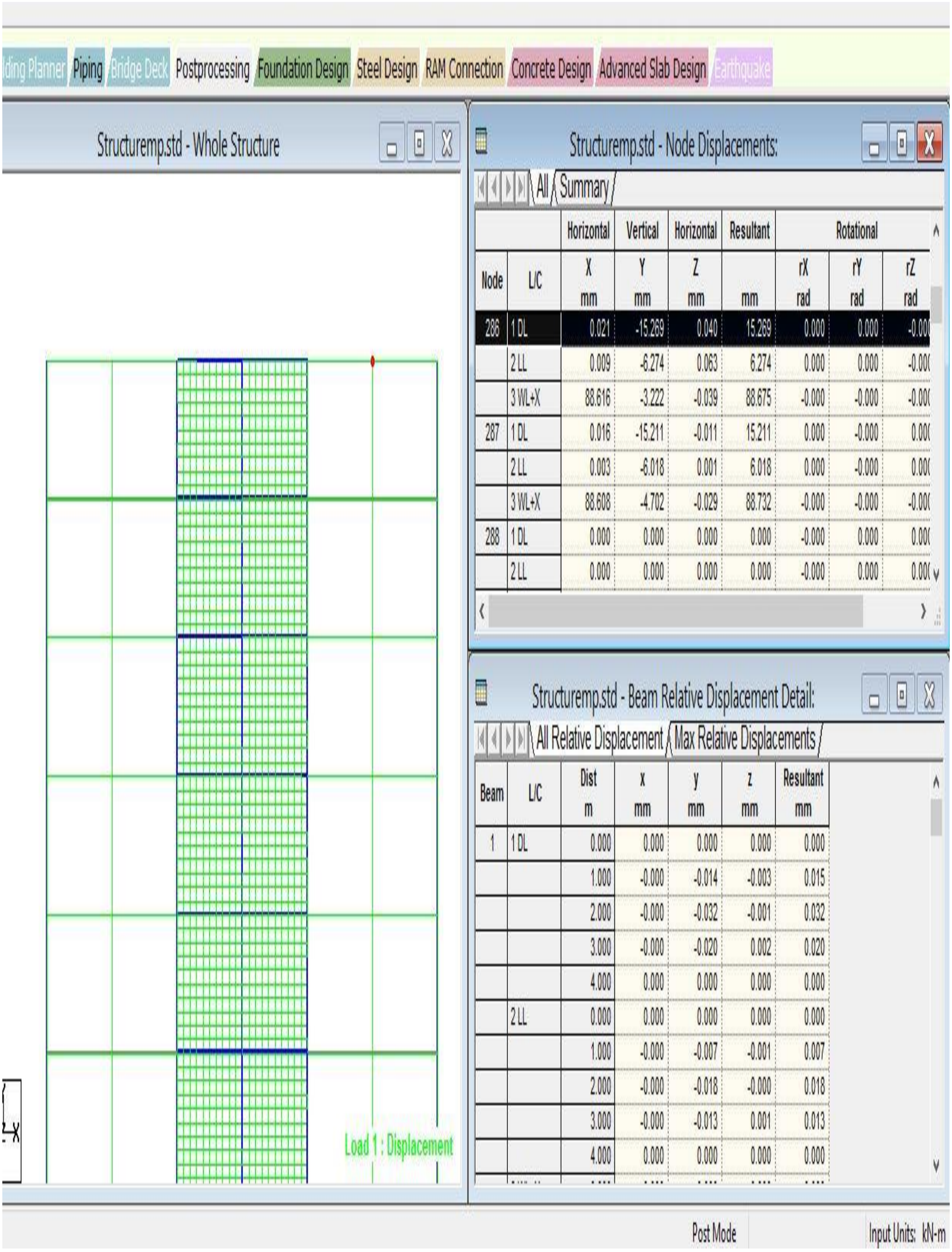


Fig4.10 : Deflected Shape

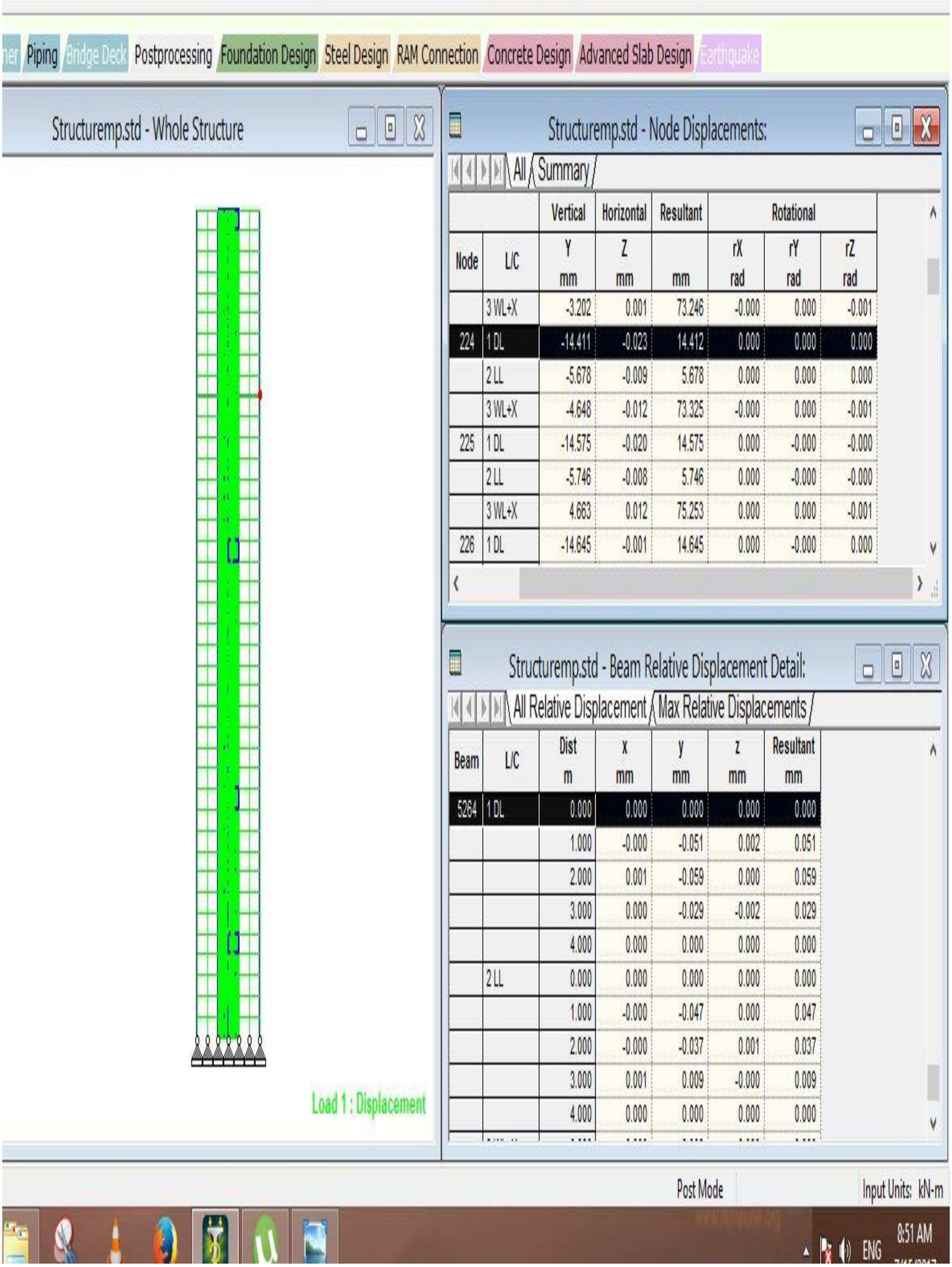


Fig4.11 : Deflection Result of a Node(224) In Envelop 1(DL+LL+WL)

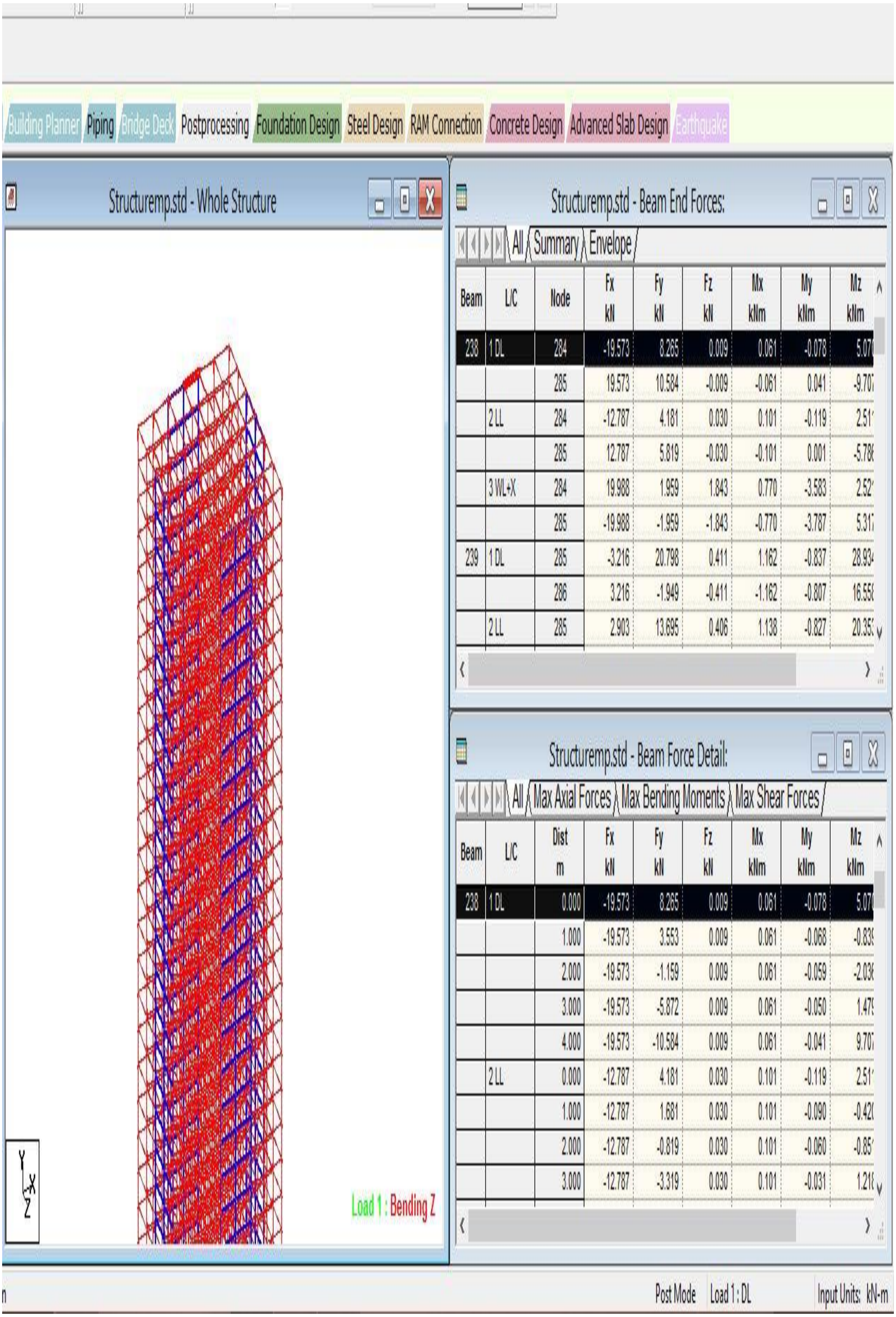


Fig4.12 : Moment Diagram Of The Building

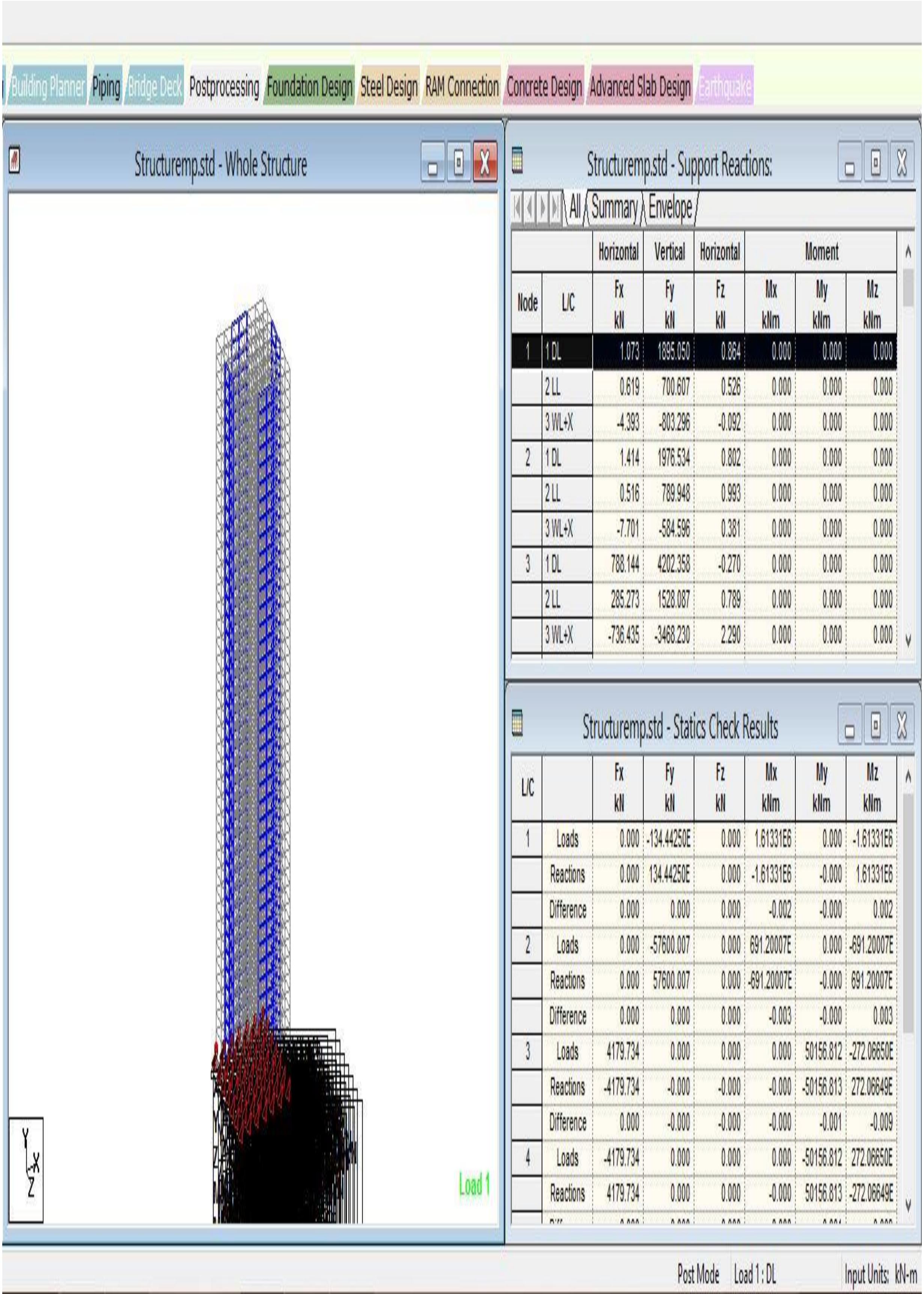


Fig4.13: Reaction Force At Supports (Node 1)

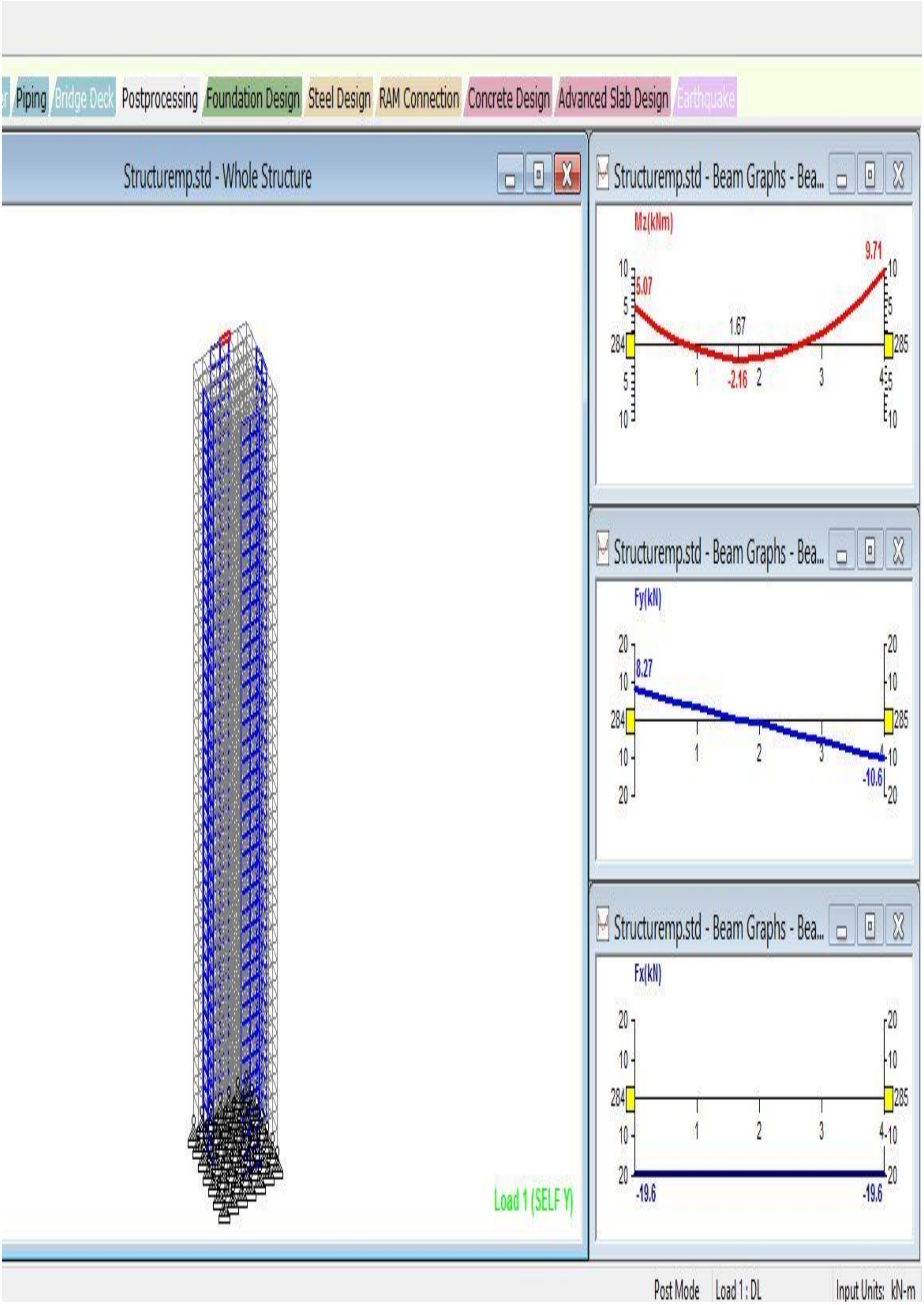


Fig4.14: Beam Result Graph (Beam No. 238)

4.2.5.4 Report File By Staad-Pro

Software licensed to	Job No	Sheet No 1		Rev
	Part			
Job Title	Ref			
	By	Date 12-JUN-17	Chd	
Client	File Structuremp.std		Date/Time 12-JUN-2017 13:48	

Job Information

	Engineer	Checked	Approved
Name:			
Date:	14-Jul-17		

Structure Type	SPACE FRAME

Number of Nodes	35201	Highest Node	2009
Number of Elements	5320	Highest Beam	5320
Number of Plates	32000	Highest Plate	37320

Number of Basic Load Cases	6
Number of Combination Load Cases	0

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	DL
Primary	2	LL
Primary	3	WL+X
Primary	4	WL -X
Primary	5	WL+Z
Primary	6	WL -Z

Primary Load Cases

Number	Name	Type
1	DL	Dead
2	LL	Live
3	WL+X	Wind
4	WL -X	Wind
5	WL+Z	Wind
6	WL -Z	Wind

Combination Load Cases

There is no data of this type.

Wind Load Definition : Type 1

Intensity (N/mm^2)	Height (m)
0.001	3.000
0.001	12.000
0.001	21.000
0.002	30.000
0.002	39.000
0.002	48.000
0.002	57.000
0.002	66.000
0.002	75.000
0.002	84.000
0.002	93.000
0.002	102.000
0.002	111.000
0.002	120.000

Exposure Factor	Range	Nodes / Height Range (m)
0.800	Nodes	1 - 2009

2 LL : Area Loads

Load (N/mm^2)	Beams
-0.003	1 - 5320

3 WL+X : Wind Loading

Direction	Type	Factor
X	1	1.000

4 WL -X : Wind Loading

Direction	Type	Factor
X	1	-1.000

5 WL+Z : Wind Loading

Direction	Type	Factor
Z	1	1.000

6 WL -Z : Wind Loading

Direction	Type	Factor
Z	1	-1.000

CHAPTER 5

COMPARISONS OF RESULTS AND DISCUSSIONS

5.1 General

It took time to run the analysis as the basic version of the software was used. Results of deflection, shear force, moment of the entire building and individual member were analyzed; also the graphical diagrams of deflection, shear force, moment of each member and of whole structure were analyzed.

5.2 Shear Wall Effect On Deflection

Storey drift also known as shear wall deflection is limited by two primary causes. The first is for limiting cracks in wall by plaster, gypsum, and paint in serviceability. The second is for limiting the shear wall's maximum inelastic response, which is important in the seismic or wind design of wood buildings. Furthermore, the relative flexibility and rigidity of shear wall and diaphragms is also calculated by storey drift.

Fig 5.1 : Graph of Deflection At Different Stories

5.3 Deflection Results In Both Analysis

TABLE- 5.1 Deflection Values comparison

storey	w/o shear wall (mm)	with shear wall(mm)	%Reduction
40	141.908	88.621	37.55038476
39	140.297	87.093	37.92240746
38	138.601	85.486	38.32223433
37	136.786	83.855	38.6962116
36	134.85	82.194	39.04783092
35	132.793	80.496	39.38234696
34	130.614	78.752	39.7063102
33	128.314	76.958	40.02369188
32	125.894	75.108	40.34028627
31	123.355	73.199	40.65988407
30	120.7	71.229	40.98674399
29	117.929	69.195	41.32486496
28	115.046	67.095	41.6798498
27	112.052	64.931	42.05279692
26	108.952	62.7	42.45172186
25	105.748	60.405	42.87835231
24	102.442	58.046	43.33769352
23	99.038	55.626	43.83368
22	95.538	53.145	44.37291968
21	91.947	50.608	44.95959629
20	88.267	48.017	45.60028097
19	84.503	45.375	46.30368153
18	80.659	42.689	47.07472198
17	76.739	39.964	47.92217777
16	72.746	37.204	48.85766915
15	66.692	34.418	48.39261081
14	64.575	31.614	51.04297329
13	60.403	28.801	52.31859345
12	56.181	25.981	53.75482814
11	51.916	23.196	55.32013252
10	47.812	20.432	57.26595834
9	43.278	17.715	59.06696243
8	36.921	15.066	59.19395466
7	34.547	12.51	63.7884621
6	30.164	10.073	66.60588781
5	25.781	7.789	69.78782825
4	21.397	5.696	73.37944572
3	16.997	3.835	77.4371948
2	12.483	2.263	81.87134503
1	7.363	1.034	85.95681108
Supports	0	0	0

- Deflection values in the building with shear wall are significantly less than the building without shear wall, at the top of building deflection of the storey has been reduced upto 37.55% .
- Moment value for beam and nodes has also been reduced in shear wall building ,that shows its more reliability to the load as compared to without shear wall building.
- By this analysis and study in the urban areas to reduce the requirement of space for the building, high rise buildings are used; and to prevent danger against wind load on those buildings ,shear wall is a good and easy choice in the construction.

5.4 Future Scope

An experimental study also can be performed on the same structures by Wind Tunnel Experiment and their results can be compared by the experiment and STAAD-PRO analysis.

CHAPTER 6

CONCLUSIONS

- From the above study work, it is observed that in 40 story building, constructing building with shear wall in short span at middle is economical and effective as compared with the building without shear wall. From this it can be concluded that large dimension of shear wall is not effective in less number of stories of any building but it is effective in high number of stories.
- Software does not take direct values from IS-875(3) for the wind load; hence must be improved.
- Software does not support Indian codes like IS-456 for concrete design and IS -13920 for shear wall design, hence must be improved.
- Results are acceptable in both building and very significantly loss (37.55% in top story) in deflection in shear wall building has been shown compared to normal building without shear wall.

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