# SEISMIC CONTROL OF G+21 FRAMED STRUCTURES BY SHEAR WALL IN PATNA (ZONE IV) AND LUCKNOW (ZONE III) USING ETABS SOFTWARE

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**ABSTRACT**

One of the major developments in seismic design over the past 10 years has been increased emphasis on limit states design, now generally termed Performance Based Engineering. This Model towards the seismic analysis of multi storey building with symmetrical plan under earthquake zones-III and zones IV. For the analysis purpose model of G +21 stories of RCC with core and edge shear walls are considered. Three techniques – the capacity spectrum approach, the N2 method and direct displacement-based design have now matured to the stage where seismic assessment of existing structures or design of new structures can be carried out to ensure that particular deformation-based criteria are met. Various parameters such as lateral force, storey shear, storey displacement, story drift can be determined. ETABS stands for Extended Three dimensional Analysis of Building Systems. ETABS is commonly used to analyze.

The paper will outline and compare the three methods, and discuss them in the context of traditional force-based seismic design and the case study in this paper mainly prioritizes on structural behavior of G+21 storey building with core and edge shear wall for sloped and plane grounded building. Modeling and analysis of the building is done on the ETABSv9.7.4 software. The seismic analysis of building is carried out for plane grounded and flat grounded building. Estimation of response such as; lateral forces, storey shear and storey displacement and storey drift is carried out. earlier design approaches which contained some elements of performance based design. Factors defining different performance states will be discussed, including the need, not yet achieved, to include residual displacement as a key performance limit. Some emphasis will be placed on soil-related problems, and the incorporation of soil/structure interaction into performance-based design. It will be shown that this is relatively straightforward and results in consistent design solutions not readily available with force-based designs using force-reduction factors.

## 1.1 INTRODUCTION

Various civil structures are primarily based on prescriptive method of building codes and loads which acts on the structure are low and resulting in elastic structural behavior. A structure can be subjected to the force greater than the elastic limit. The structural safety against major earthquake relate to the structural design of building for seismic loads. The earthquake loading behavior is different from wind loading and gravity loading which requires detail analysis to reach the acceptable elastic range in the structure. In dynamic analysis, the mathematical model of building by determining of strength, mass, stiffness and inelastic member properties are assigned. Dynamic analysis should be performed for symmetrical and unsymmetrical building. The main objective is to create awareness about dynamic effect on the building with the help of ETABSv9.7.4 software; it also Shows better response of building under dynamic loading and minimize the hazard to the life for all structures.

Structural design of buildings for seismic loads is primarily concerned with structural safety during major ground motions. Seismic loading requires an understanding of the structural performance under large inelastic deformations. Behavior of the building under this loading is different from the wind loading or gravity loading. So it requires more detailed analysis to assure accepTable seismic performance beyond the elastic range. Some structural damage can be expected when the building experiences design ground motions, because almost all building codes allow inelastic energy dissipation in structural systems. The primary step in dynamic analysis of building is to develop a mathematical model of the building, through which estimates of strength, stiffness and inelastic member properties are assigned.

The difference between the dynamic and the static analysis is based on whether the applied action of forces has enough acceleration in comparison to the structure's natural frequency.

If a load is applied sufficiently slowly, the inertia forces can be ignored and the analysis can be simplified as static analysis.

Dynamic analysis, is a type of structural analysis which covers the behavior of structures subjected to dynamic loading i.e. actions having high acceleration. Dynamic analysis is also related to the inertia forces developed by the structure when it is excited by means of dynamic loads applied suddenly. Dynamic analysis of simple structures can be done manually, however for complex structures finite element analysis is used.

ETABSis a FE (finite element) based software and it provides both static and dynamic analysis for wide range of gravity and lateral loads.

This analysis mainly deals with the study of a rectangular plan of G+21 storeys RCC building and is modeled using ETABS. The height of each storey of the building is taken as 3m, making total height of the structure as 45m above plinth level. Loads considered are taken according to the IS-875(Part1, Part2), IS-1893(2002) code and combinations are according to IS-875(Part5).

By the past records of earthquake, the demand about the earthquake resisting building is increased in seismic zones.These types of buildings are possible by providing shear walls at the core and edges of the building to withstand seismic effect.

Due to the provision of shear wall at core or at edges in multi-storied building we can resist seismic effect of earthquake. The loads are calculated by ETABS software by providing shear walls at various parts of building.

**1.2Shear wall:**

It is a structural system composed of braced panels to counter the effects of lateral loads acting on a structure. Shear wall is called as shear panels. Shear wall are designed to carry wind loads and earthquake loads. Shear walls resist in-plane loads that are applied along its height.

Shear wall sections are classified as six sections

1. L-section
2. T-section
3. H-section
4. U-section
5. W-section and
6. Box section

In the present dynamic analysis L-type sections and box sections are used. For core shear wall box type section and for edge shear wall L type section shear walls are used.

In addition to slabs, beams and columns reinforced concrete buildings often have vertical plate- like RC walls called shear walls. These walls generally start from foundation level and are continuous throughout the building height. In high rise buildings, the thickness of shear wall varies from 150 mm to 400 mm. shear walls are usually provided along both length and width of buildings.

The main two functions of the shear wall are

- Strength and
- Stiffness

**1.3 Behaviors of shear wall under seismic loading:**

Depending upon the height to width ratio, shear walls behave as slender walls, a squat wall or combination of these two. Generally slender shear walls have a height to width ratio is 2. These behave like a vertical slender cantilever beam. Bending is the primary mode of deformation and shear deformation can be neglected.Generally squat shear walls have a height to width ratio less than 0.5. These wall show significant amount of shear deformation compared to bending deformations. So shear strength governs these type of walls. Flexural strength governs the slender wall. Ideally shear wall should respond in ductile manner.

Advantages of shear walls in RC Buildings:

a. Properly designed buildings with shear walls have shown very good performance in past earthquakes.
b. Shear wall buildings are a popular choice in many earthquake prone countries.
c. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight forward.
d. Shear walls are efficient in both construction cost and effectiveness in minimizing earthquake damage in structures.
e. Shear walls significantly reduces the lateral sway of the building.

**1.4 Storey drifts:**

The lateral displacement of the storey relating to the storey lower is called storey drift. The relative lateral deflection in any one storey should not exceed the storey height divided by 500. Inter story drift is the difference between the roof and floor displacements of any given story as the building sways during the earthquake, normalized by the story height.

Core shear walls: shear walls are provided at the centre or core of the building.

Edge shear walls: shear walls are provided at the corners or edges of the building.

**1.5 Objectives:**

The main objective of this project is to check and compare the dynamic response of G+21 building with core and edge shear walls under different seismic zones, so one can pick the best substitute for construction in all earthquake-prone areas.
Core and edge shear wall in R.C. Building will be modeled in ETABSv9.7.4 software and the results in terms of storey displacement, storey drift, and storey shear are compared.
To study the comparison between lateral storey displacements and storey shears in building with core shear wall and with edge shear wall
Comparison is to be made between core and edge shear wall building models in all earthquake zones i.e. Zones – III & IV.

## 2.1 LITERATURE REVIEW:

**Mohammed Azam (**2013) presented a study on seismic performance evaluation of multistoried RC framed buildings with shear wall. A comparison of structural behavior in terms of strength, stiffness and damping characteristics is done. The provision of shear wall has significant influence on lateral strength in taller buildings while it has less influence on lateral stiffness in taller buildings. The provision of shear wall has significant influence on lateral stiffness in buildings of shorter height while it has less influence on lateral strength. The influence of shear walls is significant in terms of the damping characteristics and period at the performance point for tall buildings. Provision of shear walls symmetrically in the outermost moment-resisting frames and preferably interconnected in mutually perpendicular direction forming the core will have better seismic performance in terms of strength and stiffness.
**P.P Chandurkar and P.S. Pajgade** (2013) are investigated Changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake.
**N. Janardhanreddy**(2015) in his work seismic analysis of multistoried building with shear walls using ETABS reveals that provision of shear wall generally results in reducing the displacement because the shear wall increases the stiffness of the building and sustains the lateral forces. The better performance is observed and displacement is reduced in both x and y directions and shows better performances with respect to displacements when analysis is done by response spectrum method.
**Agrawal and Charkha** (2012) are investigation reveals that the significant effects on deflection in orthogonal direction by the shifting the shear wall location. Placing Shear wall away from centre of gravity resulted in increase in most of the members forces.
**Greeshma and Jaya** (2006) are investigated the proper connection detailing of shear wall to the diaphragm. The shear wall and diaphragm connection with hook deflects more when compared to the other two configurations. Hence, the shear wall- diaphragm connection with hook was more efficient under dynamic lateral loadings.

## 3.1 METHODOLOGY

**Code-based procedure for seismic analysis**

Main features of seismic method of analysis according to IS1893 (Part 1): 2002 are described as follows

- Equivalent Static Analysis (Linear Static)
- Response Spectrum Analysis (Linear Dynamic)
- Time History Analysis (Nonlinear Dynamic)
- Pushover Analysis (Nonlinear Static)

Suitable methods of analysis are provided in codes of practice; in general, the more complex and tall the building, the more stringent the analysis that is required.
Regular buildings up to around 15 storeys in height can usually be designed using equivalent static analysis; tall buildings or those with significant irregularities in elevation or plan require modal response spectrum analysis.

### 3.1.1 Equivalent static analysis

All design against earthquake effects must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings and begins with an estimate of peak earthquake load calculated as a function of the parameters given in the code.

### 3.1.2 Response spectrum analysis

It is a dynamic method of analysis. In the calculation of structural response the structure should be so represented by means of an analytical or computational model that reasonable and rational results can be obtained by its behavior, when response spectrum method is used with modal analysis procedure. At least 3 modes of response of the structure should be considered except in those cases where it can be shown qualitatively that either third mode or the second mode produces negligible response. The model maxima should be combined using the square root of the sum of the squares of the individual model values. With the advent of powerful desktop computers, this type of analysis has become the norm. It involves calculating the principal elastic modes of vibration of a structure. The maximum responses in each mode are then calculated from a response spectrum and these are summed by appropriate methods to produce the overall maximum response. There are computational advantages in using the response spectrum method ofseismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each modeof vibration using smooth design spectra that are the average of several earthquake motions.

The major advantages of modal response spectrum analysis (RSA), compared with the more complex time-history analysis are as follows.

(1) The size of the problem is reduced to finding only the maximum response of a limited number of modes of the structure, rather than calculating the entire time history of responses during the earthquake. This makes the problem much more tracTable in terms both of processing time and (equally significant) size of computer output.

(2) Examination of the mode shapes and periods of a structure gives the designer a good feel for its dynamic response.

(3) The use of smoothed envelope spectra makes the analysis independent of the characteristics of a particular earthquake record.

(4) RSA can very often be useful as a preliminary analysis, to check the reasonableness of results produced by linear and non-linear time-history analysis.

**3.1.3 Time-history analysis**

In this analysis dynamic response of the building will be calculated at each time intervals. This analysis can be carried out by taking recorded ground motion data from past earthquake database. A linear time-history analysis of this type overcomes all the disadvantages of Response spectrum analysis, provided non-linear behavior is not involved. The method involves significantly greater computational effort than the corresponding Response spectrum analysis and at least three representative earthquake motions must be considered to allow for the uncertainty in precise frequency content of the design motions at a site. With current computing power and software, the task of performing the number crunching and then handling the large amount of data produced has become a non specialist task.

**3.1.4Push over analysis:**

This is a performance based analysis and has aim in controlling the structural damage. In this analysis several built in hinge properties are included from FEMA 356 for concrete members. This analysis will be carried out by using nonlinear software ETABS 2013. This software is able to predict the displacement level and corresponding base shear where first yield of structure occurs. The main objective to perform this analysis is to find displacement vs. base shear graph.Pushover analysis is a simplified, static, nonlinear analysis under a predefined pattern of permanent vertical loads and gradually increasing lateral loads. Typically the first pushover load case is used to apply gravity load and then subsequent lateral pushover load cases are specified to start from the final conditions of the gravity pushover. Typically a gravity load pushover is force controlled and lateral pushovers are displacement controlled. Load is applied incrementally to frameworks until a collapse mechanism is reached. Thus it enables determination of collapse load and ductility capacity on a building frame. Plastic rotation ismonitored, and a lateral inelastic force versus displacement response for the complete structure is analytically computed.

For the present dynamic analysis, response spectrum analysis method is used in the FE based software ETABS.. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002(part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABSv9.7.4 software.

**3.2 LOADS CONSIDERED:**

Loads on a structure are generally two types.

1. Gravity loads and
2. Lateral loads

**3.2.1 Gravity loads:**

Gravity loads are the vertical forces that act on a structure. The weight of the structure, human occupancy and snow are all types of loads that need to have a complete load path to the ground.

**3.2.1.1 DEAD LOADS:**

All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 $kN/m^3$ and 25 $kN/m^3$respectively.

**IMPOSED LOADS:**

All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 $kN/m^3$ and 25 $kN/m^3$ respectively.

Live loads are taken as 2kN/m.

**3.2.2 Lateral loads:**

Lateral loads are the horizontal forces that are act on a structure. Wind loads and earthquake loads are the main lateral loads act on structures.

**WIND LOADS**

Basic wind speed zones in India are classified as six zones as per IS 875 part -3-1987.

Table – 3.1: Zone wise basic wind speeds in m/s

| Zone | Basic wind speed (m/sec) |
|---|---|
| I | 33 |
| II | 39 |
| III | 44 |
| IV | 47 |
| V | 50 |
| VI | 55 |

Design Wind Speed (V,)

The basic wind speed (V,) for any site shall be obtained from and shall be modified to include the following effects to get design wind velocity at any height (V,) 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: Where:

V = Vb X kl X k2X k3

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

kl = probability factor (risk coefficient)

k2= terrain, height and structure size factor

k3 = topography factor

**SEISMIC LOADS:**

Design Lateral Force

The design lateral force shall first be computed for the building as a whole. This design lateral force shall then be distributed to the various floor levels. The overall design seismic force thus obtained at each floor level shall then be distributed to individual lateral load resisting elements depending on the floor diaphragm action.

Earthquake loads are applied as per IS 1893-2002 in earthquake x-direction, y-directionPositive x-direction, negative x-direction, positive y-direction and negative y- direction.And load combinations are considered as per IS 1893-2002.

Design Seismic Base Shear

The total design lateral force or design seismic base shear (Vb) along any principal direction shall be determined by the following expression:

Vb = Ah W

Where,

Ah = horizontal acceleration spectrum

W = seismic weight of all the floor

Fundamental Natural Period

The approximate fundamental natural period of vibration (T,), in seconds, of a moment-resisting frame building without brick in the panels may be estimated by the empirical expression:

Ta=0.075 h0.75 for RC frame building

Ta=0.085h0.75 for steel frame building Where,

h = Height of building, in m. This excludes the basement storeys, where basement walls are connected with the ground floor deck or fitted between the building columns. But it includes the basement storeys, when they are not so connected. The approximate fundamental natural period of vibration (T,), in seconds, of all other buildings, including moment-resisting frame buildings with brick lintel panels, may be estimated by the empirical Expression:

T=.09H/√D

Where,

H= Height of building

D= Base dimension of the building at the plinth level, in m, along the considered direction of the lateral force.

Distribution of Design Force

Vertical Distribution of Base Shear to Different Floor Level

The design base shear (V) shall be distributed along the height of the building as per the following expression:

Qi=Design lateral force at floor i,

Wi=Seismic weight of floor i,

hi=Height of floor i measured from base, and

n=Number of storeys in the building is the number of levels at which the masses are located. Distribution of Horizontal Design Lateral Force to Different Lateral Force Resisting Elements in case of buildings whose floors are capable of providing rigid horizontal diaphragm action, the total shear in any horizontal plane shall be distributed to the various vertical elements of lateral force resisting system, assuming the floors to be infinitely rigid in the horizontal plane. In case of building whose floor diaphragms cannot be treated as infinitely rigid in their own plane, the lateral shear at each floor shall be distributed to the vertical elements resisting the lateral forces, considering the in-plane flexibility of the diagram.

In India seismic zones are divided into four zones, i.e Zone – II, Zone – III, Zone – IV and Zone - V. Zone – II is low earthquake prone area, Zone – III is moderate zone, Zone – IV is high earthquake prone area and Zone – V is the highest earthquake intensity zone.

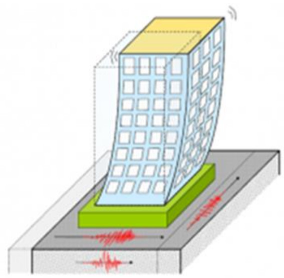


Figure – 3.3: Behavior of building under earth quake

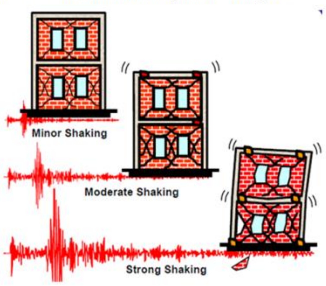



Figure – 3.4: performance objectives under different intensities of earthquake

**4.1 ETABS**

Structural Design Software for Structural Analysis Professionals:

ETABSis the present day leading design software in the market. Many design company's use this software for their project design purpose. The innovative and revolutionary new ETABS is the ultimate integrated software package for the structural analysis and design of buildings. Incorporating 40 years of continuous research and development, this latest ETABS offers unmatched 3D object based modeling and visualization tools, blazingly fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and easily decipher and understand analysis and design results.

From the start of design conception through the production of schematic drawings, ETABS integrates every aspect of the engineering design process. Creation of models has never been easier - intuitive drawing commands allow for the rapidgeneration of floor and elevation framing. CAD drawings can be converted directly into ETABS models or used as templates onto which ETABS objects may be overlaid. The state-of-the-art SAP Fire 64-bit solver allows extremely large and complex models to be rapidly analyzed, and supports nonlinear modeling techniques such as construction sequencing and time effects (e.g., creep and shrinkage). Design of steel and concrete frames (with automated optimization), composite beams, composite columns, steel joists, and concrete and masonry shear walls is included, as is the capacity check for steel connections and base plates. Models may be realistically rendered, and all results can be shown directly on the structure. Comprehensive and customizable reports are available for all analysis and design output, and schematic construction drawings of framing plans, schedules, details, and cross-sections may be generated for concrete and steel structures.

ETABS is the structural engineer's software choice for steel, concrete, timber, aluminum and cold-formed steel structure design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles, aquatic structures and much more.

Structural Software can Offer the following.

•State-of-the art 2D/3D graphical environment with standard MS Windows functionality.

•Full range of structural analysis including static, P-delta, pushover, response spectrum, time history, cable (linear and non-linear), buckling and steel, concrete and timber design.

•Concurrent engineering-based user environment for model development, analysis, design, visualization, and verification.

• Object-oriented intuitive 2D/3D CAD model generation.

•Supports truss and beam members, plates, solids, linear and non-linear cables, and curvilinear beams.

• Advanced automatic load generation facilities for wind, area, floor, and moving loads.

• Customizable

• Structural templates for creating a model.

• Toggle display of loads, supports, properties, joints, members, etc.

• Isometric and perspective views with 3D shapes.

• Joint, member/element, mesh generation with flexible user-controlled numbering scheme.

• Rectangular and cylindrical coordinate systems with mix and match capabilities.

**4.4 BUILDING DETAILS:**

4.4.1 Geometric data:

Element – G+ 21 storey

Type of frame: SMRF (Special moment resisting frame)

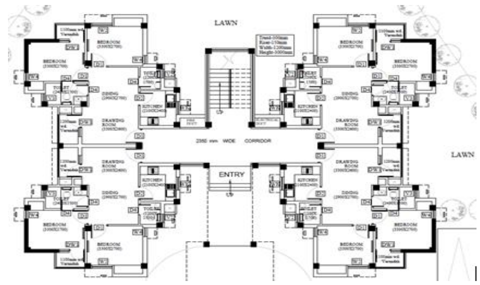
Area of building-36mX22.5m

Plinth height – 3.0m

Storey height – 3m

Total Height of building-66.5m
4.4.2 Material data:
Concrete:
Grade – M25
Characteristic cube strength of concrete (fck) – 25 N/mm2
Density of concrete (γck) – 25kN/m3
Poisson's ratio – 0.3
Steel:
Steel – Fe500
Yield strength (fy) – 500 N/mm2
Density of steel (γfy) – 78.5 kN/m3
Poisson's ratio – 0.2
Brick masonry
Density of brick masonry = 20 kN/m3
4.4.3 Earthquake Data:
Frame: Ordinary moment Resisting Frame
Locations: ZONE – III & IV
Importance Factor (I): 1.5
Damping: 5 percent
Type of Soil: Medium (Type 2)
Seismic zone factor (z)
ZONE - III– 0.16
ZONE - IV– 0.24
4.4.4 Loading Data:
Wall load : 12kN/m
Live load :2 kN/m

**Wind load:**
In x-direction (WLx) (according IS: 875-1987)
In y-direction (WLy) (according IS: 875-1987)
Earth quake loads:
In x-direction (EQx) (according IS1893-2002)
In y-direction (EQy) (according IS1893-2002)
Load combinations:
1.5 (DL + LL)
1.2 (DL + LL ± EQX)
1.2 (DL + LL ± EQY)
1.5 (DL ± EQX)
1.5 (DL± EQY)
0.9 DL ± 1.5 EQX
0.9 DL ± 1.5 EQY
In the present analysis default load combinations are used.
4.4.5 Member sizes:
Size of Beam –230mmX450mm
Size of Plinth beam-230mmX300mm
Size of Column-500mmX500mm
Depth of Slab-125mm
Thickness of Shear wall-230mm
Thickness of wall – 230mm
Clear cover for beams – 25mm
Clear cover for columns – 40mm



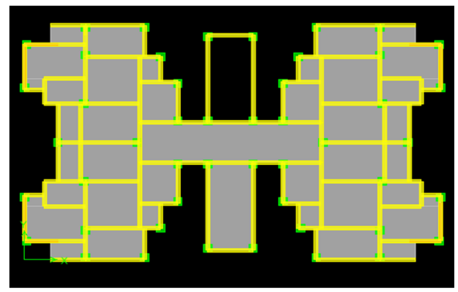


Fig-4.2:Modeling of G+21 Storey RCC Building with Edge Shear Wall

**5.1 ANALYSIS, RESULTS AND DISCUSSION**

Seismic analysis is performed on the all models of the building, i.e. building with core shear wall and building with edge shear walls. Response spectrum method is used for the analysis in ETABS. The parameters like storey shear; storey displacement, storey drift and lateral storey stiffness are calculated and compared in Earthquake zones III for edge and core shear walls.

5.1.1 Analysis of Storey Shear:

The maximum storey shear force, displacement and storey drift values are computed from ETABS for all storeys and tabulated. The maximum storey shears in all models are compared and graphs are drawn, storey number to maximum storey shears in different earthquake zones. All maximum storey shears are occurred in X-direction under worst load combination.

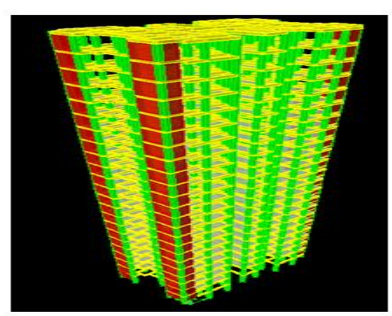


Fig-4.3: 3D View of G+21 Storey RCC Building with Edge Shear Wall

| STOREY | ESW |
|---|---|

| | Vx (kN) | Vy (kN) |
|---|---|---|
| BASE | 0 | 0 |
| STOREY 1 | 1282.59 | 1309.05 |
| STOREY 2 | 1282.37 | 1308.83 |
| STOREY 3 | 1281.17 | 1307.61 |
| STOREY 4 | 1278.47 | 1304.85 |
| STOREY 5 | 1273.67 | 1299.95 |
| STOREY 6 | 1266.17 | 1292.3 |
| STOREY 7 | 1255.38 | 1281.28 |
| STOREY 8 | 1240.69 | 1266.69 |
| STOREY 9 | 1221.49 | 1246.9 |
| STOREY 10 | 1197.2 | 1221.91 |
| STOREY 11 | 1167.22 | 1191.3 |
| STOREY 12 | 1130.93 | 1154.27 |
| STOREY 13 | 1087.75 | 1110.19 |
| STOREY 14 | 1037.07 | 1058.47 |
| STOREY 15 | 978.27 | 998.48 |
| STOREY 16 | 910.82 | 929.61 |
| STOREY 17 | 834.05 | 851.26 |
| STOREY 18 | 747.39 | 762.81 |
| STOREY 19 | 650.23 | 663.64 |
| STOREY 20 | 541.97 | 553.15 |
| STOREY 21 | 422.02 | 430.73 |

TABLE-5.1: MaximumStorey Shears (KN) for ESW in Zone –III

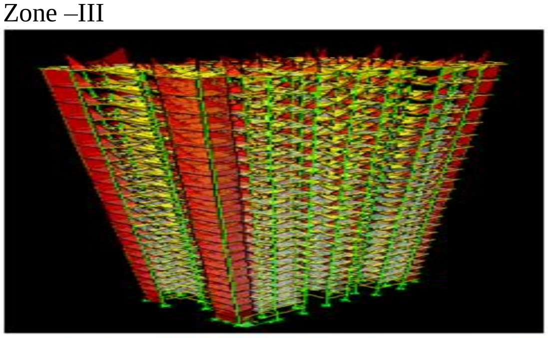


Fig - 4.4: Bending Moment of G+ 21Storey RCC Building with EdgeShear Wall

| MAX STOREY SHEARS (kN) | | |
|---|---|---|
| STOREY | ESW | |
| | Vx (kN) | Vy (kN) |
| BASE | 0 | 0 |
| STOREY 1 | 1923.88 | 1963.48 |
| STOREY 2 | 1923.55 | 1963.25 |
| STOREY 3 | 1921.75 | 1961.41 |
| STOREY 4 | 1917.7 | 1957.28 |
| STOREY 5 | 1910.51 | 1949.93 |
| STOREY 6 | 1899.26 | 1938.45 |
| STOREY 7 | 1883.07 | 1921.93 |
| STOREY 8 | 1861.03 | 1899.43 |
| STOREY 9 | 1832.24 | 1870.05 |
| STOREY 10 | 1795.8 | 1832.86 |
| STOREY 11 | 1750.81 | 1786.95 |
| STOREY 12 | 1696.4 | 1731.4 |
| STOREY 13 | 1631.62 | 1665.29 |
| STOREY 14 | 1555.6 | 1587.7 |
| STOREY 15 | 1467.44 | 1497.72 |
| STOREY 16 | 1366.23 | 1394.42 |
| STOREY 17 | 1251.08 | 1276.89 |
| STOREY 18 | 1121.08 | 1144.21 |
| STOREY 19 | 975.34 | 995.46 |
| STOREY 20 | 812.95 | 829.73 |
| STOREY 21 | 633.03 | 646.09 |

TABLE-5.2: MaximumStorey Shears (KN) for ESW in Zone –IV

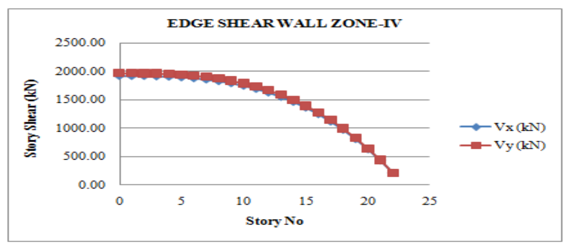



Fig-5.2: Maximum Storey Shear for Edge Shear wall Building in Zone-IV

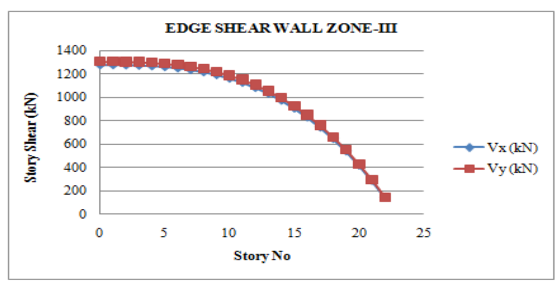



Fig-5.1: Maximum Storey Shear for Edge Shear wall Building in Zone-III

**Analysis of Storey Drift:**

Storey drift is the lateral displacement of the storey. It is the drift of one level of a multistory building relative to the level of below storey. Storey and zone wise drifts are shown below.

| MAXIMUM STOREY DRIFTS (m) in -III | | |
|---|---|---|
| | ESW IN ZONE-III | |
| STOREY | Drift-X | Drift-Y |
| STOREY 1 | 0.000422 | 0.000243 |

| | | |
|---|---|---|
| STOREY 2 | 0.000721 | 0.000493 |
| STOREY 3 | 0.000929 | 0.000686 |
| STOREY 4 | 0.00112 | 0.00087 |
| STOREY 5 | 0.001214 | 0.001024 |
| STOREY 6 | 0.001303 | 0.001152 |
| STOREY 7 | 0.001364 | 0.001258 |
| STOREY 8 | 0.001407 | 0.001345 |
| STOREY 9 | 0.001436 | 0.001413 |
| STOREY 10 | 0.001452 | 0.001465 |
| STOREY 11 | 0.001457 | 0.001502 |
| STOREY 12 | 0.001452 | 0.001525 |
| STOREY 13 | 0.001437 | 0.001536 |
| STOREY 14 | 0.001416 | 0.001537 |
| STOREY 15 | 0.001387 | 0.001527 |
| STOREY 16 | 0.00135 | 0.001509 |
| STOREY 17 | 0.001305 | 0.001484 |
| STOREY 18 | 0.001253 | 0.001454 |
| STOREY 19 | 0.001196 | 0.001419 |
| STOREY 20 | 0.001134 | 0.001385 |
| STOREY 21 | 0.001071 | 0.001353 |

| MAXIMUM STOREY DRIFTS (m) | | |
|---|---|---|
| | ESW IN ZONE-IV | |
| STOREY | Drift-X | Drift-Y |
| STOREY 1 | 0.000564 | 0.000348 |
| STOREY 2 | 0.001047 | 0.000725 |
| STOREY 3 | 0.001347 | 0.001001 |
| STOREY 4 | 0.001608 | 0.001266 |
| STOREY 5 | 0.00175 | 0.001487 |
| STOREY 6 | 0.001873 | 0.001672 |
| STOREY 7 | 0.001957 | 0.001824 |
| STOREY 8 | 0.002015 | 0.001946 |
| STOREY 9 | 0.002052 | 0.002041 |
| STOREY 10 | 0.002071 | 0.002113 |
| STOREY 11 | 0.002074 | 0.002163 |
| STOREY 12 | 0.002062 | 0.002193 |
| STOREY 13 | 0.002041 | 0.002206 |
| STOREY 14 | 0.002008 | 0.002203 |
| STOREY 15 | 0.001963 | 0.002185 |
| STOREY 16 | 0.001906 | 0.002156 |
| STOREY 17 | 0.001838 | 0.002116 |
| STOREY 18 | 0.00176 | 0.002068 |
| STOREY 19 | 0.001676 | 0.002015 |
| STOREY 20 | 0.001588 | 0.001962 |
| STOREY 21 | 0.001499 | 0.001911 |

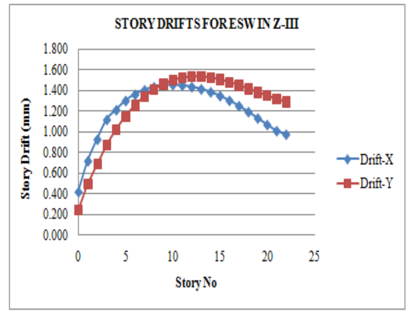



Fig-5.3: Maximum Storey Drift for Building with ESW X&Y-Direction in Zone-III

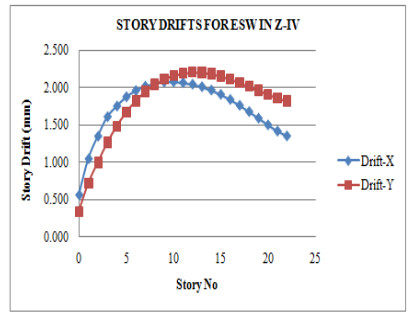



Fig-5.4: Maximum Storey Drift for Building with ESW X&Y-Direction in Zone-IV

**Analysis of Storey displacements:**

Storey displacements are the vertical displacements of members, occurs due to dead and live loads. These displacement values are same in seismic zone-III& IV. because in this analysis lateral forces are varying due to different earthquake zones and dead loads and live loads are equal in all zones. Storey displacements are compared when edge and core shear walls provided in multistory building.

| MAX STOREY DISPLACEMENTS (m) | | |
|---|---|---|
| | STOREY DISPLACEMENTS (m) FOR ESW | |
| STOREY | Z - III | Z - IV |
| BASE | 0 | 0 |
| STOREY 1 | 0.0819 | 0.0832 |
| STOREY 2 | 0.086 | 0.086 |
| STOREY 3 | 0.0946 | 0.0953 |
| STOREY 4 | 0.0946 | 0.0959 |
| STOREY 5 | 0.0967 | 0.0984 |
| STOREY 6 | 0.0983 | 0.1003 |
| STOREY 7 | 0.0998 | 0.1019 |
| STOREY 8 | 0.1013 | 0.1034 |
| STOREY 9 | 0.1026 | 0.1047 |
| STOREY 10 | 0.1039 | 0.1058 |
| STOREY 11 | 0.105 | 0.1068 |
| STOREY 12 | 0.1061 | 0.1076 |

| | | |
|---|---|---|
| STOREY 13 | 0.107 | 0.1083 |
| STOREY 14 | 0.1079 | 0.1088 |
| STOREY 15 | 0.1087 | 0.1092 |
| STOREY 16 | 0.1094 | 0.1095 |
| STOREY 17 | 0.11 | 0.11 |
| STOREY 18 | 0.1106 | 0.1106 |
| STOREY 19 | 0.1111 | 0.1111 |
| STOREY 20 | 0.1114 | 0.1114 |
| STOREY 21 | 0.112 | 0.112 |

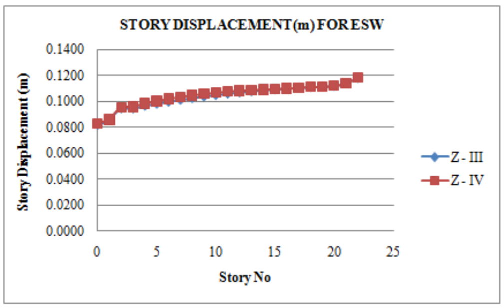



Fig-5.7: Comparison for Maximum storey displacement with edge shear wall in zone –III & IV

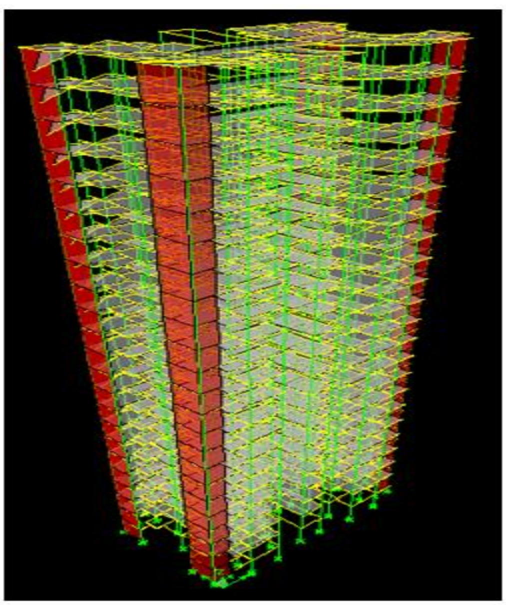


Fig-4.5: Deformation of G+21 Storey RCC Building with Edge Shear Wall

**6.1 CONCLUSION:**

The seismic analysis of building with with edge shear walls are done and compared at earthquake zones – III& IV by using ETABSv9.7.4.

Edge shear wall building model gives the nearly equal storey shears in all storeys at all earthquake zones. So selection of shear wall is mainly based on storey drift.

When shear walls are provided on the four edges of the building, maximum storey drifts are decreased compared to the without shear walls in all zones. So by providing edge shear wall, effect of seismic forces can be controlled.

Storey displacements are minimum in edge shear wall in zone – III than all storeys under earthquake zones -IV.

For better seismic performance of building, it should have adequate lateral storey stiffness. If lateral storey displacements are high, stiffness will be low or vice-versa.

So to minimize the earth quake effects edge shear wall must be provided because storey drifts are very low compared to without shear wall in earthquake zones –III& IV.

Future Scope

In the present work limited analysis i.e., considering only some parameters like storey shear, storey displacement, storey drift and storey stiffness is done by response spectrum method in ETABS software.The study could be extended by including various other parameters suchas torsional effects and soft storey effects in a building. Some of the future scopes are listed below.

Dynamic nonlinear analysis by time history method.

Nonlinear analysis by push over method.

Parametric study of models by varying height of building, Number of bays of building etc.

Performance-based or capacity based design of structure.

Continue to innovate new systems.

FEM analysis to understand beam-column junction behavior under earthquake for RCC, Steel and Composite building.

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