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Seismic Analysis of Multi-Storey R.C Structural Frames with and Without Floating Columns

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Abstract **- Rapid civilization leads to construction of thousands of buildings in urban areas. Now days, multi-storied R.C. framed structures are common in urban regions in the cities like Hyderabad, Bangalore, New Delhi, Chennai, Maharashtra, Pune etc. Due to thickly populated urban regions the buildings are extending vertically or going high or becoming more slender. Decades are evident that traffic volume in urban regions is high when compared to semi urban or rural regions. Therefore, the parking of vehicles is significant issue in urban regions leading to consider the parking storey in a building itself. Hence, parking is unavoidable in multi-storey buildings in urban regions in turn leading to create vertically irregular building (floating column buildings). To study the effect of vertically irregularity in buildings created due to parking or by some other instance. 4 mathematical Models of R.C. framed structures are created in ETAB 2016 version. From literature it can be observed that buildings which are having floating columns are more sustainable due to earthquake loading as compared to conventional R.C framed structure and unable to transfer the inertia forces safely to the ground. To study the effect of earthquake on this kind of buildings, Equivalent linear static analysis has been considered. The parameters like fundamental natural time period, fundamental mode shapes with modal mass participation factor, storey displacements, storey drifts, and base shear have been studied in detail.**

Keywords—Floating column, time history, floor displacement, storey drift, base shear, ETABS 2016.

1. INTRODUCTION

A trademark Column is an opposite auxiliary part which upkeep to plane basic individuals by methods for their loads, minutes, shear drive, hub load and so on., to hold the structure in safe condition and handover these heaps to the ground. However, at this point a day a few segments are planned in such a way, that it doesn't degree to the ground, due to various building perspectives. In those cases the sections handover above burdens as a point load on a shaft. This sort of segment is named as "Gliding segment". This Point load ascends to copious twisting minute on bar so territory of steel required will be extra in such cases. While seismic tremor emerges, the working with drifting sections hurts more when contrasted with the working with no gliding segments as a result of brokenness of structure and burden exchange way. The complete size, shape and geometry of a structure play a very vital part to keep structure safe while earthquake arises. As theory and practical study on buildings speaks that, earthquake forces established at different floor levels in a building requests to be taken down along the height to the ground by the shortest path; any deviation of discontinuity in this load transfer path results in poor performance of the building. In Earthquake study the main retort parameters are storey displacement, Storey drift, storey shear. These parameters are assessed in this paper and critical position of floating column building is observed. In this critical position the effect of cumulative section of beam and column in irregular building and regular building has been detected. Various urban multistory structures in India today have uncovered first story as an undeniable component. This is for the most part being actualized to hold up stopping or gathering anterooms in the principal story. Though the whole seismic base shear as polished by a working amid a quake is dependent on its regular period, the seismic power dispersals needing on the dispersal of firmness and mass along the tallness. The quake powers set up at dissimilar to floor levels in a building need to be transported down along the tallness to the ground by the immediate way; any eroticism or brokenness in this heap transmission way impacts in denied authorization of the building. Structures with opposite difficulties (like the inn structures with an inadequate story more extensive than the rest) beginning a quick obstacle in tremor powers at the dimension of irregularity. Structures that need less segments or dividers in a particular story or with strangely tall story grade to fall which is begun in that story. Numerous structures with an uncovered ground story proposed for stopping were extremely harmed in Gujarat amid the 2001 Bhuj tremor. Structures with segments that coast on shafts at an in the middle of story and don't go the whole distance to the establishment, have discontinuities in the heap exchange way. Henceforth, the structures recently made with these classifications of broken individuals are compromised in seismic districts. In any case, those structures can't be decimated, rather update should be possible to fortify the structure or some supportive highlights can be proposed. The segments of the principal story can be made harder, the firmness of these segments can be improved by retrofitting or these might be furnished with supporting to diminishing of the parallel distortion.

1.1 Floating column

There are numerous projects in which floating columns are implemented, particularly above the ground floor, where transmission girders are hired, so that additional exposed space is obtainable in the ground floor. These exposed spaces may be essential for assembly hall or parking purpose. The transmission girders have to be intended and detailed suitably, precisely in earth quake zones. The column is a concentrated load on the beam which cares it. As far as analysis is worried, the column is often assumed pinned at the base and is therefore taken as a point load on the transmission beam STAAD Pro, ETABS and SAP2000 can be used to do the scrutiny of this type of structure.

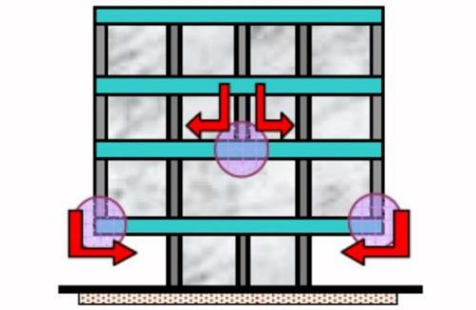

Fig 1.1

The Columns whose junior end does not extend to the ground and handovers the above loading on a beam as a point load, such type of column are called as Floating Columns. Floating columns arises in use to bid extra open space for assembly hall of parking purpose. The floating column building does not generate any problem under only vertical loading condition but it rises susceptibility in lateral loading (earthquake loading) condition, due to vertical discontinuity. During the earthquake the lateral forces established in higher storey have to be transmitted by the proposed cantilever beams due to this the overturning forces are established over the column of the ground floor. A column is supposed to be a vertical member beginning from foundation level and shifting the load to the ground. The term floating column is also a vertical component which (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn assign the load to other columns below it.

Fig.1.2:240 Park Avenue South in New York, United State

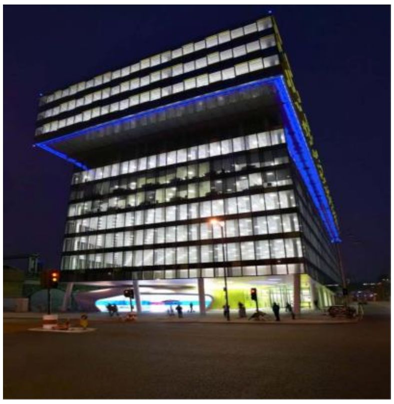

Fig. 1.3: Polestar in London, U.K

Fig.1.4: Chongqing Library in Chongqing, China

Fig. 1.5: One-Housing-Group-by-Stock-Woolstencroft-in-London-U. K

1.2ADVANTAGES AND DISADVANTAGES OF FLOATING COLUMNS

1.2.1 Advantages ;

i) By overwhelming floating columns huge purposeful space can be providing which can be Utilizing for storing and parking.

ii) In specific conditions floating columns may attest to be inexpensive in some cases.

iii)The floated column is significant for allocation the rooms and some portion can increase deprived of whole area.

1.2.2 Disadvantages;

i) Not appropriate in lofty seismic zone since speedy modification in stiffness was detected.

ii) Prerequisite vast size of girder beam to sustenance floating column.
iii) Floating columns hints to stiffness misdeeds in building.
iv) Stream of load path rises by providing floating columns. The load from structural members shall be transferable to the foundation by the shortest conceivable path.

1.3 OBJECTIVE AND SCOPE

1.3.1 Objective;
The objective of the current work is to revise**:**
i) The execution of multistory structures with gliding segments under quake excitations.
ii) Influence of delicate story on auxiliary execution of elevated structure.
iii) To recognize the auxiliary institution of the building having equivalent corner to corner swagger and floating sections with delicate story when risked to sidelong loads.
iv) Seismic answer of delicate story structure with different states of shear divider.

1.4 Scope;
In present study, an attempt has been made to study following aspects;
i) Modeling of multistory structure outlines with and without gliding segment utilizing limited component programming, E-tabs.
ii) The section extents having diverse measurements are demonstrated from ground level to the upper storey level.
iii) Dynamic investigation is finished by Time History technique is yielded out for every one of the models.
iv) Comparative study is made for all frames with and without floating column.
v) Study on the variations in the structural response due to the earthquake motions are tabulated.

2. REVIEW OF LITERATURE

Literature study contains earthquake retort of multi storey building frames with typical columns. Particular of the literatures highlighted on solidification of the surviving buildings in seismic prone areas. This literature journal exposes the extent of exploration work done:
[1] Nikhil1 & Pande (2014), emphases on the numerous kinds of irregularities like floating columns at several levels and locations. Buildings are negatively examined for the upshot of earthquake. Earthquake load as specified in IS 1893 (part 1): 2002 are deliberated in the investigation of building. A G+06 storied building with dissimilar architectural difficulties such as external floating columns, internal floating columns and combination of internal and external floating columns is evaluated for several earthquake zones. In complete study of seismic analysis, serious load combinations are originated out. For these serious load combinations, case wise dissimilarity in several factors like displacements, moments and forces on columns and beams at numerous floor level are associated and significant co-relationship between these values are recognized with graphs. This Building is planned and analyzed with the help of STAAD-Pro Software.
[2] P.V. Prasad &T.RajaSekhar (2014),passed out study on the performance of multi-storey building by and without floating columns under diverse earthquake excitation. The attuned time history and Elcentro earthquake data has stayed. The PGA of mutually the earthquake has been scaled to 0.2g and period of excitation are retained similar. A finite element ideal has been established to revision the dynamic actions of multi-story frame. The vibrant investigation of frame is calculated by changing the column measurement. It is determined that with rise in ground floor column the supreme movement is dipping and base shear differs with the column magnitudes.
[3] Mortezaei (2009) detailed statistics from recent earthquakes which providing indication that ground signals in the nearby field of a shattering burden vary from usual ground motions, as they can comprise a large energy, or ‘‘directivity” thump. This pulse can root substantial harm through an earthquake, particularly to structures with likely periods close to those of the pulse. This may be due to the statistic that these recent structures had been intended chiefly using the design fields of accessible principles, which have been advanced consuming stochastic procedures with relatively extensive period that symbolizes additional detached ground motions. Many freshly designed and constructed buildings may therefore entail firming in order to achieve well when exposed to near-liability ground motions.

[4] Rohilla2015, in this broadsheet necessity of floated columns in very populated zones is assumed, the performance and benefits of floating columns are debated. Although the floated columns are not appropriate for the earthquake lively areas as it doesn’t afford path to the tremor forces to transmit down in the ground. Structure of G+5 and G+7 for zone 2 and 5 having uneven architecture is studied for this paper. Writer resolved that floated column should be ducked in tall upswing building especially in earthquake zone 5 since it hints to storey movement and swelling in the size of beam and columns can expand the asset of building consuming floating columns.

[5] Er. Ashli Rahman (2016), has contemplated a multi-story working by and lacking skimming underpins by utilizing reaction range consider. Different instances of the building are conscious by fluctuating the area of gliding sections floor shrewd and inside the floor. The auxiliary counter of the building models concerning key timeframe, Spectral increasing speed, Base shear, Story float and Story removals is analyzed. The examination is completed utilizing programming STAAD Pro V8i programming. It was distinguished that in structure with coasted segments there is a rise in principal timeframe in both X-bearing just as Z-course as identified with building lacking floated supports. By diagram of coasting sections in a building base shear and otherworldly speeding up reductions. Therefore, it has this handy and efficient benefit over unsurprising development.

[6] Srikanth2014 has accomplished the entire work include of four models i.e., models, FC (skimming segment is on condition that specifically floor, location),FC+4(floating section is passed on by rising stature by 4m), FC+HL(floating

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segment is given by relating overwhelming burden), FC+4+HL(floating segment is given by rising the story tallness by 4m). The plan method services the completely shared procedure that permit displaying, breaking down, structuring. The creator discovered that unpredictable building will experience lash impact under tremor shaking. The model experience less dislodging evaluation for minor zone and goes on ascend for higher zone.

[7] Siddharth Shah (2015), Ended an effort to reveal the enhancements of coasting segment and delicate story in assorted quake zones by seismic examination. For these goals Push over examination is received as this investigation will trim introduction dimension of working for plan capacity (uprooting) left out behind to disaster, it helps reason for disappointment burden and flexibility limit of the structure. To accomplish this fair, three RC exposed edge structures with G+4, G+9, G+15 stories separately are examined and connected the base power and removal of RC uncovered casing structure with G+4, G+9, G+15 stories in different quake zones like Rajkot, Jamnagar and Bhuj utilizing SAP 2000 14 investigation document. The outcomes show that, the development of building floods from lower zones to higher zones, base shear accomplished from weakling investigation is plentiful going with than the base shear achieved from the identical static examination.

[8] Patil 2013, In this paper the RC building G+5 storey is revealed for seismic analysis. Three different models, normal structure, shear wall and masonry infill walls are evaluated and equated. Technique used for the analysis is correspondent static method, response spectrum method and time history method. E-tabs software is castoff for analyzing the factors. The decision of this paper, multi-storey building with shear wall performance best in earthquake among the three models.

[9] Malaviya2014 has cautious the reverberation on the cost analysis of structures design on Staad Pro. A 15m X 20m G+1 even structure building with floating column and without floating columns is deliberated for the revision established on modeling analysis, design and estimation of the structure the writer determined that the mass of concrete and steel is added in the case of structure by floated columns than the building lacking floated columns and with the deviation of placing of floating column, the quantity steel and concrete is also reformed.

3. METHOD OF ANALYSIS

3.1 LINEAR STATIC;

Linear analysis methods spring a clad proposition of flexible ability of the structures and specify where first resilient will rise. The linear static technique of analysis is limited to stunted, consistent buildings. Structural analysis is the method to evaluate a structural system to prediction its retorts and actions by using physical rules and mathematical calculation. The foremost detached of structural analysis is to govern core forces, stresses and deformation of structures under numerous load effect. Equivalent Lateral force technique is one in which all the lateral masses at each floor are planned substantially. Then the structure performance is recognized by smearing the lateral masses acting at every story in X and Y directions. These lateral loads are designed by bearing in notice the various factors comparable the Response reduction factor(R), Zone factor (Z), Importance factor (I), Horizontal acceleration coefficient (Ah), Structural response factor (Sa/g) and Total seismic weight of building (W) as per the IS code 1893-2002.

3.2 LINEAR DYNAMIC;

Dynamic analysis of structure is a part of structural analysis in which behavior of flexible structure subjected to dynamic loading is studied. Dynamic load always changes with time. Dynamic load comprises of wind, live load, earthquake load etc. Thus, in general we can say almost all the real-life problems can be studied dynamically. If dynamic loads changes gradually the structure's response may be approximately calculated by a static analysis in which inertia forces can be neglected. But if the dynamic load changes quickly, the response must be determined with the help of dynamic analysis in which we cannot neglect inertial force which is equal to mass time of acceleration (Newton's 2nd law).

Mathematically F = M x a

Where F is inertial force,

M is inertial mass and

a is acceleration.

Additionally, dynamic response (displacement and stresses) are generally far sophisticated than the compliant static shifts for similar loading amplitudes, particularly at booming situations. The actual physical structures have many numbers of displacements Therefore the utmost grave part of structural analysis is to create a computer model, with the predictable number of mass less member and finite number of shift of nodes which feigns the real behavior of structures. Another tough fragment of dynamic analysis is to analyze energy degeneracy and to boundary condition. So, it is very problematic to investigate structure for wind and seismic load. This exertion can be condensed using several programming systems.

3.3 TIME HISTORY ANALYSIS;

A linear time history analysis disables all the drawbacks of modal response spectrum analysis, provided non-linear activities is not complex. This way necessitates greater computational exertions for scheming the response at distinct time. One interesting benefit of such practice is that the comparative symbols of retort abilities are conserved in the response histories. This is significant when interface effects are reflected in design among stress resultants. Here dynamic response of the plane frame model to quantified time history well-suited to IS code spectrum and Elcentro (EW) has been assessed.

The equation of motion for a multi degree of freedom system in matrix form can be conveyed as

$[mm]\{x\ddot{x}\}+ [cc]\{x\dot{x}\}+[kk]\{xx\}=-xxg\ddot{g}(tt)[mm]\{II\}$

Where, $[mm]$= mass matrix

$[kk]$= stiffness matrix

$[cc]$= damping matrix

$\{II\}$= unit vector

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$$m = [T^T]\,[m_e]\,[T]$$

$$[m_e] = \frac{\rho A L}{420}\begin{bmatrix} 140 & 0 & 0 & 70 & 0 & 0 \\ 0 & 156 & 22L & 0 & 54 & -13L \\ 0 & 22L & 4L^2 & 0 & 13L & -3L^2 \\ 70 & 0 & 0 & 140 & 0 & 0 \\ 0 & 54 & 13L & 0 & 156 & -22L \\ 0 & -13L & -3L^2 & 0 & -22L & 4L^2 \end{bmatrix}$$

$$[T] = \begin{bmatrix} C & S & 0 & 0 & 0 & 0 \\ -S & C & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & C & S & 0 \\ 0 & 0 & 0 & -S & C & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$\ddot{x}_g(t)$= ground acceleration

The mass matrix of every component in global route can be initiate out using following manifestation:

The resolution of comparison of motion for any itemized forces is tough to succeed, primarily due to link variables {x} in the fleshly coordinate. In genre superposition analysis a group of normal coordinates i.e. principal coordinate is distinct, such that, when uttered in those coordinates, the equations of motion suits undid. The physical coordinate {x} may be linked with normal or principal coordinates {q} from the alteration expression as,

$\{x\}$ = [Φ] { }

[Φ] is the modal matrix

Time derivative of { } are, $\{\dot{x}\}$ = [Φ] $\{\dot{q}\}$

$\{\ddot{x}\}$ = [Φ] $\{\ddot{q}\}$

Switching the time derivatives in the equation of motion, and pre-multiplying by [Φ]T results in,

$[\Phi]^T[m][\Phi]\{\ddot{q}\}+[\Phi]^T[c][\Phi]\{\dot{q}\}+[\Phi]^T[k][\Phi]\{q\}=(-\ddot{x}_g(t)[\Phi]^T[m]\{I\})$

Further clearly it can be signified as follows: $[M]\{\ddot{q}\}+[C]\{\dot{q}\}+[K]\{q\}=\{P_{eff}(t)\}$

Where, $[M]=[\Phi]^T[m][\Phi]$

$[C]=[\Phi][c][\Phi] = 2\,\zeta\,[M]\,[\omega]$

$[K]=[\Phi][k][\Phi]$

$\{P_{eff}(t)\}=(-\ddot{x}_g(t)[\Phi]^T[m]\{I\})$

[M], [C] and [K] are the diagonalized modal mass matrix, modal damping matrix and modal stiffness matrix, respectively, and {Peff(t)} is the operative modal force vector.

3.4 RESPONSE SPECTRUM ANALYSIS;

Response-spectrum analysis (RSA) is a linear-dynamic statistical analysis technique which pacts the stimulus from corresponding unusual approach of vibration to specify the likely maximum seismic response of a mainly elastic structure. Response-spectrum analysis contributes vision into dynamic comportment by measuring pseudo-spectral acceleration, velocity, or displacement as a utility of structural period for a specified time history and level of curbing. It is practical to wrap response spectra such that a smooth curve signifies the crowning response for every gratitude of structural period. Response-spectrum analysis is preferable for design decision-making as it relays structural type-selection to dynamic show. Response spectra aids to attain the topmost structural response under linear range, which can practice to acquire lateral forces advanced owing to tremor, thus enables in seismic impervious design of structure.

According to IS 1893-2002 the Response spectrum curve is given as;

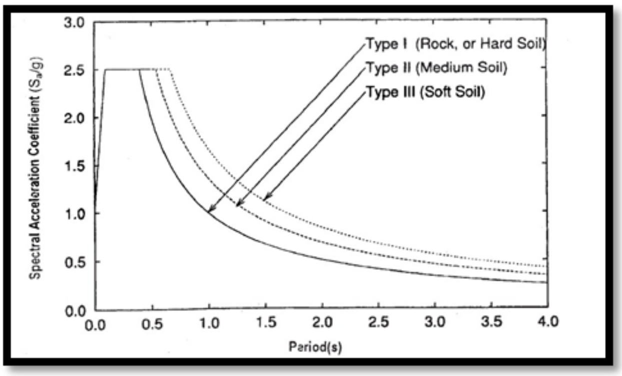

Fig 3.1: Response Spectrum Curvature

4. DESCRIPTION OF STRUCTURE

A computational study was carried out using the ETABS 16.0.1software. The models were used to study effect of floating column. There are 4 model has workout, in which model 1 regular building without floating column and model 2 is same building with extreme columns are floated. Whereas, model 3 is same building with intermediate columns are floated and model 4 has the same building with extreme columns are floated and shear wall at the middle is introduced. The plan layout of the G+10 building is shown in the figures. The plan dimension and height of each storey is kept same throughout the project in all models and present the data of all models in tabulated and line graph form. Model was made by using M-30 grade concrete and Fe500 grade rebar are used for Slabs, Beams, columns. Seismic zone factor is considered as 0.10 as it comes under zone II, response reduction factor is considered as 5. Importance factor is considered as 1.5 as per IS1893.Time period is calculated with and without floating columns. Analysis Special Moment Resisting Frame type is carried out on G+10 building with a dimension of 12m x 15m and typical storey height of 3.15m. Rectangular Column of 350mm x 600mm and Beam of 300mm x 450mm.Adopting slab thickness as 125mm and wall thickness as 200mm and shear wall thickness as 230mm.By considering all earthquake and wind load combination and it checked for same load combination as per IS codes. Loads such as live load, floor finish load, wall load are adopted as 3KN/m2, 1KN/m2 and12.5KN/m2, respectively and dead load too is adopted as per IS 456; 2000.All other Earthquake loads as per IS 1893.Unite weight of RCC and unite weight of masonry are 30KN/m2 and 20 KN/m2 respectively.

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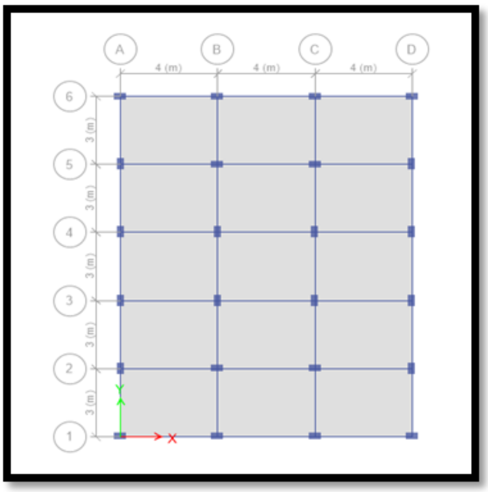


Fig 4.1: PLAN OF THE BUILDING

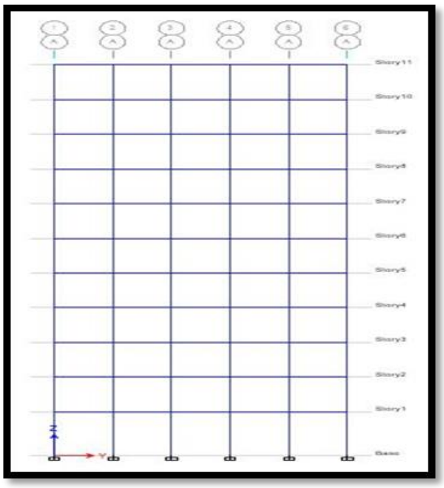


Fig4.2: ELEVATION

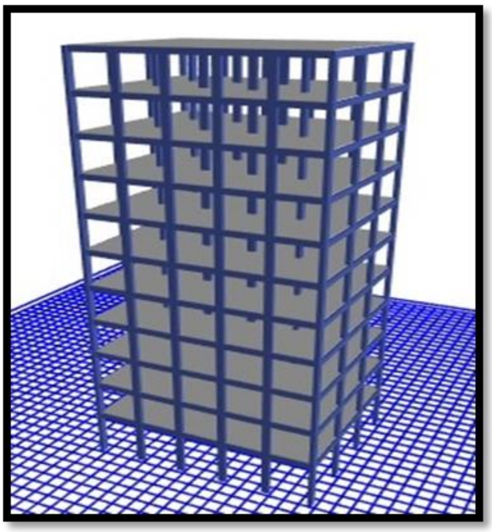


Fig4.3: 3D EXTRUDE VIEW

5. MODELLING OF STRUCTURE

5.1 SOFTWARE SYNOPSIS;

Modeling tools and templates, code-based load prescriptions, analysis procedures and solution techniques, all coordinate with the grid-like geometry exclusive to this class of structure. Basic or radical systems under static or dynamic conditions may be assessed using ETABS. For a sophisticated assessment of seismic performance, modal and direct-integration time-history investigates may couple with P-Delta and Large Displacement effects. Nonlinear links and concentrated PMM or fiber hinges may capture material nonlinearity under monotonic or hysteretic behavior. Intuitive and united sorts so buses of any complexity useful to appliance. ETABS categories persuasive and totally integrated basics for plan of equally steel and reinforced concrete structures. The program affords the manipulator with selections to generate, adapt, consider and plan structural models, all from within the similar operator interface. The program delivers cooperating atmosphere in which the operator can revise the stress conditions, sort appropriate deviations, such as revising member properties, and re-examine the results short of the essential to re-run the analysis. The yield in together graphical and tabulated presentations can be gladly printed. In this project seismic analysis of six dissimilar models is evaluated using E-TABS-2015. The assessments of outcomes are in terms of storey displacement, Storey drift, lateral forces, Fundamental Time period, storey shear, modes shapes etc.

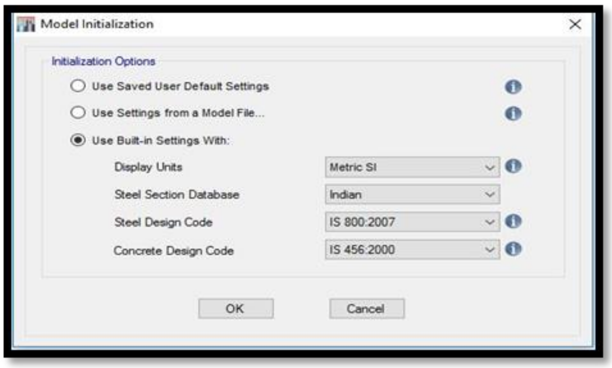
5.2 PROCEDURE FOR STRUCTURAL MODELLING IN E-TABS IS GIVEN BELOW:

STEP1: LAYING OF MODEL WITH TEMPLATE

Step: 1.1:

Select Start New Model using Template and select **"Use Built-In Settings with"** and select

Display Units : Metric SI
Steel Section Data Base : Indian
Steel Design Code : IS 800:2007
Concrete Design Code : IS 456:2000



Step 1.2: Enter the Grid and Story Dimensions in storey data sheet and click on **Custom Grid Spacing** then **Click on Edit Grid Data**

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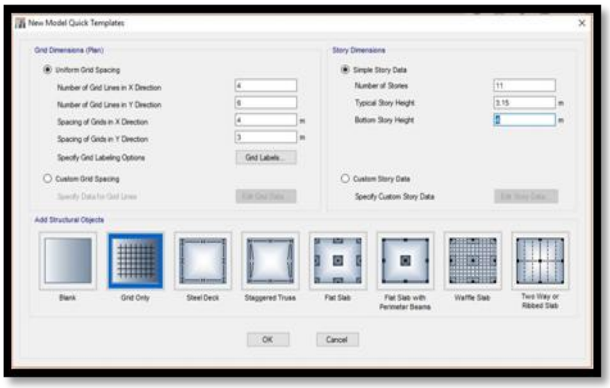
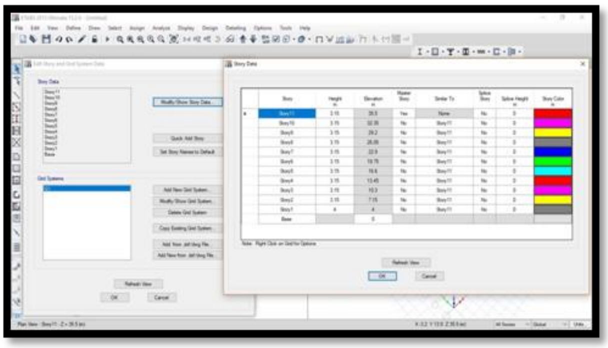
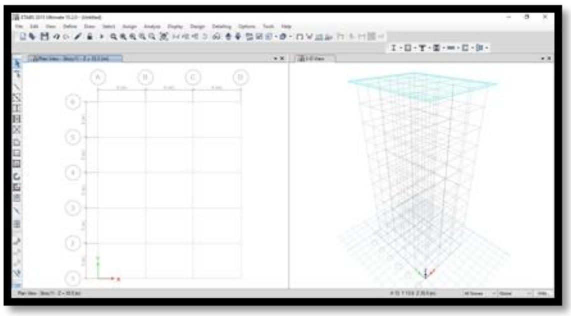




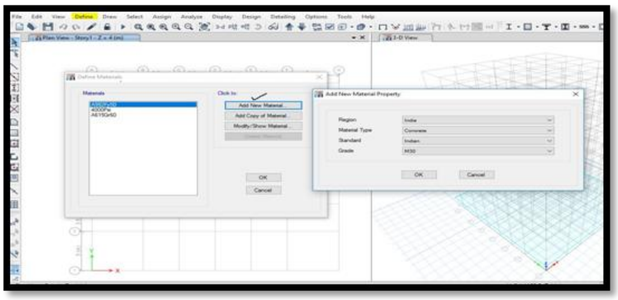
Observing story and grid system data as shown in fig above; Plan Grid layout and 3D layout of model are created as shown in figure below;



STEP 2: DEFINE MATERIAL PROPERTIES

Step 2.1:Define >> Material Properties >> Add New Material

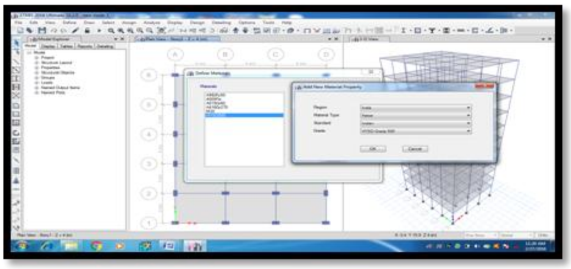
Enter the details as shown in figure below for Concrete then click on "OK".



Step 2.2:

Define >> Material Properties >> Add New Material

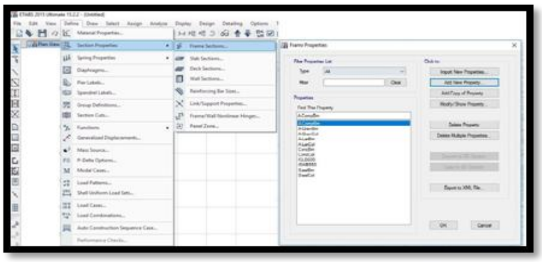
Enter the details as shown in figure below for **Rebar** then click on **"OK".**



STEP 3: DEFINE SECTION PROPERTIES

Step 3.1: Defining of Beam Property

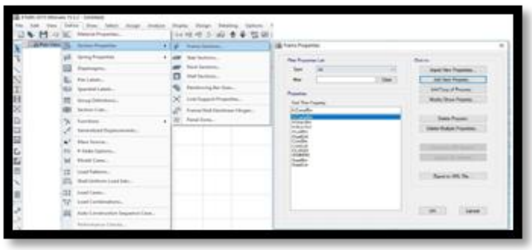
Define >> Section Properties >> Frame Sections >> Add New Property



Enter the Beam section properties as shown in figure below and click on **"Modify/show Rebar"** to enter reinforcement details for Beam as shown in figure below then click on "OK"

Step 3.2: Define of Column Property

Define >> Section Properties >> Frame Sections >> Add New Property



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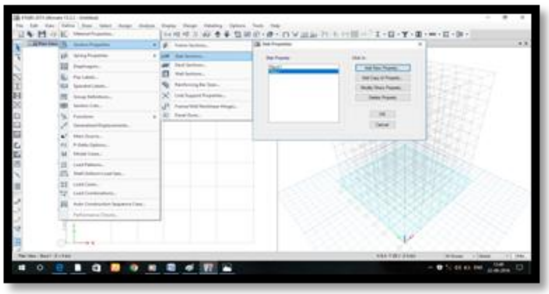
Enter the Column section properties as shown in figure below and click on **"Modify/show Rebar"** to enter reinforcement details for Column as shown in figure below then click on "OK"

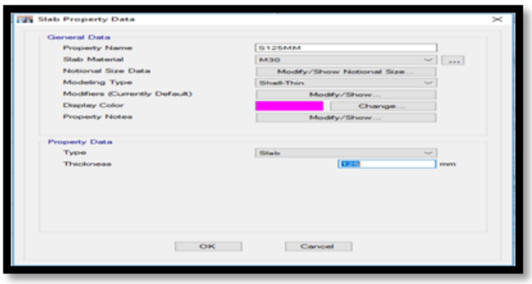
Step 3.3:

Define of Slab Property

Define >> Section Properties >> Slab Sections >> Add New Property



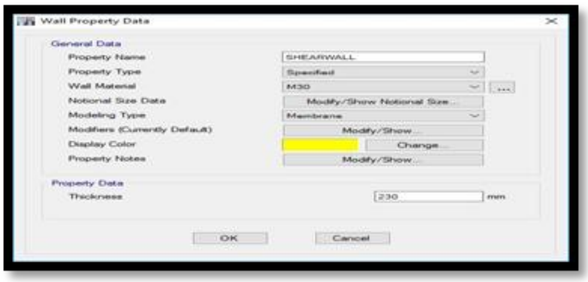
Specify slab section properties as shown in figure below;



Step 3.4: Define of Shear wall:

Define >> Section Properties >> Wall Sections >> Add New Property

Enter the Shear Wall section properties as shown in figure below and click on "**OK**

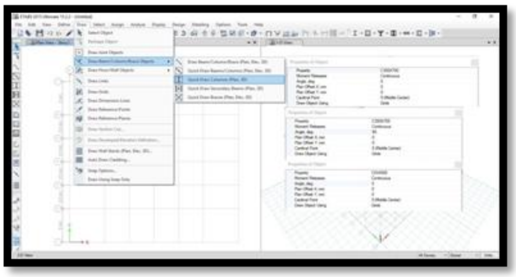


STEP4: DRAWING OF COLUMNS /BEAMS /SLABS/ SHEAR WALL:

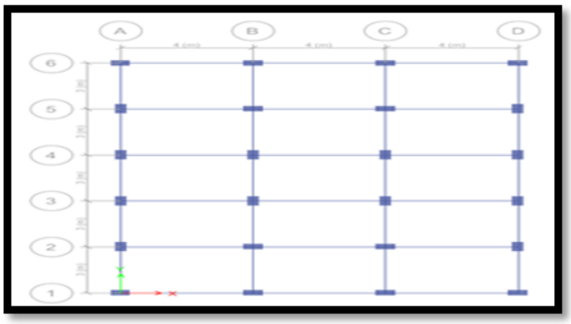
Step 4.1: Placing & Orientation of Columns

Draw >> Draw Beam/Column/Brace Objects >> Quick Draw Columns (Plan, 3D)

Select the property type of column and place the columns where ever necessary according their Orientation, Properties, Shape as shown in below figure,



Placed columns are shown below;

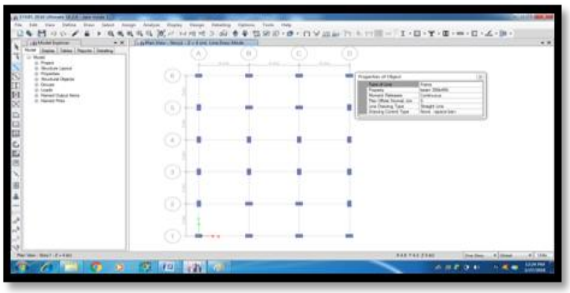


Step 4.2: Drawing of Beam

Draw >> Draw Beam/Column/Brace Objects >> Quick Draw Beams/Columns (Elev,Plan,3D)

Select the property type of Beam (Ex: B300x450) and Place them where ever necessary according as shown in below figure

Drawn Beams are shown in below figure:



Step 4.3: Drawing of Slabs

Draw >> Draw Floor/Wall Objects >> Quick Draw Floor/Wall (Plan, Elev)

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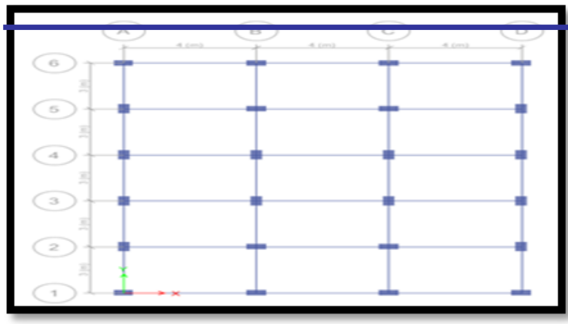
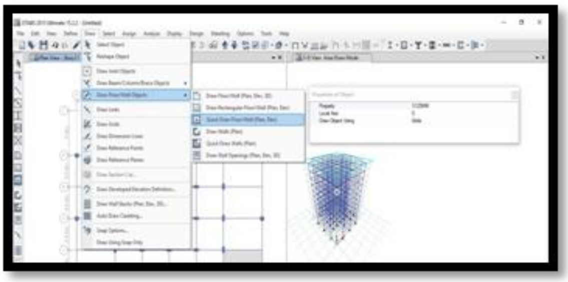
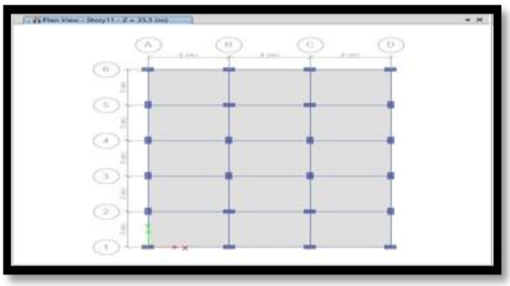


Select the property type of Slab (EX. S125MM) and Place them where ever necessary according as shown in below figure**:**



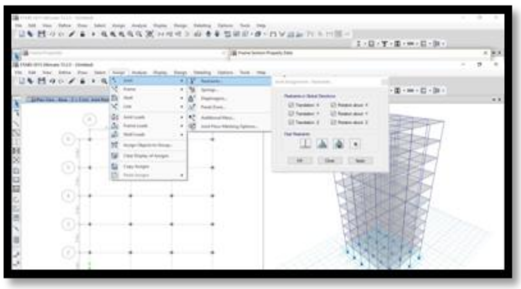
Drawn Slabs are shown in below figure:



Step 4.4: Go to the **"Base Plan"** and select all the slabs and Delete them and see that modify storey is kept to "One Storey" only.

STEP 5: ASSIGNING OF SUPPORTS:

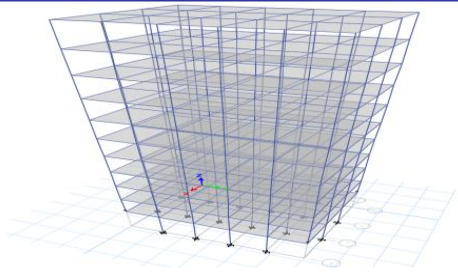
Go to the "Base Plan" and select all the joints and Go to **Assign >>Joint >> Restraints >> Select Fixed Support >> Apply >> Ok**



STEP6:RELEASING OF PARTIAL FIXITY OF MEMBERS

Go to the "Storey Plan 1" and "Storey Plan 2" and select the frames and Go to

Assign >> Frame >> Releases/Partial Fixity >> Release At Start/End >> Apply Ok



CHECK: Analyze >> Check Model >> Select All >>Ok

See that there are warning message is displayed and if so move on to next step.

STEP 7: DEFINING OF LOAD PATTERNS

The Dead Load and Live Load are auto defined, if not define them and define Superimposed dead load as below

Step 7.1: Defining of SIDL:

Define >> Load Pattern >> SIDL >> Super Dead >> Multiplier "0" >> Add New Load >> Ok

Step 7.2: Defining of Earthquake Loads:

Step 7.2.1: Earthquake Load in X –Direction.

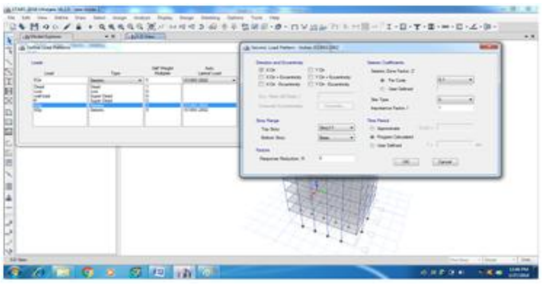
Define >> Load Pattern >> EQX >> Seismic >> Multiplier "0" >>select Auto lateral Load as **IS 1893 2002** >>Click on **Add New Load >> Ok**

Select **EQX** >>Click on **Modify Lateral Load** I**ndirection& Eccentricity Box** select only **X-Direction** and **Deselect all**

Step 7.2.2: Earthquake Load in Y –Direction

Define >> Load Pattern >> EQY >> Seismic >> Multiplier "0" >>select Auto lateral Load as **IS 1893 2002** >>Click on **Add New Load>> Ok**

Select **EQY** >>Click on **Modify Lateral Load** I**ndirection& Eccentricity Box** select only **Y-Direction** and **Deselect all**

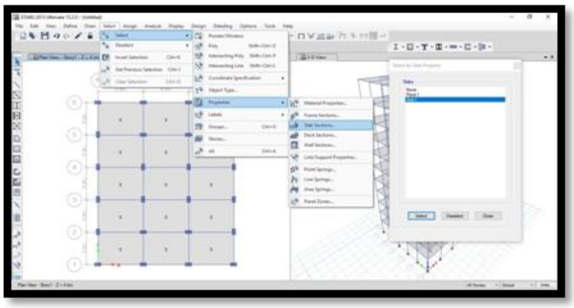


STEP 8: ASSIGNING OF LOADS

Step 8.1: Assigning of Loads to Shell Sections

Step 8.1.1: For Live Load

Go to **Select >> Properties >> Slab Sections >> S125MM >> Close**



Go to **Assign>> Shell Loads >> Uniform >> Shell Load Assignment**

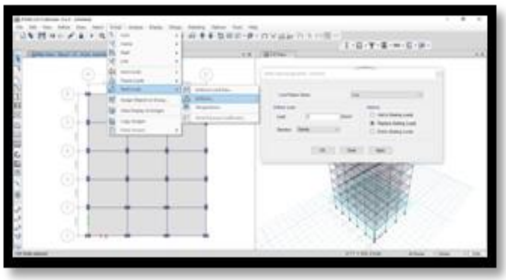
Enter the details as shown below for Live Load:

Load Pattern Name : Select **Live**

Load : Enter **3Kn/m²**

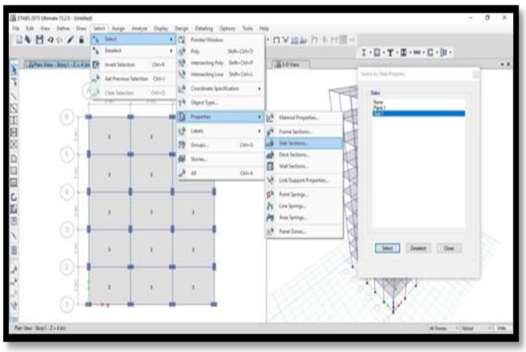
Load Direction : **Gravity**

Select **Replace to Existing/Add to Existing.>>Apply >> Ok**



Step 8.1.2: For Super Imposed Dead Load

Go to **Select >> Properties >> Slab Sections >> S125MM >> Close**



GO to **Assign>> Shell Loads >> Uniform >> Shell Load Assignment**

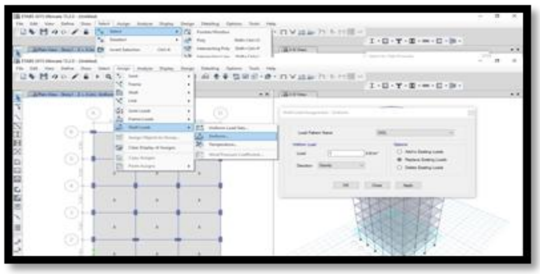
Enter the details as shown below for Superimposed Dead Load:

Load Pattern Name : Select **SIDL**

Load : Enter **1KN/m²**

Load Direction : **Gravity**

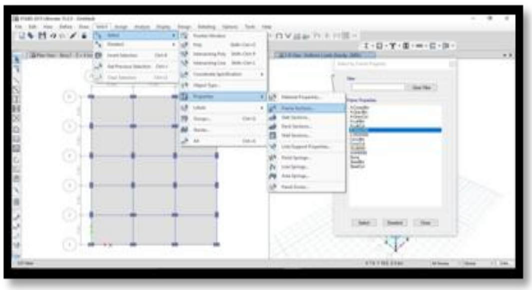
Select **Replace to Existing/Add to Existing>>Apply >>OK**



Step 8.2: Assigning of Loads to Frame Sections

Step 8.2.1: For Live Load

Go to **Select >> Properties >> Frame Sections >> B300X450 >> Close**



Go to **Assign>> Frame Loads >> Distributed >> Frame Load Assignment**

Enter the details as shown below for Superimposed Dead Load:

Load Pattern Name : Select **Wall Load**

Load Type : **Forces**

Load Direction : **Gravity**

Uniform Load : Enter **12.5Kn/m²**

Select **Replace to Existing/Add to Existing.>>Apply >> Ok**

STEP 9: LOAD COMBINATIONS

Go to Define>> **Load Combinations** >>Select **Add Default Design Combination** >>Select **Concrete Frame Design >> OK**

STEP 10: Define of Mass Source:

Go to Define>>**Define**>>Select **Mass Source**>>Select **Add New Mass Source.**

Enter the details as shown:

Mass Source Name: MS Src2,

Mass Multipliers for Load Patterns: Add: Load Pattern: **Dead, Multiplier: 1**

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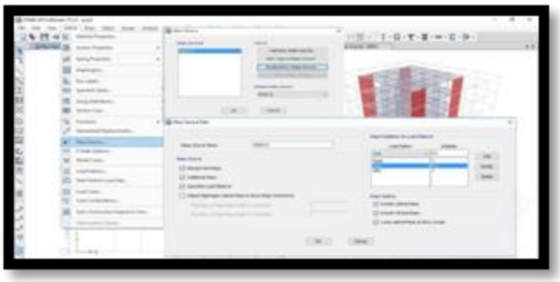
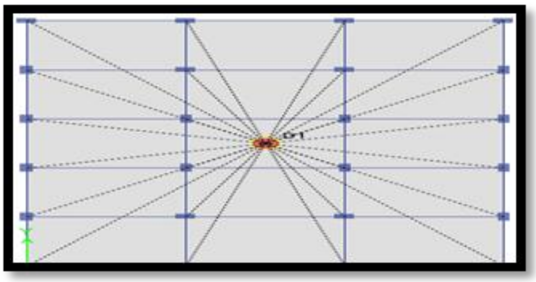
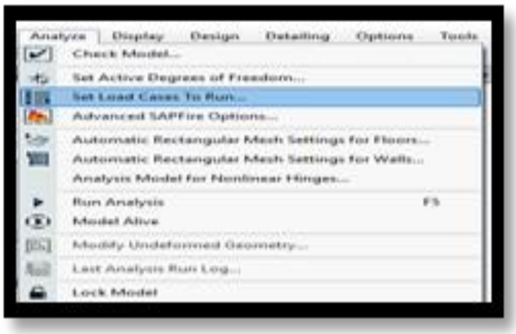
Add: Load Pattern: **SIDL,** Multiplier**: 1**
Add: Load Pattern: **Live,** Multiplier**: 0.25**
Change default mass source to MsSrc2 and Select the previous mass source and delete it.

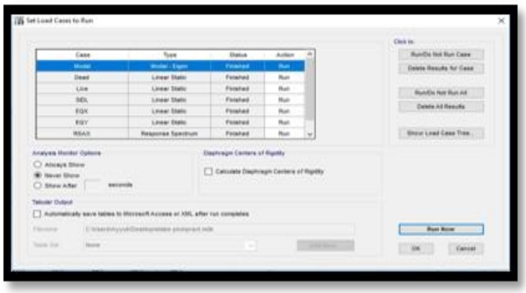


STEP 11: DIAPHRAGM ASSIGNING
Go to Select >> Object Type >> Floors
Go to Define>> **Assign** >> **Shell** >> select **Diaphragms** >>select **D1** >> **Apply** >> **OK.**

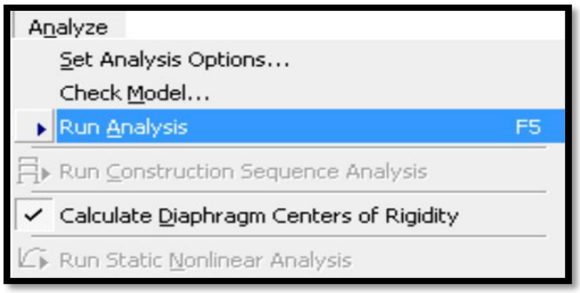


STEP 12: MODEL ANALYSING
Go to **Analyze** >>Select **Set Load Cases To Run** >> **Run Now** >> **OK**





Run analysis from **Analysis > Run Analysis command**



CHECK ANALYSIS >> check model >>select all >> ok
See that are warning message is displayed

5.3BUILDING MODELS DESCRIPTION

5.3.1 MODEL 1:

It is the bare frame model in which the weights of the masonry wall of 230mm thick have been assigned on all over the beams.
The above procedure has been analyzed for Model 1.

5.3.2 MODEL 2:

This model is same as Model 1 in addition the extreme corner columns of ground storey have been removed or floated.
The following procedure will analyze the Model 2:
i) Open the ETABS Program
ii) Click the **File** menu >**Open** > **MODEL 1**
iii) Set the main window to Elevation View
iv) Remove the Corner Columns to Float from Base Story
v) Select the Floating Columns > **Assign** > **Frame** > **Releases/Partial Fixity** >**OK**
to assign fixed support
vi) Go to Select > Object Type > Floors >
Go to Define> **Assign** >**Shell** > Select **Diaphragms** >Select **D1** >> **Apply** >> **OK.**
vii) Go to Analyze > Check Model
viii) Go to Analyze > Run
ix) Save the MODEL 1 file to Save As (MODEL 2).
The following figures have been resultant from E-tabs

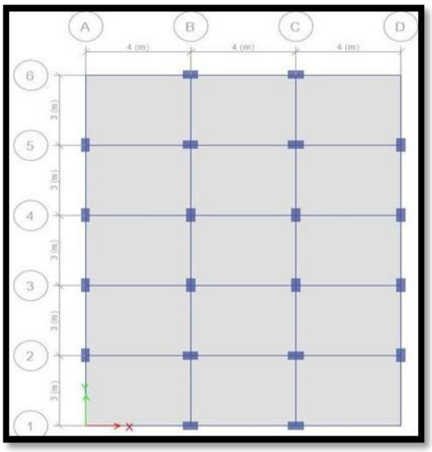


Fig-5.1: PLAN

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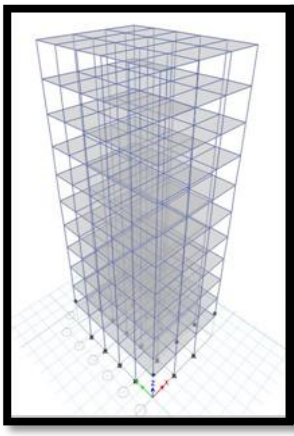


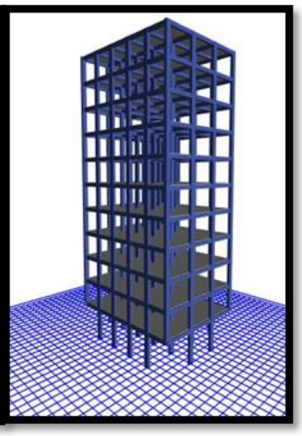


Fig-5.2: 3D VIEW **Fig-5.3: EXTRUDE VIEW**

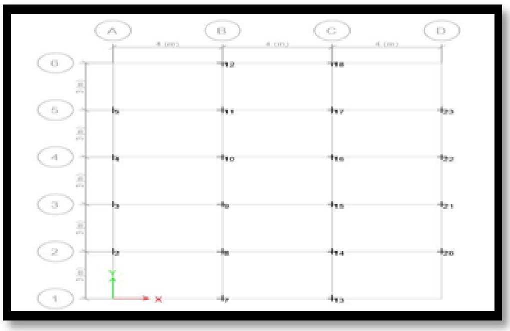


Fig-5.4: COLUMN NUMBERING

5.3.3 MODEL 3:

This model is same as Model 1 in addition to middle columns outer periphery of ground storey have been removed or floated.

The following procedure will analyze the Model 3 :

i) Open the ETABS Program
ii) Click the **File** menu >**Open > MODEL 1**
iii) Set the main window to Elevation View
iv) Remove the Centre Columns to Float from Base Story
v) Select the Floating Columns > **Assign > Frame > Releases/Partial Fixity >OK**
to assign fixed support
vi) Go to Select > Object Type > Floors >
Go to Define> **Assign >Shell** > Select **Diaphragms** >Select **D1 >> Apply >> OK.**
vii) Go to Analyze > Check Model
viii) Go to Analyze > Run
ix) Save the MODEL 1 file to Save As (MODEL 3).

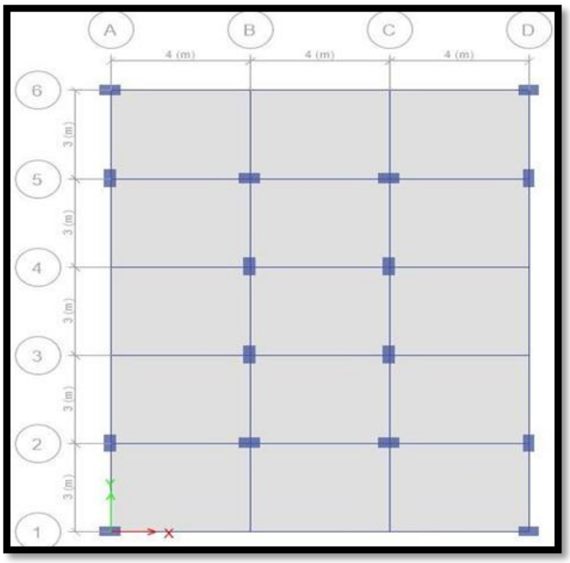
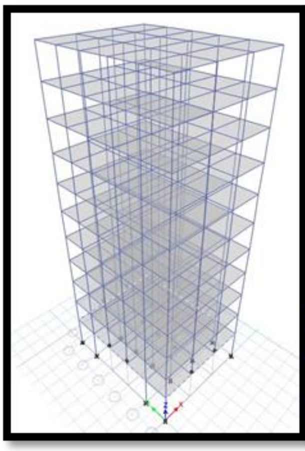


Fig-5.5: PLAN



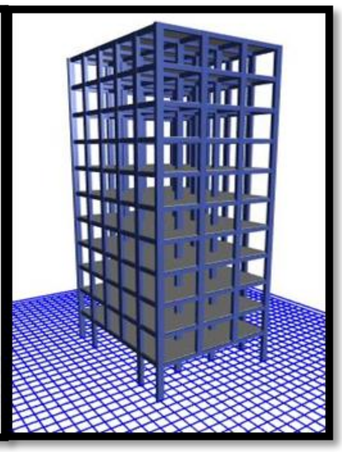


Fig-5.6: 3D VIEW **Fig-5.7: EXTRUDE VIEW**

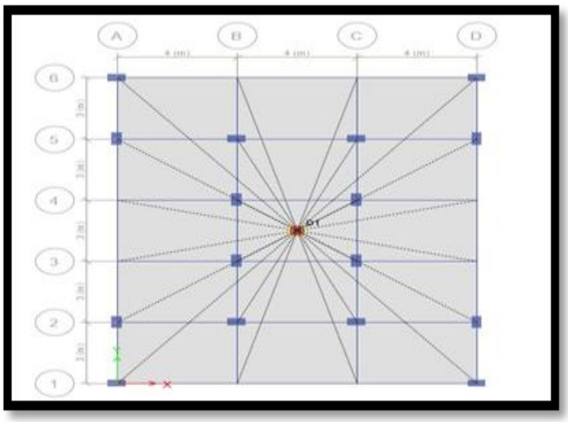


Fig-5.8: DIAPHRAGM VIEW

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5.3.4 MODEL 4:

This model is same as Model 1 in addition the extreme columns of ground storey have been removed or floated and the lift at the Centre of the building.

The following procedure will analyze the Model 5 :

i) Open the ETABS Program
ii) Click the **File** menu >**Open > MODEL 1**
iii) Set the main window to Elevation View
iv) Remove the Extreme Columns to Float from Base Story
v) Select the Floating Columns > **Assign > Frame > Releases/Partial Fixity >OK**
to assign fixed support
vi) Define Shear Wall:
Define > Section Properties > Wall Sections > Add New Property
vii) Go to **Select > Object Type > Floors >**
Go to Define> **Assign >Shell** > Select **Diaphragms** >Select **D1 > Apply > OK.**
viii) Go to **Analyze > Check Model**
ix) Go to **Analyze > Run**
x) Save the MODEL 1 file to Save As (MODEL 5).

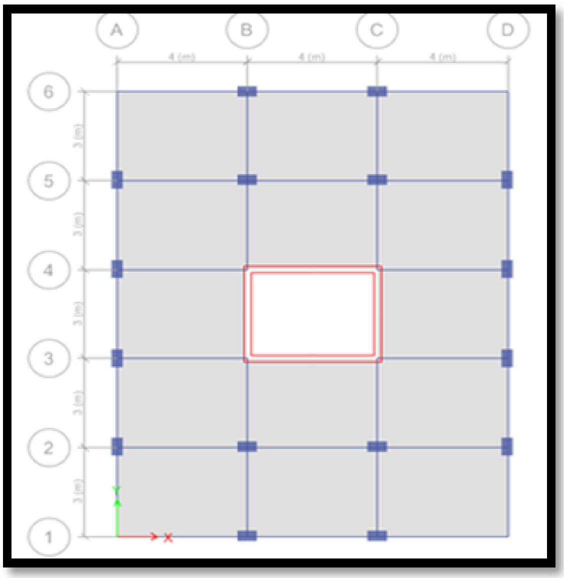
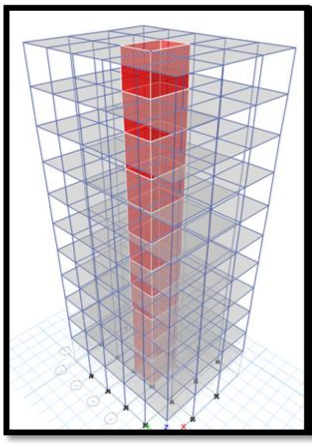


Fig-5.9: PLAN



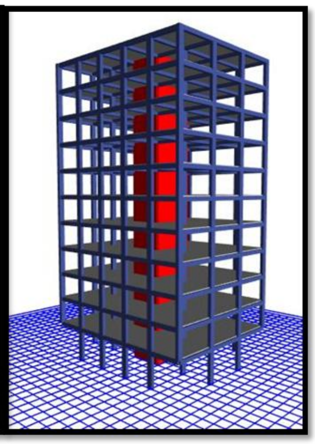


Fig-5.10: 3D VIEW **Fig-5.11: EXTRUDE VIEW**

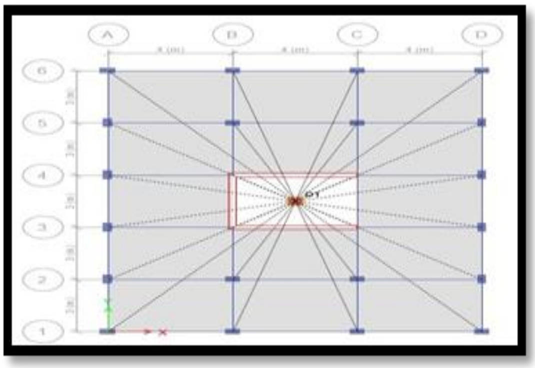


Fig-5.12: DIAPHRAM

6.RESULTS AND DISCUSSIONS

6.1 GENERAL

In this chapter we will debate around the outcomes which we attained from ETABS after evaluating the models and results have been specified in a tabular system and graphical illustration for well empathetic.

The Following features have been considered and the results are selected from the computer program

- Storey Displacement
- Storey Drift
- Base shear
- Fundamental Time Period
- Mode Shapes

6.1.1 STOREY DISPLACEMENT:

Storey displacement is the lateral effort of the building produced by lateral force. The bent shape of a building is utmost vital and most visibly point of evaluation for any building. No other factor of assessment can contribute a superior idea of activities of the structure than comparison of storey displacement. The Displacement should be identical less in a structure or else the structure may ruin and the entire strength will be condensed and there will be no human comfort.

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Storey level	MODEL 1	MODEL 2	MODEL 3	MODEL 4
	UX	UX	UX	UX
STOREY1	1.661	1.955	2.282	0.402
STOREY2	3.368	3.837	4.371	1.07
STOREY3	5.113	5.656	6.153	1.957
STOREY4	6.856	7.457	7.874	3.005
STOREY5	8.565	9.221	9.554	4.163
STOREY6	10.203	10.918	11.169	5.383
STOREY7	11.73	12.51	12.682	6.629
STOREY8	13.101	13.955	14.052	7.869
STOREY9	14.263	15.205	15.232	9.078
STOREY10	15.164	16.212	16.174	10.245
STOREY11	15.774	16.95	16.85	11.359

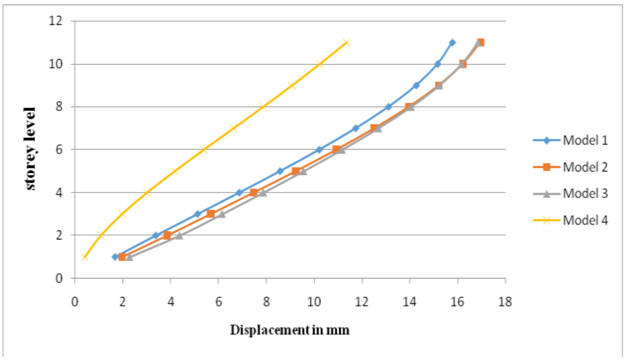

Table No-1 & Chart No- 1;
Displacement in Longitudinal Direction

storey level	MODEL 1	MODEL 2	MODEL 3	MODEL 4
	UY	UY	UY	UY
STOREY1	1.621	1.736	2.193	0.469
STOREY2	3.129	3.39	4.034	1.222
STOREY3	4.648	5.021	5.608	2.202
STOREY4	6.163	6.637	7.141	3.333
STOREY5	7.648	8.22	8.64	4.556
STOREY6	9.073	9.744	10.082	5.82
STOREY7	10.403	11.175	11.436	7.083
STOREY8	11.596	12.478	12.668	8.314
STOREY9	12.609	13.612	13.737	9.489
STOREY10	13.394	14.533	14.6	10.598
STOREY11	13.914	15.209	15.224	11.637

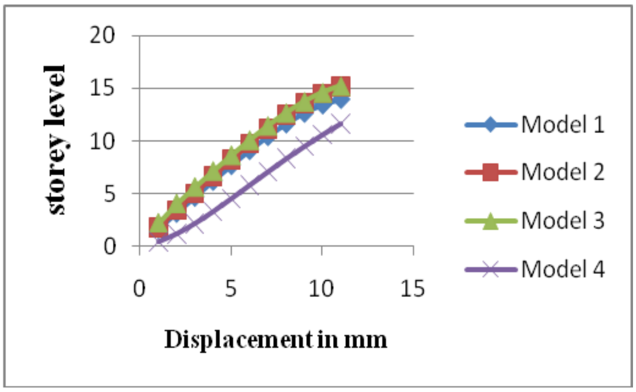

Table No-2 & Chart No- 2;
Displacement in Transverse Direction

It can be understood from overhead figures, the displacement of the storey of buildings is reduced by developing MODEL-4.The displacement in Model-2 has been observed by 10 % increase by Model-1, Model-3 has been increased by11% Model-4 has been condensed by 83%.
According to this work, the drop of displacement of stories is due to rise of stiffness of structure as well as decline of velocity and acceleration of structure. In other words by generating the MODEL-4, the retort of structure such as velocity and acceleration can be condensed and it is the reason of drop of displacement.

On detecting, displacements at the whole storey in the MODEL-3 are more than those in other model. Here as one can see displacements deepest in end stories, very great at the higher stories. The displacement is of interest with favor to structural stability, strength and human comfort. The displacement of MODEL-3 is more than the other model. It means that Structure is more even chance of Structural Strength reduction is less. Human comfort is good.

6.1.2STOREY DRIFT

Storey drift is the drift of one level of a multistory building comparative to the below level. Intermediate story drift is the variance amongst the roof and floor displacements of any specified story as the structure influences through the tremor, stabilized by the story height. For example, for a 10foot high story, an inter-story drift of 0.10 specifies that the roof is displaced one foot in relation to the floor below.
The larger the drift, the larger the likelihood of destruction. Crowning inter story drift values larger than 0.06 designates ark destruction, while values larger than 0.025 specify that the destruction could be stern enough to posture a serious hazard to human safety. Values in excess of 0.10 indicate likely building downfall. According to I.S 1893 -2002 permissible storey drift is equals to 0.004 times height of storey.

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Storey Level	MODEL 1	MODEL 2	MODEL 3	MODEL 4
	UX	UX	UX	UX
STOREY 11	0.000129	0.000156	0.000143	0.000236
STOREY 10	0.000191	0.000213	0.000199	0.000247
STOREY 9	0.000246	0.000265	0.00025	0.000256
STOREY 8	0.00029	0.000306	0.00029	0.000262
STOREY 7	0.000323	0.000337	0.00032	0.000264
STOREY 6	0.000347	0.000359	0.000342	0.000258
STOREY 5	0.000362	0.000373	0.000356	0.000245
STOREY 4	0.000369	0.000381	0.000364	0.000222
STOREY 3	0.000369	0.000385	0.000377	0.000188
STOREY 2	0.000361	0.000398	0.000442	0.000141
STOREY 1	0.000277	0.000326	0.00038	6.70E-05

Table No-3 Storey Drift in Longitudinal Direction

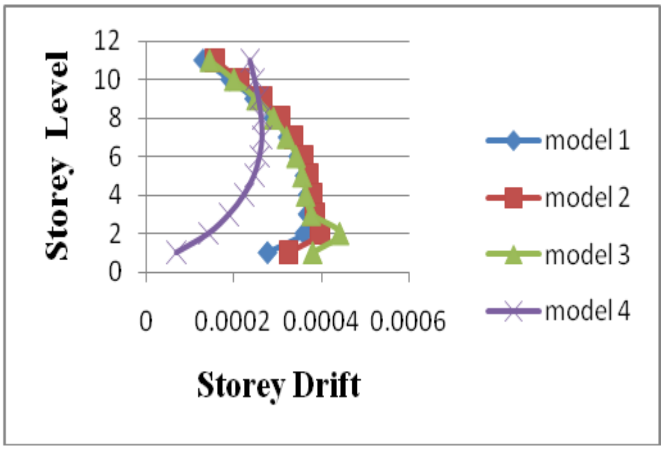

Chart No- 3 Storey Drift in Longitudinal Direction

Storey level	MODEL 1	MODEL 2	MODEL 3	MODEL 4
	UY	UY	UY	UY
STOREY 11	0.00011	0.000143	0.000132	0.00022
STOREY 10	0.000166	0.000195	0.000183	0.000235
STOREY 9	0.000214	0.00024	0.000226	0.000249
STOREY 8	0.000253	0.000276	0.000261	0.000261
STOREY 7	0.000281	0.000303	0.000287	0.000267
STOREY 6	0.000302	0.000322	0.000305	0.000267
STOREY 5	0.000314	0.000335	0.000317	0.000259
STOREY 4	0.000321	0.000342	0.000324	0.000239
STOREY 3	0.000322	0.000345	0.000333	0.000207
STOREY 2	0.000319	0.00035	0.00039	0.000159
STOREY 1	0.00027	0.000289	0.000365	7.80E-05

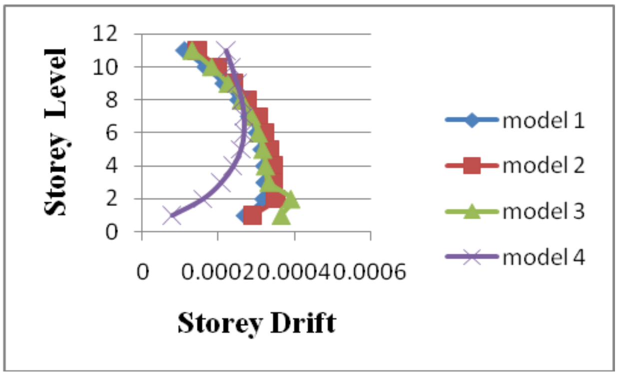

Table No-4 & Chart No- 4;
Storey Drift in Transverse Direction

When we study Model 1,2,3 we conclude that the storey with floating columns are very much flexible in transferring the inertia forces generated by seismic loading. Storeys with floating columns are always weak so therefore special concentration should be given when we are handling any floating columns. Storey drift analysis of Model 4 is less when compared to Model 1, 2, 3.

Models	TIME PERIOD IN SEC		
	Mode 1	Mode 2	Mode 3
Model 1	1.711	1.521	1.349
Model 2	1.836	1.641	1.411
Model 3	1.875	1.695	1.485
Model 4	1.065	1.012	0.755

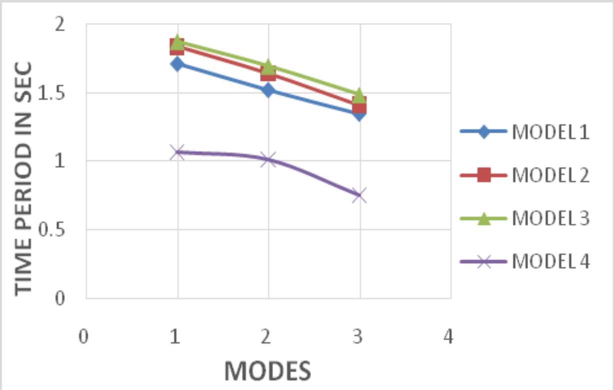

Table No-7& Chart No-7;
Modes VS time period .

The fundamental natural time period is huge enough for Model 3 when we compare with mathematical models. Model 4 showing substantially least amount of fundamental natural time period for all the 3 modes of the building. Therefore, we can conclude the fundamental natural time period drastically reduce when we consider the impact of vertical and lateral stiffening elements.

6.1.5 MODE SHAPES: Mode Shape is the shapes of the structure which determines the natural frequencies of the structure when affected.

Model 1:

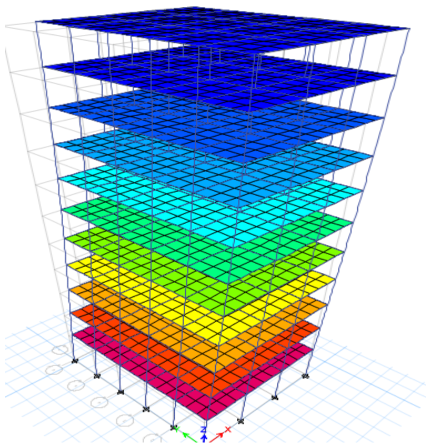

Fig-6.1: Mode-1 Time period 1.711 sec

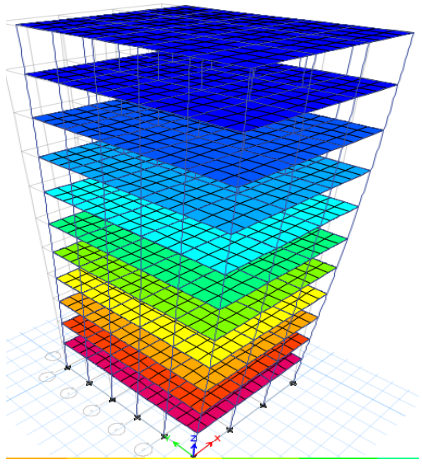

Fig-6.2: Mode-2 Time period 1.521 sec

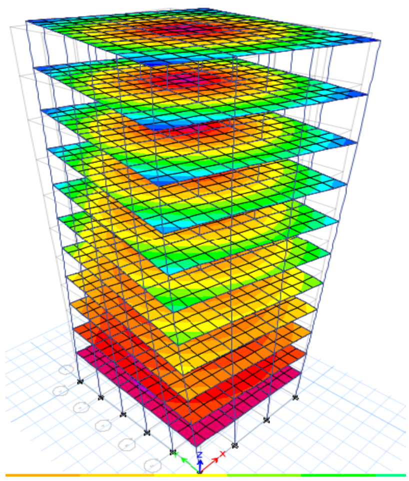

Fig-6.3: Mode-3 Time period 1.349 sec

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Model 2:

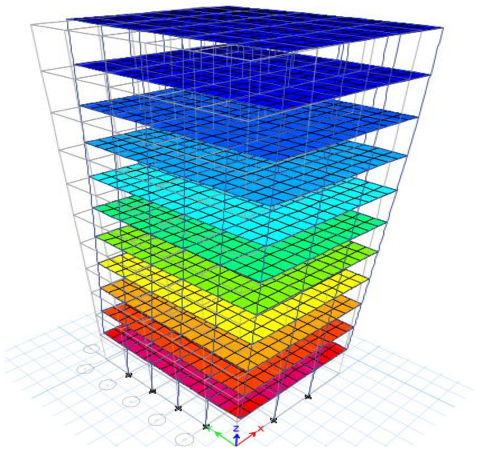

Fig-6.4: Mode-1 Time period 1.836sec

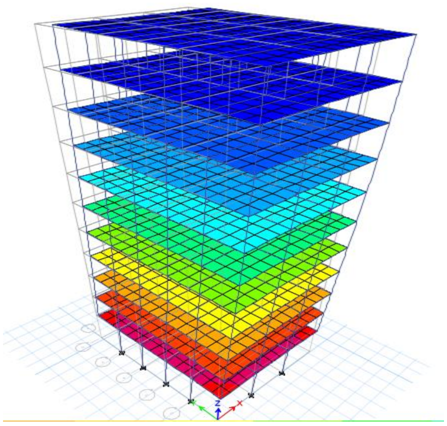

Fig-6.5: Mode-2 Time period 1.641 sec

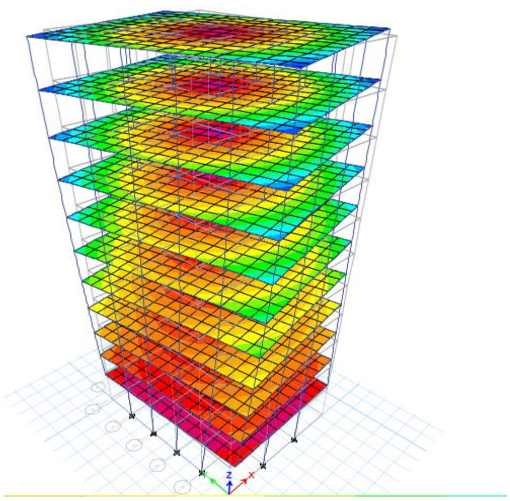

Fig-6.6: Mode-3 Time period 1.411 sec

Model 3;

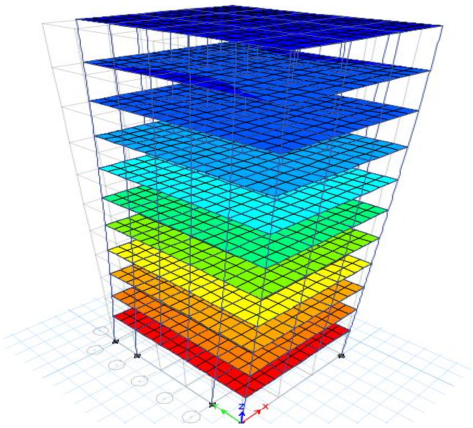

Fig-6.7: Mode-1 Time period 1.875 sec

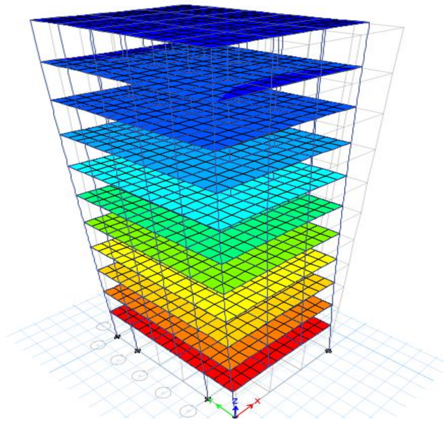

Fig-6.8: Mode-2 Time period 1.695sec

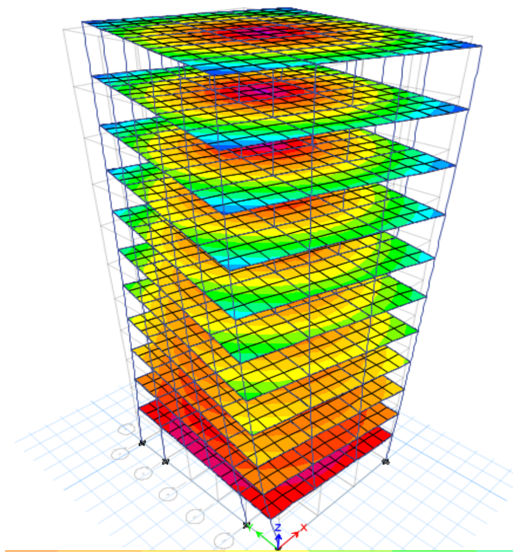

Fig-6.9: Mode-3 Time period 1.485 sec

Model 4;

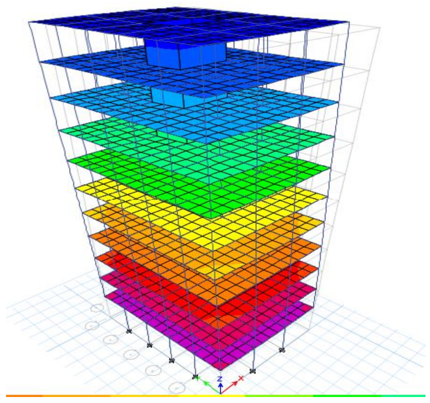

Fig-6.10: Mode-1 Time period 1.065 sec

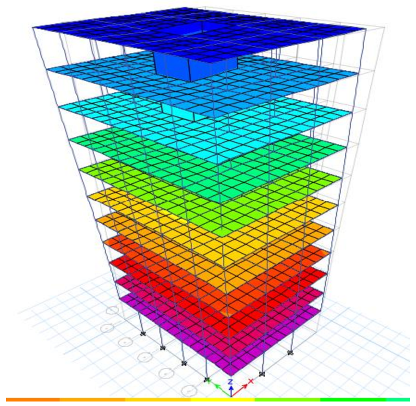

Fig-6.11: Mode-2 Time period 1.012 sec

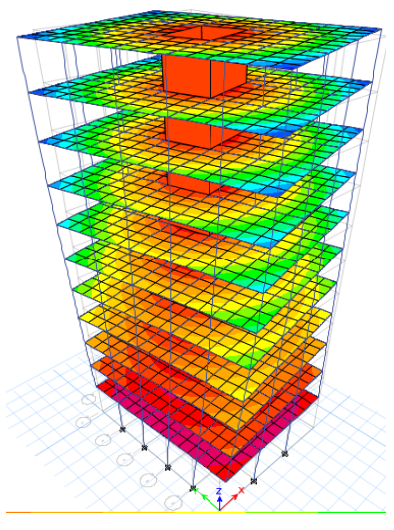

Fig-6.12: Mode-3 Time period 0.755 sec

7. CONCLUSIONS & SCOPE FOR FUTURE STUDY

7.1 CONCLUSIONS;

[1].Displacement analysis reveals that models with core wall shows huge reduction in overall displacements when we compare with all other building models. Therefore consideration of shear wall in turn increases the stiffness of the building and should be handling carefully for vertically irregular buildings.

[2]. When we study Model 2,3 we conclude that the storey with floating columns are very much flexible in transferring the inertia forces generated by seismic loading.

[3]. Storey with floating columns are always weak so therefore special concentration should be given when we are handling any floating columns.

[4]. When we study for base shear analysis we conclude that Model 1, 2, 3 are showing nearly same responses. When we see Model 4 the base shears are considered large enough. Therefore we could say that a vertical stiffener like core wall will impart huge resistant to seismic loading in turn improves the overall response.

[5]. The fundamental natural time period is huge enough for Model 3 when we compare with mathematical models. Model 4 showing substantially least amount of fundamental natural time period for all the 3 modes of the building. Therefore, we can conclude the fundamental natural time period drastically reduce when we consider the impact of vertical and lateral stiffening elements.

[6]. vertically irregular building models are showing nearly same response as of Model 1.

7.2 SCOPE FOR FUTURE STUDY

[1]. The study can be extended for future works when the buildings are situated in weak soil zone in which the soil structure interaction can be done.

[2]. It can also be extended for future work where the buildings are situated in highly terrain areas.

[3]. It can also be extended for non-linear seismic analysis such as time history & push over analysis in which overall performance of buildings are predicted in a better sense.

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