International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 2, Mar-Apr-2026, ISSN (Online): 2395-566X

Comparative of Flat and Grid Slab System with Conventional Slab System Using Etabs Software

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Abstract- — Understanding the behaviour of bolstered concrete is vital for properly predicting future earthquake loading consequences on reinforced concrete systems and designing the structural gadget to undergo seismic pressures. Accurate seismic load consequences on the structural device are vital no longer just in multi-story buildings but additionally in usual residential constructions. This research examines the results of slab kinds at the performance of load-bearing systems in multi-tale reinforced concrete systems underneath seismic hundreds, in accordance with the modern-day Turkish Earthquake Code (TEC). This research conducts a comparative analysis of a flat slab gadget with 4 beam versions for a seven-story structure. The examine is conducted with pushover evaluation with the assistance of the ETABS software program application. The beam variations are labeled as follows: a structure with a completely flat slab (no beams), a shape with a flat slab and perimeter beams (apart from indoors beams), a shape with a flat slab and all beams, and a structure with a flat slab, whole beams, and brick walls. The examine findings, including base shear, storey drift, time period, and frequency, are tested for the G+8 building model.

Keywords: Structure Design and Analysis of slab system, Flat Slab System, ETABS.

I. INTRODUCTION

Construction engineering is a subdivision of civil engineering that concentrates on the bodily creation of systems, together with residential buildings. A simple shape has 4 walls, a roof, and important provisions for human life, which includes sustenance, apparel, and shelter. In historic times, human beings resided in caves, at the back of foliage, or below lumber to guard themselves from wild animals, rain, and daylight. As time improved, people started dwelling in huts constituted of wooden branches. Recently, the vintage houses had been transformed into captivating abodes. Mansions in immaculate situation are the area of the prosperous.

II. GRID SLAB

Floors, bridge decks, and slabs assisting water tanks and other systems are an increasing number of reliant on interconnected grid networks. The planar structural device called a grid is made up of non-stop components that move or intersect with each other. Numerous areas in India and somewhere else have used grids to span expansive, column-loose spaces. The structure is known as Grid if it's far exposed to masses which are applied commonly to its plane. The parts that make it up are continuous and meet at intersections or pass over. Not best are grids greater visually attractive than different roofing systems, however they also offer some of practical benefits.

Figure 1. 1 : Grid slab

III. FLAT SLAB

A reinforced concrete slab that doesn't employ beams but as a substitute rests on concrete columns is called a flat slab. Square slabs termed "drop panels" and assisting columns endure the brunt of a flat slab's weight, which can be carried out to both a one- or two-sided aid device. In this situation, drop panels are crucial because they boom the floors system's usual capability and sturdiness beneath the vertical stresses, which in flip

improves the development's fee-effectiveness. The trendy top for drop panels is about double that of the slab. For asymmetrical column layouts, along with ramps and flooring with curved curves, flat slabs are a terrific preference. They also are best for maximum constructing initiatives. There are numerous advantages to using flat slabs, inclusive of a depth answer, stage soffit, and greater design freedom.

Building on flat slabs is probably luxurious, however it presents engineers and designers a variety of innovative leeway. Flat slabs have numerous uses within the building method, from improving the performance of destiny designs and layouts to streamlining installation operations and cutting down on production time. It is suggested to minimise the usage of drop panels and maximise the thickness of flat slabs wherever viable. In order to keep the floor's flat soffits and acquire their benefits, it is crucial to solid the drop panels as a part of the column.

Figure 1. 2 : Flat slab

IV. ETABS

ETABS, a current and current software, is the preeminent preference in integrated programming programs for structural evaluation and layout. This contemporary ETABS integrates 40 years of ongoing improvements in contemporary design to provide unparalleled 3-dimensional modelling and visualisation equipment, rapid linear and nonlinear analysis capabilities, state-of-the-art and comprehensive planning capabilities for numerous materials, and intelligent graphical displays, reviews, and schematic representations that permit users to hastily and effortlessly recognise and interpret configuration and testing effects.

Throughout every phase of the construction configuration method, ETABS is concerned, from the initial layout of the define to the manufacturing of the schematic representations. Natural example costs allow for the speedy getting old of the floor and surrounding boom, making model creation less complicated than ever before. It is viable to directly convert CAD documents into ETABS models or use them as a basis for incorporating ETABS components. The current SAPFire sixty four-bit solver contains nonlinear display strategies inclusive of improvement sequencing and temporal outcomes (e.G., move slowly and shrinkage), enabling the speedy evaluation of giant and complex fashions.

V. EARTHQUAKE LOADING

The seismic load refers to the inner stresses skilled via the mass of a constructing because of the shaking of its foundations due to a seismic occasion. Inertial translational forces are of primary problem in seismic layout. These translational inertial stresses have a extra effect on a shape than vertical or rotational additive cracks. Important seismic forces encompass landslides, landslides, and liquefaction of the nearby subsoil due to vibrations. The frequency of earthquakes is inversely proportional to their price. Even if a shape can be designed to face up to the maximum intense earthquake with out inflicting large harm, the want for such strength throughout the lifestyles of the assignment can no longer justify the immoderate extra fee.Two vital methodologies are used to estimate the seismic load. These strategies preserve in thoughts the traits of the shape and previous seismic data inside the place. The similar lateral strain way is the primary method. The maximum base shear is calculated the usage of an initial calculation of the vital period of the shape and the maximum format plane acceleration, similarly to relevant special problems. The second technique is a modal assessment, which incorporates studying the modal frequencies of the shape and mixing them with the spectra of the seismic layout to determine the maximum modal reaction.

VI. IMPORTANCE OF SEISMIC DESIGN CODES

The floor vibrations created with the resource of earthquakes create deformations and stresses in structures. Therefore, homes should be designed to face up to these stresses and deformations. Seismic codes help to improve the behavior of systems in case you want to withstand the consequences of earthquakes with the least harm to humans and assets. Every US A. There are seismic code techniques to help development engineers plan, layout, detail, and gather structures.

A)An Earthquake Resistant Structure Has Four Virtues In It, Namely

- Its length, shape, and load-bearing structural structure all make it easier to transmit inertia forces to the floor, which is a good structural configuration.
- Lateral Strength: The damage it has endured allows it to resist a maximum amount of lateral (horizontal) strain before folding.
- Part II, Sufficient Stiffness: Its contents are unaffected by low-to-mild shaking thanks to its lateral load-resisting mechanism.
- Section IV. Good Ductility: The design and detailing techniques enhance its ability to withstand large deformations, even after yielding under intense earthquake shaking.

B)**Indian Seismic Codes**
Seismic codes are very particular to the region or software. Considerations of business cloth classifications, criminal stages of seismic risk, and community seismology are all prominent of their thoughts. Catastrophic event. The Bureau of Indian Standards (BIS) has formally posted the subsequent codes:
It is correct. Indian Standard Specifications for the Fifth Revision of Earthquake Resistance in Building Design (IS 1893, Part 1), 2002.

B. Indian Standard Code of Practice for Earthquake-Resistant Design and Construction of Buildings (IS 4326, 1993, 2nd edition).

Standards for Enhancing the Seismic Resilience of Earthen Structures (IS13827, 1993) - Indian Standard.

Guidelines for reinforcing the seismic resilience of low-electricity masonry structures (IS13828, 1993).

Standards for the ductile detailing of bolstered concrete homes vulnerable to seismic forces (IS 13920, 1993) in India. The modern standards no longer offer device resilience towards earthquakes of any magnitude. Nonetheless, they exert maximum effort to ensure that structures can undergo mild earthquakes with out structural impairment and large earthquakes without catastrophic failure.

Architectural Features
As a way to emphasise an attractive and strong functional form, architects remember very excellent and contemporary houses. At other times, it's the structural device that works in tandem with the building's shape to produce awe-inspiring results. The chosen forms and structures therefore have a full-scale impact on the structure's performance as a whole. The lessons learnt from the arena's past earthquakes about the best and worst structural configurations were invaluable.

Size of Buildings
The horizontal displacement of the earth within the oscillation path is of daily importance in over-thrust constructions with a huge height/base ratio. Fast yet very tall houses are more vulnerable to the destructive effects of seismic motion. Additionally, the columns and walls may not be able to support the horizontal seismic stress in houses with large flat surfaces, such as warehouses.

Vertical Layout of Buildings
Buildings with uneven floor widths generate an abrupt increase in seismic forces upon collapse; any break in this load transfer path leads to an ugly average performance of houses with uneven floor widths, which in turn causes an abrupt increase in seismic forces at the break. Damage or disintegration is more likely to occur in buildings with low column counts, single-story walls, or very high floors. In this strategy. Numerous homes in Gujarat suffered extensive damage or collapsed after the 2001 Bhuj earthquake because they had basements or open floors that were used for parking. Issues, including as twisting and damage to the shorter columns, might arise when buildings are built on sloped terrain and have towering top columns at the bottom of the slope. In column houses, the direction of weight transfer is interrupted when it maintains or flows on the beams of a mezzanine level rather than amplification to the base. Reinforced concrete walls are meant to transmit seismic vibrations in theory, but they will fail badly in an earthquake if they do not magnify into the floor but save you to a greater degree.

Adjacent Buildings
Problems with twisting and damage to shorter columns caused by many steeply slanted columns are common in residences built on uneven floors. There are load switch discontinuities in buildings where the columns either do not increase to the muse's size or stand or gaze at the flight of beams on an intermediate aircraft. In order to transfer seismic loads to the inspiration, some systems use reinforced concrete walls. However, these walls will be severely destroyed in the event of an earthquake if they aren't reinforced all the way to the floor but instead stop at a higher level.

Design Aspect
Anywhere on Earth where a major fault exists increases the likelihood of an earthquake occurring, whether on land or at sea. Damage to the built environment around an earthquake's

source causes death as the tremors travel through the ground. Massive earthquakes that happen under or at sea not only destroy nearby buildings, but they also cause tsunamis, which are huge waves that affect locations far from the epicentre. Every home is designed to withstand the combined forces of gravity and seismic loads, with an emphasis on providing an abundance of vertical and lateral electrical current and stiffness to meet the current building code's deflection standards and the long-standing structural requirements. Because of the built-in safety feature used in the design specifications, the majority of systems are effectively protected against vertical wobble. In full-span systems, vertical acceleration is just as important as it is in structural form and conventional equilibrium evaluation. When formulating a strategy to mitigate the effects of natural disasters like earthquakes and cyclones, the following three aspects of restricted states are considered:

Serviceability Limit State
There is little structural harm to the form in these cases. A society's most vital infrastructure—hospitals, nuclear power plants, public gathering spots, etc.—must be built to withstand the forces of earthquakes. These structures should be able to continue operating normally in the case of a hurricane or earthquake.

Limit State with Damage Control
So, even if the form becomes damaged in a natural catastrophe like a hurricane or earthquake, it can still be fixed afterwards. Since this institution is necessary for covering most everlasting dwellings, the form should have developed to be pleasant with a regulated ductility reaction.

Design Considerations And Modeling of Building
In the present study, analysis of G+ 8 stories building in Zone V seismic zones is carried out in ETABS.

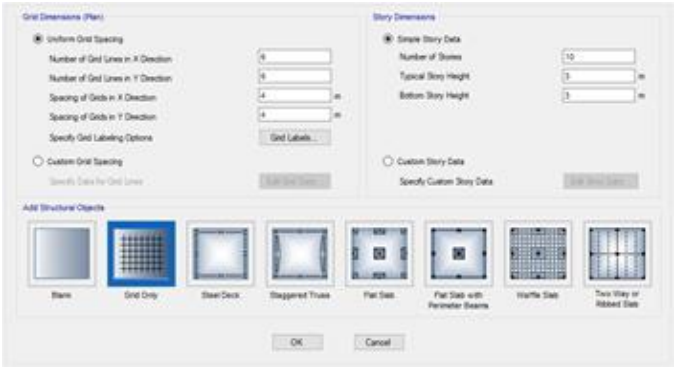
- **Basic parameters considered for the analysis are**
- Grade of concrete : M30
- Grade of Reinforcing steel : HYSD Fe500
- Dimensions of beam : 460mmX690mm
- Dimensions of column : 690mmX690mm
- Thickness of slab : 150 mm
- Drop panel Size : 2000mm
- Drop : 690mm
- Reinforcement details
  Bar size : 25d
  Corner bar size : 20d
  Number of bars on column : 10no's
- Height of bottom story : 4m
- Height of Remaining story : 3m
- Live load : 3 KN/m2
- Dead load : 2 KN/m2
- Density of concrete : 25 KN/m3
- Seismic Zones : Zone 5
- Site type : II
- Importance factor : 1.5
- Response reduction factor : 5
- Damping Ratio : 5%
- Structure class : C
- Basic wind speed :44m/s
- Risk coefficient (K1) : 1.08
- Terrain size coefficient (K2) : 1.14
- Topography factor (K3) : 1.36
- Wind design code : IS 875: 1987 (Part 3)
- RCC design code : IS 456:2000
- Steel design code : IS 800: 2007
- Earth quake design code (Part 1) : IS 1893 : 2002

VII. MODELING OF BUILDING IN ETABS

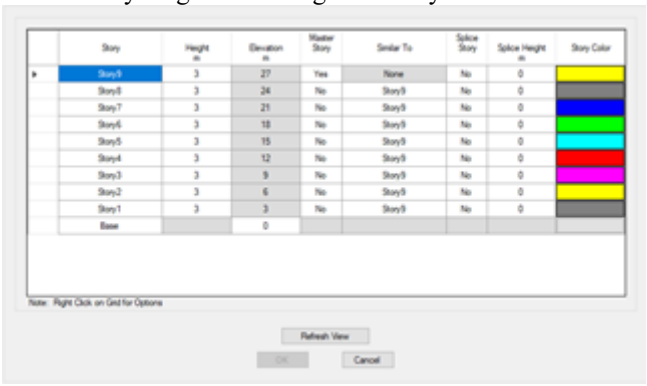
- Open ETABS program.
- Check the units of the model in the drop-down box in the lower right-hand corner of the ETABS window, click the drop-down box to set units to Kn-m.

- Click the File menu > New model command

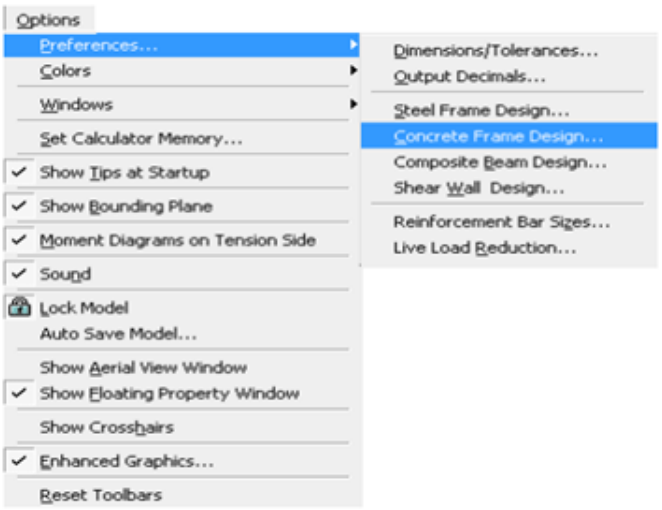
- The next form of Building Plan Grid System and Story Data Definition will be displayed after you select NO button.



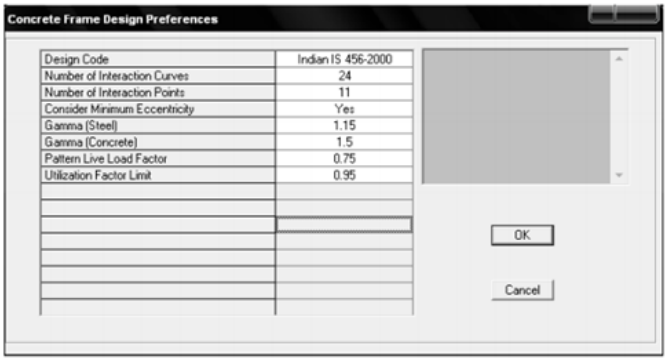
- Set the grid line and spacing between two grid lines. Set the story height data using Edit Story Data command



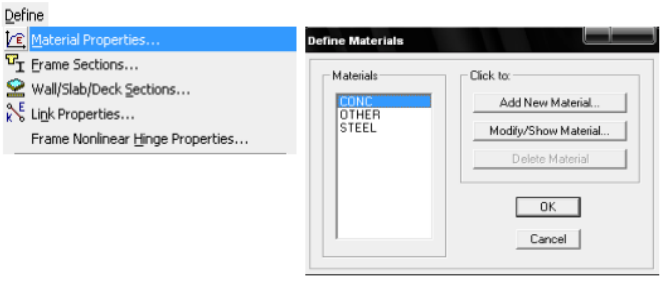
- Define the design code using Options > Preferences > Concrete Frame Design command



- This will Display the Concrete Frame Design Preference form as shown in the figure.

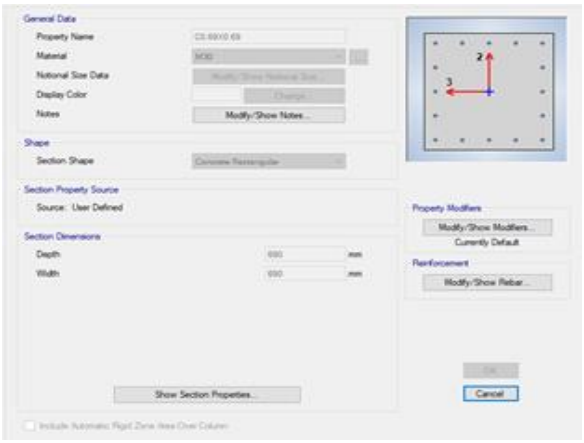


- Click the Define menu > Material Properties

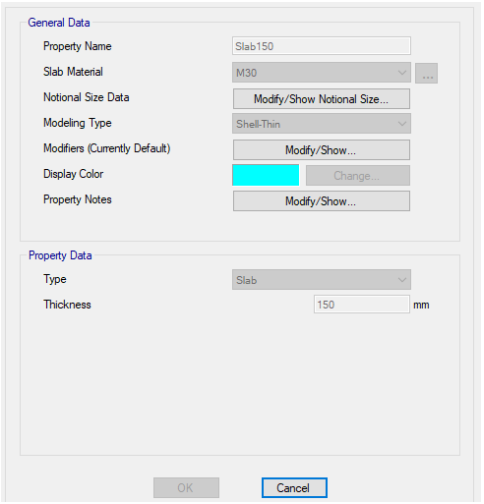


- Add New Material or Modify/Show Material used to define material properties

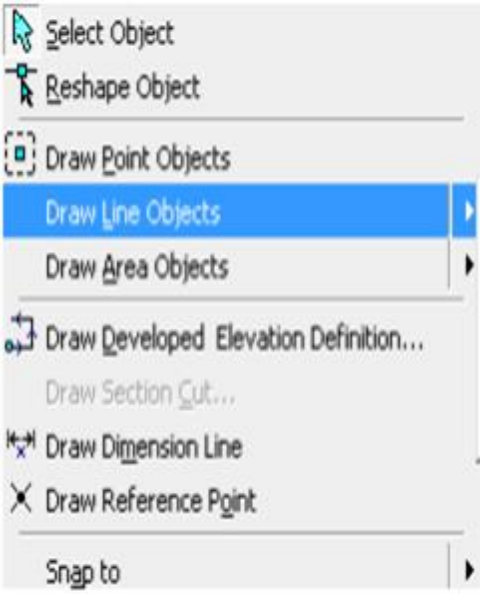
- Define section columns and beams using Define > Frame section
-

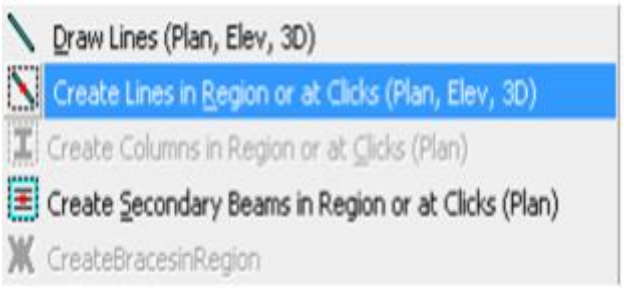


- Define wall/slab
- To define a slab as membrane element and one way slab define using special one way load distribution

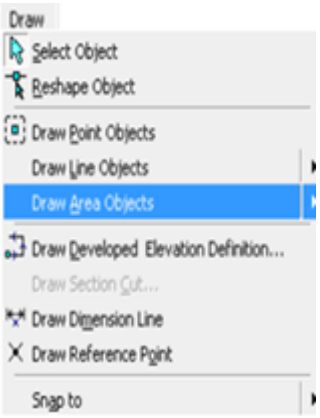


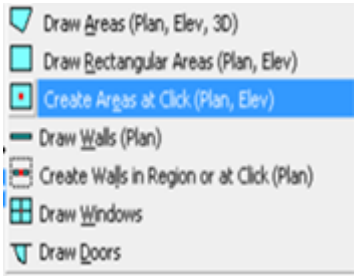
- Generate the model Draw beam using Create Line Command and draw column using Create Column command



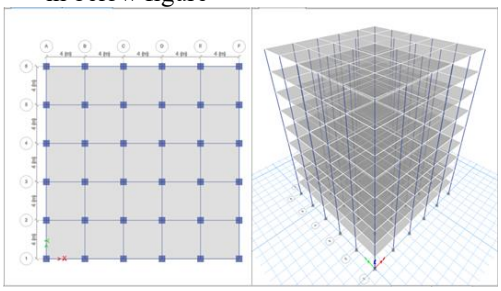


- Slab is created using 3 options in which 1st draw any shape area, 2nd draw rectangular area and 3rd create area in between grid line



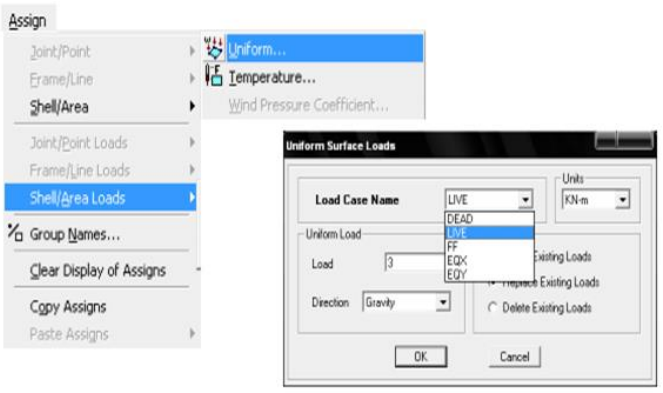


- Above creating option used to generate the model as shown in below figure

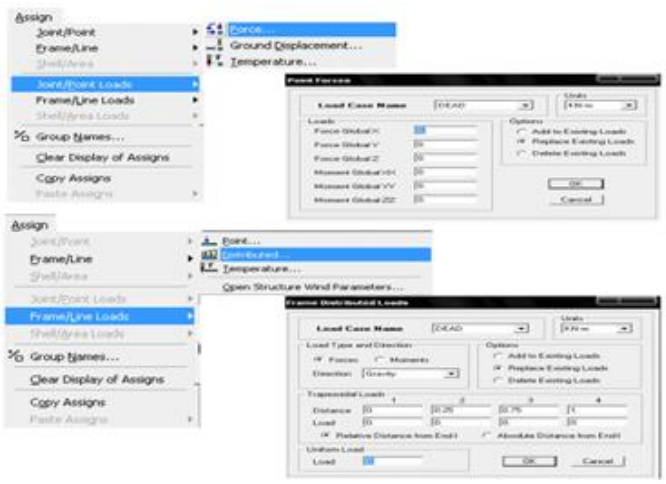


- Define various loads (Dead load, live load, wind load, Earthquake load)

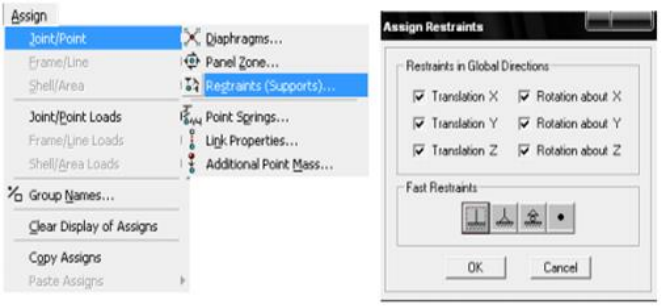
- Dead Load: self weight multiplier is used 1 to calculate dead load as default. Live load or any other define load 1st select the member where assign this load than click the assign button.



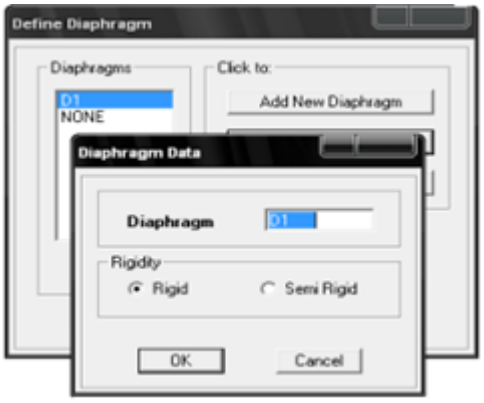
- Assign point load and uniform distributed load Select assigning point or member element than click the assign button

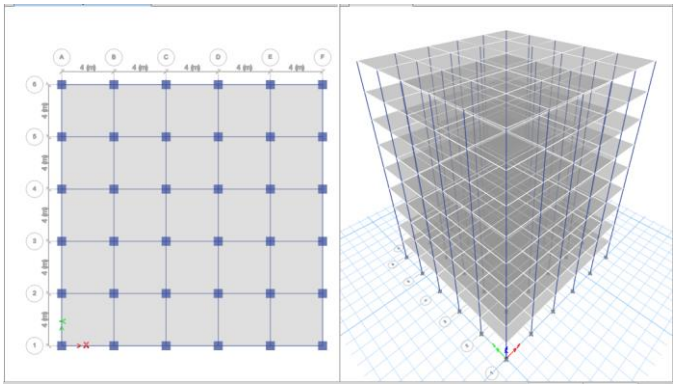


- Assign support condition Drop-down box in the lower right-hand corner of the ETABS window, Select only bottom single storey level to assign fixed support using assign > Joint/Point>Restrain (Support) command

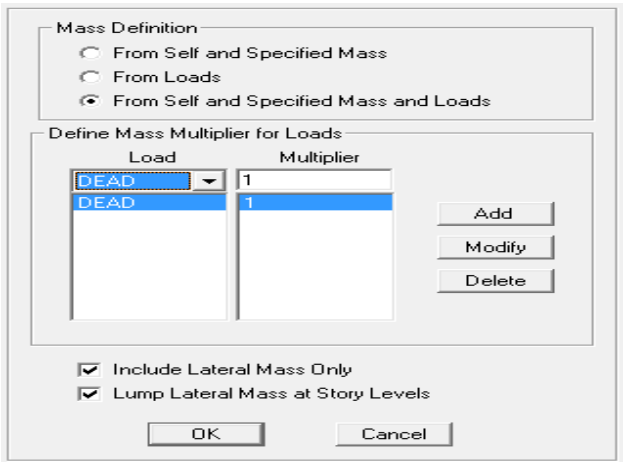


- In building, slab is considered as a single rigid member during earthquake analysis. For that, all slabs are selected first and apply diaphragm action for rigid or semi rigid condition.

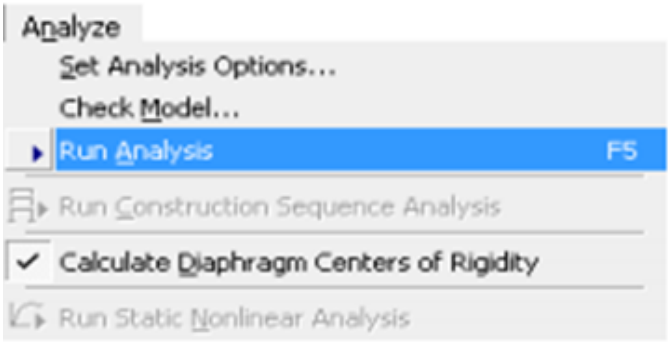




- Mass source is defined from Define > mass source command

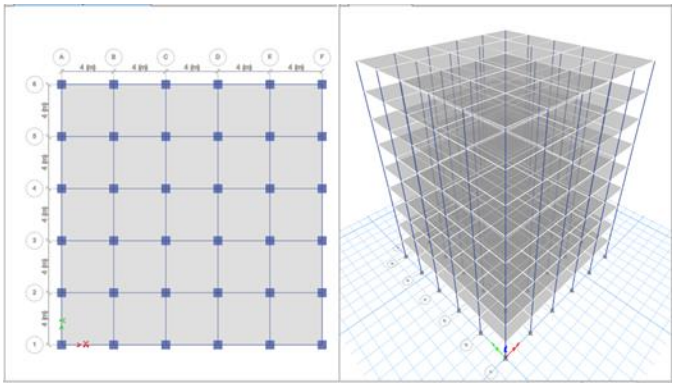


- Run analysis from Analysis > Run Analysis command



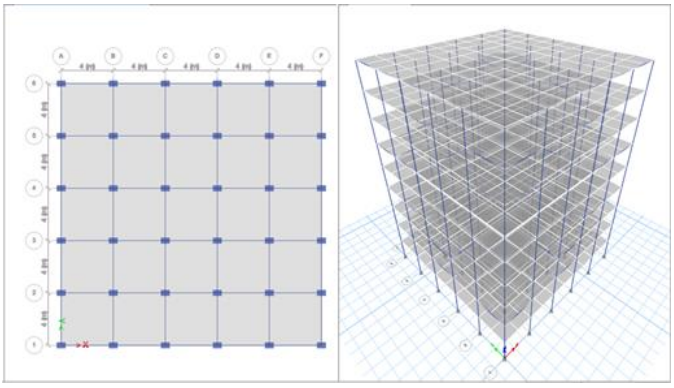
VIII. MODELS IN ETABS SOFTWARE

Normal slab system



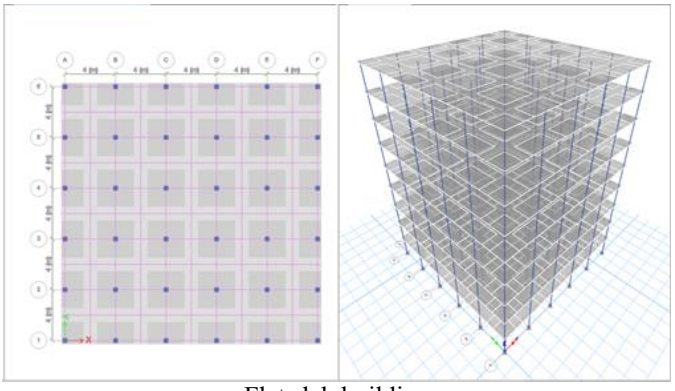
Normal Slab building

Grid Slab System



Grid Slab building

Flat Slab System



Flat slab building

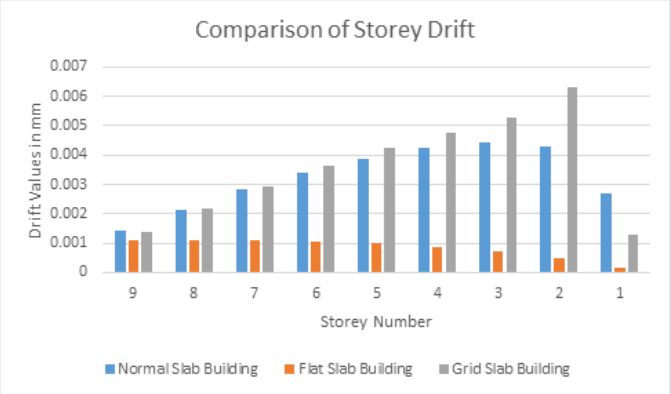
IX. RESULTS AND ANALYSIS

Storey drift

Storey drift values

Storey Number	Normal Slab Building	Flat Slab Building	Grid Slab Building
9	0,001426	0,001087	0,001378
8	0,002131	0,001095	0,002165
7	0,002815	0,00109	0,002943
6	0,003406	0,001058	0,003646
5	0,003885	0,000989	0,004259
4	0,004241	0,000873	0,004781
3	0,004434	0,000703	0,005265
2	0,004287	0,000472	0,006325
1	0,002699	0,000174	0,001298

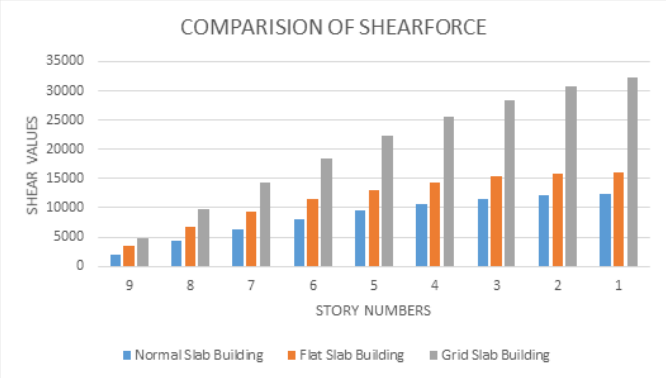
International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 2, Mar-Apr-2026, ISSN (Online): 2395-566X



Comparison of storey drift values

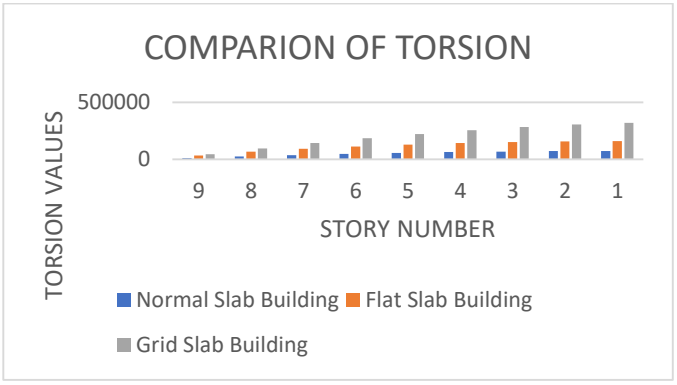
Story shear

Storey Number	Normal Slab Building	Flat Slab Building	Grid Slab Building
9	2082,004	3421,962	4705,172
8	4315,806	6765,828	9697,17
7	6290,501	9377,616	14319,51
6	8017,682	11459,93	18531,14
5	9486,555	13108,16	22299,87
4	10693,23	14385,62	25601,99
3	11612,64	15294,09	28407,2
2	12219,5	15850,98	30668,57
1	12478,15	16050,22	32243,94



Story torsion

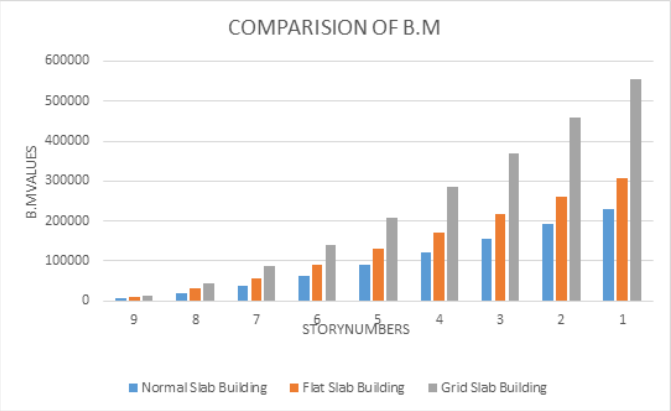
Storey Number	Normal Slab Building	Flat Slab Building	Grid Slab Building
9	12492,02	34219,63	47051,72
8	25894,84	67658,29	96971,7
7	37743,01	93776,17	143195,1
6	48106,08	114599,3	185311,4
5	56919,33	131081,6	222998,7
4	64159,39	143856,3	256019,9
3	69675,86	152940,9	284072
2	73316,98	158509,8	306685,7
1	74868,92	160502,3	322439,4

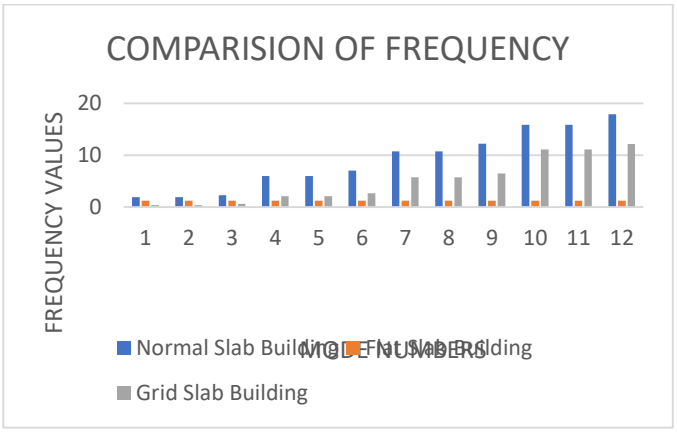


Story bending

Storey Number	Normal Slab Building	Flat Slab Building	Grid Slab Building
9	6246,012	10265,89	14115,51
8	19166,24	30425,72	43192,71
7	37923,51	58130,99	86077,13
6	61752,78	91769,38	141486,6
5	89872,65	130018,8	208052
4	121481,2	171781,8	284333,7

3	155739,5	216070,9	368825,1
2	191753,6	261985,2	459913,8
1	228600,9	308746	555639,9



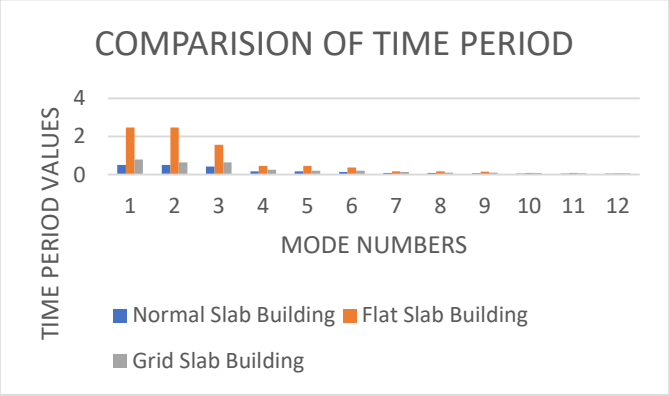


Story frequency

MODE	Normal Slab Building	Flat Slab Building	Grid Slab Building
1	1.936	1,247	0,404
2	1,936	1,247	0,404
3	2,302	1,247	0,639
4	6,026	1,247	2,14
5	6,026	1,247	2,14
6	7,056	1,247	2,636
7	10,775	1,247	5,762
8	10,775	1,247	5,762
9	12,218	1,247	6,49
10	15,887	1,247	11,103
11	15,887	1,247	11,103
12	17,882	1,247	12,19

Story time period

MODE	Normal Slab Building	Flat Slab Building	Grid Slab Building
1	0,516	2,474	0,802
2	0,516	2,474	0,645
3	0,434	1,565	0,639
4	0,166	0,467	0,257
5	0,166	0,467	0,207
6	0,142	0,379	0,203
7	0,093	0,174	0,143
8	0,093	0,174	0,115
9	0,082	0,154	0,114
10	0,063	0,09	0,098
11	0,063	0,09	0,078
12	0,056	0,082	0,077



X. CONCLUSIONS

The outcomes of this investigation brought about the following findings:

- For an equivalent span or grid size, the quantity of concrete required for a flat slab multi-story shape is minimal, but the quantity for a grid slab multi-tale constructing is maximal. Conversely, the quantity of concrete required for an most excellent multi-tale slab configuration exceeds that of a flat slab creation.
- In evaluation to flat slab creation, the X and Y drift values for abnormal building systems are decrease whilst using a grid slab gadget. In assessment to flat slab structures, grid slabs will enjoy less displacement from a displacement viewpoint.
- Systems with a flat slab system had lower values of shear force in each the X and Y-guidelines compared to systems with a grid slab machine. The shear force additionally will increase as one descends from the higher to the decrease memories.
- Systems with a flat slab device had a decrease cost for Building Torsion (T) in comparison to systems with a grid slab machine. The value of a building's torsion grows with every ground.
- As compared to buildings with a grid slab machine, people with a flat slab machine had lower bending second values in the X and Y-instructions. The importance of the bending second additionally grows as one descends from the upper stories to the lower ones.
- Since the thickness of a flat slab is extra than that of a grid slab, and because the amount of metallic used in a flat slab is higher than that of different combos, the total quantity of concrete required for a flat slab is maximal.
- The overall height of a flat slab is lower than that of a grid slab.
- All span/grid sizes of the shape show that gird or coffered slab multi-story homes have the very best structural price, whilst flat slab multi-story buildings have the lowest value.
- The cost according to rectangular metre for each slab system that became studied fluctuates as the structure's span or grid size will increase. The results display that the flat slab system has the lowest price in line with square metre and the grid slab system has the best.

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