ANALYSIS AND DESIGN OF MULTI-STOREY BUILDING WITH GRID SLAB USING ETABS

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ABSTRACT: Grid floor systems consist of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement.

In present study, "Analysis and Design of multi-storey building with grid slab using ETABS" is carried out and parameters like quantity of concrete, quantity of steel, bending moment, shear force and displacement of grid slab is considered .In the present study, G+6 Building is considered and analysis and design is done for both Gravity and lateral (earth quake and wind) loads. The analysis and design of slab system is done as per IS 456-2000 and IS 1983-2002.The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of the beams running in perpendicular directions are generally kept the same. Instead of rectangular beam grid considered here a diagonal. And this is compared with the flat slab.

I. INTRODUCTION

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses. Grid slab: Interconnected grid systems are being commonly used or supporting building floors bridge decks and overhead water tanks slabs. A grid is a planar structural system composed of continuous members that either intersect or cross each other. Grids are used to cover large column free areas and have been constructed in number of areas in India and abroad. Is subjected to loads applied normally to its plane, the structure is referred as Grid. It is composed of continuous member that either intersect or cross each other. Grids in addition to their aesthetically pleasing appearance provide a number of advantages over the other types of roofing systems.

STRUCTURE GRID:

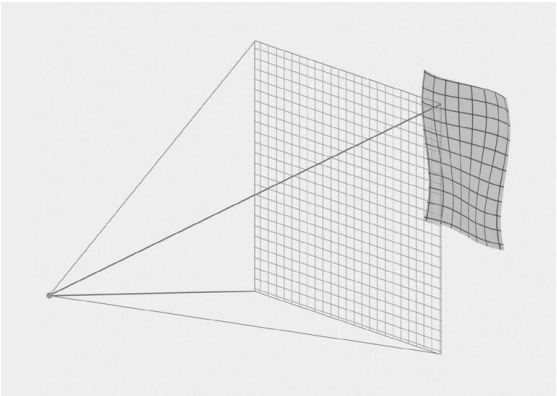
The plank and beam system described above is the simplest system for creating flat, horizontal surfaces. However, greater efficiency can be achieved by designing the flooring as one integral slab and spanning the flooring in two directions supported by a rectilinear grid of beams known as structural grid.

SKEWED GRIDS:

When the overall shape of a structural grid does not approximate a square, structural and economic efficiency can sometimes be gained by employing a skewed grid.

CURVED SURFACE GRIDS :

The skewed grid can be warped to form a curved surface grid and spans large distances in an efficient manner. The structural concept of the arch is combined with the characteristics of skewed grids to increase efficiency.



DIAGONAL GRID :

A Diagonal grid is a framework of diagonally intersecting metal, concrete or wooden beams that is used in the construction of building and roofs.

ADVANTAGES OF GRID SLBS

i. Grids are very efficient in transferring concentrated loads and in having the entire structure participate in the load carrying action.

ii. Reduce the depth to span ration of rectangular grids.

iii. Reduction in depth, towers, structural and other cost by reducing the height of the building

Uses of Grid slabs

i. Grid slabs can be used as both ceiling and floor slab

ii. Used in the areas where number of columns are provided i.e., it is basically used in the areas which has huge spans.

iii. Used for specialized projects that involves clean rooms, spaces requiring seclusion from low frequency vibration or those needing low floor deflections.

iv. The concrete grid slab is often used for industrial and commercial buildings

while wood and metal waffle slabs are used in many other construction sites.

v. This form of construction is used in airports, parking garages, commercial and industrial buildings, residences and other structures requiring extra stability.

Vi. The main purpose of employing this technology is for its strong foundation characteristics of crack and sagging resistance. Grid slab also holds a greater amount of load compared with conventional concrete slabs.

Features of the grid slab

i. They are used on flat sites.
ii. No beam excavation is required.
iii. No controlled or rolled fill is used.
iv. Cardboard slab panel/void formers are used.
v. Slab panels are on 1 meter grids (approximately).
vi. Trench mesh or individual bars can be used.

vii. Slab thickness is 85 – 100 mm.

viii. Internal beams are 110 – 200 mm
ix. There is minimal concrete volume.
x. No beam down drag from clay (above ground slab) occurs.

xi. Shrinkage of slab is lower than stiffened rafts and footing slabs.

xii. They used 30% less concrete than a stiffened raft.
xiii. They use 20% less steel than a stiffened raft

II. OBJECTIVES

•To Plan Multi-storey Building Using AUTOCADD

• To analyses and design a multi-storey building with Grid Slab using ETABS

III. LITERATURE REVIEW

Varalakshmi V et.al (2014) has published a journal on "Analysis and Design of G+5 Residential Building",IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) the various components like beam, slab, column and foundation. The loads namely dead load and live load were calculated as per IS 875(Part I & II)- 1987 and HYSD bars i.e. Fe 415 are used as per IS 1986-1985. They concluded that the safety of the reinforced concrete building depends upon the initial architectural and structural configuration of the total building, the quality of the structural analysis, design and reinforcement detailing of the building frame to achieve stability of elements and their ductile performance.

Chintha Santhosh, Venkatesh Wadki, S.Madan Mohan, S.Sreenatha Reddy (2016) has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" "Analysis and Design of Multistory Building with Grid Slab Using ETABS". Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of the beams running in perpendicular directions are generally kept the same. Instead of rectangular beam grid, a diagonal. In the present problem G+5 Building is consider

and analysis and design is done for both Gravity and lateral (earth quake and wind) loads. And this is compared with the flat slab.

S. A. Halkude, C. G. Konapure and S. P. Pasnur 2015 has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" "Effect of Depth of Periphery Beams on Behavior of Grid Beams on Grid Floor". investigating various parameters involved, a solution for optimum structural configuration can be found for the grid floor. The present work includes the parametric investigation in terms of flexural actions such as bending moments and shear force. Spacing of grid beam is one of the important parameters considered for investigations, along with depth of grid beam & depth of periphery beam. Stiffness method is used for analysis which is less time consuming as compare to other analysis methods, where spacing of grid beams i.e. (l/b) is varied for hall size (L/B) with constant ratio. Here the depths of periphery beams (PB) are varied, for considered depth of periphery beams; various depths of grid beams (GB) are varied to arrive at optimum solution.

Coronelli, Dario 2015 has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" "Nonlinear Static Analysis of Flat Slab Floors with Grid Model". Presented the grid model is proposed for the nonlinear behavior of flat-slab structures. The inelastic response of the structure is concentrated in point hinges introduced into beam finite elements, modeling the response in bending, torsion, and shear. Both concentric punching and failures with unbalanced moments and shear are investigated. Static pushover analysis is used for the effects of gravity and lateral loads. The results are compared to experimental studies on interior, lateral, and corner slab-column connections. The effect of different types and arrangements of transverse reinforcement and the influence of the gravity load level on the drift capacity are shown. The formulation with internal moments, torque, and shear is synthetic and computationally light; three-dimensional (3-D) spatial configurations are considered.

Navjot Kaur Bhatia and Tushar Golait 2017 has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" Studying the Response of Flat Slabs & Grid Slabs Systems in Conventional RCC Buildings. Presented modern slab systems have showed potentials for improvement in the conventional techniques of slab casting. Recent advances in the field of RCC Design are linked to the use of Flat Slabs and Grid Floors. Flat Slabs are highly versatile elements widely used in construction, providing minimum depth, fast construction and allowing flexible column grids. In flat slabs, the beams used in conventional slabs are done away and the slab is made to rest directly over the columns. In case of higher loads, a drop panel or a column head is provided to reduce the intensity of loads. Flat slabs are particularly appropriate for areas where tops of partitions need to be sealed to the slab soffit for acoustic or fire reasons. Grid floor systems consist of beams spaced at regular intervals in perpendicular directions, monolithic with slab. The rectangular or square void formed in the

ceiling is advantageously utilized for concealed architectural lighting. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. This paper focuses on studying the behavior of conventional slab, flat slab and grid slab separately. A comparative study was done to identify the best slab system.

CH.Rajkumar Dr.D.Venkateswarlu has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" "Analysis and Design of Multi-storey Building with Grid Slab Using ETABS." In the present problem G+ Building is consider and analysis and design is done for both Gravity and lateral (earth quake and wind) loads. And this is compared with the flat slab. Dynamic analysis will be carried out for the building as specified by code IS 1893-2002 (part1). As per the clause 19.6 of IS 19.6 of IS 456 – 2000, in addition to above load discussed, account shall be taken of the following forces and effects if they are liable to affect the safety and serviceability of the structure. Further, the comparison between regular and modular type indicates the overall feasibility of the scheme without affecting its stability in gravity as well as lateral loads.

Maloth Naresh, Posam Rukesh has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" "Analysis and Design of Multi-storey Building with Grid Slab Using ETABS. In the present problem G+5 Building is consider and analysis and design is done for both Gravity and lateral (earth quake and wind) loads. And this is compared with the flat slab. Grid slab structures possess maximum base shear in comparison with flat slab with and without drop in both zones. Storey drift values of different types of buildings are within the permissible limit as per IS-1893-2002 code provision i.e. 0.4% of the floor height.

Sandesh (2012) has worked on Dynamic Analysis of Special Moment Resisting Frame Building with Flat Slab and Grid Slab. A popular form of concrete building construction uses a flat concrete slab (without beams) as the floor system. This system is very simple to construct, and is efficient in that it requires the minimum building height for a given number of stories. Unfortunately, earthquake experience has proved that this form of construction is vulnerable to failure, when not designed and detailed properly, in which the thin concrete slab fractures around the supporting columns and drops downward, leading potentially to a complete progressive collapse of a building as one floor cascades down onto the floors below

Mohammed Mafaz has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology". "Analysis and Design of G+3 Hospital Building Provided with Grid Slab". It is increasing overall stiffness of the building thus, reducing the sway problem in the structure. Analysis and design of building using ETABS reduces a lot of time in the work. The software had provide more area of steel in the RCC members as compared to theoretical calculation. The study of hospital building with grid slab in this

paper shows results are more conservative in Static analysis as compared to the dynamic analysis.

Dunnala Lakshmi Anuja, et.al (2019): has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" "Planing, Analysis and Design of Residential Building(G+5) By using STAAD Pro. Frame analysis was by STAAD-Pro. Slab, Beams, Footing and stair-case were design as per the IS Code 456-2000 by LSM. The properties such as share deflection torsion, development length is with the IS code provisions. Design of column and footing were done as per the IS 456-2000 along with the SP-16 design charts. The check like one-way shear or two way shear within IS Code provision. Design of slab, beam, column, rectangular footing and staircase are done with limit state method. On comparison with drawing, manual design and the geometrical model using STADD Pro.

TorbenValdbjorn Rasmussen (2013) has worked on Novel Radon Sub-Slab Suctioning System. . The function of this system is based on the principles of pressure reduction within the zone below the ground-floor construction. Unfortunately, earthquake experience has proved that this form of construction is vulnerable to failure, when not designed and detailed properly, in which the thin concrete slab fractures around the supporting columns and drops downward ,leading potentially to a complete progressive collapse of a building as one floor cascade, this project is mostly based on software and it is essential to know the details about these software's.

L.G.Kalurkar has publish International Research Journal of Engineering and Technology (IRJET) 'Analysis and design of multistory building by using STAAD Pro'. The design and analysis of multistoried G+5 building using composite structure at earthquake zone-3. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software. Equivalent Static Method of Analysis and Response spectrum analysis method are used for the analysis of both Composite and RCC structures. The results are compared and found that composite structure more economical.

P.Jayachandran has publish International Research Journal of Engineering and Technology (IRJET). Analysis and design of multistory building by using STAAD Pro. The design and analysis of multistoried G+4 building at Salem, tamilnadu, India. The study includes design and analysis of footings, columns, beams and slabs by using two software's named as STAAD.PRO and RCC Design Suit.

Balaji U & Selvarasan M. E. has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" 'Design and analysis of multi-storied building using static and dynamic loading conditions using ETABS'. Assuming that the material properties were linear, static and dynamic analysis was performed. These non-linear analyses were carried out by considering severe seismic zones and the behavior was assessed by taking types II soil condition. Different response like displacement & base shear were calculated and it was observed that

displacement increased with the building height.

Mohammed Rizwan Sultan, D. Gouse Peera has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology" ' Dynamic analysis of multi-storey building for different shapes'. Studied behavior of the structure in high seismic zone and also evaluated Storey overturning moment, Storey Drift, Displacement, Design lateral forces etc. For this purpose, a 15 storey-high building of four totally different shapes like Rectangular, L-shape, H-shape, and C-shape were used for comparison. The complete models were analyzed with the assistance of ETABS 9.7.1 version. In the present study, Comparative Dynamic Analysis for all four cases had been done to evaluate the deformation of the structure. Authors indicate that, Building with severe irregularity produces more deformation than those with less irregularity particularly in high seismic zones. And guar building is highest compared to irregular shaped build conjointly the storey overturning moment varies inversely with height of the storey. The storey base shear for reigns. Storey drift permitted is 0.004.times the height of storey drift increases with increase in height of the storey up to 7th storey reaching to maximum value and then it again starts decreasing (Fig 1). The maximum storey drift permitted is 0.004 x height of storey.

MR. Abhay Guleria has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology "Structural analysis of a multi-storey Building using ETABS for different plan configurations. E-tabs is commonly used to analyze: skyscrapers, parking garages, steel & concrete structures, low and high rise buildings, and portal frame structures. The case study in this paper mainly emphasizes on structural behavior of multi-storey building for different plan configurations like rectangular, c, l and I-shape. Modeling of 15- story R.C.C framed building is done on the E-tabs software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement are computed and then compared for all the analyzed cases.

Prof. Kishore Chandra Biswal & Prof.A Vasha 'Seismic analysis of multistory building with floating column'. Now a day's buildings with floating column is a typical feature in construction in urban India. This study light on the importance of the presence of the floating column in the analysis of building. Alternate measures, involving stiffness balance of the first storey and the storey above, are proposed to reduce the irregularity introduced by the floating columns. Fem codes are developed for 2d multi storey frames with and without floating column to study the responses of the structure under different earthquake excitation having different frequency content keeping the page and time duration factor constant.

Sayyed Feroz Sikandar, Shaikh Zameeroddin., Prof. Agrawal. A. has published a journal on "International Journal of Innovative Research in Science, Engineering and Technology", Analysis and Design of Multistory Building using ETABS 2017. For obtaining this skill, an apartment building

is analyses and designed, Located in Latur, Maharashtra with (G+10) storey having a car parking facility provided at basement floor. The building has a shear wall around the lift pit. The modeling and analysis of the structure is done by using ETABS and the designing was done. Design of slab, stair case and an isolated footing are done manually. The design methods involves load calculations manually and analysing the whole structure by ETABS.

Shravan Kumar Reddy& Mrs. N. Monica Madhuri has published "International Journal of Research", "Analysis and Design of Multistoried Building With Grid Slab Using E-tabs"Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of the beams running in perpendicular directions are generally kept the same. Instead of rectangular beam grid, a diagonal.

Monica Madhuri has published "International Journal of Research", "Analysis and Design of Multistory Building With Grid Slab Using E-tabs". Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions monolithic with slab. They are generally employed for architectural reasons for large rooms such as auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement. The rectangular or square void formed in the ceiling is advantageously utilized for concealed architectural lighting. The sizes of the beams running in perpendicular directions are generally kept the same. Instead of rectangular beam grid, a diagonal. In the present problem G+5 Building is consider and analysis and design is done for both Gravity and lateral (earth quake and wind) loads. And this is compared with the flat slab. Grid is highly redundant structural system and therefore statically indeterminate. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab.

IV. SUMMARY OF LITERATRUE REVEW

1. 1.In this present work ETABS is used to analysis the R.C moment resting frame structure ofG+5 considering the gravity and lateral loads.

2. The various components like beam, slab, column and foundations loads namely dead load and live load were calculated as per IS 875(Part I & II)-1987 and HYSD bars i.e. Fe 415 are used as per IS 1986-1985.

3. Grid floor systems consisting of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are general employed for architectural reasons for large rooms such as auditoriums, theatre halls, show room of shops where column free space is often the main requirement.

4. Grid floor systems consist of beams spaced at regular intervals in perpendicular directions, monolithic with slab. They are generally employed for architectural reasons for large rooms such as

auditoriums, vestibules, theatre halls, show rooms of shops where column free space is often the main requirement.

5. . Storey drift permitted is 0.004.times the height of storey drift increases with increase in height of the storey up to 7th storey reaching to maximum value and then it again starts decreasing .The maximum storey drift permitted is 0.004 x height of storey.

6. Analysis and design of building using ETABS reduces a lot of time in the work. The software had provide more area of steel in the RCC members as compared to theoretical calculation.

7. Assuming that the material properties were linear, static and dynamic analysis was performed. These non-linear analyses were carried out by considering severe seismic zones and the behavior was assessed by taking types II soil condition.

V. METHOLOGY

- ✓ **INTRODUCTION:** The objective and scope of the project are determined and knowledge about ETABS and Grid slab.
- ✓ **LITERATURE REVIEW:** Literature reviews of various authors are collected and their results were studied.
- ✓ **PREPARATION OF PLAN IN AUTOCAD:** A G+10 IT building plan is drawn in AUTOCAD
- ✓ **IMPORTING TO ETABS:** The plan drawn in AUTOCAD is imported in ETABS with proper grid spacing.
- ✓ **DEFINING AND ASSIGNING MATERIALS:** The material specifications are assigned and beams and columns are placed.
- ✓ **ASSIGNING LOADS AS PER IS CODES:** After the building is designed various loads are assigned as per IS CODE specifications.
- ✓ **ANALYSE THE BUILDING MODEL:** Run the analyses after applying loads
- ✓ **SUPPORT REACTIONS** : Structural system transfer their loading through a series of elements to the ground.
- ✓ **FRAME FORCES** : In mechanics, compression is the application of balanced inward ("pushing") forces to different points on a material or structure, that is, forces with no net sum or torque directed so as to reduce its size in one or more directions.
- ✓ **DIAPHRAGN DRIFT :** Drift problem as the horizontal displacements of tall buildings is one of the most serious issues in building design, relating to the dynamic characteristics of the building during earthquakes and strong winds.
- ✓ **CHECK RESULT:** The results are checked for any errors.
- ✓ **CONCLUSION**

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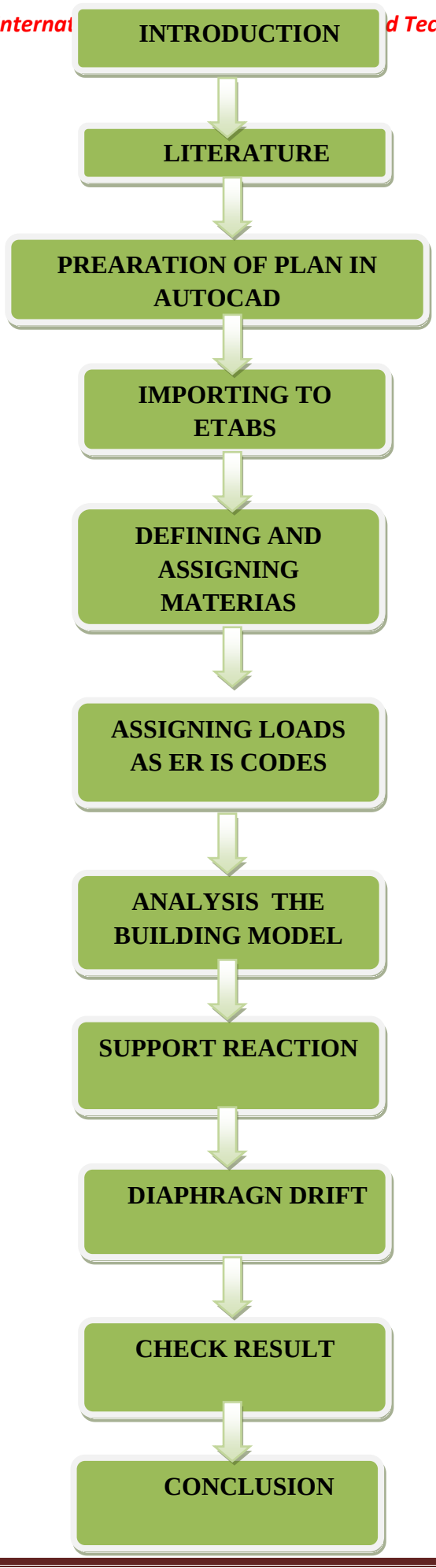

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