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Analysis and Design of Multi-Story Building with Grid Slab

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Abstract: ***The rapid growth of urbanization has led to a significant increase in the construction of multi-story buildings, demanding innovative and economical structural systems. One such system is the grid slab, which provides enhanced load distribution and structural stiffness compared to conventional slab systems. This study focuses on the analysis and design of a multi-story building incorporating a grid slab system, aimed at optimizing strength, stiffness, and cost efficiency. The analysis was carried out using ETABS 2020 software, considering dead load, live load, wind load, and seismic load as per IS 456:2000, IS 875 (Part 1–3):2015, and IS 1893:2016. The results show that the grid slab system improves structural performance by reducing slab thickness and controlling deflection, making it a suitable alternative for medium- to high-rise structures.***
Keywords: Grid slab, Multi-story building, Structural analysis, ETABS, Deflection control, IS codes, Load distribution.

I. INTRODUCTION

The demand for high-rise buildings has increased due to rapid urbanization and limited land availability. The choice of a suitable slab system significantly influences the overall performance and economy of a structure. Traditional slab systems, such as flat and conventional slabs, are often uneconomical for large spans due to excessive deflection and material usage.

A grid slab (waffle slab), consisting of a network of ribs running in perpendicular directions, effectively reduces slab weight while maintaining structural integrity. This system is ideal for large spans, architectural flexibility, and efficient load transfer to columns.

The present study investigates the structural efficiency of a multi-story RC building with a grid slab, focusing on deflection control, moment distribution, and overall economy compared with a conventional slab system.

II. OBJECTIVES OF THE STUDY

1) To design a multi-story RC building incorporating a grid slab system.
2) To perform structural analysis under various load conditions using ETABS.
3) To compare the behavior of grid slabs with traditional slab systems in terms of bending moments, deflections, and material utilization.
4) To optimize the design for cost-effectiveness and serviceability.

III. METHODOLOGY

The following methodology was adopted for the present study:

A. Modeling

A G+10 RCC building was modeled in ETABS 2020 with a grid slab system. The building was assumed to be located in Seismic Zone III as per IS 1893 (Part 1):2016.

B. Design Parameters

Plan Dimensions: 30 m × 25 m
Storey Height: 3.2 m
Grid spacing: 1.0 m to 1.5 m
Grade of Concrete: M30
Steel Grade: Fe 500
Live Load: 3 kN/m²
Floor Finish: 1.0 kN/m²
Seismic Load: As per IS 1893:2016
Wind Load: As per IS 875 (Part 3):2015

C. Analysis

Load combinations as per IS 456:2000 and IS 875 were used.
Both linear static and dynamic (response spectrum) analyses were performed.
Structural parameters such as bending moment, shear force, deflection, and storey drift were obtained.

D. Design

Slab, beam, column, and foundation designs were carried out in ETABS.
Reinforcement details were optimized to ensure economy and serviceability.

IV. RESULTS AND DISCUSSION

The analysis results demonstrated that the grid slab system efficiently reduced the self-weight of the slab by approximately 20–25% compared to a conventional slab.
Maximum deflection in grid slabs was found to be 30–40% lower than that of conventional slabs due to increased stiffness.
Bending moments were significantly reduced in the central panel region, resulting in optimized reinforcement distribution.
The storey drift values were within the permissible limits prescribed by IS 1893:2016, ensuring good lateral stability.
The use of grid slabs led to a reduction in overall material consumption, making the design cost-effective and structurally efficient.

V. DESIGN HIGHLIGHTS

Slab thickness: 110 mm (with ribs 300 mm deep and 150 mm wide)
Beam size: 300 × 600 mm
Column size: 500 × 500 mm
Foundation: Isolated footings designed based on soil bearing capacity (200 kN/m²)
Reinforcement optimized to maintain safety and economy

VI. ADVANTAGES OF GRID SLAB SYSTEM

Reduces dead load due to voids in slab ribs.
Provides architectural flexibility and aesthetic ceiling appearance.
Controls deflection and improves load distribution.
Minimizes material consumption and enhances seismic performance.
Suitable for long-span structures like auditoriums, offices, and parking decks.

VII. CONCLUSIONS

The present study concludes that the grid slab system is an efficient and economical structural option for multi-story buildings.
The grid slab reduces self-weight, enhances stiffness, and minimizes deflection.
The system satisfies all the strength and serviceability requirements prescribed by IS codes.
Overall, the grid slab proves to be a superior alternative to traditional slab systems for medium and high-rise structures.

VIII. FUTURE SCOPE

Further studies may include:

1) Comparative study of grid slabs using various materials such as lightweight concrete or fiber-reinforced concrete.
2) Nonlinear dynamic analysis under real earthquake records.
3) Experimental validation of analytical models.

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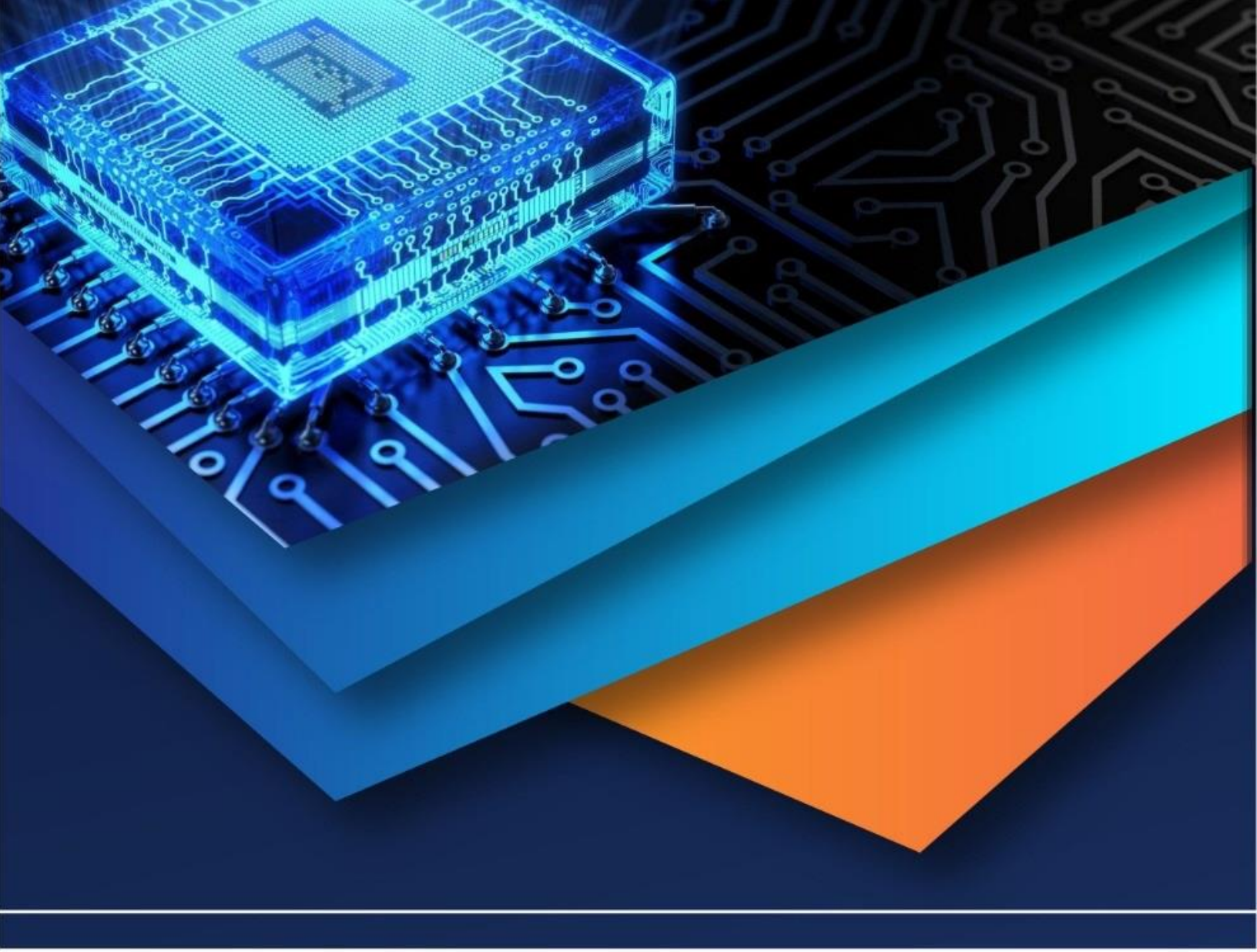

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