Design of Residential Building

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2025/Feb

Introduction

The design of residential buildings is a critical aspect of civil engineering that requires careful consideration of functionality, safety, and structural efficiency. These buildings play a vital role in urban development by accommodating a growing population and catering to diverse commercial and residential needs. The ground floor in such designs often serves commercial purposes, like grocery stores, while the upper floors provide residential apartments, ensuring a balanced utilization of space.

Objectives

1. Ensure Structural Integrity: Apply structural analysis techniques using SAP2000 to ensure the building's safety, stability, and compliance with the Saudi Building Code (SBC).
2. Optimize Load Distribution: Calculate and apply appropriate load distributions for the building, considering both dead and live loads, to ensure efficient structural performance.
3. Utilize AutoCAD for Precise Drafting: Use AutoCAD to create accurate and detailed architectural and structural drawings, ensuring proper coordination between different elements of the design.
4. Incorporate Modern Engineering Tools: Leverage SAP2000 for the analysis and design of structural elements such as beams, columns, and slabs, ensuring cost-efficiency and material optimization

Methodology

The methodology of this project follows a structured approach, starting from the initial drafting phase to the final structural design. The steps involved in this methodology include:

1. Initial Data Collection and Analysis:
• Review and analyze the existing AutoCAD floor plans of the building.
• Identify errors, inconsistencies, and areas for improvement in the initial design.
2. Revised Design and Modifications:
• Modify the existing plans, including the addition of a store on the ground floor.
• Ensure compliance with the Saudi building code and safety standards.
3. Structural Analysis:
• Import the modified AutoCAD plans into SAP2000 for structural analysis.
• Apply loads such as dead loads and live loads.
• Use SAP2000 to simulate the building's structural response under different loading conditions.
4. Design of Structural Elements:
• Design the structural elements of the building, including columns, slabs, and beams, based on the analysis results.
• Perform calculations to ensure that all elements meet the required safety and functionality standards.
5. Final Verification:
• Cross-check the final design with the Saudi building code and other relevant standards.

AutoCAD Result

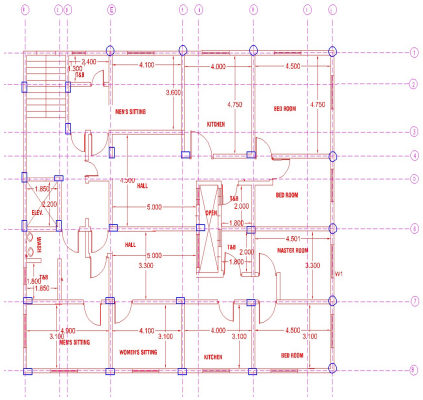

Figure.1: Show the Architectural plan

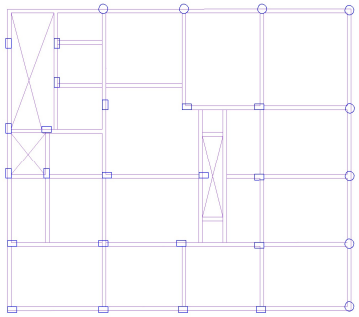

Figure 2: Show the structural plan

Figure 1: Architectural Plan This figure shows the architectural plan, detailing the layout of walls, columns, and doors. It provides a clear representation of the spatial distribution of rooms and internal divisions within the structure.

Figure 2: Structural Plan This figure represents the structural plan, focusing on the distribution of structural elements such as columns and beams. It includes engineering details related to loads and design specifications to ensure the building's structural stability and safety.

SAP 2000 analysis

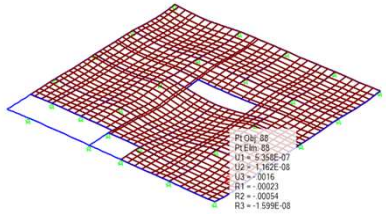

Figure 3: Show the deformation (mm)

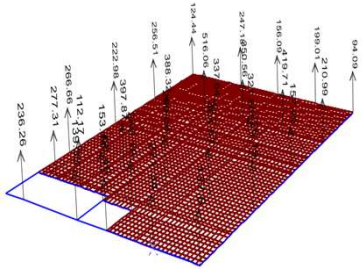

Figure 4: Show the reaction on joint (kN)

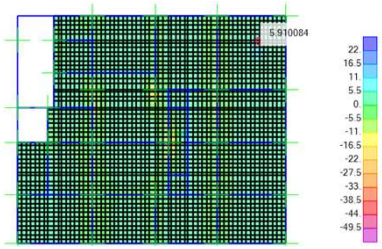

Figure 5: show the Moment in slab (kN.m)

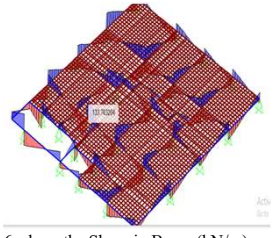

Figure 6: show the Shear in Beam (kN/m)

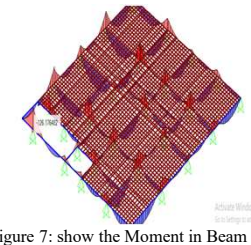

Figure 7: show the Moment in Beam (kN.m)

Design

Table 1: Reinforcement table of beam

Reinforcement table of beam					
model	depth (cm)	width (cm)	Top reinforcement	Bottom reinforcement	Stirrups
B1	50	30	3Ø16	3Ø16	Ø8@20cm
B2	60	30	3Ø16	3Ø16	Ø8@20cm
B3	50	30	4Ø16	4Ø16	Ø8@20cm
B4	50	30	5Ø16	5Ø16	Ø8@20cm

Table 2: Reinforcement table of column

Column	Length (cm)	Width (cm)	Reinforcement	Stirrups
C1	20	20	4Ø16	Ø8@20cm
C2	30	30	4Ø16	Ø8@20cm
C3	40	30	6Ø16	Ø8@20cm
C4	50	30	8Ø16	Ø8@20cm
C5	60	30	8Ø16	Ø8@20cm
C6 (Circular)	60	Ø40	6Ø16	Ø8@20cm

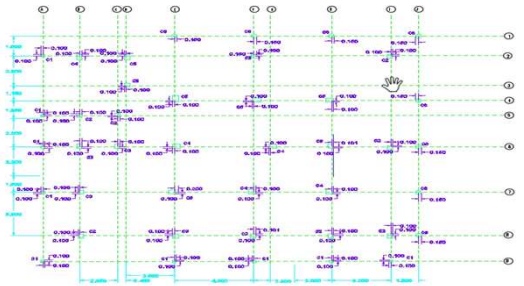

Figure 8: Axis and column plane.

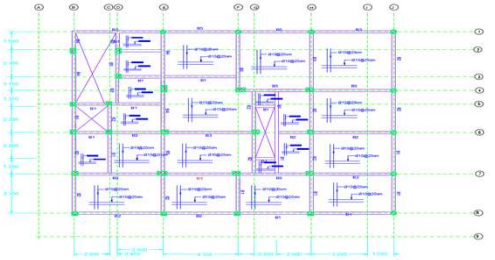

Figure 9: Structure plane.

conclusion

The design improvements successfully balanced structural integrity with practical space use, meeting building code requirements. These changes offer valuable insights into optimizing both architectural and structural aspects for future projects.

After conducting the structural analysis using SAP2000, the results indicate significant improvements in load distribution and structural stability compared to the initial design.