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An Attempt to Design of High-Rise Structures Using ETABS

Sagar N. Khadake[1], Dr. Sourabh Kumar Singh[2]
[1]Ph.D. Scholar SJJTU & Lecturer PLGP Latur (MH-State) Dept. of Civil Engineering
[2]Head of Department & Guide, SJJTU Dept. of Civil Engineering, JUNJHUNU, India

Abstract: This paper aims to discuss about ETABS (i.e., Extended Three Dimensional Analysis of Building Systems) and its various stages of Design civil engineering structures. Designer will be able to specify the loads and perform the analysis all conveniently and quickly. It helps in understanding the overall behavior of the structure in terms of resulting bending moment, shear forces and deformations which can be viewed or plotted. Define the boundary conditions, assign material properties. Designer will be able to generate the geometry.
Keywords: ETABS, Bending moment, shear force.

I. THE IMPORTANCE OF HIGH OF ETAB IN HIGH-RISE BUILDING DESIGN

When it comes to designing large and complex structures like high-rise buildings, there are many tools available to architects and engineers to help them ensure that their designs are safe and efficient. One such tool that has gained popularity in recent years is ETAB, a powerful software application that is specifically designed to help architects and engineers create high-rise structures that are both safe and efficient.

With its powerful design modules, analysis tools, detailing options, and advanced reporting capabilities, ETAB is quickly becoming one of the most popular software applications among professionals who specialize in high-rise building design. ETAB offers a range of features that make it an ideal tool for high-rise building design.

One of the key features of ETAB is its powerful design modules, which allow architects and engineers to create efficient high-rise structures that are both safe and stable. In addition, ETAB also offers a range of analysis tools that can be used to determine the safety and stability of the building, including options for analyzing earthquake and wind loads. With its detailing options, architects and engineers can also create precise drafts and annotations, while the application's advanced reporting capabilities make it easy to generate detailed project reports.

II. INTRODUCTION

The rapid urbanization and population growth witnessed in recent decades have led to a significant increase in the demand for infrastructure, particularly in the construction of high-rise buildings. High-rise structures have become a prominent feature of modern urban landscapes, serving as solutions to spatial constraints and addressing the need for efficient land use. The design and analysis of such tall structures pose unique challenges, requiring sophisticated engineering tools and methodologies to ensure their safety, functionality, and sustainability.

The evolution of urban landscapes over the past few decades has been marked by unprecedented population growth and rapid urbanization. As a consequence, the demand for infrastructure, specifically high-rise buildings, has surged to accommodate the spatial needs of expanding urban populations.

High-rise structures represent a pivotal solution to the challenges of limited land availability, enabling the vertical optimization of space and contributing to the creation of iconic skylines around the world.

However, the design and construction of high-rise buildings present unique challenges that require sophisticated engineering solutions. Factors such as wind loads, seismic forces, foundation considerations, and material selection become increasingly complex as buildings rise in height. Traditional design methods, while adequate for low to mid-rise structures, often fall short when applied to the intricacies of tall buildings. This research seeks to contribute to the existing body of knowledge by critically examining the application of ETABS in high-rise building projects. By delving into the historical evolution of high-rise structures and the technological advancements that have enabled their construction, this study aims to contextualize the role of ETABS in the broader landscape of structural engineering.

In doing so, it aspires to provide a comprehensive understanding of the software's significance in meeting the intricate demands posed by the design and analysis of high-rise buildings in the 21st century.

High-rise structures stand as iconic solutions to the challenges posed by the limited availability of space in densely populated urban areas.

In response to the exponential growth of city populations, architects and developers are turning to the vertical dimension as a means of accommodating the surge in demand for residential, commercial, and mixed-use spaces. The verticality of high-rise buildings allows for the efficient use of limited land resources, offering a compelling solution to the spatial constraints faced by expanding urban landscapes.

III. THE ROLE OF ETABS IN HIGH-RISE DESIGN

As high-rise construction becomes increasingly integral to urban development, the role of computational tools in facilitating the design process cannot be overstated. Among these tools, ETABS (Extended Three-Dimensional Analysis of Building Systems) has emerged as a cornerstone in the field of structural engineering, offering a comprehensive platform for modeling, analysis, and design of complex building structures.

A. Three-Dimensional Modeling Capabilities

ETABS distinguishes itself with its robust three-dimensional modeling capabilities, allowing engineers and architects to create accurate representations of the entire structural system. This includes the intricate details of high-rise buildings, such as floor slabs, columns, shear walls, and foundations.

The three-dimensional modeling approach not only mirrors the real-world geometry of the structure but also enables a more accurate simulation of the complex interactions between various components.

B. Dynamic Analysis and Performance Evaluation

The dynamic behavior of high-rise structures under different loading conditions, including wind and seismic forces, is a critical aspect of their design.

ETABS employs advanced algorithms to conduct dynamic analyses, providing insights into the structural response to dynamic forces. This capability is particularly vital for ensuring the safety and stability of high-rise buildings, where the dynamic interactions between the structure and external forces play a pivotal role.

C. Seismic Design and Response Spectrum Analysis:

Given the vulnerability of tall buildings to seismic events, ETABS includes specialized features for seismic design. The software allows engineers to perform response spectrum analysis, which assesses the structure's response to ground motion over a range of frequencies.

By accounting for the dynamic characteristics of the soil-structure interaction, ETABS aids in designing high-rise structures that can withstand seismic forces while maintaining structural integrity.

D. Nonlinear Analysis for Realistic Behavior:

High-rise buildings often exhibit nonlinear behavior under extreme conditions, such as during severe earthquakes or windstorms. ETABS facilitates nonlinear analysis, allowing engineers to model material and geometric nonlinearities. This capability is crucial for accurately predicting the performance of the structure under extreme loading scenarios, ensuring a more realistic representation of its behavior.

In summary, ETABS stands as a powerful and versatile tool in the arsenal of structural engineers and architects engaged in high-rise construction.

Its ability to handle the complexities of three-dimensional modeling, dynamic analysis, nonlinear behavior, and optimization positions it as a key enabler in the pursuit of safe, efficient, and innovative high-rise designs. This research endeavors to delve into the specific applications and implications of ETABS in the context of high-rise building design, contributing to a deeper understanding of its role in shaping the future of urban architecture and engineering.

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IV. METHODOLOGY

The research paper deals with a typical highrise building design through ETAB. The layout drawing, sample design for shear wall, column and beams are presented as follows:

A. Layout Drawing

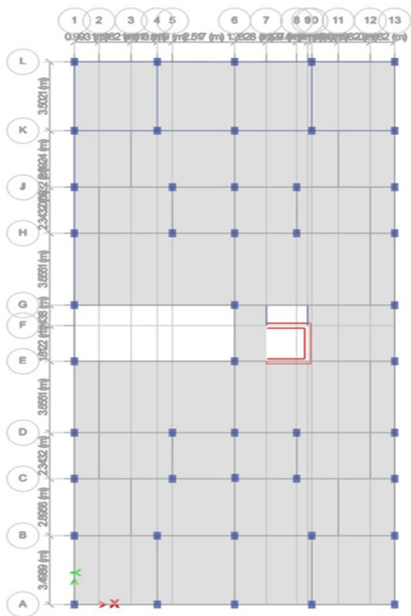

Fig: 5.1- 2D & 3D

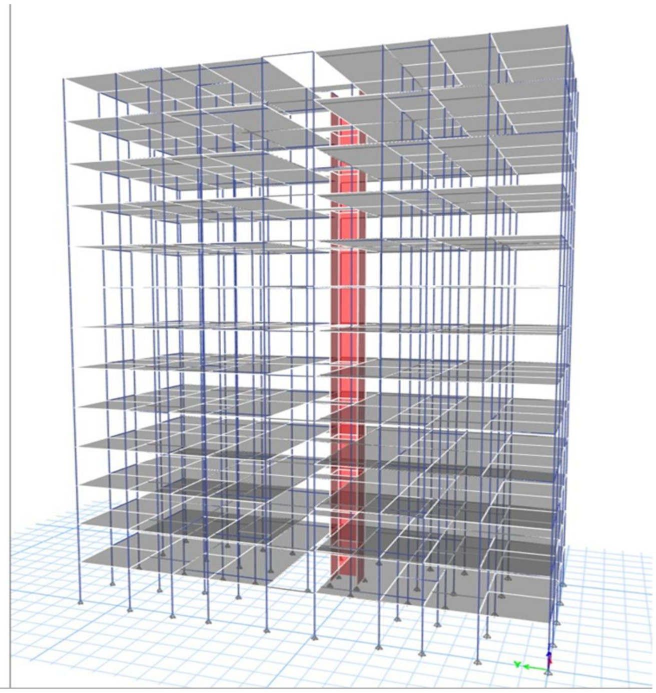

Fig: 5.2 Shear Wall Design

ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
Story11	PW4	8602.8	12392.8	1676.4	250	0.765

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
24855.58	27.58	1	413.69	413.69

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	7764.6	12392.8	9441	12392.8	1676.4	250
Bottom	Leg 1	7764.6	12392.8	9441	12392.8	1676.4	250

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm²)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm²
Top	1048	0.0025	0.003	DWal2	470.7343	-17.1893	-50.8421	419100
Bottom	1048	0.0025	0.003	DWal2	515.1731	17.0703	42.1684	419100

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	625	DWal2	470.7343	-50.8421	31.0035	279.9397	581.4625
Bottom	Leg 1	625	DWal2	515.1731	42.1684	31.0035	279.9397	581.4625

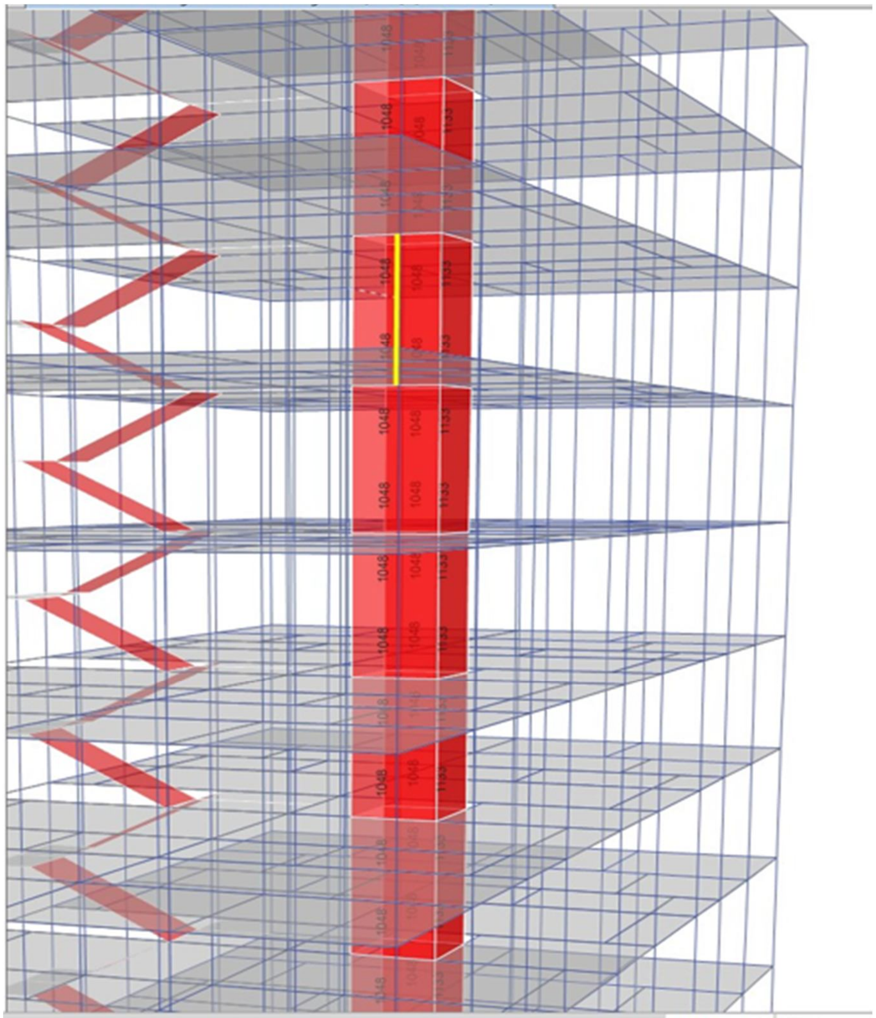

Fig:5.2 – Shear Wall

B. Beam Sample

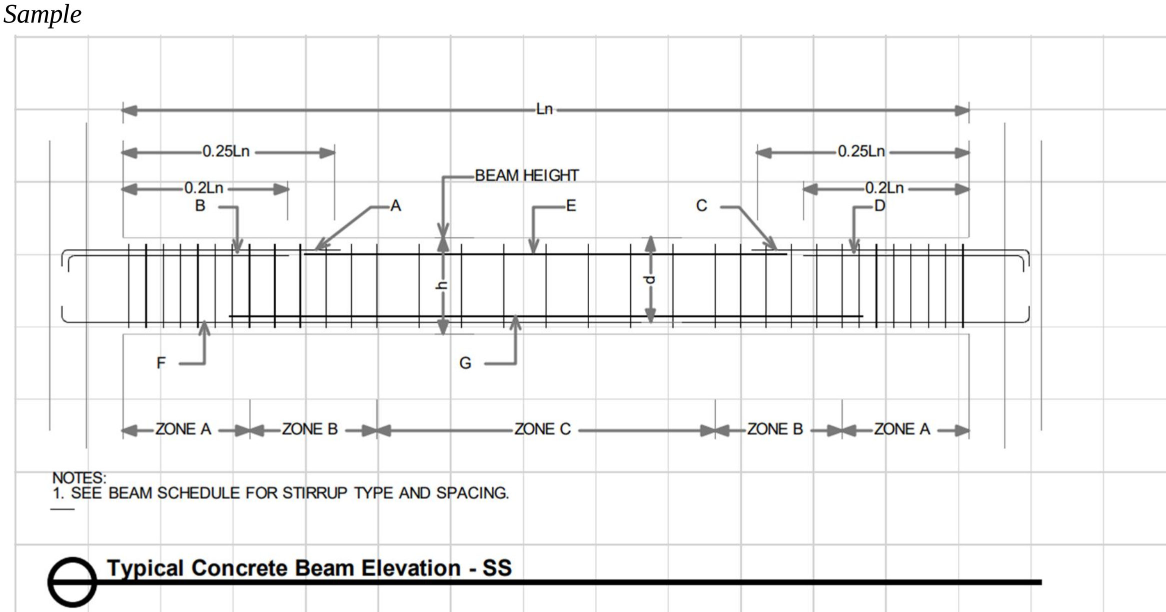

Fig:5.3- Typical Beam

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C. Sample Column

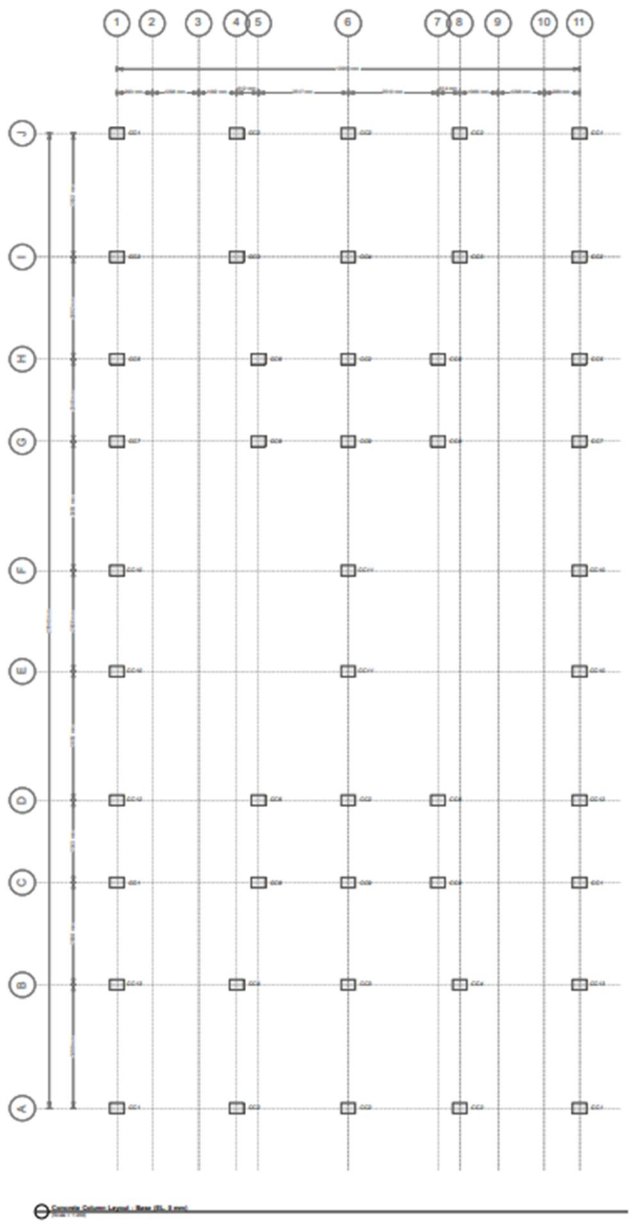

Fig: 5.4- Column Layout

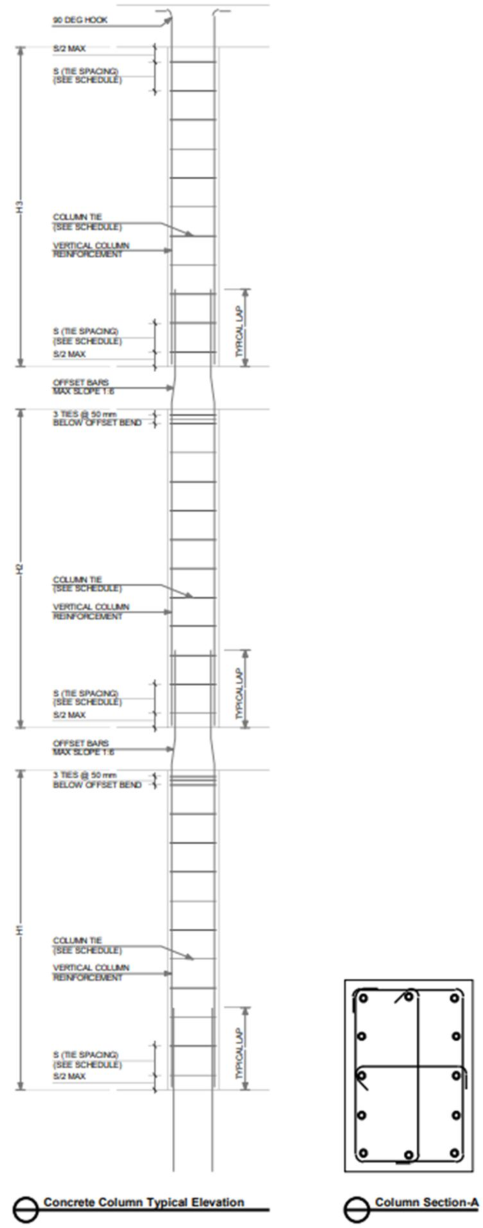

Fig: 5.5- Column Design

V. CONCLUSIONS

1) The capabilities of ETABS software in the context of high-rise building design and analysis are exercised.
2) The efficiency of ETABS in modeling complex structural systems inherent in high-rise buildings is experienced.
3) The accuracy of ETABS predictions in comparison with real-world performance data is observed.
4) It is advantageous to design highrise structures through ETAB effectively and with short time.
5) The use of ETABS in the design and analysis of high-rise buildings is recommended.

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