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"DESIGN & ANALYSIS OF A HIGH-RISE PREFABRICATED BUILDING IN NORTH EAST INDIA (GUWAHATI, ZONE 5)"

Ms. Neiniroi Rymbai[1], Ms. Raisa Tamsin Hussain[2]

M.Tech Student, The Assam Royal Global University, Guwahati[1]

Assistant Professor, The Assam Royal Global University, Guwahati[2]

Abstract: Modular construction is becoming increasingly popular in North East India, especially in Guwahati, due to its efficiency and sustainability. This innovative construction method offers several benefits in a region where logistics and construction materials can be challenging. It is particularly advantageous in areas prone to natural disasters and allows for flexibility in design while being customizable to meet various requirements. Modular construction can offer significant benefits in North East India. The region's challenging topography, weather conditions, and seismic activity make transportation and logistics difficult. The prefabricated modules can be transported more easily to remote areas, making construction more feasible in this region. This paper explores the benefits of utilizing precast shear walls and sandwich panel walls in the northeastern region. The study involves the design and analysis of a structure using software such as ETABS and Revit, which are Building Information Modeling Software (BIM). The measurements adhere to IS 456:2000 and IS 15916:2010 of the Indian Standard Codes.

Keywords: Modular Construction, North-East India, Precast Shear Wall, Revit (BIM), ETABS, Sandwich Panel Wall

I. INTRODUCTION

Modular Construction in North-East India, including Guwahati, Assam has been gaining popularity and sustainability. This construction involves assembling building components off-site in a controlled environment and then transporting them to the site. The use of precast shear walls and sandwich panel walls in the region offers several advantages. Precast shear walls are prefabricated concrete walls that provide structural support and enhance the building's resistance to lateral loads such as wind and earthquakes. Sandwich panel walls consist of two outer layers with an insulation core in between. These panels are lightweight, energy efficiency, and quick to install. The seismic performance of precast shear walls and sandwich panel walls is a crucial aspect to consider since this region is prone to earthquakes. Both precast shear walls and sandwich panel walls exhibit favorable seismic performance characteristics making them suitable choices for construction in this region. Proper design, construction techniques, and adherence to building codes like IS 456:2000, IS: 875(Part-3)-1987, IS: 1893(Part-I)-2002 and IS 15916:2010 are essential to maximize the seismic resistance of buildings utilizing these walls system. In North-East India where construction materials may be limited or transportation challenging, the use of these walls can streamline the construction process, reduce construction time, and minimize waste. Additionally, these construction methods align with the region's growing focus on Eco-friendly.

Objectives

1. To design a 10-story building in Guwahati, Assam, Zone 5, susceptible to earthquakes using modular construction (sandwich panel walls & precast shear walls).

2. To ensure the building's safety it will be analyzed in ETABS according to the requirements in IS codes. Once it passes the design check a 3D model will be created in Revit, which is Building Information Modeling Software.

3. After completing the analysis, it will determine the safety of this construction method in the North Eastern Region, where the traditional method is mostly preferred.

II. MODULAR CONSTRUCTION

A construction method where the components are constructed off-site and then put together on-site. This approach is great for regions like North-East India and uses pre-made parts like precast shear walls and sandwich panel walls for efficient and sustainable building. Overall, it is a modern and efficient way to construct buildings with high quality.

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A. Need for Modular Construction

1. The need for modular construction in North East Guwahati stems from the region's fast, reliable solutions.

2. And adaptable building solutions that can address posed by its geography and infrastructure.

3. The speed and precision of modular construction are crucial in a region like the Northeast, where weather conditions and logistical constraints can impact construction timelines.

4. By prefabricating building components off-site, projects can be completed quickly and with higher quality, meeting the demand for efficient and sustainable methods in the area.

B. Sandwich Panel walls

Sandwich panels are composite materials made by sandwiching insulation between two metal surfaces, typically steel or aluminum. These panels are commonly used in construction for walls due to their lightweight and insulating properties. The thickness of sandwich wall panels can range from 40–200 mm, depending on the type of insulation used.

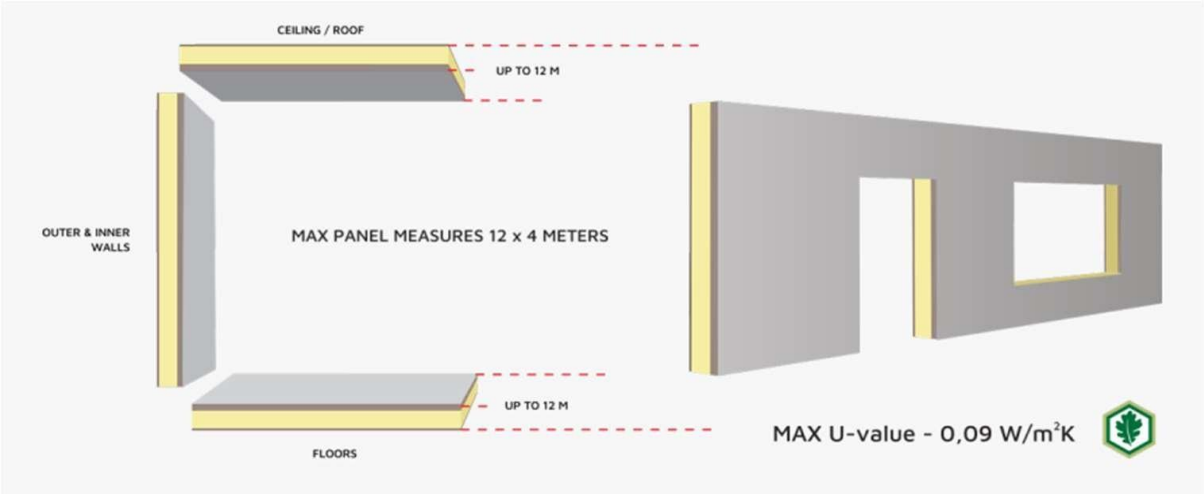

Fig 1: Sandwich Panel wall

C. Precast Shear Walls

Precast shear walls consist of two reinforced concrete panels connected by metal stiffeners, with a space in between for pouring ready-mix concrete. The size of these walls varies depending on factors such as building height, design loads, and seismic considerations. Typically, the width of these walls ranges from 6 to 12 feet, and they can be several stories high, depending on the building's height.

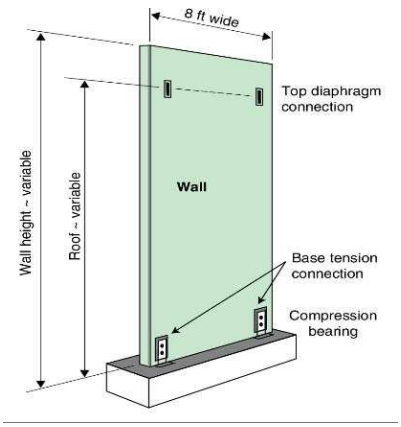

Fig 2: Precast Shear wall

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III. METHODOLOGY

The methodology employed is response spectrum analysis

a. Modelling of the building

The process begins with creating the plan in AutoCAD. Next, the prefabricated structure is designed and analyzed in ETABS, which includes a response spectrum analysis and an analysis of sandwich panel walls and shear walls. The 3D model of the structure and wall details are designed and rendered in Revit (BIM) software. Once the design and analysis are completed, the results are checked to ensure the safety of constructing precast walls in this region.

b. Building dimension details:

1. The specifications for the G+10 building are provided below. Additionally, the analysis models used in ETABS and the 3D model created in Revit (BIM) are listed.

TABLE 1: PARAMETERS FOR THE G+10 BUILDING

S.NO	PARAMETERS	CONFIGURATION
1	Structure Type	Precast Structure
2	Plan dimension	18m x 18m
3	Height of story	3m
4	No of Story	10
5	Thickness of Sandwich Panel	200mm
6	Grade of Steel	Fe 550
7	Grade of Concrete	M40

TABLE 2: SEISMIC PARAMETERS OF THE BUILDING

S.NO	PARAMETERS	CONFIGURATION
1	Seismic Zone	Zone V
2	Area/Location	Guwahati
3	Latitude	26.1059° N
4	Longitude	91.7321° E
5	Soil Type	Alluvial/Piedmont
6	Size of walls	As per IS 15916:2010
7	RCC Design	As Per IS 456:2000
8	Size of beams & columns	As per IS 15916:2010
9	Live Load	3 kN/m2
10	Dead Load	12 kN/m

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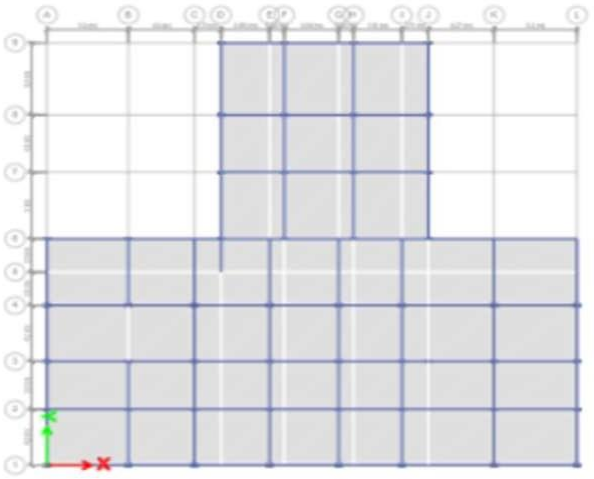

Fig 3: Plan View of the Building

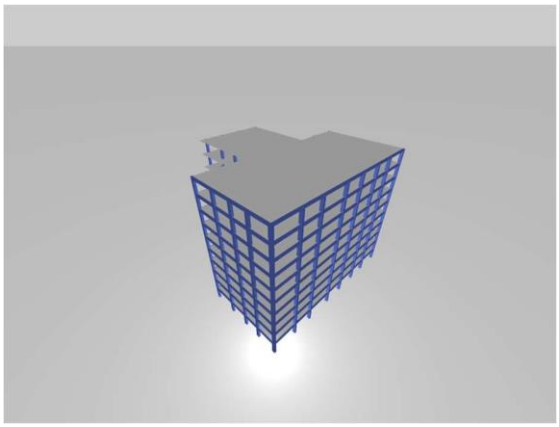

Fig 4: 3D model rendered in ETABS

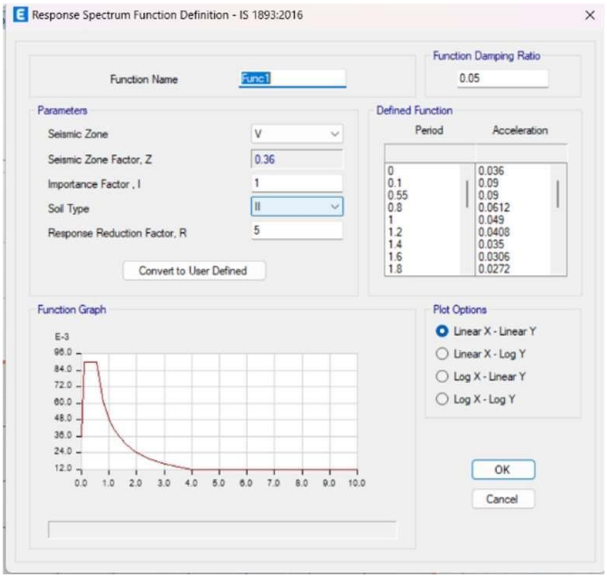

Fig 5: Response spectrum Analysis

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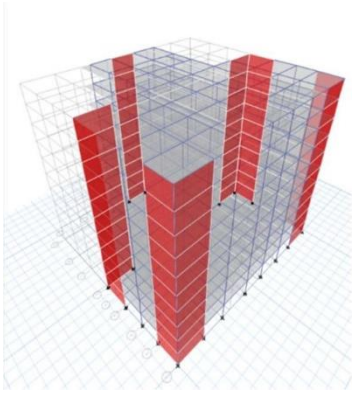

Fig 6: Analysis Of Shear Wall

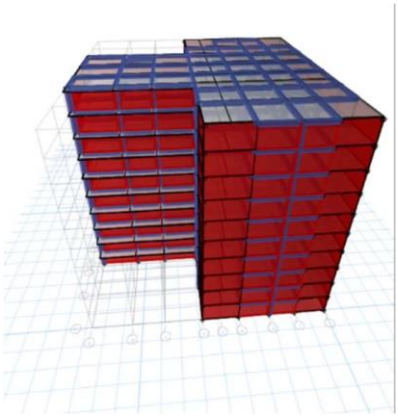

Fig 7: Analysis of Precast Shear wall &Sandwich panel wall

Fig 8: 3D Model Rendered in Revit (BIM) front view

Fig 9:3D Model Rendered in Revit (BIM) Back View

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c. Analysis

➢ ETABS, or Extensive Three Dimensional & Analysis Systems, is a software used for structural analysis and design in the Civil Engineering and Architecture fields. It is an intuitive and powerful tool for confidently analyzing complex structures, helping engineers and architects design safe and efficient structures that meet project requirements. With capabilities such as finite element analysis, response spectrum analysis, and design optimization, ETABS is a popular choice for structural engineers. It also aids in predicting and simulating the behavior of structures under various loading conditions, ensuring that buildings are designed to be safe and structurally sound.

IV. RESULTS

1. Displacement

➢ The displacements in structures with precast shear walls and buildings without precast shear walls and sandwich panel walls were compared.

➢ It was observed that structures with precast shear walls and sandwich panel walls experience lower displacement compared to buildings without walls.

➢ According to the IS Codes, the displacement should not exceed 0.004 times the height of the building. Therefore, buildings with precast shear walls and sandwich panel walls are considered safer.

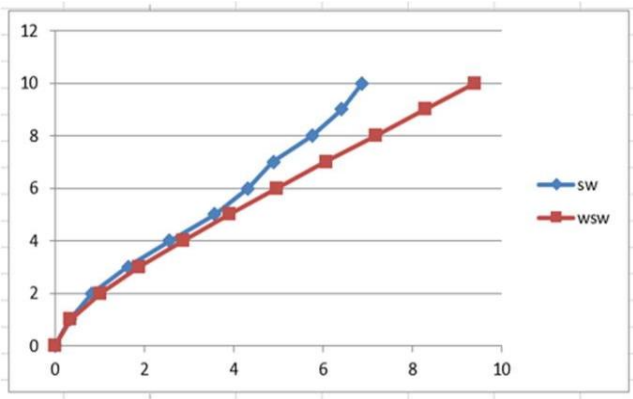

Fig 10: Comparison of displacement, **Note**: Sw-Shear wall, Wsw-Without Shear wall

2. Story Drift

 The application of precast shear walls and sandwich panel walls in the precast building enhances the safety of the structure.

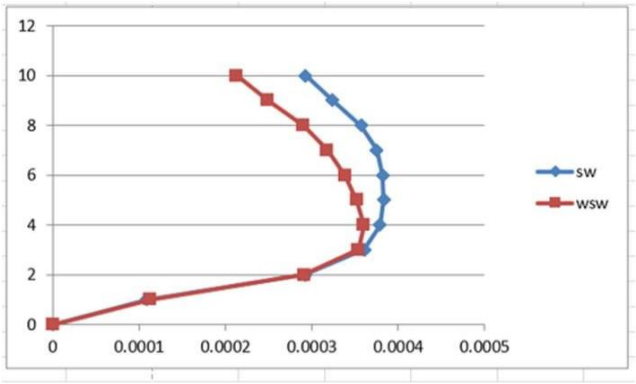

Fig 11: Comparison of Story Drift, **Note**: Sw-Shear wall, Wsw-Without Shear wall

3. Story Shear

 Based on the graph, it is evident that the building with the precast shear wall has a higher shear story

 If the shear force exceeds a certain value, the structure will undergo deformation. Therefore, applying a precast shear wall is safer as it can carry maximum lateral loads

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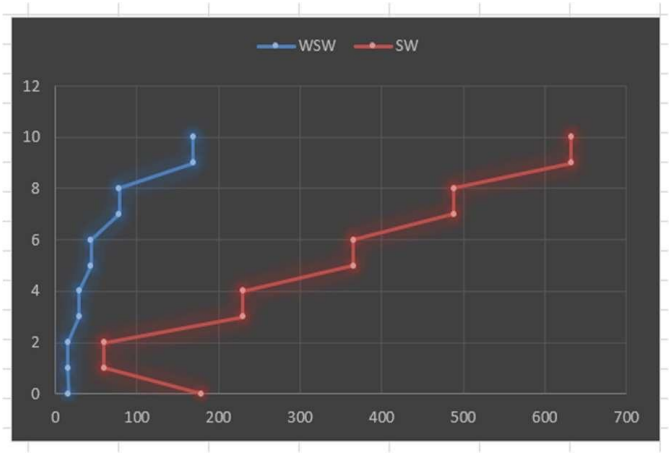

Fig 12: Comparison of Story Shear, **Note**: Sw-Shear wall, Wsw-Without Shear wall

V. CONCLUSION

In this study, analysis of a G+10 prefabricated building is conducted using ETABS. The 3D model is created in Revit, a Building Information Modelling software. The study includes an analysis of displacement, story shear, story drift, and response spectrum of the structure. A comparison is made between the structure with precast walls, sandwich panel walls, and the prefabricated structure without these walls. The conclusion is determined based on the comparison.

- It was previously observed that structures with walls experienced a displacement of 6.868 kN, which is less than the displacement of 9.398 kN observed in structures without walls, indicating that these walls can be utilized in this region
- The shear force of 633.943 kN of the prefabricated structure with precast shear walls and sandwich panel walls is higher than the shear force of the precast structure without walls, which is 169.10803 kN.
- This, along with its flexible and versatile modular construction, makes it a practical choice for a wide range of projects, including residential and commercial buildings

Future Scope

- Looking ahead at the future potential of modular construction in North East India, there is a significant opportunity for the growth and adoption of this innovative construction method
- Given the region's unique geographical and climatic challenges, modular construction can offer benefits such as quicker construction timelines, cost-effectiveness, and reduced environmental impact
- As infrastructure development in the North East region continues to expand, embracing modular construction techniques can help meet the increasing demand for efficient and sustainable building solutions

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REFERENCES

[1]. R. Mark Lawson, M. ASCE; Ray G. Ogden and Rory Bergin (2012) " Application of Modular Construction in High-Rise Buildings",DOI: 10.1061/(ASCE)AE.1943-5568.0000057. © 2012 American Society of Civil Engineers
[2]. S.Ghosh and N.Cleland (2012) "Performance of Precast Concrete Building Structures". First published online June 1, 2012, https://doi.org/10.1193/1.4000026
[3]. A. Deka, H. Doloi and R. H. Crawford (2017), " Prefabrication Technique for low-cost housing in Assam", EPiC Series in Education Science Volume 1, 2017, Pages 393–401 AUBEA 2017: Australasian Universities Building Education Association Conference 201.
[4]. IS: 875(Part-3)-1987. Code of practice for design loads (other than earthquake) for buildings and structures, wind loads. Bureau of Indian Standard, New Delhi.
[5]. IS 15916:2010. Building Design and Erection Using Prefabricated Concrete-Code Of Practice",© BIS 2010 Bureau Of Indian Standards, New Delhi.