



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 12, December 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.524

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Performance based Analysis of Bubble Deck Slab System with Different Bubble Materials over Flat Slab System

Mohd Mehraj, M.E., M.A. Azeem

Student, Department of Structural Engineering, Deccan College of Engineering and Technology, India

Assistant Professor, Deccan College of Engineering and Technology, India

ABSTRACT: The Bubble Deck slab system introduces an innovative approach to structural design by reducing the dead load while maintaining comparable load-bearing capacities. This research compares the seismic performance of a Bubble Deck slab system with traditional flat slabs. Using ETABS 2018, a G+15 multi-storeyed building was modeled with M30 concrete and bubble materials such as High-Density Polyethylene (HDPE), High-Density Polypropylene (HDPP), and Epoxy. Parameters including base shear, displacement, storey force, and drift were analyzed. Results indicate HDPP as the optimal material due to its significant reduction in base shear and storey forces, making it a lightweight, efficient alternative for seismic-prone regions.

KEYWORDS: Bubble Deck, Flat Slab, HDPE, HDPP, Epoxy, Seismic Analysis, ETABS

I. INTRODUCTION

Concrete slabs are integral structural components, consuming substantial material and contributing significantly to the dead load of a structure. Traditional flat slabs, though advantageous in design simplicity, often lead to excessive weight, impacting seismic performance. The Bubble Deck slab system, developed in the 1990s, addresses these concerns by incorporating void formers within the slab, reducing weight without compromising structural integrity.

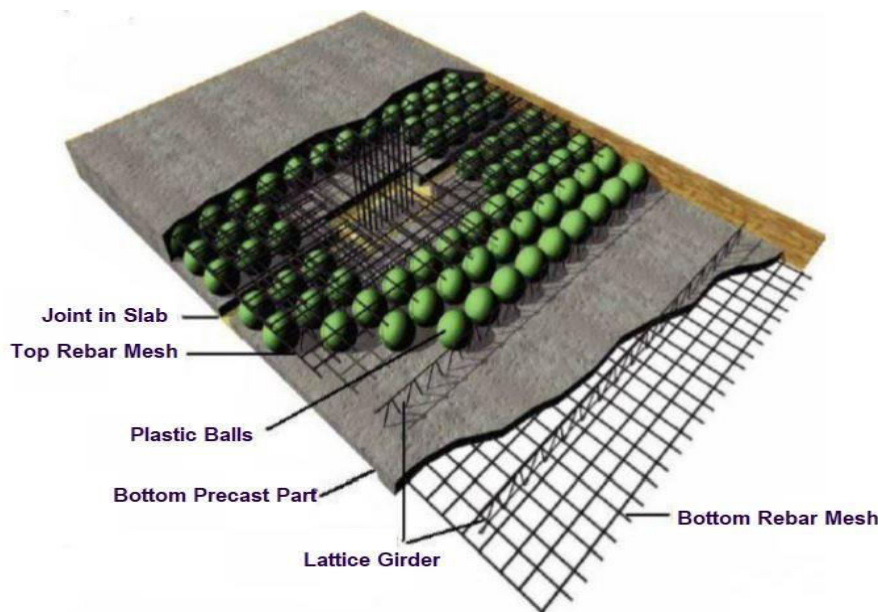


Fig 1. Bubble deck slab

This study evaluates the seismic response of Bubble Deck slabs using different bubble materials (HDPE, HDPP, and

Epoxy) compared to conventional flat slabs. Linear Dynamic Analysis was employed using ETABS 2018 to determine the impact on parameters such as base shear, displacement, and storey drift.

1.1 Objectives

- To assess the seismic response of Bubble Deck slabs with various bubble materials.
- To compare critical response parameters with those of traditional flat slabs.
- To identify the most efficient bubble material for reducing structural weight and enhancing seismic performance.

II. LITERATURE REVIEW

Numerous studies have demonstrated the potential of Bubble Deck systems in reducing dead weight and improving construction efficiency. Manju and Shiny (2019) highlighted a 100% capacity increase with bubble slabs, whereas Shreya Singh (2018) quantified weight reductions of up to 8.85% with HDPE and 6.51% with Epoxy. Fatma and Chandrakar (2018) confirmed time and cost savings of up to 20% and 12%, respectively, with Bubble Deck technology. Recent works by Mohammed Shafiq (2017) and Mahalakshmi and Nanthini (2017) corroborated the seismic advantages of reduced dead load through Bubble Deck systems.

This research builds on these findings by integrating advanced materials (HDPE, HDPP, Epoxy) and employing linear dynamic analysis to validate their efficacy.

III. METHODOLOGY

3.1 Building Specifications

A G+15 multi-storeyed RCC building located in seismic Zone IV was modeled in ETABS 2018. Key dimensions include:

- Slab: 31.5m x 16.6m, thickness = 0.2m
- Beams: 350 x 700mm
- Columns: 600 x 600mm, 900 x 900mm



Fig.2 Typical floor plan
ETABS

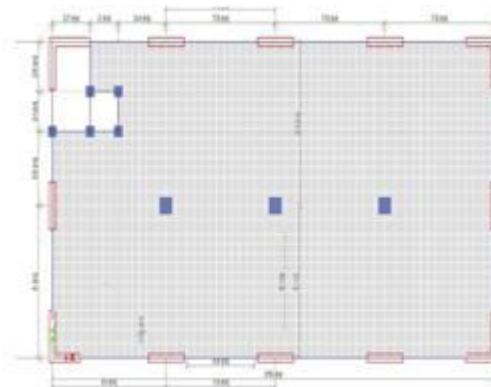


Fig. 3. Typical plan Layout in

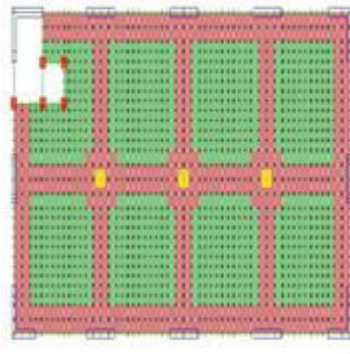


Fig:4 Modelling of flat slab in ETABS

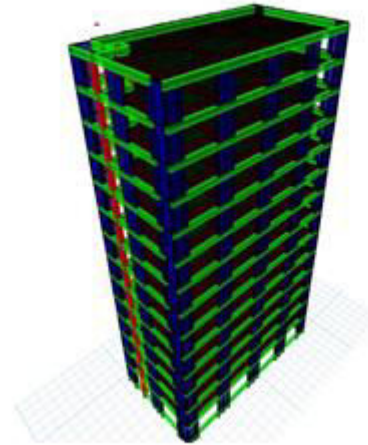


Fig: 5 3D-view of the model in ETABS

3.2 Materials

- Concrete: M30
- Reinforcement: Fe500 steel
- Bubble Materials: HDPE, HDPP, Epoxy

Properties	M30	HDPE	HDPP	Epoxy
Density (kg/m ³)	2400	970	850	1570
Youngs Modulus (Pa)	27X10 ⁹	1035	1265	1.2x10 ¹¹
Poisson Ratio	0.2-0.3	0.45	0.42	0.25
Bulk Density (Pa)	15X10 ⁹	3450	2635.4	8x10 ¹⁰
Shear Modulus (Pa)	11.25X10 ⁹	356.9	445.42	4.8x10 ¹⁰

3.3 Load Conditions

- Dead Load: ** Wall load (6.6 kN/m), floor finish (1.2 kN/m²)
- Live Load: 4 kN/m²
- Seismic load: As per IS 1893 (Part 1):2016
- Wind Load: As per IS 875 (Part 3):2015

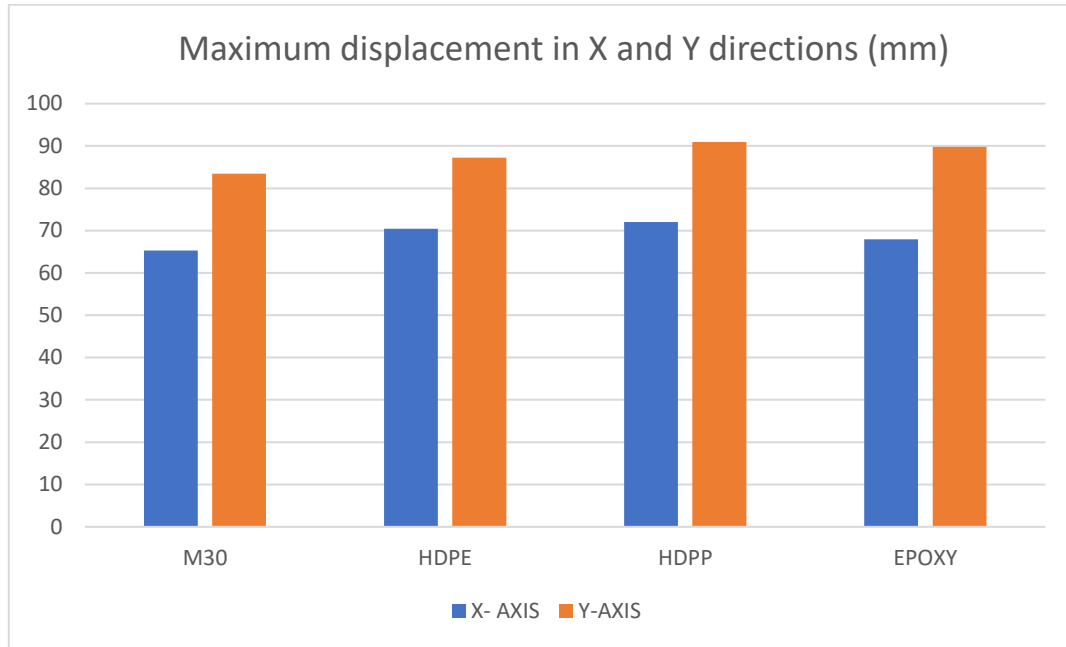
3.4 Analysis Approach

The building was analyzed using the Response Spectrum Method to evaluate seismic performance. Load combinations were applied to simulate realistic conditions. Material properties were defined based on experimental data.

IV. RESULTS AND DISCUSSION

4.1 Maximum Displacement

Displacement was observed to increase for Bubble Deck systems compared to flat slabs due to reduced mass. HDPE, HDPP, and Epoxy showed 8%, 10%, and 4% increases in X-direction displacement, respectively.

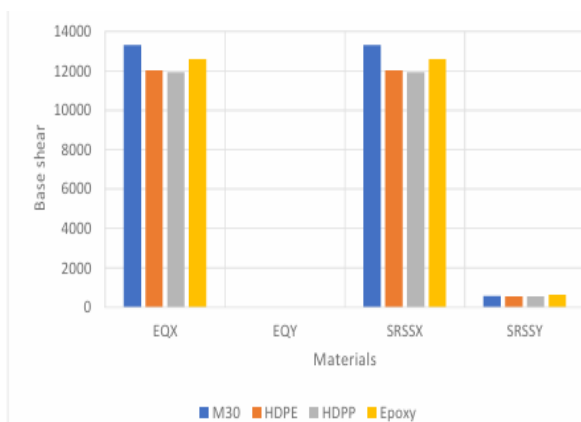


Graph 1: Maximum displacement in X and Y directions (mm)

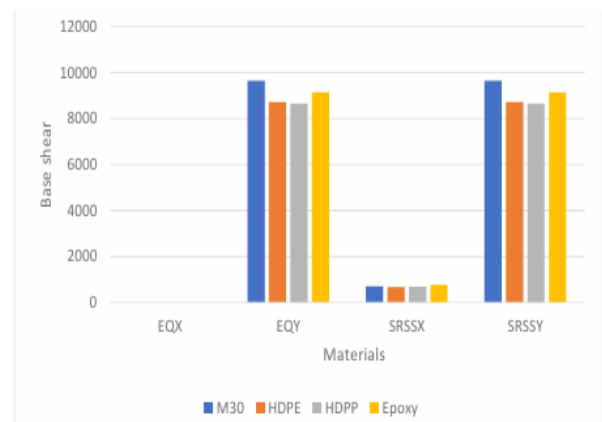
- As seen from the graph for case of HDPE, HDPP and Epoxy displacement is found to be increased by 8%,10% and 4% respectively when compared with M30 in X direction.
- As seen from the graph for case of HDPE, HDPP and Epoxy displacement is found to be increased by 4%,8% and 7% respectively when compared with M30 in Y direction.
- As HDPE, HDPP and Epoxy have lower densities when compared with M30, this causes reduction in mass of the structure as a result displacement increases.

4.2 Base Shear

Base shear was significantly reduced for Bubble Deck materials. HDPP achieved the highest reduction (12%) compared to M30.



Graph 2: Base Shear (kN) in X Direction



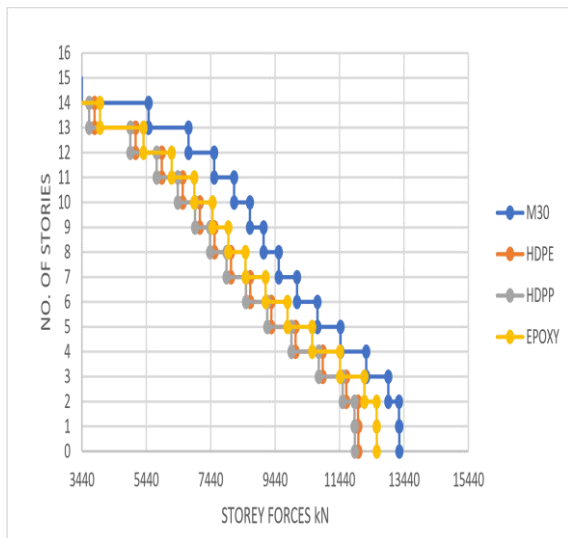
Graph 3: Base Shear (kN) in Y Direction

- As seen from the graph for case of HDPE, HDPP and Epoxy base shear got reduced by 10.8%, 12% and 5.5% respectively when compared with M30 in X direction.

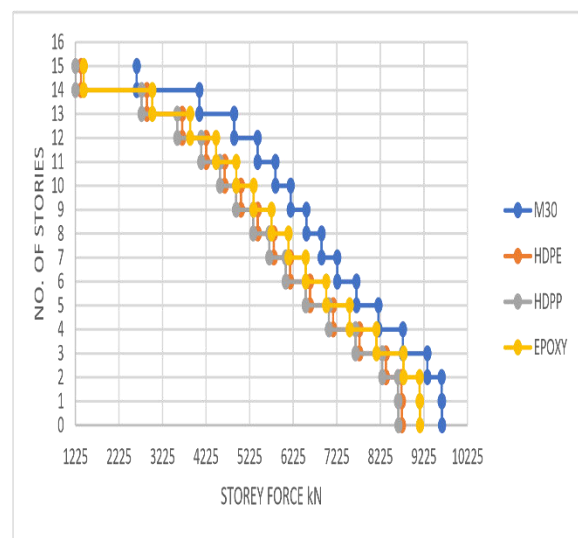
- As seen from the graph for case of HDPE, HDPP and Epoxy base shear got reduced by 10.5%, 11.59% and 5.5% respectively when compared with M30 in Y direction.
- The reason for the lower base shear for HDPP material is due to reduced dead load on the structure.

4.3 Storey Force

Storey forces decreased for all Bubble Deck materials. HDPP recorded a maximum reduction of 57% in X-direction and 53.4% in Y-direction compared to M30.



Graph 4: Storey force in X Direction



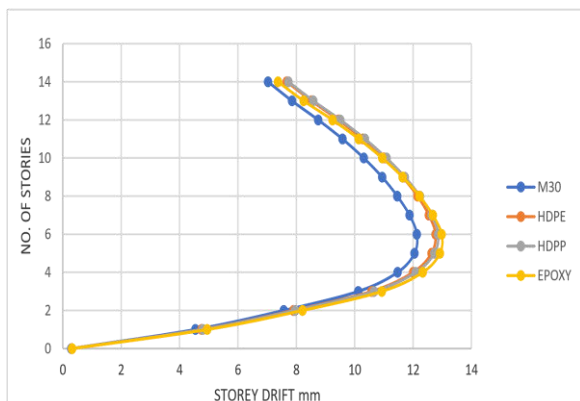
Graph 5: Storey force in Y Direction

As seen from the graph overall storey force for case of HDPE, HDPP and Epoxy got reduced by 30.71%, 33.7% and 27.4% respectively when compared with M30 in X direction.

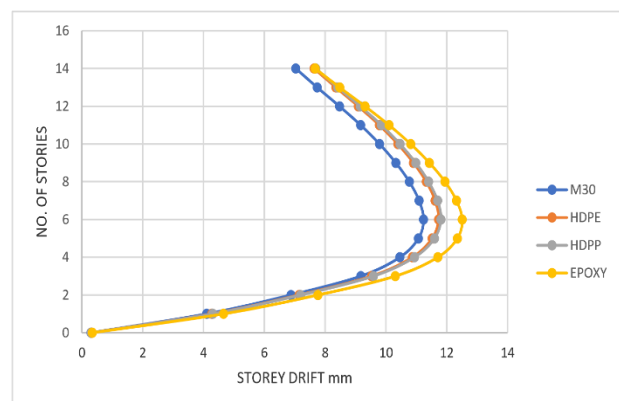
- As seen from the graph overall storey force for case of HDPE, HDPP and Epoxy got reduced by 29%, 31.9% and 25.7% respectively when compared with M30 in Y direction.
- The reduction in overall storey force is due to HDPE, HDPP and Epoxy being light weight which makes the structure lighter hence reducing storey forces.

4.4 Storey Drift

Storey drift values were higher for Bubble Deck slabs but remained within permissible limits, demonstrating their suitability for seismic applications.



Graph 6: Storey Drift in X Direction



Graph 7: Storey Drift in Y Direction

Drift is found to be increased for all the bubble materials when compared with M30. This is because of higher mass of M30 compared with all other materials used.

V. CONCLUSION

This study confirms the superior performance of Bubble Deck systems in seismic conditions. HDPP emerged as the most effective material, reducing base shear, storey forces, and structural weight significantly. The following conclusions are drawn:

- Bubble Deck systems reduce dead load and enhance seismic performance.
- HDPP offers the best performance among the tested materials, with the highest reductions in base shear and storey forces.
- Bubble Deck technology is cost-effective, environmentally sustainable, and viable for irregular and complex designs.

5.1 Limitations and Future Scope

While the study demonstrates promising results, further research is needed to validate the long-term performance of Bubble Deck materials under varying environmental conditions. Exploring additional materials and advanced modeling techniques could expand the applicability of this system.

REFERENCES

1. Manju, N., & Shiny, J. (2019). Structural behavior of bubble deck slab.
2. Singh, S. (2018). Analysis on bubble deck slab using FEA.
3. Fatma, N., & Chandrakar, V. S. (2018). Experimental investigation of bubble deck slabs.
4. Mohammed, S. (2017). Use of bubble deck in construction.
5. Mahalakshmi, S., & Nanthini, S. (2017). Biaxial slabs using bubble deck.
6. IS 1893 (Part 1):2016. Indian Standard Criteria for Earthquake Resistant Design of Structures.
7. IS 875 (Part 3):2015. Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details