*International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)*
**ISSN: 2456-236X**
Vol. **11** Special Issue **03** | **2026**

# Bubble Deck Slab: An Innovative Sustainable Concrete Floor System

Hrishikesh Raikar[1], Dip Dalvi, Pratik Andhari[2], Justin Fernandes[3], Yash Chavan[4], Vishal Kushe[6]

[1,2,3,4,5] *Student, Department of Civil Engineering, Metropolitan Institute of Technology and Management Sindhudurg, Maharashtra, India*

[6] *Assistant Professor, Department of Civil Engineering, Metropolitan Institute of Technology and Management Sindhudurg, Maharashtra, India*

**DOI: 10.5281/zenodo.20646745**

**ABSTRACT**

***Bubble Deck slab is an advanced floor construction technology developed to reduce the self-weight of conventional reinforced concrete slabs without significantly affecting structural strength. In traditional slabs, a considerable portion of concrete located in the middle zone does not effectively contribute to load carrying capacity during bending. Bubble Deck technology improves this inefficiency by replacing the non-structural concrete in the central portion of the slab with hollow plastic spheres made of high-density polyethylene (HDPE). These spheres are placed between two layers of reinforcement mesh and are surrounded by concrete, forming a biaxial hollow slab system. The presence of these hollow elements reduces the volume of concrete used in the slab while maintaining adequate stiffness and structural performance. As a result, the overall weight of the slab can be reduced by approximately 30–35 percent compared to conventional solid slabs. A lighter structural system decreases loads on columns, beams, and foundations, which may lead to reduced construction costs and improved material efficiency. In addition, the reduction in concrete usage contributes to lower carbon emissions, supporting environmentally sustainable construction practices. Bubble Deck slabs also allow longer spans and provide greater flexibility in architectural design due to the reduction in column requirements. Because of these advantages, the system has gained increasing attention in modern commercial buildings, high-rise structures, and large span floor systems. This study presents an overview of Bubble Deck slab technology, including its structural concept, components, advantages, and potential applications in contemporary construction.***

***Keywords:*** *- **Bubble Deck Slab, Biaxial Hollow Slab, Lightweight Concrete Structure, Sustainable Construction, HDPE Plastic Spheres***

## 1.INTRODUCTION

In modern construction, reinforced concrete slabs contribute significantly to the total weight of a building. Conventional solid slabs contain a large amount of concrete in the central portion, which does not actively participate in resisting structural stresses during bending. This excess concrete increases the dead load of the structure and results in higher loads on beams, columns, and foundations. To overcome this limitation, innovative slab systems have been developed to reduce unnecessary material while maintaining structural efficiency.

Bubble Deck slab is a modern construction technology designed to reduce the weight of reinforced concrete slabs by introducing hollow plastic spheres within the concrete. These spheres are usually made from recycled high-density polyethylene (HDPE) and are placed between layers of reinforcement mesh. The hollow spheres replace the ineffective concrete in the middle zone of the slab, where stresses are minimal, while maintaining solid concrete at the top and bottom where compressive and tensile stresses occur. The concept of Bubble Deck slab is based on the principle that concrete in the central region of a slab does not contribute significantly to load-bearing capacity. By removing this unnecessary concrete and replacing it with lightweight spheres, the slab becomes lighter while still maintaining structural strength and stiffness. Studies have shown that Bubble Deck slabs can reduce the self-weight of the slab by approximately 30–35 percent compared to conventional solid slabs.

In addition to reducing structural weight, Bubble Deck technology also provides several practical benefits such as longer spans, reduced material consumption, improved architectural flexibility, and lower environmental impact. Due to these advantages, Bubble Deck slabs are increasingly being used in commercial buildings, office complexes, parking structures, and high-rise buildings.

### 1.1 Concept and Working Principle of Bubble Deck Slab

The Bubble Deck slab system is based on the structural principle that concrete located in the middle portion of a slab contributes very little to its load-bearing capacity during bending. In a typical reinforced concrete slab subjected to bending, compressive stresses develop at the top surface while tensile stresses occur at the bottom surface. The central zone between these two layers experiences very low stress and therefore does not significantly participate in resisting structural loads. Bubble Deck technology utilizes this concept by replacing the ineffective concrete in the middle zone with hollow plastic spheres.

In this system, hollow spheres made from high-density polyethylene (HDPE) are placed between two layers of reinforcement mesh before the concrete is poured. The reinforcement mesh helps maintain the position of the spheres and ensures proper distribution of loads throughout the slab. Once the concrete hardens, the hollow spheres create voids within the slab, resulting in a biaxial hollow slab structure. Despite the presence of these voids, the slab continues to behave structurally similar to a conventional reinforced concrete slab.

The arrangement of spheres allows the slab to efficiently transfer loads in two directions, which improves structural performance and allows longer spans between supports. Since a considerable amount of concrete is removed from the slab, the overall dead load of the structure is significantly reduced. This reduction in weight can decrease the loads acting on beams, columns, and foundations, which may result in more economical structural design.

Additionally, the use of recycled plastic spheres contributes to sustainable construction practices by reducing concrete consumption and lowering the environmental impact associated with cement production. Because of these advantages, Bubble Deck slabs are considered an efficient and environmentally friendly alternative to conventional solid slabs in modern construction.

### 1.2 Components of Bubble Deck Slab

A Bubble Deck slab consists of several structural components that work together to form a lightweight yet strong floor system. These components ensure that the slab maintains its structural integrity while reducing the amount of concrete used. The main components of a Bubble Deck slab include reinforcement meshes, hollow plastic spheres, concrete layers, and sometimes steel lattice girders that help maintain the position of the spheres during construction.

The first important component is the top reinforcement mesh, which is placed near the upper surface of the slab. This reinforcement is primarily responsible for resisting compressive stresses and controlling cracking that may occur due to loads or temperature variations. The top reinforcement also helps in distributing loads across the slab.

The second component is the bottom reinforcement mesh, which is placed near the lower surface of the slab. This reinforcement is designed to resist tensile stresses that develop when the slab bends under applied loads. The bottom reinforcement plays a crucial role in maintaining the flexural strength of the slab.

Another essential element is the hollow plastic spheres, which are usually made from recycled high-density polyethylene (HDPE). These spheres are positioned between the top and bottom reinforcement layers. Their purpose is to replace the non-structural concrete located in the middle portion of the slab. By creating hollow voids inside the slab, the spheres reduce the overall volume of concrete without affecting structural performance.

The concrete layer surrounds the reinforcement and the plastic spheres, forming the final structural element. The concrete provides compressive strength and protects the reinforcement from environmental effects such as corrosion. In some construction systems, steel lattice girders are also used to hold the reinforcement and spheres in position before and during concrete placement. Together, these components create a structural system that reduces slab weight while maintaining adequate strength, stiffness, and durability for modern building construction.

## 2. TYPES OF BUBBLE DECK SLABS

Bubble Deck slabs are generally classified into different types depending on the method of manufacturing and construction. These types mainly differ in the way reinforcement, hollow spheres, and concrete are assembled before installation at the construction site. The three commonly used types of Bubble Deck slabs are reinforcement modules, filigree elements, and finished plank elements. Each type has its own advantages in terms of transportation, installation, and construction speed.

### 2.1 Reinforcement Modules

Reinforcement module type Bubble Deck slabs consist of prefabricated reinforcement cages that contain the hollow plastic spheres. In this system, the spheres are held between the top and bottom reinforcement meshes using steel connectors. These modules are transported to the construction site and placed within the formwork before concrete is poured. After proper placement, concrete is cast around the reinforcement and spheres to form the final slab structure.

This type of Bubble Deck system provides flexibility in construction because the modules can be easily handled

and arranged according to the structural design. It is commonly used in projects where in-situ concrete casting is preferred.

### 2.2 Filigree Elements

Filigree elements are semi-precast components that include a thin precast concrete layer at the bottom along with reinforcement and hollow spheres. These elements are manufactured in a factory and then transported to the construction site. Once the panels are placed in position, additional reinforcement and concrete are poured on top to complete the slab.

This method improves construction speed and quality because a portion of the slab is already precast under controlled factory conditions. It also reduces the amount of formwork required at the site.

### 2.3 Finished Plank Elements

Finished plank elements are fully precast Bubble Deck slab units produced in factories. These planks contain the hollow spheres, reinforcement, and concrete as a single complete element. The finished units are transported to the construction site and directly installed using cranes.

This type offers the fastest construction time since most of the work is completed in the factory. It also ensures better quality control and reduces on-site labor requirements. However, transportation and lifting equipment must be properly planned due to the size and weight of the precast elements.

## 3. METHODOLOGY

The methodology of this study is based on a conceptual and comparative analysis of Bubble Deck slab technology in relation to conventional reinforced concrete slabs. The research primarily focuses on understanding the structural concept, components, and performance characteristics of Bubble Deck slabs through the study of available literature, technical reports, and previous research publications. Information related to the design concept, working principle, and structural behavior of the system was collected from various academic journals and engineering sources.

In this study, the structural configuration of the Bubble Deck slab system was examined to understand how hollow plastic spheres replace non-structural concrete in the middle portion of the slab. The analysis focused on the arrangement of reinforcement meshes, the placement of high-density polyethylene (HDPE) spheres, and the role of surrounding concrete in maintaining structural strength. The influence of these components on slab weight, load transfer, and bending behavior was also reviewed.

A comparative evaluation between Bubble Deck slabs and conventional reinforced concrete slabs was also carried out. Important parameters such as slab weight, concrete consumption, span capability, construction efficiency, and environmental impact were considered during the comparison. This evaluation helped identify the advantages and structural efficiency of the Bubble Deck slab system.

## 4. STRUCTURAL PERFORMANCE OF BUBBLE DECK SLAB

The structural performance of a Bubble Deck slab is similar to that of a conventional reinforced concrete slab but with reduced self-weight due to the presence of hollow plastic spheres. In this system, the hollow spheres replace the ineffective concrete located in the central portion of the slab. During bending, compressive stresses develop in the top region of the slab while tensile stresses occur in the bottom region. Since the middle portion carries minimal stress, removing concrete from this region does not significantly affect the structural capacity of the slab.

The arrangement of hollow spheres allows the slab to act as a biaxial slab, meaning that loads can be distributed in two directions. This results in efficient load transfer to supporting beams and columns. Despite the presence of voids, the slab maintains sufficient stiffness and strength because the reinforcement and outer concrete layers remain intact.

Experimental and analytical studies have shown that Bubble Deck slabs can achieve similar load carrying capacity compared to conventional slabs while significantly reducing the overall structural weight. The reduction in dead load leads to lower forces on structural members and can improve the overall efficiency of the building structure. In addition, the construction process can be faster because many components of the Bubble Deck system can be prefabricated in factories. Prefabrication improves construction quality and reduces on-site labor requirements. The system also helps reduce the amount of formwork needed during construction. Overall, Bubble Deck slabs provide advantages such as reduced structural weight, improved material efficiency, longer spans, faster construction, and lower environmental impact. These benefits make Bubble Deck technology an attractive alternative to traditional reinforced concrete slab systems in modern building construction.

### 4.1 Advantages of Bubble Deck Slab

Bubble Deck slab technology provides several advantages compared to conventional reinforced concrete slabs. One of the most important benefits is the reduction in self-weight of the slab, which can be approximately 30–35 percent lower than that of traditional solid slabs. This reduction decreases loads on columns, beams, and

foundations.

Another advantage is the reduction in concrete consumption, which lowers material costs and supports environmentally sustainable construction practices. Bubble Deck slabs also allow longer spans and larger column-free spaces, providing greater flexibility in architectural design. In addition, the use of prefabricated modules can improve construction speed and quality while reducing on-site labor requirements.

**Fig -1** Table 1

| Parameters | Conventional Reinforced Concrete Slab | Bubble Deck Slab |
|---|---|---|
| Structural Weight | Higher self-weight | Reduced weight (about 30–35%) |
| Concrete Consumption | Large quantity of concrete required | Reduced concrete usage due to hollow spheres |
| Span Length | Moderate span capability | Allows longer spans between columns |
| Construction Speed | Normal construction process | Faster construction due to prefabricated modules |
| Environmental Impact | Higher carbon emissions due to more cement use | More sustainable with reduced material usage |
| Architectural Flexibility | Limited column spacing | Larger column-free spaces possible |

## 5. CONCLUSIONS

Bubble Deck slab technology provides an innovative approach for reducing the self-weight of reinforced concrete slabs while maintaining structural performance. By replacing the non-structural concrete in the middle zone with hollow plastic spheres, the slab becomes lighter and more material efficient. The reduction in structural weight decreases loads on beams, columns, and foundations, which can lead to more economical structural design. In addition, Bubble Deck slabs allow longer spans and provide greater architectural flexibility. The technology also supports sustainable construction practices by reducing concrete consumption and lowering environmental impact. Therefore, Bubble Deck slabs can be considered an effective alternative to conventional reinforced concrete slab systems in modern building construction.

## 6. ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the faculty members of the Civil Engineering Department for their valuable guidance and support during the preparation of this research paper. The authors also thank the institute for providing the necessary resources and academic environment to complete this work successfully.

## 7. REFERENCES

[1 Jorgensen, C., BubbleDeck – A Revolutionary Biaxial Hollow Core Slab System, BubbleDeck International, Denmark, 2008.

[2]. Ibrahim, M., “Structural Behavior of Bubble Deck Slabs,” International Journal of Civil and Structural Engineering, Vol. 4, No. 2, pp. 134–142, 2013.

[3 Kanchwala, H., and Patil, R., “Comparative Study of Bubble Deck Slab and Conventional Reinforced Concrete Slab,” International Journal of Engineering Research and Technology (IJERT), Vol. 5, Issue 6, pp. 456–460, 2016. [4]. Prakash, S., and Kumar, A., “Analysis and Design of Bubble Deck Slab System,” International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 4, pp. 5893–5898, 2017.

[5]. Bhanumathi, K., and Suresh, B., “Experimental Study on Bubble Deck Slab System,” International Journal of Civil Engineering and Technology, Vol. 8, Issue 3, pp. 1234–1241, 2017.