BUBBLEDECK TECHNOLOGY AND ITS APPLICATION POTENTIAL IN MULTI-STOREY BUILDINGS IN VIETNAM

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ABSTRACT:

BubbleDeck is a biaxial voided slab technology that incorporates recycled plastic spheres within the concrete zone near the neutral axis to reduce self-weight while preserving the structural performance of conventional flat slabs. This study examines the structural principles of the BubbleDeck system, its construction procedures, field quality control requirements, and its applicability under Vietnamese conditions. The study is based on a comprehensive review of Vietnamese and international literature, combined with a comparative analysis of the system against current Vietnamese reinforced concrete design standards. The findings indicate that BubbleDeck slabs can reduce dead load by approximately 30% to 50%, depending on slab configuration, while enhancing architectural flexibility and shortening construction time when implemented using a semi-precast method. These results provide a technical and scientific basis for evaluating the feasibility and practical potential of BubbleDeck technology in the Vietnamese construction industry.

Keywords: BubbleDeck, biaxial voided slab, beamless flat slab, construction technology, punching shear, reinforced concrete structure.

1. Introduction

In the development of multi - storey buildings, reducing structural self - weight, enlarging usable space, and accelerating construction have become major criteria for slab solutions. Beamless flat slabs attract interest because they support architectural planning, MEP coordination, and efficient site organization. However, as spans increase, the dead load of a solid reinforced -concrete slab also rises quickly, which in turn increases the demands on columns, walls, and foundations.

BubbleDeck was developed as an alternative system in which the concrete that contributes little to load resistance near the neutral axis is replaced by hollow recycled - plastic balls. In this way, both material consumption and permanent loads can be reduced. In Vietnam, the technology has attracted attention since the late 2000s and has been discussed from the perspectives of technical effectiveness, economics, and green - building criteria.

2. Research method and scope

The references used in this paper are grouped

into three categories: Vietnamese - language sources reflecting the implementation context of BubbleDeck in Vietnam; official technical documents from the technology developer describing structural configuration, product variants, construction logic, and international publications on flexural behavior, stiffness, and punching shear of biaxial voided slabs.

The paper does not perform detailed calculations for a specific project; instead, it provides a scientific overview. Therefore, statements such as the level of dead - load reduction, the influence on stiffness, or the risk of punching failure are presented as ranges or trends that depend on slab configuration rather than as fixed values for every project. When compared with the domestic regulatory framework, TCVN 5574:2018 is used as the general basis for reinforced - concrete design, especially for strength, punching shear, and deformation requirements.

3. Research results

3.1 Construction process and quality control

From a construction perspective, BubbleDeck can be implemented either by placing reinforcement - ball modules on conventional formwork or by using semi-precast panels with a precast bottom concrete layer. Official BubbleDeck documentation describes two main versions: the cast - in - situ version and the precast panel version. Although they differ in the level of prefabrication, both follow the same overall logic; prepare the shoring system; install formwork or semi - precast panels; position the reinforcement - ball modules; add connection reinforcement, edge reinforcement, and strengthening steel in column zones, slab edges, and openings; then cast the concrete, cure it, and remove supports in accordance with technical requirements.

First, the scaffolding and formwork must ensure sufficient stiffness, geometric stability, and accurate slab soffit elevation. Deviations at this stage may lead to errors in concrete cover or in the working position of the hollow spheres. During module installation, it is essential to maintain the correct sphere spacing, concrete cover thickness, and the relative positions of the top and bottom reinforcement with respect to the balls. If the modules float, shift, or cluster during concreting, the actual working section will differ from the design section. In column zones, service openings, and slab edges, omitting the balls or changing to a solid zone must be regarded as a structural requirement rather than merely a construction option.

During concreting, the technical requirements go beyond achieving the specified concrete strength; the pouring sequence, vibration, and curing must also be organized appropriately to prevent floating balls, segregation, or local voids. For semi - precast members, the surface of the precast bottom layer must be cleaned, moistened, and properly prepared at the interface so that the slab behaves monolithically after casting. After placement, the time for removing supports must be tied to the actual concrete strength and the support arrangement in order to avoid early - age deflection and cracking. Overall, the expected time - saving benefits can only be achieved if module fabrication is standardized and on - site control is managed as an industrialized process rather than as uncoordinated manual work.

3.2 Applicability under Vietnamese conditions

From a technical point of view, BubbleDeck is suitable for projects that need flexible space, medium to large spans, beamless flat slabs, and reduced self - weight in order to optimize columns, walls, or foundations. In high - rise residential buildings, offices, schools, hospitals, and multi - storey parking structures, this slab system can create overall benefits because the flat soffit simplifies MEP routing and the lower structural mass can also reduce the required size of other load-bearing components. In addition, because the system uses recycled plastic balls and reduces the amount of concrete in the slab, it is often associated with goals related to material saving and lower emissions.

In Vietnam, however, the effectiveness of BubbleDeck depends not only on the technology itself but also on design capability, the supply chain for prefabricated components, and the rigor of

construction control. Design standards clearly require reinforced-concrete structures to be checked for strength, stiffness, normal serviceability, and punching shear. These provisions mean that engineers must demonstrate the shear resistance, punching capacity, and deformation performance of a voided slab using an appropriate analytical model rather than relying only on claims associated with the technology.

Another major challenge is the gap between being merely constructible and being truly industrialized. If the entire process is still carried out in a largely manual way, the expected schedule benefit will be greatly reduced. Experience from voided slab systems shows that stable quality is obtained only when the reinforcement - ball modules are manufactured consistently, local strengthening zones are standardized, and inspection checklists are specified for each step. Under conditions where contractors are unfamiliar with the technology, or where the project includes many openings, concentrated loads, and complex details, widespread application of BubbleDeck should therefore be considered carefully.

Furthermore, the environmental and economic performance of BubbleDeck should be evaluated over the whole project life cycle rather than only at the slab level. Reducing the concrete volume in the slab may also benefit columns, walls, and foundations, but it simultaneously introduces requirements for module manufacturing, erection control, and workforce training. Accordingly, BubbleDeck becomes a clearly superior option only when the project has sufficiently large spans to benefit from dead - load reduction, a floor plan open enough to exploit the flat - slab advantages, and a reliable construction supply chain.

4. Conclusions and recommendations

BubbleDeck is a biaxial voided slab system with a clear mechanical basis: it removes the less efficient concrete around the neutral axis in order to reduce dead load while preserving the working mechanism of a reinforced - concrete flat slab. The literature review indicates that the technology can provide substantial benefits in self-weight reduction, spatial flexibility, and the organization of semi-precast construction. Experimental studies also consistently show that the slab-column zone is the most critical location; if the hollow balls are arranged inappropriately, punching resistance and shear capacity may decrease significantly.

For Vietnam, BubbleDeck has potential, but it should be implemented only on the basis of verifiable design calculations and tight construction control. Indicators such as “50% material reduction” or “40% faster construction” should not be treated as default values; they must be determined for the actual configuration of each project. Design documents should clearly define solid zones, prohibited areas for ball placement, strengthening reinforcement, and inspection procedures at slab-column joints. Additional domestic technical guidance for biaxial voided slab systems is also needed in order to bridge the general requirements of TCVN 5574:2018 with the analysis models and construction-control procedures specific to BubbleDeck. Only under those conditions can the technology be applied effectively, safely, and sustainably in practice ■

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CÔNG NGHỆ SÀN BUBBLEDECK VÀ TIỀM NĂNG ỨNG DỤNG TRONG XÂY DỰNG NHÀ CAO TẦNG TẠI VIỆT NAM

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TÓM TẮT:

BubbleDeck là công nghệ sàn rỗng hai chiều, sử dụng các quả cầu nhựa tái chế được bố trí trong vùng bê tông gần trục trung hòa nhằm giảm trọng lượng bản thân nhưng vẫn duy trì khả năng như kết cấu của sàn phẳng truyền thống. Nghiên cứu này phân tích nguyên lý làm việc của hệ sàn BubbleDeck, quy trình thi công, các yêu cầu kiểm soát chất lượng tại hiện trường và khả năng áp dụng trong điều kiện Việt Nam. Nghiên cứu được thực hiện trên cơ sở tổng quan hệ thống các tài liệu trong nước và quốc tế, kết hợp với việc so sánh, đối chiếu công nghệ này với các tiêu chuẩn thiết kế kết cấu bê tông cốt thép hiện hành của Việt Nam. Kết quả cho thấy sàn BubbleDeck có thể làm giảm tải trọng tĩnh từ khoảng 30% đến 50%, tùy thuộc vào cấu hình bản sàn, đồng thời tăng tính linh hoạt trong thiết kế kiến trúc và rút ngắn thời gian thi công khi áp dụng giải pháp bán lắp ghép. Những kết quả này cung cấp cơ sở khoa học và kỹ thuật quan trọng để đánh giá tính khả thi và tiềm năng ứng dụng của công nghệ BubbleDeck trong ngành xây dựng Việt Nam.

Từ khóa: BubbleDeck, tấm sàn rỗng hai chiều, tấm sàn phẳng không dầm, công nghệ xây dựng, lực cắt xuyên, kết cấu bê tông cốt thép.