مجلة دجلة • المجلد ٦ ،العدد ٤ (٢٠٢٥)، ص: ٢٥ - ٣٤
ISSN: 2222-6583

# Bubble Deck Slab -A Review

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## Abstract

The most crucial phase of building construction is the slab, which also happens to be one of the structural components requiring the most concrete. As a consequence, the alternative biaxial hollow slab technology, sometimes referred to as the bubble deck slab, was created. By deleting the concrete section of the standard slab that does not contribute to structural performance, The slab system in question is recognised for its high efficiency in improving both the design and performance of buildings, while simultaneously reducing the overall weight of the structure. There are technological advancements that have shown a significant reduction in slab weight, ranging from 30% to 50%, and have proven to be very efficient specifically for hollow slabs. Furthermore, it should be noted that a less quantity of concrete is required when utilizing 1 kilogramme of recycled plastic, since it has the potential to substitute for 100 kilogrammes of concrete. In industrial construction projects for new prefabricated buildings all around the globe, bubble deck slabs are being employed more and more. In comparison to traditional reinforced concrete slabs, it has a variety of benefits, such as cheaper overall costs, less material usage, and improved structural efficacy. The papers and journals chosen utilizing the database search engine were used in this research to conduct a thorough examination of the literature. In this research, we examine the many bubble slab types, material requirements, benefits, and applications. The results will make it possible for people to evaluate the bubble deck slab system's feasibility and its potential to replace the present floor slabs more thoroughly.

**Keywords:** Bubble Deck Slab, Hollow Bubble balls, Reinforcement, Advantages.

**الخلاصة :**

المرحلة الأكثر أهمية في تشييد المبنى هي السقوف، والتي تصادف أيضًا أنها أحد المكونات الهيكلية التي تتطلب معظم الخرسانة. ونتيجة لذلك، تم إنشاء تقنية الألواح المجوفة ثنائية المحور البديلة، والتي يشار إليها أحيانًا باسم السقوف الفقاعية. من خلال حذف القسم الخرساني من السقوف القياسية الذي لا يساهم في الأداء الهيكلي، يتم التعرف على نظام السقوف المعني لكفاءته العالية في تحسين كل من تصميم وأداء المباني، مع تقليل الوزن الإجمالي للهيكل في نفس الوقت. هناك تطورات تكنولوجية أظهرت انخفاضًا كبيرًا في وزن السقوف، يتراوح من ٣٠% إلى ٥٠%، وأثبتت فعاليتها للغاية خاصة بالنسبة للألواح المجوفة. علاوة على ذلك، تجدر الإشارة إلى أن هناك حاجة إلى كمية أقل من الخرسانة عند استخدام كيلوغرام واحد من البلاستيك المعاد تدويره، حيث أن لديه القدرة على استبدال ١٠٠ كيلوغرام من الخرسانة. في مشاريع البناء الصناعية للمباني الجاهزة الجديدة في جميع أنحاء العالم، يتم استخدام ألواح الفقاعات بشكل متزايد. بالمقارنة مع الألواح الخرسانية المسلحة التقليدية، فهي تتمتع بمجموعة متنوعة من الفوائد، مثل التكاليف الإجمالية الأقل، واستخدام أقل للمواد، وتحسين الكفاءة الهيكلية. تم استخدام الأوراق والمجلات المختارة باستخدام محرك بحث قاعدة البيانات في هذا البحث لإجراء فحص شامل للأدبيات. في هذا البحث، نقوم بدراسة العديد من أنواع الألواح الفقاعية ومتطلبات المواد والفوائد والتطبيقات. ستمكن النتائج الأشخاص من تقييم جدوى نظام ألواح السطح الفقاعي وقدرته على استبدال ألواح الأرضية الحالية بشكل أكثر شمولاً.

**الكلمات المفتاحية : السقوف الفقاعية، كرات الفقاعات المجوفة، التسليح ، الفوائد .**

## Introduction:

The amount of the slab's deflection will increase in proportion to the weight on it or the increase in the space between the columns. Thus, the slab's thickness keeps growing. Due to increasing slab self-weight, higher slab thickness will result in heavier slabs. Additional building supplies like concrete and steel reinforcement will be required due to the larger size of the column and base. As a result, cutting-edge prefabricated construction technology employing bubble deck slabs made of high density polyethylene (HDPE) has recently been deployed in several industrial projects around the world. The middle concrete layer of a normal slab is replaced with plastic balls in a bubble deck slab, which is hollow, flat, and spans in two directions. This compromises the structural performance of the slab.

The first biaxial hollow slab was created in the 1990s by Jorgen Bruenig, a Danish inventor well known for creating Bubble Deck. The innovative Bubble Deck slab prefabricated construction technique has lately been used to a number of industrial projects throughout the globe.

In order to virtually remove all concrete from the core of a floor slab that is not providing any structural function, hollow plastic spheres are inserted into the floor and clamped in a factory-made reinforcing framework. The outcome is a significant reduction in structural dead weight.

**Literature Review:**

The creation of a biaxial hollow core slab, which was afterwards named the bubble deck slab, may be attributed to Denmark. The reduction of structural quadrature may be achieved by effectively deleting the non-essential concrete from the central portion of a floor surface, which does not contribute to its structural integrity. This practise aids in the maintenance of a flat floor surface. These products are founded upon an innovative technology that has just been awarded a patent. This technology use direct methodologies for integrating steel and air to fabricate bubble deck slabs. The flat surface exhibits a spherical fissure in its core, which has the remarkable ability to absorb 35% of its own weight. As a result, the presence of this fissure obviates the need for imposing limitations on transitory and dead loads. The architectural design has a high degree of flexibility, enabling it to readily accommodate curved plane designs that may lack consistency. Due to the use of this technology, it becomes feasible to achieve larger spans, expedite the construction process, reduce costs, and eliminate the need for delay beams. According to the manufacturer of the bubble deck plank, use of their product has the potential to provide a cost reduction of up to 3% for the project as a whole. The concept of bubble deck slabs, which include self-supporting concrete flooring, is an innovative and environmentally advantageous approach. The first implementation of the Bubble Deck slab floor technology is now taking place in the Netherlands, marking its global debut. The use of bubble deck slab flooring enables the construction of tiered slabs, slabs with a roof layer, and single-story slabs. The absence of beams or supports in the bubble deck may be attributed to the flat nature of the cement floor. The principal characteristic that sets this design apart is the inclusion of permeable plastic spheres, which have been integrated into the flooring and affixed to a reinforced structure that has undergone large-scale production at a manufacturing facility. Through the use of this particular kind of reinforced construction, it becomes feasible to simultaneously generate the upper and lower reinforcements of the concrete floor.

In her study conducted in 2009, Tina Lai investigated the structural characteristics of bubble deck slabs and their potential use as lightweight bridge decking. The researcher discovered that bubble deck slabs provide many benefits. Based on the results obtained from this study investigation, it can be concluded that bubble deck technology exhibits a higher level of superiority compared to normal biaxial concrete slabs in terms of the performance of office floor systems. The accuracy of the previous inquiry and experiment has been validated by the use of finite element models of office slabs, which were produced in SAP 2000 specifically for the purpose of this research. In contrast, voided slabs exhibit little use in the construction of a pedestrian bridge's superstructure.

This research article outlines the findings of many investigations, including analyses of bending strength and deflection behaviour, shear strength, punching shear, dynamic punching shear, anchoring, fire resistance, and sound isolation (Sergiu et al., 2009). Based on the outcomes of this

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ISSN: 2222-6583

study, it may be inferred that the Bubble Deck has characteristics akin to those of a spatial structure, since it is the only documented instance of a porous concrete floor structure. This is attributed to the fact that the Bubble Deck is the only documented example of a porous concrete floor construction. The observation that the shear strength exceeds that of a standard slab system provides evidence for the advantageous influence of the spheres. In this work, a slab element was analysed under static gravity pressures on a one-to-one scale in order to investigate the characteristics of its deflection, splitting, and failure. To evaluate the deflection, splitting, and failure properties of concrete slabs containing spherical voids, usually referred to as bubble deck slabs, the slabs were subjected to these stresses .

The major focus of this work conducted by Prabhu Teja et al. (2012) was on the structural behaviour of the bubble deck slab. Extensive study was undertaken on a global scale, leading to a desire to discuss the distinct characteristics of bubble deck boards. The finite element approach is used by SAP 2000 to validate the distributions of moment, deflection, and stress. The researchers arrived at the determination that the building industry often provides three primary categories of construction flooring, namely hollow core slab floors, solid concrete floors, and prefabricated filigree slab floors. Nevertheless, it has been shown that this state-of-the-art technique used in the construction of slabs exhibits more efficacy when compared to the commonly employed classic biaxial concrete slab. The researchers reached the determination that the bending loads experienced by the bubble deck slab were 6.43 percentage points lower compared to those encountered by a solid slab. Additionally, the deflection of the bubble deck slab was found to be 5.88 percentage points higher, while its shear resistance was 0.6 times greater. Furthermore, the bubble deck slab exhibited a weight reduction of 35 percent. The findings of a study conducted by Amer et al. (2013) were published, which aimed to examine the potential of reinforced two-way bubble decks in reducing the self-weight of slabs and enhancing their flexural strength. This paper presents a two-dimensional representation of the spatial distribution of voids inside a bubble deck slab. The relationship between bubble diameter and slab thickness has been identified as a crucial factor in the functioning of bubble deck slabs. To ascertain the flexural characteristics of the bubble deck slab, a series of two-dimensional flexural experiments were conducted utilizing a dedicated loading apparatus. The primary objectives of these studies were to investigate the ultimate load capacity, deflection behaviour, concrete compressive strain, and fracture pattern of the slab. Based on the findings of several studies, it has been shown that the relationship between the diameter of vacancies and the thickness of the slab has an influence on both the fracture pattern and the flexural behaviour. As stated by Churakov (2014), the bubble deck slab technique is used to significantly decrease the vertical dimension of a structure by removing the majority of the concrete material from the central portion of the slab. This central concrete section is deemed nonessential to the structural integrity of the building. To enhance the floor's performance, the excess concrete inside the central area of the slab has been substituted with hollow and spherical HDPE pellets. The use of a lighter-weight slab has the potential to decrease the overall weight of the building's foundation, columns, and walls by up to fifty percent. One advantage of this phenomenon is its contribution to the escalation of industrial waste generation, as well as the heightened consumption of fuel and carbon dioxide, specifically .

In a study conducted by Shetkar and Hanche (2015), it was observed that the use of the bubble deck technology resulted in a significant improvement in the flexural capacity, stiffness, and shear capacity of reinforced concrete slabs. Remarkably, these enhancements were achieved while utilizing the same quantity of concrete and reinforcement as in conventional RC slabs. This was ascertained by utilizing an equivalent quantity of concrete and reinforcing materials. The researchers used bubble diameters ranging from 180 mm to 450 mm and slab depths ranging from 230 mm to 600 mm. The research indicates that the link between the slab thickness and the bubble width affects the behaviour of bubble deck slabs. Furthermore, it has been shown that the conventional reinforced concrete (RC) slab necessitated a greater volume of concrete, ranging from 30 to 50 percent more, compared to alternative slab designs. The use of concrete is reduced as a result of the substitution of one kilogramme of concrete with one kilogramme of recycled plastic. Hence, it is vital to decrease the inert weight by a magnitude of fifty percent. This approach facilitates the construction of a foundation with less spatial impact and expedites the building process by minimising material use. Consequently, this phenomenon contributes to a decrease in the aggregate quantity of carbon dioxide ($CO_2$) emissions stemming from the production of cement. Bubble deck technology is considered to have little influence on the surrounding ecology and has a remarkable ability to endure over an extended period of time.

Surendran and Ranjitham (2016) conducted a study that included both experimental and computational analyses of a bubble deck slab. The objective of their research was to explore the potential use of recycled spherical spheres as a strategy to reduce the volume of concrete needed in the central portion of the slab. The results of the experiments indicate that a bubble deck slab has a capacity to bear pressure that is 80 percent more than that of a conventional slab. The stress and deformation outcomes were assessed by Finite Element Analysis (FEA) to provide a comparative analysis between conventional slabs and bubble deck slabs. Upon conducting a comparative analysis of the aforementioned findings, it has been determined that the deck slab exhibits a higher level of performance in comparison to the concrete slab .

In their research, Ali and Kumar (2017) used ANSYS workbench 14.0 software to examine the behavioural characteristics of a traditional slab in contrast to a bubble deck slab. According to the results, it was reported that the performance of a bubble deck slab was better to that of a standard solid concrete slab. In comparison to the highest stresses and internal forces seen in the solid platform, the hollow deck exhibits a reduction of around forty percent. The use of HDPE spheres in concrete leads to a decrease in the overall dead load. Based on the results of their inquiry, a bubble deck demonstrates superior performance compared to a traditional concrete slab in all aspects. Furthermore, the aforementioned investigations and demonstrations were supported by the implementation of finite element analysis on slab models .

The main objective of this study is to conduct an analysis of the distinctions and similarities between bubble deck slabs and conventional slabs (Devyanshu & Nidhi, 2017). The spatial distribution of the monolith between its columns was a primary factor taken into account throughout the design phase. The longevity of two-way reinforced concrete slab systems developed in Europe throughout the 1990s was found to be significantly enhanced with the use of the bubble deck slab technology. Engineers should duly consider the reduced weight of the hollow sphere while constructing the structural system of the aforementioned construction, as it has certain advantages in comparison to the more cumbersome slabs. The researchers used a bubble deck slab in their study (Muhammad et al., 2017). Throughout the duration of this investigation, an assessment was conducted to determine the load bearing capacity of the bubble deck board. Furthermore, a comparative analysis was conducted by contrasting it with a standard slab that exhibited a variable B/H ratio. Furthermore, a calculation was performed to determine the potential reduction in concrete use achievable by the incorporation of spheres inside the interior of the slab. The researchers reached the determination that bubble deck slabs exhibited less efficacy compared to conventional slabs due to their diminished load-bearing capacity. The bubble deck slabs have shown a weight reduction ranging from 10.55% to 17% when compared to conventional slabs, hence providing a notable advantage. The observed weight loss is noteworthy. This article is based on a structural system known as a bubble deck, which comprises of hollow spherical elements (Ritti et al., 2017). This examination aims to analyse and compare the advantages provided by conventional slabs and bubble deck slabs, utilizing data acquired from a diverse array of research sources. In the construction industry, several building materials are used, including hollow spheres, reinforcing rods, and concrete. The researchers arrived at the

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determination that the implementation of smaller foundations was vital as a result of the decrease in structural inert weight. Furthermore, there has been a significant decrease in the use of concrete. The fireproof construction had a much improved makeover. The production expenses saw a little increase, necessitating the employment of highly qualified personnel, while also facing limitations due to the capacity restrictions of the piercing shears. The data presented in this paper are derived from a study done by Harshit et al. (2017) pertaining to a bubble deck slab. Based on the results of this study, it is recommended to use a slab that is 30-50% less in weight compared to conventional slabs as a means to mitigate the burdens exerted on the foundation, walls, and columns. A variety of void-filled slabs exist, with the most prevalent types including completed planks, filigrane components, and reinforcing modules. Upon doing experiments to assess the compressive and flexural capacities of bubble deck slabs, the researchers arrived at the finding that the moment of resistance exhibited similarities to that of a solid slab. The use of bubble deck planks enhances thermal insulation properties and also enhances the durability of the planks. The research conducted by Dheepan et al. (2017) is grounded on an experimental study conducted on a bubble deck slab, which included the use of polypropylene spheres. Based on the results obtained from this study, it is seen that the flexural strength of a slab exhibits an increasing trend in proportion to the spacing between the bars. Notably, it is worth mentioning that the thickness of the slab does not have any influence on this particular correlation. The researchers reached the determination that the flexural strength of the slab is greater when subjected to a 60mm ball diameter compared to a 75mm ball diameter, regardless of whether the ball spacing is set at 20mm or 30mm. The presence of voids inside the slab enhances its thermal insulation properties. In comparison to the traditional slab, our efforts have yielded positive outcomes in terms of cost reduction, construction time reduction, and the use of ecologically sustainable technologies. The research conducted by Lakshmipriya et al. (2018) focused on the production of slab models utilizing bubble deck technology. This project used recycled rods, steel reinforcing, and diagonal girders. Based on the research results, the replacement of one metre cubed of concrete with a porous high-density polythene spheroid led to a notable decrease of 27% in the overall quantity of concrete needed. When subjected to a comparative analysis with other porous floor systems, it may be argued that bubble deck has a greater capacity for force dispersion. According to the study conducted by Sankalp et al. (2019), the research conducted on a flat surface utilizing the bubble deck technique was of an experimental nature. Examples of materials often used in construction include cement, aggregates, cylindrical spheres, concrete, and steel reinforcing. The researchers arrived at the determination that a reduction of 10.07 percentage points occurred in the quantity of inert load due to the implementation of strategies involving decreased utilisation of concrete and materials. The maximum load capacity is reduced due to an increase in deflection experienced by the flat surface of the bubble deck. Cracks were seen on the underside, exhibiting both longitudinal and diagonal orientations. The fractures exhibited mostly diagonal orientations. There was a reduction of 13.39% in expenditures in comparison to the standard threshold. In 2019, Victor Oaze Francis performed a study to assess the suitability and effectiveness of the bubble deck plank. Examples of materials often used include concrete, reinforcing steel, and plastic spheres. The properties that were assessed were rigidity, deflection, bending strength, shear strength, piercing shear, and fire resistance. The use of bubble deck slab technology offers many advantages, including reduced project duration, enhanced construction efficiency, and lower construction expenses. The researchers reached the determination that the bubble deck slab demonstrated feasibility as a viable substitute for the conventional solid slab. The present study by Shahed et al. (2019) examines the bubble deck slab and provides an analysis of its many characteristics. To assess the efficacy of the bubble deck slab relative to a conventional slab and quantify the concrete saved, the filling of the slab included the use of porous polythene spheres. Furthermore, the researchers conducted an investigation and comparison of the self-weights of the slabs utilizing universal testing equipment. Moreover, the researchers conducted an investigation and made a comparison between the failure modes in the splitting patterns of both types of slabs. The outputs of the M20 and M25 concrete slab grades were assessed. Based on the conclusions drawn by specialists, it has been determined that bubble deck slabs exhibit enhanced flexural strength, improved stiffness, and increased shear force capacity. In comparison to a traditional slab, the structure exhibited a cost effectiveness that was forty percent higher.

Based on the findings of Quraisyah et al. (2020), it has been observed that the bubble deck layout exhibits comparable quantities of concrete and reinforcing materials to those of a solid slab. However, the bubble deck layout demonstrates a minimum of 70 percent higher flexural capacity, stiffness, and shear capacity in comparison to the solid slab. As a result, there is a reduction in the quantity of concrete used, ranging from 30 to 50 percent. Furthermore, when comparing strain and deflection, the bubble deck slab demonstrates superior performance over the standard slab. In the study conducted by Quraisyah et al. (2020), it was found that the self-weight of a bubble deck slab exhibits a reduction of 30-50% in comparison to that of a normal concrete slab. The use of one kilogramme of recycled plastic has the potential to mitigate the need for one hundred kilogrammes of concrete, thereby leading to a reduction in the requirement for freshly manufactured cement and a decrease in global greenhouse gas emissions. In summary, bubble deck slabs exhibit superior structural performance, optimise resource utilisation, provide cost-effectiveness, and enable expedited construction compared to standard concrete slabs. As a result of this, the aforementioned process exhibits characteristics of sustainability and environmental friendliness .

Sonia and Vijay Kumar (2021) propose that the bubble deck is a novel method for integrating air, steel, and concrete into a two-way structural platform. The plastic spheres, composed of a porous substance inside, are securely affixed within the slab by the use of steel reinforcements. The investigation included an analysis of many aspects pertaining to the structural performance of the bubble deck slab, including flexural strength, shear strength, piercing shear, anchoring, fracture pattern, fire resistance, and creep. Furthermore, an evaluation was conducted on the structural behaviour. This method does not need the use of wood or column heads and may be employed for the placement of pavers at ground level as well as on rooftops. Plastic spheres with a central aperture are used for the fabrication of bubble deck slabs. The load-bearing capability of bubble deck slabs is much reduced when compared to that of traditional slabs. The concept of effective volume is used to enhance the efficiency of concrete usage by including additional materials throughout the building process. The use of a bubble deck slab enables the potential for increased spans between column supports. Bubble deck slabs provide enhanced structural integrity and cost-effectiveness when contrasted with conventional slabs .

According to Zalena and Chan (2021), the use of HDPE hollow elliptical spheres in the construction of bubble deck slabs offers benefits over those manufactured with spherical balls. This is attributed to the reduction of drawbacks and the enhancement of load-bearing capacity. The lamination of glass fibre reinforced polymer (GFRP) material onto the concrete slab is a viable approach to enhance the structural integrity of the slab system and mitigate deflection. Hence, the bubble deck system, recognised as an environmentally sustainable building technique, has comparable shear strength and load-bearing capability to that of a standard slab. This phenomenon arises due to the composition of the bubble deck system, which mostly consists of air .

The use of the Bubble deck technology offers economical benefits, including a decrease in material consumption, hence facilitating expedited construction processes. According to Chavhan et al. (2022), the use of lower foundation proportions results in a design that exhibits enhanced fire resistance compared to conventional slabs. The use of hollow spherical spheres in the building of a bubble deck has the potential to enhance the load bearing capacity of the deck.

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**Type of Bubble Slab:**

The different kinds of bubble deck slab systems have been brought to light, as stated by (Dheepan et al., 2017) and (Oukaili & Merie, 2018). There are three (3) different kinds of bubble deck slabs: reinforcing modules, filigree sections, and finished planks. Each one has its own unique characteristics.

**3-1 Reinforcement Modules:** The reinforcement modules type of bubble deck slab is shown in Figure 1. This particular form of bubble deck slab consists of a prefabricated bubble deck slab that has plastic spheres precisely positioned between reinforcement steels. After that, in order to prepare the building site for the pouring of traditional concrete, these components are carried to the location where the work will be done and installed on standard formwork, along with extra reinforcing. Because the components may be piled on the site before to installation, this kind is an excellent choice for building sites that are rather modest in size.

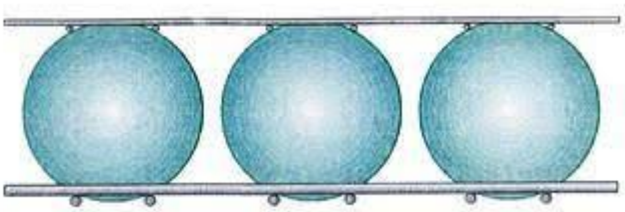

**Fig.1: Reinforcement modules Bubble Deck**

**Filigree Elements:** The bubble deck slab with filigree components, as seen in Figure 2, is a hybrid construction system that integrates both in-situ and pre-cast methodologies. Prior to the integration of plastic spheres and reinforcing steels, a pre-cast bottom concrete layer, measuring sixty millimetres in thickness, is manufactured and afterwards brought to the construction site. Subsequently, the subsequent step involves the procedure of on-site casting. During the casting process, temporary supports are used to secure the plastic spheres in position above the concrete layer. The inclusion of more steel may be necessary for this particular build, depending upon the specific design considerations. The use of plastic spheres and reinforcing steels in new building is very advantageous as it allows architects full autonomy over their location. It is recommended to use this particular kind of paver in the event that a slab exhibits a void, such as one that is employed for the purpose of steps.

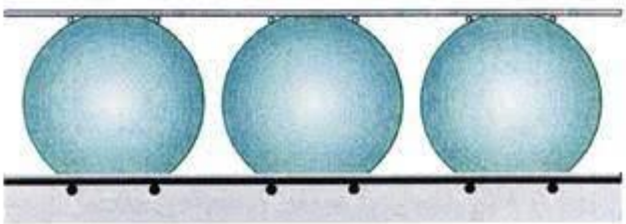

**Fig 2: Filigree element slab system**

**Finished Plank:** The completed plank variant of the bubble deck slab is seen in Figure 3, showcasing the manufacturer's prefabrication of the whole element into its ultimate configuration. The kind of bubble deck slab in question is often referred to as the finished plank variant. Subsequently, the thing, in its completed form, is transported to the designated location. This particular variation exhibits less utility compared to other types, mostly owing to its reliance on load-bearing walls or support timbers. The aforementioned bubble deck material is suitable for expedient construction and is capable of covering relatively short distances.

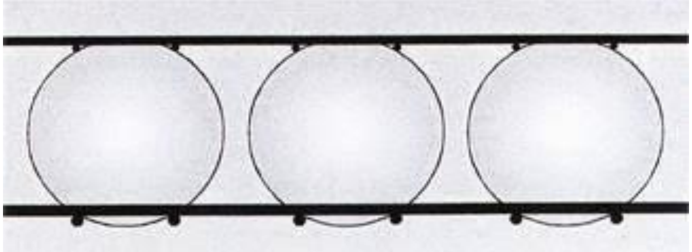

**Fig 3: Finished planks Bubble Deck**

**Materials of Bubble Slab:**

(Shetkar and Hanche, 2015) (Mirajkar, et al., 2017): A bubble deck slab is made up of three (3) primary components: reinforcement bar, concrete, and bubble balls.

**4-1 Bubble Balls:**

The cavities are often constructed using a nonporous material that exhibits no chemical reactivity with the reinforcing rods or the concrete. The bubbles possess sufficient strength and stiffness to effectively support the masses, despite their inherent flexibility. The dimensions of the bubbles exhibit a range spanning from 180 to 450 centimetres. In order to maintain appropriate spacing, it is necessary for the distance between bubbles to exceed one-ninth of the bubble's diameter. Additionally, the surface depth may range from 230 millimetres to 600 millimetres. The form of the used bubble might vary between elliptical and spherical, contingent upon the specific circumstances.

**4-2 Concrete:**

The Bubble Deck floor system uses a combination of cement and aggregates, with the latter being limited to a maximum size of 20 millimetres. These two constituents form the concrete material used as joint filler in the system. The inclusion of plasticizers in the composition of concrete is unnecessary due to the absence of any need for their presence .

Self-compacting concrete (SCC) is often used in construction sites for the purpose of casting prefabricated filigree slabs and filling joints. Self-compacting concrete (SCC) exhibits the desirable property of being able to be poured into moulds, effectively manoeuvring around densely packed reinforcing elements and confined spaces. Additionally, SCC facilitates the passage of air while preventing the undesirable separation of its constituents.

**4-3 Reinforcement bar:**

The reinforcement is comprised of two braidable or weldable apertures, one located at the bottom of the plates and the other one located at the top of the plates. Interlaced layers and diagonal girders are both forms of steel that are fabricated in order to provide the vertical support that the bubbles need. The transverse ridges of the slab and the size of the bubbles that are used both have a role in determining the distance that exists between the bars.

**Advantages And Applications:**

**5-1 Advantages:**

**Structural**:

Reduced weight
increased strength-
fewer columns
no beams or ribs below the ceiling and 30–50% less concrete than a normal solid slab are all advantages of this design.

**Construction**:

Less equipment is required because of weight.
It is simple to insert pipes and ducts onto slabs.
Less work to be done on the building site

**Engineering:**

Buildings with exceptional explosive resistance work best with columns and the biaxial flat slab design.This slab and column system is regarded as an elastic vertical structure used in the construction of earthquake-resistant buildings.

**Environment**:

Lower energy and material use

Lower CO2 emissions

Every part can be recycled

**Economy :**

Construction may be finished more quickly and with less resources, and structures are more versatile and straightforward to erect.

**5-2 Application:**

The proposed development encompasses a variety of land uses, including industrial buildings, residential living spaces, offices, villas, apartments, and other similar structures. Additionally, the plan includes provisions for educational institutions, parking facilities, hospitals, factories, and labs. Notably, the cantilevers within the design include the capability to expand vertically up to 10 times the height of the deck

**Conclusions:**

In the realm of building, there is a need for diverse methodologies that provide superior cost-efficiency, ease of implementation, and environmental sustainability. The use of the bubble deck slab system aligns with our objectives of achieving cost-effectiveness, ease of construction, and environmental sustainability. The bubble deck technology is a novel approach that effectively reduces the need of concrete in secondary and intermediate supporting components, including beams, reinforced concrete columns, and structural walls. Moreover, it facilitates a reduction in worldwide carbon dioxide emissions. In summary, the bubble deck slab exhibits several benefits in comparison to the typical concrete slab. These advantages include enhanced structural integrity, diminished material use and expenses, heightened operational efficiency, and expedited building duration. Therefore, this technology exhibits sustainability and environmental friendliness.

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