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COMPARATIVE ANALYSIS OF THE BUBBLE DECK SLAB AND CONVENTIONAL SLAB

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Abstract

The most crucial component of any building structure that uses a lot of concrete is the slab. With the help of the ground-breaking building technique known as Bubble Deck, the amount of structurally futile concrete in the middle of a floor slab between columns is almost eliminated. This significantly reduces structural dead weight. The direct method of connecting air and steel is the basis of the unique approach used in Bubble Deck. Plastic balls are used to replace the concrete in the centre of a typical slab, which does not improve its structural performance. The result is a hollow, flat slab that spans in two directions. On the other hand, a conventional slab or normal slab is any slab that is supported by beams and columns. In these varieties, the slab has a short thickness while the beam has a significant depth. Following the columns, the load is passed to the load-bearing beams. Comparatively speaking, this needs more formwork than the Bubble Deck slab. The numerous studies on bubble deck and conventional slab systems were covered in this study. The specified aims must be realized through documentation effort and theoretical analysis of all the works on bubble deck and conventional slab concept produced by various writers. The concrete in the centre of the bubble deck slab was designed and built using hollow plastic bubbles to eliminate the concrete that serves no structural purpose and to reduce the weight of the slab itself. Therefore, compared to a normal concrete slab, the self-weight of a bubble deck slab can be lowered by around 30% to 50%, which can lessen the loads placed on columns, walls, and foundations. Finally, using a bubble deck slab has numerous advantages over using a traditional concrete slab, which include: better structural performance, lower materials and labor costs, quicker building times, and environmental friendliness. Additionally, it was found that the deflection of a bubble deck is 5.88% greater than that of a standard solid slab since the hollow component reduces stiffness. The shear resistance of a slab made of bubble deck material is 0.6 times more than a standard solid slab of equal thickness. However, by adding vertical reinforcement, the necessary resistance can be achieved.

***Keywords: Conventional solid slab, Bubble deck slab,* Steel reinforcement, Concrete, Hollow balls, Cement, Aggregate.**

1. INTRODUCTION

In the modern building sector, the economy is crucial. Reinforced concrete slabs are a common type of building material in contemporary architecture. Concrete is widely used in the building sector and is crucial to the industry. Due to the additional concrete needed to construct a floor system, the structure's economy suffers. Plastic waste is used to make polypropylene balls. A polypropylene ball is positioned in the middle of the slab to aid in the preservation of concrete. Some of the concrete is swapped out for polypropylene balls. Because bubble deck slabs are lightweight, they are more efficient and have less dead weight (Pulikonda 2018). According to the author, the slab, which also uses the most concrete during construction, is the most important structural element. The slab will deflect significantly under heavy load acting on it or on the clear gap between the columns. The slab's thickness so continues to increase.

Aziz and Heng (2021) believes that due to an increase in slab self-weight, the weight of the slab will rise as their thickness does. Due to the increase in foundation and column size, more building materials like concrete and reinforcement steel will need to be used during construction. As a result, the innovative prefabricated construction technology that uses bubble deck slabs made of high density polyethylene (HDPE) has lately been deployed in many industrial projects all over the world. Jorgen Bruenig of Denmark invented the first biaxial hollow slab, also referred to as a bubble deck slab, in the 1990s. The study indicated that HDPE bubble deck slabs virtually do away with the middle concrete section of traditional slabs, which does not increase structural performance, by employing hollow balls made of recycled plastic.

Dwivedi[1] et al (2016) is of the opinion that the invention of the bubble deck slab will drastically reduce structural dead weight by directly coupling air and steel reinforcement. It offers a number of advantages over a typical concrete slab, including lower overall costs, fewer material usage, more structural effectiveness, quicker construction, and environmental friendliness. The use of bubble deck is a cutting-edge technique that dramatically enhances building performance and design while reducing total costs by removing the concrete dead weight in the middle of a floor slab. According to the study, the consumption of concrete can be reduced by substituting 1 kg of recycled plastic bubble for 100 kg of concrete. Cement production should be decreased to reduce global carbon dioxide (CO_2) emissions (Dwivedi[1] et al. 2016).

Prof. Patel[1*], Prof. Sankhat [2*], and Prof. Patel[3*] (2018) indicated that a significant amount of the mass of a concrete slab is replaced with hollow or foam-filled plastic balls. Thanks to a cutting-edge new technology called Bubble Deck, the study appreciates. Technically, it results in a voided biaxial slab. The volume of the voided concrete can be reduced by the reinforced concrete voided slab. In the 1950s, the hollow slab was developed. It has only been used once and must be supported by a fixed wall or a beam. It was designed to produce a hollow two-axis slab with the same function as a solid slab but substantially less weight due to the significant concrete removal. Since it helps define space, a slab is an important structural element when creating a building. Slabs are one of the biggest users of concrete. The author added that the weight-restricted span of the horizontal slabs is the primary issue with concrete buildings, and that due to this; the main advancements in reinforced concrete have focused on reducing the material's weight or addressing its inherent flaws. Typically, slabs are designed to handle just vertical loads. The slab must be thicker as a result. Increased slab thickness leads to larger foundations, columns, and slabs.

Shital et al (2021) noted that the economy has a huge impact on the current construction sector and that reinforced concrete slabs are a common type of construction material today. The construction industry relies heavily on concrete, which is vital to the sector. Since a floor system necessitates the construction of more concrete, the structure's economy suffers. The study further discovers that balls made of polypropylene are created from used plastic. To protect the concrete, a polypropylene ball is placed in the centre of the slab. Polypropylene balls are used in place of some of the concrete. The reduced slab dead load and greater effectiveness of bubble deck slabs are both a result of their small weight, the study reveals.

Lalit (2020) detects that the invention of the bubble deck slab will drastically reduce structural dead weight by directly coupling air and steel reinforcement. It offers a number of advantages over a typical concrete slab, including lower overall costs, fewer material usage, more structural effectiveness, quicker construction, and environmental friendliness. The use of bubble deck is a cutting-edge technique that dramatically enhances building performance and design while reducing total costs by removing the concrete dead weight in the middle of a floor slab. Lalit (2020) further discloses that the consumption of concrete can be reduced by substituting 1 kg of recycled plastic bubble for 100 kg of concrete. Cement production should be decreased to reduce global carbon dioxide (CO_2) (Dyg [1,2,3,] Kartini[3], and Hamidah[3] 2020). Lalit (2020) unearths that the slab, which also uses the most concrete, is the most important structural element of any building. Significant load acting on the slab or the clear span between the columns will cause the slab to deflect significantly. As a result, the slab's thickness keeps increasing. While the author fathoms out that due to the increase in slab self-weight, the weight of the slabs will increase as the thickness of the slabs grows. Pulikonda (2018) maintains that as a result of the increase in slab thickness, the size of the foundation and columns will likewise increase, requiring a higher consumption of building materials like concrete and reinforcement steel. Because of this, a lot of industrial projects throughout the world have recently utilized the new prefabricated construction technology that uses bubble deck slabs constructed of high density polyethylene (HDPE), the author says. The first biaxial hollow slab, often referred to as a bubble deck slab, according to the study, was developed in the 1990s by Jorgen Bruenig of Denmark. The central concrete section of conventional slabs is essentially eliminated with HDPE bubble deck slabs since hollow balls made of recycled plastic are used instead, which does not enhance structural performance.

2. LITERATURE REVIEW

Lakshmipriya[1] and Karthikpandi[2] (2018): Solid slabs are less advantageous than plastic voided slabs for lengthy spans. Shorter spans do not require thinner slabs; therefore only small voids can be used, saving very little money. To drastically reduce the slab's overall weight while still maintaining load capacity requirements, bigger voids can be employed with longer spans. Although there are more steps in the manufacture of a plastic voided slab than a solid slab, the process is not appreciably more complicated. For bays of the same size, plastic voided slabs frequently require less reinforcement. Overall, plastic voided slab systems are a great alternative to solid concrete slabs in many instances. Weight reductions and architectural flexibility are both feasible with plastic voided slabs. The investigation shows that void slab technology is superior to a typical biaxial concrete slab. The results showed that substituting a hollow, high density polyethylene sphere for 1 m3 of concrete reduced the cost of concrete by 27%. Compared to other hollow floor technologies, Bubble Deck will disperse the forces more uniformly. Because of the three-dimensional construction and the smooth progressive force flow, hollow regions won't have a negative impact or result in any strength loss. It causes substantial cost reductions.

Aziz and Heng (2021): The floor slab is one of the most important structural elements of a building. Due to its detrimental effects on the environment and ineffectiveness in providing the building with necessary structural support, the traditional slab construction method is raising controversy. The usual method typically calls for using more concrete, which increases the dead weight of the building and, eventually, increases the overall cost of the project. Many engineers and technicians want to provide the construction industry a brand-new floor slab system—the bubble deck slab system—as a result of these issues. Growing consumer awareness of the advantages of using environmentally friendly materials will increase demand for green construction. To minimize drawbacks and boost load-bearing capacity, it will be preferable to employ a bubble deck slab with hollow HDPE elliptical balls rather than spherical ones. To further strengthen the slab system and reduce deflection value, glass fiber reinforced polymer (GFRP) sheet can be layered into the concrete slab. As a result, while still being an environmentally friendly construction method, the bubble deck system may perform nearly as well in terms of loads bearing capacity and shear strength as the traditional slab.

Deepak et al. (2022): It is essential that the slab plays its part in transferring loads to other structural components. It provides safety by covering. It transmits the weight by bending in one or two directions. Concrete is becoming more expensive on a daily basis. To fix this, plastic balls are used in place of the concrete. A slab's concrete content is reduced by about 35% when a bubble deck is used, and time is also saved. Bubble deck is the most environmentally friendly concrete building technique. In this novel building technique, recycled plastic components are used to make the slab lighter on its own.

Konuri and Dr.Varalakshmi (2019); Gajewski, Staszak, Garbowski (2023): Due to the air bubbles replacing the concrete, the slab has a lower dead load and a higher permissible span. Less concrete is needed when plastic hollow balls are used in place of concrete in the slabs, which not only saves money and resources but also makes the structure lighter. The foundations and columns will consequently be smaller as well. The Bubble Deck has been chosen as the low-risk building option for both large and complex projects as well as for greenhouse constructions by the most significant projects throughout the world. Bubble Deck removes up to 35% of the structural concrete. When paired with the thinner ground, smaller foundations, and columns, as well as the thinner facade, construction expenses may be reduced by as much as 10%. Semi-precast panels have shown to be the most economically advantageous approach to apply the technology, according to experience. In comparison to conventional concrete construction, this approach frequently removes more than 95% of the pricey formwork.

Prof. Patel[1*], Prof. Sankhat [2*], Prof. Patel[3*] (2018): The bubble deck slab, a biaxial hollow core slab, was developed in Denmark. This is a strategy to greatly lower the structural cost by essentially removing all of the concrete in the middle of a floor slab that does not fulfill the structural function. The basis for bubble deck slabs is a novel, patented technology that joins steel and air directly. The plastic sphere used to construct the flat slab's center pore shape allows for the removal of 35% of the slab's own weight, lowering dead load and immediate constraints. Stall beams can be removed using this method, and greater spans can be built more quickly and affordably. The bubble deck slab, according to the manufacturer, can reduce the project's overall cost by up to 3%. Bubble deck slabs are a modern and green alternative to traditional flooring when utilized as self-supporting concrete floors. With the use of the bubble deck slab floor technology, one-story, tier-style, and roof layer slabs can all be built. The slab floor of the bubble deck is a flat slab, thus there aren't any beams or columns. The reinforced framework that was built in a factory with the hollow plastic spheres fixed inside is the centrepiece of the floor. Along with this reinforced design, the top and bottom of the concrete floor are strengthened. Delivered to the construction site in factory units up to 3 meters wide are precast slab floors and various thin concrete shells, like spherical reinforced constructions.

Lakshmikanth and Poluraju (2019): It is clear that voided slab is improving constantly and that it was once fairly popular. The benefits of bubble deck include improved load carrying, shear, flexural, and fire resistance in addition to reduced slab weight and increased slab span. They are assembled on the job site by putting connecting rods in position and pouring concrete. After the concrete has had time to dry and set, the floor is ready for use. The plastic sphere's diameter in relation to the thickness of the floor can reduce material or concrete use by 35% when compared to a solid concrete floor of the same thickness. This type of building is useful for reducing earthquake damage because it lowers the weight of the structure.

Manvi[1] et al. (2015): Buildings with traditional Reinforced Concrete (RC) frames are routinely built today. Bubble Deck slab structures have many advantages over conventional RC frame buildings, including greater architectural freedom, better use of available space, ease of formwork, and quicker construction. The investigation shows that slab structures with bubble decks are lighter than slab structures with standard foundations. The cost of a Bubble Deck slab structure is 15.8% cheaper than a conventional slab. The study's findings indicate that for high-rise buildings, bubble deck slab constructions are more cost-effective than conventional slab structures. A conventional slab has walls or beams supporting it. Although conventional slabs are normally rectangular in shape, other shapes, like as triangles, circles, and trapezoids, are also possible. Such parallel-sided slabs that are supported carry weights by bending perpendicular to the supports. Flexural, shear, and torsional loads are transmitted to the supports by the slab. In essence, they are wide shallow beams and are known as one-way slabs. Slabs supported on all four sides also function as one-way slabs if the length of the slab is much greater than its width. Slabs that can hold weights are square or have a base that is fashioned like a rectangle, and are supported on all four sides.

Lalit (2020): The conventional slab system is made up of a slab and thin beams that are spaced randomly in perpendicular directions. The seismic behavior of structures with a flat slab and those with a conventional slab is similar, however there are certain idiosyncrasies. When compared to tall structures using a standard slab system, Bubble Deck slab constructions are more resilient but less aesthetically beautiful. The flat slab is a popular building material that speeds up construction and reduces weight. The conventional slab offers benefits including increased stiffness, increased weight carrying capacity, safety, and affordability. In comparison to conventional RC frame structures, the usage of bubble deck slab buildings has a number of benefits, including more architectural flexibility, better space use, easier formwork, and quicker construction. The mass of buuble deck slab structures is lower than that of conventional slab structures.

Lait (2010) and Aziz and Heng (2021): The typical floor slab has the drawbacks of offering minimal structural support and substantially increasing a building's self-weight. The bubble deck slab system was created to go around these limitations. The majority of the three materials that make up Bubble Deck are steel, plastic spheres, and concrete. Steel reinforcement needs to be at least Grade Fy60 strong. The steel is built in two ways: mesh layers for lateral support and diagonal girders for vertical support of the bubbles; Plastic spheres: The hollow spheres are made of recycled high-density polyethylene, or HDPE. Concrete is created using ordinary Portland cement and aggregates with a maximum size of 75 mm. There is no need for plasticizers in the concrete mixture. Prefabricated Bubble Deck slabs allow for quicker on-site fabrication.

Gajewski, Staszak, Garbowski (2023): The self-weight of the structure is decreased by the bubble deck slab by using plastic hollow bubbles manufactured from waste plastic in place of portion of the concrete. The primary function of the plastic sphere is to reduce the dead load of the deck by a factor of two when compared to a solid slab of the same thickness, with little effect on deflection behavior or bending strength. The slab is much lighter than a solid slab despite having the same capabilities because there isn't any extra concrete there. Even if the building is eventually knocked down or rebuilt, the spheres could still be used again. Foam can be used to increase energy efficiency, fire protection, and sound insulation by filling the dead air space inside the hollow spheres, which serves as insulation.

Abishek [1] and Iyappan[2] (2021): The structural dead weight can be reduced by using bubble deck sheets to completely remove the concrete from the middle of the floor sheet. Ineffective concrete has taken the place of high-density hollow spheres (HDPE) in the center of the slab. The bubble deck's efficiency increases as its weight decreases. Due to the bubble deck slab's reduced material use and reduced greenhouse gas emissions, we can accomplish green building. The benefits include a decline in the amount of material, load, and value consumed as well as a reduction in production and transportation-related pollutants, namely CO2 emissions. This technology is also environmentally friendly. Substitute locally available spherical bubbles for the concrete currently utilized in the bubble deck technique. According to this, the monolithic slab element is tested for load carrying, deformation, cracking, and failure in the plant while being subject to static gravity loads.

Dyg [1,2,3,] Kartini[3], and Hamidah[3] (2020): The slab is one of the structural elements of a building that requires the most concrete and is also its most important part. An alternative biaxial hollow slab system known as a bubble deck slab was developed in order to enhance building design and performance while decreasing self-weight by removing the concrete portion in the middle of a standard slab that does not contribute to structural performance. They are technologies that are extremely effective for hollow slabs and greatly reduce slab weight by 30–50%. In addition, less concrete is utilized because 100 kilogram of concrete can be replaced by 1 kg of recovered plastic. Bubble deck slabs are increasingly being used in industrial projects all over the world for new prefabricated buildings. It offers numerous advantages over a conventional reinforced concrete slab, including lower overall costs, fewer material consumption, increased structural effectiveness, quicker construction, and environmental friendliness. The goal of this study was to describe the relevance and varied qualities of bubble deck slabs in comparison to conventional reinforced concrete slabs based on previous studies and research that has been done.

Shital et al (2021): Bubble deck slabs can be built by removing concrete from the slab that isn't essential for the aggregate to interlock for shear resistance and using the remaining concrete as the compression block for flexural resistance. Additionally, this well-known method enables wider spans with lower design loads on the columns and footings with the least amount of deflection and without compromising the slab's flexural strength. The structural behavior of the bubble deck slab is thoroughly examined in this study. In order to assess the structural behavior of bubble deck slabs subjected to general loads, this article presents analytical and experimental experiments. The structural behavior of the bubble deck slab has been assessed using flexural strength, shear strength, punching shear, anchoring, crack pattern, fire resistance, creep, and crack pattern, among other factors. Following a review of the literature, it was found that bubble deck slabs are more economical and effective in terms of structural integrity than traditional slabs.

Garg[1] et al. (2019): A bubble deck may carry thicker spans than a site-cast concrete structure without the use of post-tensioning or pre-stressed sections. The advisors were able to accelerate the external design while postponing the inside because the total construction time for the building was shortened. The capacity of Bubble deck technology to create strong, often husky, concrete slabs that span broader spaces and the opportunity to visually design greater cantilevers are significant departures from traditional construction techniques. According to the Bubble deck Group, the hollow spheres at the center of this technology ensure a 35% reduction in the dead weight from the building's concrete slabs. These muscular slabs cover a larger surface, thus supports are not required. The Bubble deck slab floor rule is relevant for slabs that are used for storeys, roofs, and ground floors. Considering that the floor of a bubble deck is completely flat, there are no beams or column heads. The presence of hollow plastic spheres in the flooring that are held in place by a reinforcing framework created in a factory is the major identifying feature. This reinforcement structure serves as reinforcement in addition to the upper and lower reinforcement of the concrete floor.

Balasubramanya , Hokrane, and Saha (2017): Hollow elliptical or spherical balls made of recycled plastic are used in the Bubble Deck slab. In order to reduce self-weight, a Bubble Deck slab includes a two-dimensional configuration of voids within the slabs. By directly connecting steel and air, Bubble Deck is a ground-breaking technique for virtually eliminating concrete from the neutral axis of a traditional slab, which serves no structural purpose. This significantly reduces structural dead weight. One of the main aspects of the project is to design each slab and compare them in terms of stiffness and economy. It was discovered that the rigidity of the bubble deck slab with 60mm balls is greater than that of the slab with 70mm balls and the traditional slab. Using a bubble deck slab with a 60mm diameter and a 70mm diameter of 9.41% will save about 14% of the cost. It was discovered that using 60mm balls would use less concrete overall. This means that, when compared to conventional slab, the bubble deck slab with a 60mm diameter is more effective in terms of strength, stiffness, and economics.

Nagma and Vinaysingh (2018): The technology behind Bubble Deck makes it possible to construct wider cantilevers as well as stronger, frequently thicker, concrete slabs that cover larger regions. In order to significantly reduce the amount of concrete required for a building's construction, significantly strengthen the overall frame, and more evenly distribute the weight of the concrete that is actually used, Bubble Deck was developed. By basically removing all of the concrete from a floor slab's midsection, which serves no structural purpose, structural dead weight is significantly reduce. Also, by adding spherical bubbles before casting the concrete, bubble deck technology decreases the volume of the concrete. This technique is known as a bubble deck slab. Hollow high density polyethylene spheres in place of the ineffective concrete in the slab's middle reduce dead weight and improve floor performance. Less energy is used in manufacture, transportation, and execution of bubble deck construction, which also results in lower emissions of exhaust gases, particularly CO_2, and lower costs. It's a green technology, too.

Mohan and Sukumaran (2018): The relationship between bubble diameter and slab thickness affects how a bubble deck slab behaves. Two meshes, one at the bottom and one at the top, are used as reinforcements and can be welded or tided together. In order to create adequate bubbles between the top and bottom meshes, the spacing between the bars is maintained in accordance with those specifications. By locking ellipsoids between the top and bottom reinforcement meshes, this method creates a natural cell structure that behaves like a solid slab. The inefficient concrete in the slab's middle is replaced with hollow spheres made of High Density

Polyethylene (HDPE), which lowers the dead weight and improves the performance of the floor. The fundamental problem with horizontal slabs in concrete projects is the heavy weight, which reduces the span. Therefore, the main advancements in reinforced concrete have concentrated on increasing span, decreasing weight, or eliminating concrete's inherent weakness in stress. The slab is primarily intended to withstand vertical loads. However, since people's interest in residential environments has grown recently, noise and vibration from the slab are becoming more significant, and as the span is raised, so too is the slab's deflection. The slab thickness should be increased as a result. The slabs become heavier as the thickness is raised, and the size of the foundations and columns will also rise.

3. MATERIALS AND METHODS

The comparison of the conventional slab and bubble deck would be covered in this research article. The qualitative data gathering strategy is used in this investigation. The existing research articles written by different writers would be the subject of extensive literature assessments. Google Scholars, Science Direct, EBSCO, and Engineering periodicals would all be used to gather data. The contents of 19 peer-reviewed published articles would be examined and assessed. Comparative data analysis would be used to analyze the information gathered.

4. FINDINGS

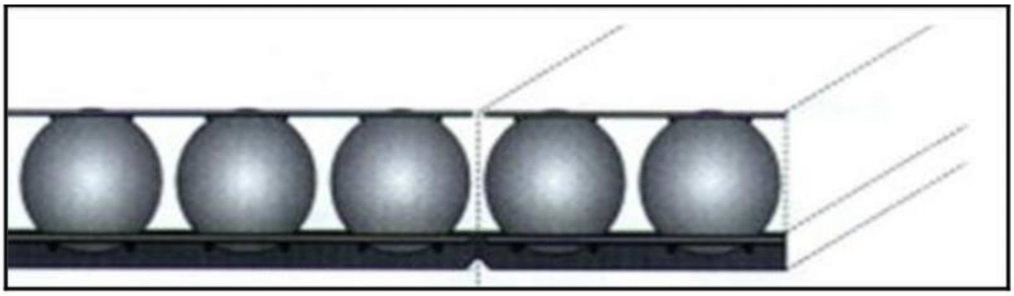
The study found that using recycled plastic balls in place of concrete can reduce the volume of the concrete by 100 kg, and that 1 kg of recycled plastic can replace that amount of concrete; Formwork becomes more economical when beams are removed; Bubble deck slab considerably increases the safety against earthquakes and is fireproof. Just from the weight savings, and fire-proof structure. By employing hollow spherical balls, the bubble deck system can achieve a larger load bearing capacity while using less material and cutting down on building time. Materials are moved with much less transit.

Utilizing bubble deck slabs helped create a sustainable environment by reducing energy use and carbon emissions. Due to its less weight, higher strength, fewer columns, lack of beams or ribs under the ceiling, and reduced number of columns, the bubble deck slab was found to be superior to the conventional slab. The biaxial flat slab system and columns from Bubble Deck are perfect for buildings with exceptional explosive resistance. It eliminates hefty facades and stiff walls, which in the worst scenario results in the structure's collapse by stifling air pressure. The automated manufacture of prefabricated modules results in higher-quality output. Low-effort construction eliminates the chance for mistakes, and the slab's modest weight makes installation with lightweight, inexpensive lifting equipment easy.

However, the investigation showed that one of the drawbacks of bubble deck slab is its poor punching shear capacity and limited thickness. Additionally, it was found that skilled labor is necessary to complete the task correctly. The bubble deck slab's load carrying capacity is lower. Additionally, it was discovered that ordinary concrete slabs are thin and lightweight. The presence of beams ensures the resistance to lateral loads. More weight may be carried by a conventional slab than by a bubble deck slab.

The study found that one drawback of a conventional slab is that the height of the building might increase as a result of the distance between floors. The study also noted that installing beams disrupts the building's natural light and airflow. Further research revealed that a conventional slab's formwork and reinforcement installation is challenging to manage. The investigation disclosed that there are three different varieties of Bubble deck slab.

Filigree Elements is the name for Type A. This kind includes both created and un-constructed parts. In type A, a layer of concrete that is 60 mm thick and a portion of the finished depth are precast and sent to the construction site without the bubbles and steel reinforcement. Then, on top of the precast layer, the bubbles are kept in place by interconnected steel mesh and supported by temporary stands, as illustrated below. This style of bubble deck is ideal for new construction projects because the bubble placements and steel mesh arrangement can be decided by the designer.



Filigree Bubble Deck Type A

Source: https://www.researchgate.net

Reinforcement Modules are the name for the Type B bubble deck slab. As seen in the illustration below, this kind has a reinforcing module made up of a pre-assembled steel mesh and plastic bubbles. These components are delivered to the job site, placed on conventional formwork, joined with any additional reinforcement, and then conventional concrete pouring techniques are used to set them in place. Since the modules in this type of Bubble Deck can be stacked on top of one another for storage until needed, they are ideal for building sites with limited space.

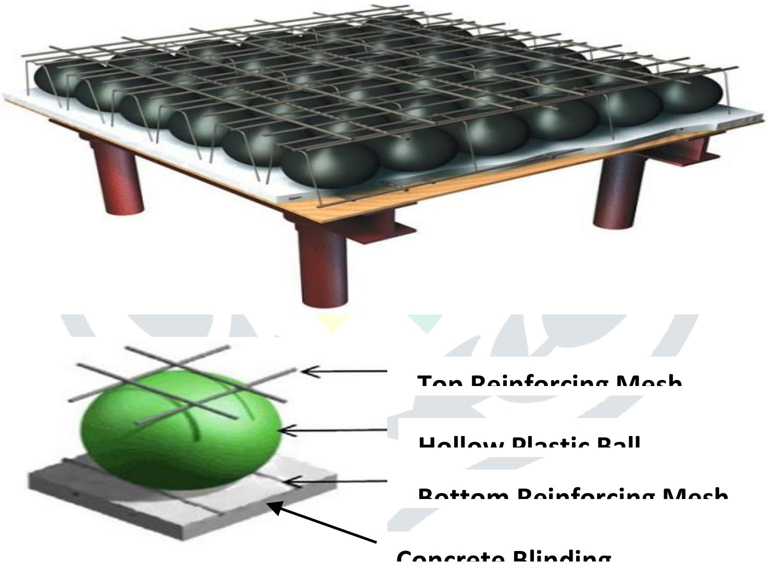
Finished Planks Bubble Deck Type C

Source: https://www.researchgate.net

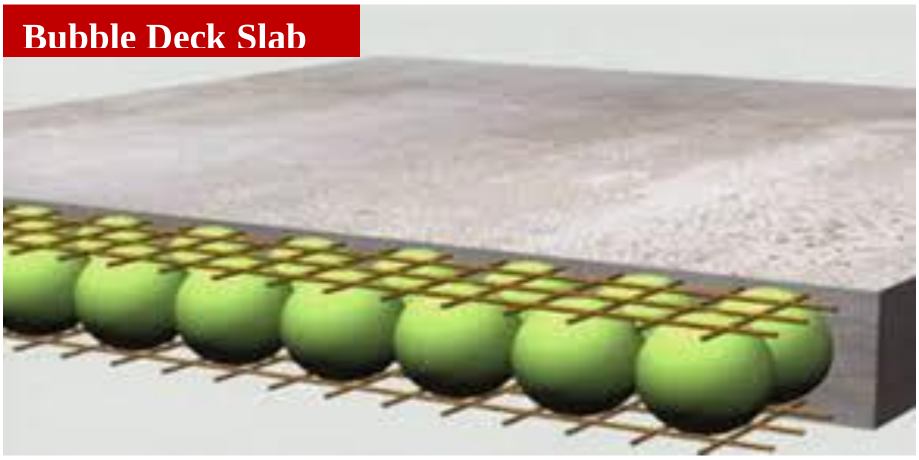
Finished Planks are the Type C Bubble Deck slab variety. The concrete, reinforcement mesh, and plastic spheres are all included in this type of shop-fabricated module, as seen below. The module is supplied on-site after being constructed to the desired depth in the shape of a plank. Bubble Deck Type C is a one-way spanning design that necessitates the installation of support beams or load-bearing walls, in contrast to Type A and B. Shorter spans and constrained building schedules are best suited for this style of bubble deck.

5. ANALYSIS

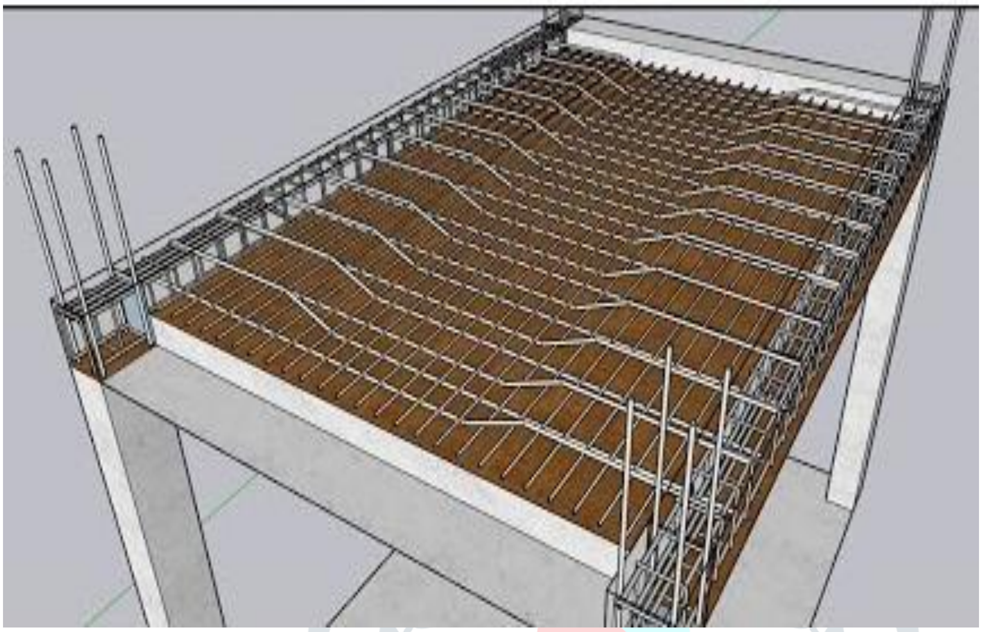
Plastic balls are used by Bubble Deck to fill the slab, and a prefabricated reinforcing system holds the balls in place. This biaxial method enables greater spans and thinner floors by reducing weight while maintaining the performance of reinforced concrete slabs. The observation that the space between the columns of a solid slab has little structural consequence other than to add weight is the foundation for the concept of bubble deck. Instead, an internal lattice girder and a grid of voids are inserted between layers of reinforcing welded wire steel to create a slab that is typically 35% lighter and performs like solid reinforced concrete. Once the concrete is poured over the balls in the panels, the bubble deck system effectively resembles and performs like a monolithic two-way slab that disperses force uniformly and continuously, as demonstrated below:

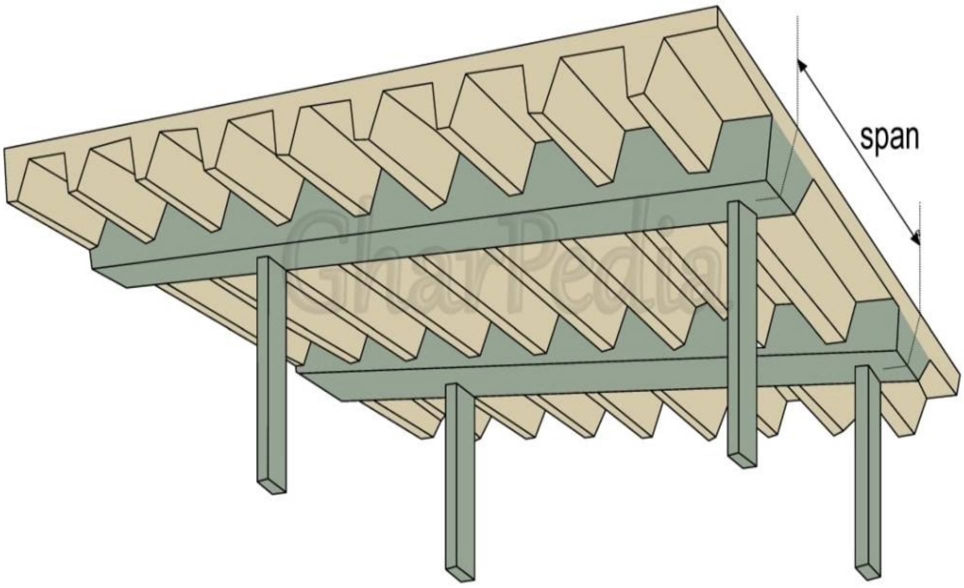


Analysis of Bubble Deck Slab

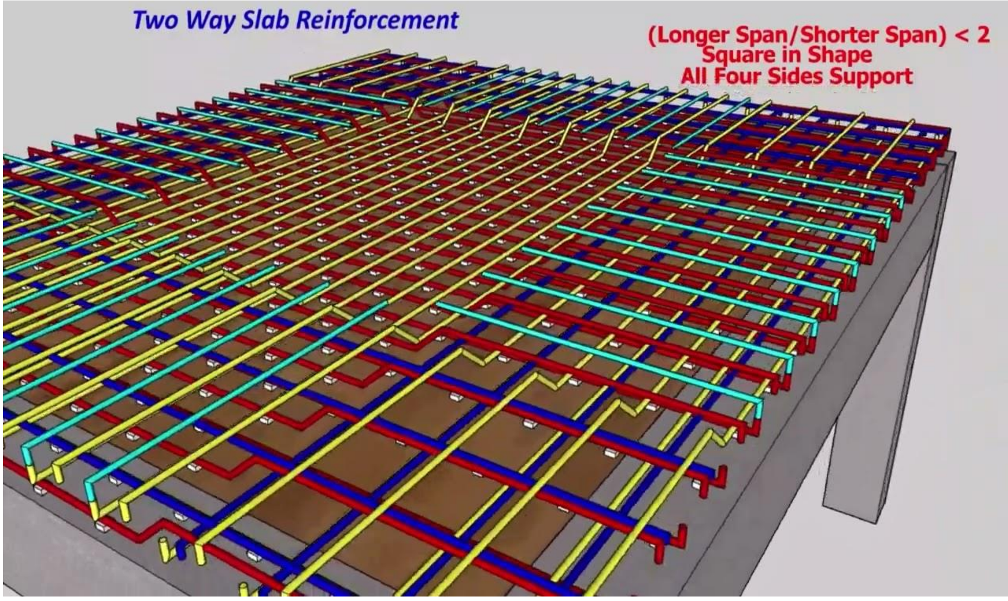


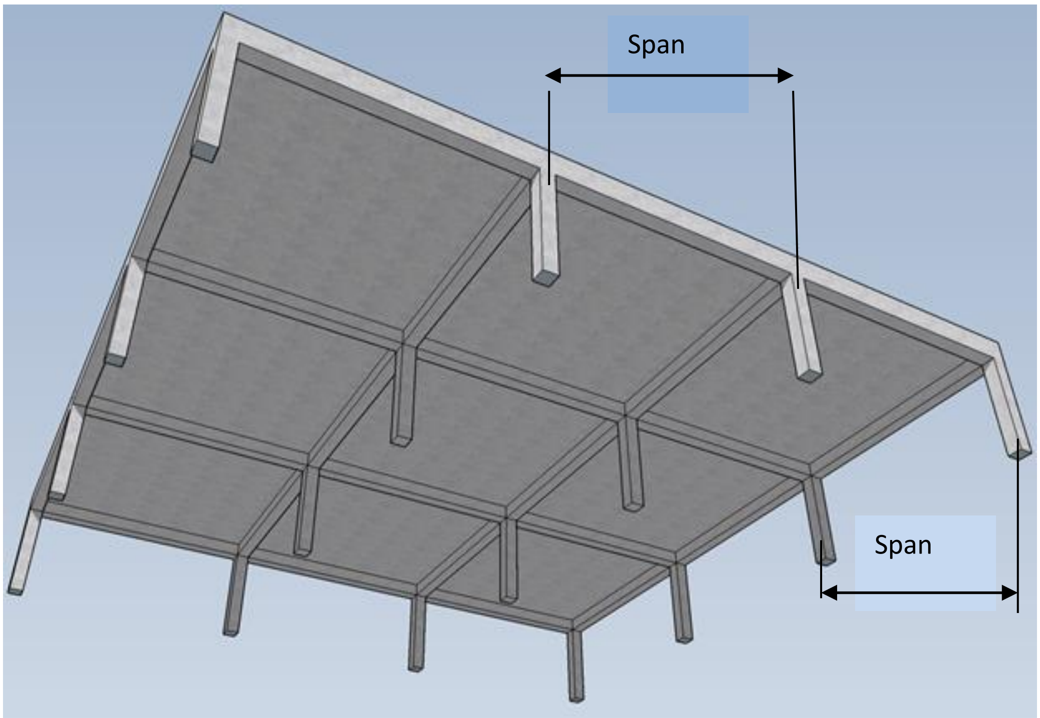
Regular or conventional slabs are terms used to describe slabs that are supported by beams and columns. In these designs, the weight or load is transferred to the load-bearing beams and then to the columns while the slab's thickness is quite minimal. When compared to a bubble deck slab, this requires more formwork. On the conventional type slab, column caps are not required. Conventional concrete slabs can take on any shape depending on how the building's floor is laid out. A typical slab of concrete is reinforced with main (primary) reinforcing bars that are horizontally organized and distribution bars that are vertically distributed. Based on its length and width, this sort of slab can be divided into two categories: one-way slabs and two-way slabs. The primary reinforcement in a one-way slab spans only one direction. The larger span to shorter span ratio should be equal to or greater than 2. The main reinforcement spans both directions in a two-way slab. The larger span to shorter span ratio should be less than two. As displayed below:





One – Way concrete slab with beams spanning in one direction between supports





Two - Way concrete slab with beams spanning in two directions between supports

CONCLUSION

Bubble Deck Slab offers technology that is affordable, simple to construct, and ecologically benign. Storey, roof, and ground floor slabs can all be constructed using the Bubble deck slab. A slab floor for a bubble deck is completely flat and devoid of beams and column heads. The primary feature is the inclusion of hollow plastic spheres that are clamped in a factory-made reinforcing structure. Although the construction of bubble deck slabs involves a high level of hand labor knowledge, they have proven advantageous in practically every way, including material savings, structural performance, and user comfort. When the same amount of concrete and reinforcement are used as in the conventional solid slab, the bubble deck configuration provides significantly improved flexural capacity, stiffness, and shear capacity of at least 70%, attaining 30–50% concrete economy in contrast to the conventional solid slab. In comparison to a conventional slab, the load and deflection yield better results for bubble deck slabs. As 100 kg of concrete are replaced by 1 kg of recycled plastic, less concrete is used. This prevents the production of cement and permits a decrease in world CO_2 emissions. In an office floor system, this analysis has shown that the Bubble Deck technology is more effective than a conventional biaxial concrete slab.

CONFLICT OF INTEREST

The author declares no conflict of interest in this study.

REFERENCES

1. Abishek [1] V·, Iyappan[2] G. R. (2021). Study on Flexural Behavior of Bubble Deck Slab strengthened with FRP. Journal of Physics: Conference Series doi:10.1088/1742-6596/2040/1/012018

2. Aziz Z. A.; Heng C. L. (2021). Bubble Deck Slab System: A Review on the Design and Performance

3. **Balasubramanya** N., **Hokrane S. and Saha S. (2017).** Comparative Studies of Conventional Slab and Bubble Deck Slab Based on Stiffness and Economy

4. Deepak C., Pritesh S., Omkar M., Prachi S., Bhagyashree R., Vrushabh O., and Sanjay B. (**2022).** Review Study on Bubble Deck Slab. DOI: 10.35629/5252-0404391395

5. Dwivedi[1] A. K., Prof. Joshi[2] H. J., Rohit Raj[3], Prem Prakash Mishra[4], Mamta Kadhane[5], Bharati Mohabey[6] (2016). Voided Slab Design: Review Paper
6. Dyg. S. Q. A. A.[1,2,3] , ,*, Kartini[3]. K, Hamidah[3]. M. S. (2020). Comparative Study on Bubble Deck Slab and Conventional Reinforced Concrete Slab – A Review. E-mail address: https://doi.org/10.37934/arms.70.1.1826

7. Gajewski, T.; Staszak, N.; Garbowski, T. (2023). Optimal Design of Bubble Deck Concrete Slabs: Serviceability Limit State. Materials. https://doi.org/
10.3390/ma16144897

8. Garg[1] A., Goyal[1] A., Tushar[1] P, Jangid[1] C., Mohit[1], Hussain[2] A. (2019). Bubble Deck Slab Construction and its Applications.

9. Konuri S., Dr.Varalakshmi T.V.S. (2019). Review on Bubble Deck Slabs Technology And Their Applications.

10. Lait T. (2010). Structural Behavior of Bubble Deck* Slabs And Their Application to Lightweight Bridge Decks

11. Lakshmikanth L., Poluraju P. (2019). Performance of Structural Behaviour of Bubble Deck Slab: a Review. International Journal of Recent Technology and Engineering (IJRTE), Volume-7, Issue-6C2

12. Lakshmipriya[1] N., and Karthikpandi[2] M. (2018). Study and Model making of Slab using Bubble Deck Technology.

13. Lalit B. (2020). Comparative Analysis of Flat Slabs & Conventional RC Slabs with and without Shear Wall.

14. Manvi[1] A., Gouripur[1] S., Sambrekar[1] P., Ramanjeetkaur[1], Dr. kishor s. kulkurni[2] (2015). Cost comparison between conventional and flat slab structures.

15. Mohan A. and Sukumaran A. (2018) Performance Analysis of Bubble Deck Slab Using Elliptical Balls, International Journal of Engineering Research & Technology (ijert), (Volume 6 – Issue 06).

16. Nagma F[1] and Vinaysingh C[2]. (2018). To study Comparison between Conventional Slab and Bubble Deck Slab

17. Prof. Patel[1*] J., Prof. Sankhat [2*] A. K., Prof. Patel[3*] M. P. (2018). A Review Paper on Bubble Deck Slab Design Consideration.
18. Pulikonda, S. (2018). Bubble Deck Slab.

19. Shital B. et al (2021). IOP Conf. Ser.: Mater. Sci. Eng. 1197 012072

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