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A Review on Plastic Voided Slab

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Abstract:

The most widely utilized building material is concrete. Concrete usage goes too far, which produces CO_2. The result will be global warming. In building construction, it's crucial to use less concrete. Voided slabs are recommended for this. A void slab is a technique for virtually removing some concrete from the tension zone. The structural dead weight is significantly decreased. By applying plastic balls, cavities are created in this slab. Use of High Density Polyethylene (HDPE) spherical balls to fill the voids in the middle of a slab eliminates 35% of a slab self-weight without affecting its deflection behaviour & bending strength, compared to solid slab having same thickness. This helps in reduce of self-weight, less emission of CO_2 as less concrete will be used in slab and large spans in slabs can also be adopted. Theliteraturepapersrelatedtoourtopicwerereviewed.

Keywords **—voided slab, HDPE balls, conventional slab**

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I. INTRODUCTION

One of the most crucial, well-used, and efficiently designed parts of a construction is a slab. The thickness of the slab keeps growing when there is a significant load pressing on it and a greater distance between the two columns. For the reason that the slabs self-weight keeps rising, it comprises more materials like steel and concrete than other components. Since cement is produced, it contributes to 5% of the global CO_2 emissions and is a heavier material. In terms of cost and materials, voiding a slab is one of the most efficient ways to replace a traditional slab. By practically removing the concrete from the center of a floor slab that is not serving any structural purpose, known as a "voided slab," one can significantly reduce structural dead weight. It is a kind of reinforced concrete slab that uses voids filled with air to lesser the amount of concrete needed. These voids make construction more affordable and less harmful to the environment. Another significant advantage of the technique is that the slab weighs less than a typical solid slab. 35% of the self-weight of a flat slab is removed by void formers in the centre of the slab.

Fig1. Plasticvoidedslab

II. LITERATURE REVIEW

Tambe Yogesh (2021) used Ansys Workbench 14.5 to compare a voided slab to a regular slab. The overall deformational behavior of reinforced concrete solid and voided slabs under symmetrical and asymmetrical loads is the focus of the study that is being presented. The reinforced concrete slabs with a void diameter of 60 mm and dimensions of 1 m x 1 m x 0.12 m were modeled and tested under various loading conditions, such as uniformly distributed loading. Because the analysis's analysis diameter is as tiny as 60mm, the deformation in a voided slab is roughly similar to that of a solid slab. According to the study above, the typical weight loss is 0.73%.

Adenanetal.(2020)conducted a comparison between a reinforced concrete slab and a bubble deck slab. The experimental effort involved casting and testing slabs with standard and bubble decks of dimensions 700 mm by 700 mm by 150 mm. Continually blowing recycled plastic balls with diameters of 90 and 120 creates bubbles. These conclusions have been reached as a result of their review. In comparison to a normal slab, the bubble deck configuration offers much better flexural capacity, stiffness, and shear capacity (at least 70%). Comparing the concrete economy to a solid slab, it is between 30% and 50%.

Domaleet al.(2020) This project outlines bubble deck slabs and how they can be built, resulting in lighter and less expensive structures. Using this method, we have produced 35% of the concrete and building materials. By placing HDPE balls in the slab's center, this study aimed to reduce the dead load of the slab. High-density hollow balls are used to form a 30 to 50% flexible slab, which has a number of advantages over standard slab by reducing loads placed on structural parts including columns, walls, and foundations. The bubble deck enables a 20% faster construction process when compared to traditional construction techniques.

AnsariandAhmad(2020)carried out a test to look at how adjusting the bubble thickness could improve the structural behavior of a bubble slab. HDPE balls that were 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 cm thick were used to create bubble slabs. According to the analysis's findings, bubble slabs produce less deflection and spend 14.98 kg less concrete per 150 mm of thickness than traditional slabs. A bubble slab with HDPE bubbles that are 2 cm thick saves 63.04% more in deflection. According to their analysis, an HDPE bubble should be 2 cm thick at all times.

Fatma (2018) conducted a study to compare the bubble deck slab and the standard slab. The dimensions of the conventional and bubble deck slabs are 1 x 1 x 0.125 m. In that experiment, it was discovered that the continuous bubble deck type slab lowered the volume of the concrete, therefore reducing the weight of the slab. In comparison to traditional slab, the load on bubble deck continuous type slab has also increased by 23%. The load carrying capability of a bubble deck slab with an alternate bubble configuration is 11% and 6% higher than that of a standard slab. In comparison to a conventional slab, it was found that the load, deflection, and weight characteristics produce better results for bubble deck slabs.

Lakshmipriya and Karthikpandi (2018), have written a technical paper titled "Study and model slab making using Bubble Deck technology" and have discovered the following: The outcome showed that replacing a 1 m cube of concrete with a hollow high-density polyethylene sphere reduced the cost of concrete by 27%. The forces will be distributed more evenly by Bubble Deck than by any other hollow floor structure. The empty sections and 3D structure ensure that they won't have any unfavorable effects or reduce the strength.

Varshney et al. (2017) carried out review research on the bubble deck slab. They research the many forms of bubble deck slab. The study focuses primarily on the benefits of bubble deck slabs from a structural, building, engineering, environmental, and economic standpoint. Additionally studied are the structural characteristics of bubble deck slabs. According to their analysis, bubble deck slabs can lower the structural concrete in slabs by up to 35% and other structural components by up to 20%. It was a time-saving strategy that made building 20 percent faster than it would have been otherwise. Less material and energy are consumed in bubble deck slabs. It lowers CO2 emissions by as much as 40kg/m2. When spherical balls are used to fill the spaces in the centre of a slab, 35% less weight is carried by the slab as a whole.

Hokrane and Saha 2017 Studies Comparing the Bubble Deck Slab to the Conventional Slab based on economy and stiffness A standard slab and a bubble deck slab measuring 1 m x 1 m and a bubble deck slab made up of bubbles with varied diameters of 60 mm and 70 mm were cast and tested. When the concrete volumes for bubble deck slab and conventional slab were compared, it was found that employing bubble deck slabs with 60 mm and 70 mm in diameter could save around 14% and 9.41% of the cost, respectively. As a result, it was determined that among all the slabs examined, the amount of concrete for 60 mm balls was more cost-effective. In summary, the bubble deck slab with a 60 mm diameter is more efficient in terms of weight, strength, and stiffness comparedtoconventional slab

JamalandJolly(2017) Utilizing spherical and elliptical balls, a study on the structural behavior of a bubble deck slab was done.After researching the material's characteristics, spherical and elliptical HDPE balls were used to cast slabs. To analyze the structural behavior of a bubble deck slab with spherical and elliptical balls subjected to uniformly distributed loads with suitable boundary conditions, finite element analysis (FEA) was conducted using FEA software and ANSYS. They draw the conclusion that the bubble deck slab with elliptical balls has a higher load carrying capability than the bubble deck slab with spherical balls based on the analysis's findings. In comparison to bubble deck slabs with spherical and elliptical balls made of M25 grade concrete, those made of M30 grade concrete perform better. saving with bubble deck slab saves weightupto33.15%around onesphericalballand34.9%forone ellipticalball

Vakil et al. (2017) have conducted a study on a comparison of bubble deck slabs and solid deck slabs and have concluded as follows: investigations and experiments carried out on the Bubble Deck slab. According to their research, Bubble Deck would distribute forces more effectively than any other hollow floor systems (an absolute optimum). The hollow areas won't have a negative effect and won't result in a loss of strength because to the three-dimensional structure and the gently graduated force flow. As the only known hollow concrete floor construction, Bubble Deck operates like a spatial structure. Tests show that the shear strength is much higher than anticipated, which suggests that the balls have a favorable affect. All experiments, claims, and engineering knowledge support the unmistakable conclusion that Bubble Deck behaves in some way like a solid deck and does so in consequence. With less mass, it will adhere to the same laws and regulations as a solid deck and result in significant cost savings.

Pandey and Srivastava (2016) carried out an analysis using the FEM (Finite Element Method) on a bubble deck slab design. Both the bubble deck slab and the solid deck slab are examined. Both slabs were modeled in ANYSIS 2000 using experimental data, and their static responses to various loadings were examined. The bubble deck slab's maximum moment and internal stresses were 64% greater than those of the solid deck. As a result of the hollow portion's reduced stiffness, they draw the conclusion that the deflection of a bubble deck is 18% greater than that of a solid slab. When compared to solid deck slab, the weight of bubble deck slab is 15% less. Compared to previous slab systems, this one has greater benefits, including a decrease in self weight and material savings.

Mohammed saisulla and Azeem (2017) compare the seismic performance of a flat slab with a standard slab over a bubble deck slab. With the use of SAP 2000 software, the seismic behavior of various sizes of standard slabs, flat slabs, and bubble deck slabs is assessed in this study. Displacement, bending moments, shell stresses, axial force, and foundation response are the primary parameters assessed in this study. When compared to the bubble deck slab, it can be shown that the moments in the traditional slab are around 36% fewer, those in flat slabs with drops are 4–5% higher, and those in flat slabs without drops are 61–66% more. When compared to the bubble deck slab, the shear forces in the conventional slab are roughly 60% lower, those in the flat slab with drop are roughly 31% less, and those in the flat slab without drop are roughly 22 to 31% higher. The stresses are at least 7% higher in all conventional slab systems than they are in bubble deck slabs.

TiwariandZafar(2016),In terms of slab performance, forces and maximum stresses, deflection, and durability of the floor slab, they compared bubble deck slab with conventional concrete slab. They found that the conventional slab performed worse than the bubble deck slab and that the internal forces and 40% maximum stresses in the hollowed-out bubble deck were lower than those in the solid slab because of the reduction in dead weight. Although they found that the bubble deck deflected 10% more than a solid conventional slab, this was because the bubbles reduced the rigidity of the material.

Packirisamy(2016) The load carrying capacities and concrete utility values between the solid and the bubble deck slab were clearly compared in the paper. Using SAP 2000, the samples were modelled. After inserting the stiffness multiplication factor and self-weight, they concluded by providing design strategies for bubble deck that are analogous to those used for conventional solid slabs. It also showed the most recent real-world initiatives based on the same methodology. The parallels between the solid and voided slabs, with the exception of the edge-column connections, were stated as the conclusion. identified the bubble deck system as an environmentally friendly and sustainable technology.

John and Varghese (2015) used ANSYS to conduct a research on the bubble deck slab's behavior. In ANSYS, a 3D solid slab and bubble deck slab with 1 m x 1 m x 0.125 m dimensions were modeled. The study's chosen bubble had a 64mm diameter. They draw the conclusion from their analysis that the bubble deck technology is a ground-breaking system that does away with secondary supporting structures like beams, RC columns, and structural walls. A bubble deck will more effectively disperse forces than any other hollow structure. Bubble deck is additionally 15% less expensive and has a 40% greater breadth. The price is 30% lower and the volume of concrete used is reduced by 33% for the same span with a bubble deck.

Saifee Bhagat (2014) investigated the properties of the voided slab in comparison to the flat plate slab, including moment of inertia, shear capacity, stiffness reduction factor, and weight reduction factor. The solid flat plate slab and the voided flat plate slab are taken into consideration, with interior spans varying from 6 x 6 to 14 x 14, thicknesses ranging from 280 to 600 mm, and spherical balls inserted anywhere between 180 and 450 mm. Based on the findings, it can be said that spherical balls cause a stiffness reduction of between 10% and 20%. The self-weight of flat plate slabs can be decreased by up to 32% by adding spherical voids.

PurnachandraSaha (2014) aims that by nearly eliminating all of the concrete in the slab's middle that does not serve as structural support, the bubble deck slab is a technique to significantly reduce the structure. The HDPE hollow sphere balls improve the efficiency of the floor by replacing the extra concrete in the slab's middle. The foundation, columns, and walls of the entire building are under less load thanks to the introduction of a lighter slab that is 30 to 50% stronger. The benefit of the generation of industrial waste and the use of energy from gas, primarily CO2.

Kivanc (2014): A solid slab and a bi-axial voided slab's experimental analyses are contrasted. For various span lengths and load intensities, different software was utilized to build FE models. Different void formers, including Nautilus, Mushrooms, and both, were employed. Intensities of the loads varied from 0.2 to 1 t/m2. 6 to 18 meters of slabs were available. The cost and concrete consumption for various slab lengths and load intensities were compared. In the end, it was found that the slab with void former Nautilus used 40% less concrete and cost 50% less than the conventional slab.

Allawi2014 The structural performance of the voided concrete reinforced slabs was tested using one-way voided slabs. In order to fully compare the investigational work with the theoretical situations and to assess the validity of the suggested numerical ideal, a nonlinear finite element analysis (FEA) was performed using ANSYS. The final results revealed that the highest weight loss was 13.7%, followed by a maximum load strength of about 96.8% and a stiffness of 97% of the original reference slab. The difference between the obtained (FEA) load and ultimate deflection and the laboratory values is less than 10%.

Reshma Mathew andBinu. P (2006)compared bubble deck slab piercing shear characteristics to solid slab. In contrast to solid slabs, bubble deck slabs have a lower punching shear capacity. As a result, the GFRP strips are used as a reinforcement system for the bubble deck slab in a variety of orientations. Utilizing ANSYS software, a finite element study was performed. Comparing strengthened slabs to control bubble deck slabs, stronger slabs have a larger punching capability. Because the bubble deck slab has been strengthened, the load carrying capacity has increased by up to 20%. 230 mm thick flat slabs with 180 mm diameter HDPE balls inserted into them can reduce the weight of each ball by up to 23.62%.

III. CONCLUSIONS

The literatures on voided Slab hasbeen reviewed. From this literature review, we can conclude that voided Slab is good in load carrying capacity even for reduction in 30% self-weight, and most importantly it reduces the construction cost by replacing central inactive concrete with HDPE (High Density Polyethylene) balls. The voided slab may be expected to fail when the loading point falls between two adjacent HDPE balls as this was found to be the weaker zone of voided slab. The voided slab configuration gives much improvedflexuralcapacity,stiffnessandshearcapacityatleast70%compared toconventionalslab.

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