

Comparative Study of Conventional Slab and Voided Slab

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ABSTRACT: Slab is largest member which consumes concrete. If the load acting on the slab is large or clear span between columns is more, the thickness of slab increases. It leads to consume more material such as concrete and steel due to this, self-weight of slab is increases to avoid these disadvantages voided slab system is used. Reinforced concrete slab with plastic voids is a new and innovative type of construction. It is developed to allow for lighter self-weight of the structure while maintaining similar load carrying capacity of a solid slab. High density polyethylene (HDPE) hollow spheres replace the ineffective concrete from the centre of the slab and decrease the dead load. The advantages are less energy consumption both in production and transport, less emission of exhaust gases from production and transport, especially CO₂ and reduce the material, the load, lower the cost and it is also a Green Technology. The Bubble deck slab floor system can be used for storey, roof and ground floor slabs. The effect is to decrease the overall weight by as much as 15% when compared to a solid slab of the same bearing capacity.

KEYWORDS: voided slab, conventional slab, cost, eco-friendly light weight.

I. INTRODUCTION

The basic need of human is food, shelter and clothing. This all three needs fulfil by engineers and in that one shelter can be done by particularly civil engineer. Every person have a dream to have own house with all safety and economic. For construction of the structure materials are require and the major material used for construction are concrete and steel. Concrete is a strong, durable material composed of cement, aggregate and water. But due to concrete self-weight and emission of CO₂ occurs which ultimately cause the environment, hence by reducing the percentage of concrete the eco-friendly structure can be develop.

The main obstacle with concrete constructions, in case of horizontal slabs, is the high weight, which limits the span. For this reason major developments of reinforced concrete have focused on enhancing the span reducing the weight or overcoming concrete's natural weakness in tension. In a general way the slab was design only to resist vertical load. However recently due to more use at domestic level slabs are subjected to more noise and vibration, so to minimize it there is need to increase the thickness which ultimately result in increased weight of slab. Increasing the slab thickness makes the slabs heavier, and will increase column and foundation size. Thus, it makes buildings consuming more materials such as concrete and steel reinforcement. To avoid these disadvantages which were caused by increasing of self-weight of slabs, the voided slab system is used. The Bubble Deck method for the two direction reinforced composite concrete slab with gaps was sinverted in Denmark, it is licensed similarly COBIXA and U-BOOT technology can be use. It was conceived to achieve saving of concrete and energy in building construction. Increasing the slab thickness makes the slabs heavier, and will increased column and foundations size. Thus, it makes buildings consuming more materials such as concrete and steel reinforcement. To avoid these disadvantages which were caused by increasing of self-weightof slabs, the voided slab system, was suggested. The result is "an eco-friendly, budget-friendly floor system with the same stability and stiffness gleaned from traditional methods, all while using less material and time to construct.

In this project the voided slabs are reinforced concrete slabs in which voids allow to reduce the amount (volume) of concrete. In building construction, slab is very important structural member to make a space. And the slab is one of the largest member consuming concrete. When the load acting on the slab is a large or clear span between columns is more, the slab thickness is on increasing. To avoid these disadvantages various studies carried out and researchers suggest voided flat plate slab system to cut the self-weight of the slab. A voided flat slab system is known as one of the effective slab system, which can reduce the self-weight of the slab.

The ideal of voided concrete has been investigated since the early 1900. In a traditional reinforced concrete slab span, the bottom portion will be in tension and therefore will require steel reinforcing to prevent failure. The top portion will be in

compression, and the middle portion will effectively work only as a bridge holding the top and bottom portions together. In construction applications, long-span can become very thick and require large amounts of concrete. Because of the mechanics in slab spans, engineers began to look for ways to remove the middle concrete in a slab, voided concrete came about as a viable option for slab lightening.

In general, slab is designed only to resist vertical load. When span of the building is increasing, deflection of slab is more important. Therefore, the slab thickness is on the increase. The increasing of slab thickness makes slab heavier, and it leads to increase column and base size. Thus it makes building consume more material. However recently due to more used at domestic level slabs are also subjected to more noise and vibration, so to minimize it there is need to increase the thickness makes the slabs heavier, and will increase column and foundation size. Thus, it makes buildings consuming more materials such as concrete and steel reinforcement. To avoid these disadvantages which were caused by increasing of self-weight of slabs, the bi-axial hollow slab system (void slab) was suggested. This slab system could optimize the size of vertical members like walls and columns by lightening the weight of slabs.

The bubbles are made by embodying high density polypropylene in the concrete, arranged according to the project and placed between the reinforcement meshes. The material that are made of don't react chemically with the concrete or the reinforcement, it has no porosity and has enough rigidity and strength to take over the loads as much as from the pouring of the concrete as from the subsequent phases of this process.

II.LITERATURE REVIEW

(A) Tae-young jang, sang-mo kim, sang-dae kim (June 2006) have worked on, “*new eco-friendly two-way void slab*” [1]

In this paper, the comparative study between new eco-friendly slab systems with existing general floor slab is carried out on the basis of the structural economic and environmental effect during total life cycle of building. The results achieved by the South Korea were certified by the Europe. The certifications were due to eco-friendly effects such as saving fossil energy and reducing CO₂ emission by the reduction of concrete and reinforcing bar.

(B) J. H. Chung, H. K. Choi, s. C. Lee, c. S. Choi (2011) have worked on “*shear capacity of bi-axial hollow slab with donut type hollow sphere*”[2]

This paper presents the shear capacity of bi-axial hollow system is widely known as one of the effective slab systems which can reduce the self-weight of slab. This paper concluded the results on the basis of two parameters i.e. shear capacity of specimen and crack pattern.

The test specimen was designed of four type of slabs one was conventional R.C slab and others were hollow slab. The test parameters include two different shapes and materials of plastic balls.

(C) Renata baskova, maria kozlovska, alena tazikova and zuzana strukova (November 2017) have worked on

“*Comparative study of lightweight slab solution in terms of construction cost*” [5]

In this study, it is understood that when the spacing between the balls increases, the flexural strength of the slab increases irrespective of change in the thickness of the slab. It is also observed that the flexural strength of the slab in 60mm ball diameter is higher than the flexural strength of slab in 75mm ball diameter for both 20mm and 30mm spacing of the balls. It is finally concluded that the optimum diameter of the hollow spherical balls that can be used in bubble deck slab for normal purpose is 60mm and the optimum spacing between the balls can be 30mm. There is a 35-50% reduction in use of concrete which leads to reduction in self-weight of slab with same flexural. Strength of the slab compared to the conventional slab. Due to the voids in the slab it has excellent thermal insulation property. Lower total cost, decreased construction time and green technology compared to conventional slab.

(D) Saranya p., sankaranarayanan km (May 2019) have worked on “*Voided slab with high volume fly ash concrete*” [6]

In this paper, they use high volume fly ash concrete for making voided slab. According to this paper they balance both environmental sustainability and cost effectiveness of overall construction. They prepare four models of high-volume fly ash concrete slab.

(E)K.R. dheepan, S. Saranya, S.aswini (2017) have worked on “Bubble deck slab using polypropylene balls” [3] Presented experiment study on bubble deck slab using polypropylene balls. In this work polypropylene balls of 60mm and 75mm diameter are used. The balls are arranged at 20mm and 30mm spacing which are continuously arranged. The lateral support is provided by fabricating steel in meshes at top and bottom and vertical support provided by diagonal girders. As the spacing between balls increases, diameter decreases and flexural strength of slabs increase. Optimum diameter obtained is 60mm and optimum spacing is 30mm. The maximum flexural strength obtained for the slab with 100mm depth 60mm diameter and 30mm spacing.

III.METHODOLOGY

Design analysis by laboratory method

3.1 Design a bubble deck slab consist of different steps:

- i. Basic test on cement, fine aggregate and coarse aggregate.
- ii. Take 65mm diameter spherical balls
- iii. Mix design for M25 grade concrete.
- iv. Preparation of slab specimens. Prepare two slab in which one is conventional slab and other is voided slab with dimension 0.5 m X 0.6 m with depth 150mm. as per IS specified. Voided slab is the combination of reinforced concrete and PVC balls
- v. Curing must be done for 7 days.
- vi. Test the both specimens on machine.
- vii. Note the result and compare the voided slab with conventional slab.

3.2 Types of material

For design of slab the main material is cement, sand and aggregate. The different test were done on material.

3.2.1 concrete

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete. It is interesting to note that the ingredients of good concrete and bad concrete are the same. If meticulous care is not exercised, and good rules are not observed, the resultant concrete is going to be of bad quality. With the same material if intense care is taken to exercise control at every stage, it will result in good concrete. The various stages of manufacture of concrete are given below:

1. Batching 2. Mixing 3. Transporting 4. Placing 5. Compacting 5. Curing

Batching:

The measurement of materials for making concrete is known as batching. There are two methods of batching.

- i) Volume batching
- ii) Weigh batching

Weigh Batching: Strictly speaking, weigh batching is the correct method of measuring the Material. For important concrete, invariably, weigh batching system should be adopted. Use of weight system in batching, facilitates accuracy, flexibility and simplicity. Different types of weigh batchers are available, the particular type to be used, depends upon the nature of the job. Large weigh batching plants have automatic weighing equipment. The use of this automatic equipment for batching is one of sophistication and requires qualified and experienced engineers.

Mixing: Thorough mixing of the materials is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. There are two methods adopted for mixing concrete:

- (i) Hand mixing
- (ii) Machine mixing

1) Hand mixing: Hand mixing is practiced for small scale unimportant concrete works. As the mixing cannot be thorough and efficient, it is desirable to add 10 per cent more cement for the inferior concrete produced by this method.

3.2.2 HDPE balls

A linear polymer, High-density polyethylene (HDPE) is prepared from ethylene by a catalytic process. The absence of branching result in a form more closely packed structure with a higher density and somewhat higher chemical resistance than LDPE (low-density polyethylene). HDPE is also somewhat harder and more opaque and it can withstand rather higher temperatures (1200 Celsius for short periods, 1100 Celsius continuously).

The size of steel bar vertical direction is 62cm and in the horizontal direction is 24 cm and the spacing between is 6.5cm and the diameter of bar is 10mm.and the diameter of HDPE ball is 6.5cm.the combination of bar and ball are show in fig. are given below.



Fig.1 Placing of plastic ball in reinforcement

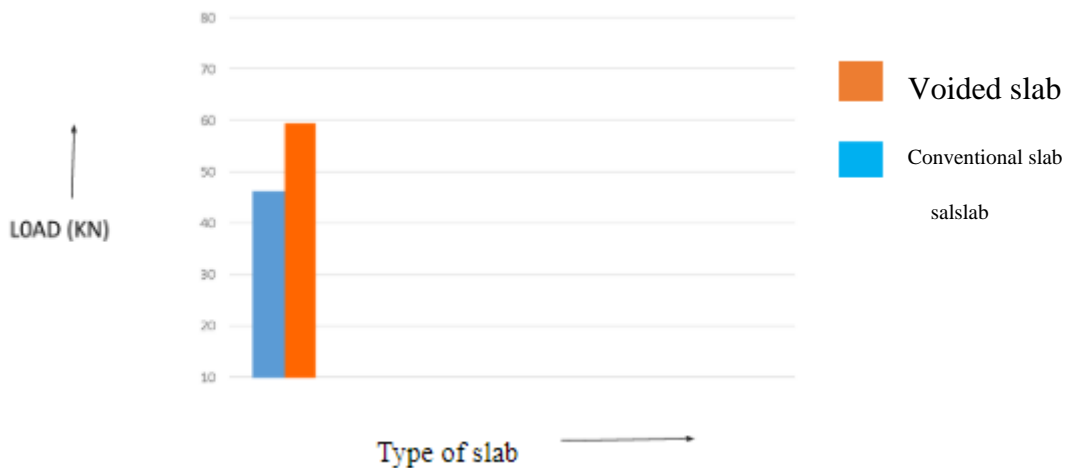


Fig.2 steel reinforcement

3.2.3. Preparation of reinforcement

We know that concrete are provided in the bubble deck slab for the compressive zone and the steel bar are provided for the tension zone. The mesh of bar are given in fig.2

IV.RESULT



The quantity of fine aggregate, coarse aggregate cement and W/C ratio as follows:

The results of 2 slab constructed, were tested. The results are as follows:

Properties	Conventional slab	Voided slab
Cement	41.4 (kg)	33 (kg)
Coarse aggregate	0.062 (m3)	0.05 (m3)
Fine aggregate	0.0285 (m3)	0.022(m3)
W/C ratio	0.5	0.5

Types of load	Conventional slab	Voided slab
Point load(KN)	46.2	59.49
Deflection(mm)	4	9.2
Dead load(KN)	3.65	2.917



Estimation of slab:

Consider a slab of 3m X 3m size its estimation as follow,

No.of item	Particular item	Qty .	Unit	Rate (Rs.)	Per	Amount (Rs)
1.	Concrete 1:1:2 work	1.80	M3	3600	M3	6480
2.	Steel TMT 10mm dia.bar	58.63	Kg	41	Kg	2403.83

The length of single cranked main bar along both span , assume 45O bent up angle. Length is 3.65m(by calculating)

For conventional slab

Table no.1: Measurement work of conventional slab

No.of item	Particular item	No.	Length (m)	Width (m)	Height (m)	Quantity (m ³)
1.	Concrete work	1	3.46	3.46	0.15	1.80
2.	Centering and shuttering work Bottom slab Edge slab	1	3	3	0.15	9
		4	3.46	-		2.076
						<hr/> 11.076
3.	Steel work in reinforcement in bending , binding and placing wire. 10mm dia.bar along one span 10mmdia.bar along other span	13	3.65			47.45
		13		3.65		47.45
						<hr/> 94.9 @0.62kg/m

Table no.2: Abstract work of conventional slab

No.of item	Particular item	Qty .	Unit	Rate (Rs.)	Per	Amount (Rs)
1.	Concrete 1:1:2 work	1.80	M3	3600	M3	6480
2.	Steel TMT 10mm dia.bar	58.63	Kg	41	Kg	2403.83



Table no.3: Measurement work of voided slab

No. Item	Particular item	No.	Length (m)	Width (m)	Height (m)	Quantity (m ³)
1.	Concrete work	1	3.46	3.46	0.15	1.80
2.	HDPE ball dia.65mm Thickness 5mm	90	-	-	-	0.298
3.	Steel work on both span One span Other span	13 13	3.65	3.65		47.45 47.45 <hr/> 94.09 @ 0.62 kg/m

Table no.4: Abstract work of voided slab

No. of item	Particular item	Qty.	Unit	Rate (Rs.)	Per	Amount
1.	Concrete 1:1:2 work	1.80	M3	3600	M3	6480
2.	TMT steel 10mm dia. Bar	58.63	M3	41	Kg	2403.83
3.	HDPE ball	90		5	Per ball	450
Total = Rs.8242						

Total difference in cost of slab = (cost of conventional slab) -(cost of voided slab)

$$= 8883.83- 8242$$

$$= 641.83 \text{ Rs.}$$

Therefore, with use of voided slab from above estimation we conclude that there is 216 Rs. less per sq.m of slab.

V. CONCLUSION

- In comparative of conventional slab the volume of concrete in voided slab are less required that is 21.30% approximately and because of that Rs 216 / per sq.m less by use of voided slab, hence it is cost effective technique.
- In comparison of conventional slab the deflection is more in voided slab and also as per the IS code recommendation voided
- slab safe in shear.
- Voided slab technology is environmental green and sustainable; avoiding the cement production allows reducing global
- CO2 emission and also use of waste plastic is possible in this technology.



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