Comparative Study of Flat Plate Slab and Voided Slab Lightened with U-Boot Beton

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Abstract - *The flat plate slab is gaining popularity among architects. The flat plate slab provides a way for architect to achieve completely flat ceiling with no beam protrusion. There is also improvement in the construction speed and cost savings from using this system which requires only simple formwork. But when load acting on the slab is large or clear span between columns is more so it is required to increase the slab thickness; hence the self-weight of slab is increased due to increased volume of slab and also more amount of steel is required to resist this increased weight of slab. Voided slabs eliminate concrete where it isn't needed and the subsequent weight reduction due to this eliminated concrete makes longer spans possible. In this study the design process for flat plate slab is compared with Voided slab lightened with U-Boot Beton through a design comparison of total slab area of 21 m by 21 m having panels of 7 m by 7 m and also the deformation of both type of slabs is analysed by using ETABS Software.*

Key Words: Voided Slab, U-Boot Beton, Flat Slab, Self-Weight of Slabs, Analysis of Deflection, Design of Slab, ETABS.

1. INTRODUCTION

Voided slab systems are significantly lighter than flat plate concrete slabs while maintaining the ability to have large spans. Slabs are lighter because less concrete is used in voided slab construction than flat plate slab construction. Voided slab systems were first introduced in Europe in the 1990s. Since the 1990s, many European companies have patented their own voided slab systems. As a result, most uses of plastic voided slabs have occurred in Europe. Two plastic voided slab brands, BubbleDeck and Cobiax, have also been utilized in the United States. U-Boot Beton, or U-Boot, is a voided slab system from the Italian company Daliform. U-Boot Beton does not use spherical void formers like previous systems but uses truncated-pyramid shaped void formers instead. These void formers create many "I" shaped beams making up the slab. In terms of construction the U-boot system is similar to the Cobiax system because it is meant to be cast entirely on the site using formwork. After forms are erected, the steel and void formers are placed before the concrete is poured in two lifts. The shape of the U-boot void formers allows them to be efficiently stacked during transportation to the site of construction, saving space and potentially leading to reduced shipping costs compared to spherical former systems, this is an additional design benefits of voided slab systems over all the design systems that use spherical void formers.

2. OBJECTIVES

1.To compare self-weight of flat plate slab and self-weight of voided slab lightened with U-Boot Beton.

2.To analyse both the slab systems under same conditions in ETABS to find out the deformation due to self-weight of both the slabs.

3. DESIGN CALCULATIONS FOR SELF-WEIGHT

Data Assumed:

Grade of Concrete = M20

Column Size = 500 x 500 mm

Total area of slab = 21 m x 21 m

Size of each panel = 7 m x 7m

Length of middle strip = 3 m

Density of Concrete = 2500 kg/m^3

Thickness:

For flat slab having panel of size 7 x 7 = 7000/ (0.9 x 32)

= 243.05

≈ 250 mm

∴ d = 250 mm & D = 280 mm

3.1 FOR FLAT PLATE SLAB

Self-Weight of Slab = Density x Thickness
= 25 x 0.28
= 7 KN/m^2

3.1 FOR VOIDED SLAB WITH U-BOOT BETON

Self-Weight of Slab = Density x Equivalent thickness
= 25 x 0.258
= 6.45 KN/m^2

Here the equivalent thickness for 1m^2 area was found by subtracting the volume of voids from the volume of concrete in total area of slab. Volume of voids can be calculated by finding out number of U-Boot Betons required in each panel an in total area of slab by positioning U-Boot Betons and then multiplying number of U-Boot Beton with Dimensions of U-Boot Beton used.

After comparison we can observe that the self-weight of slab is reduced due to introduction of U-Boot Beton in voided slab.

4. ANALYSIS OF DEFORMATION DUE TO SELF-WEIGHT OF SLAB USING ETABS 2016

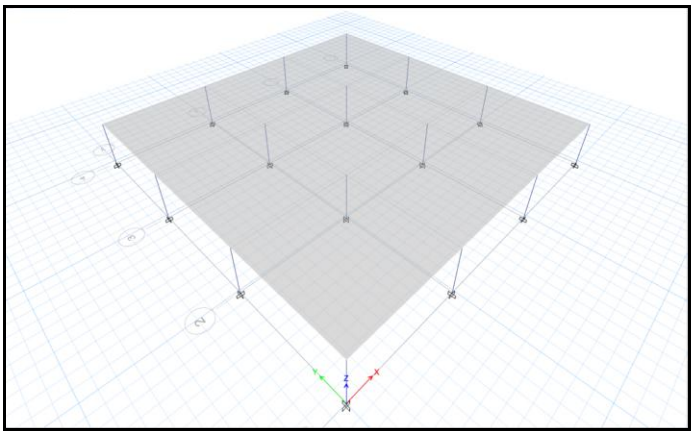

Fig -1: Flat Slab Model of 21 m x 21 m

The flat slab of size 21 m x 21 m having panel size of 7m x 7m is modelled by using ETABS 2016. It is divided into two strips which are column strips and middle strips. These strips are used for the design purpose.

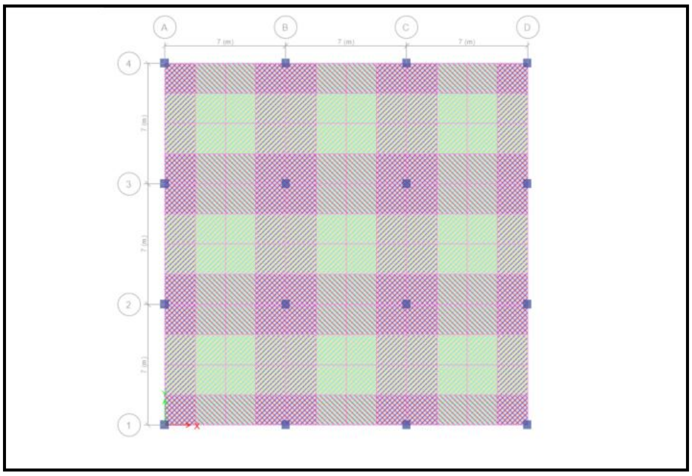

Fig -2: Graphical Representation of Strip Width

The above figure shows graphical representation of strip width which is defined by the software. This model is analyzed by using the software for both types of slabs. The results obtained are follows:

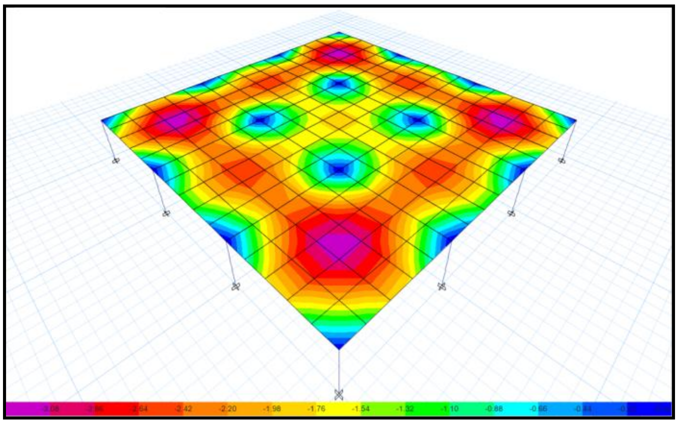

Fig -3: Displacement Contours of Flat Plate Slab

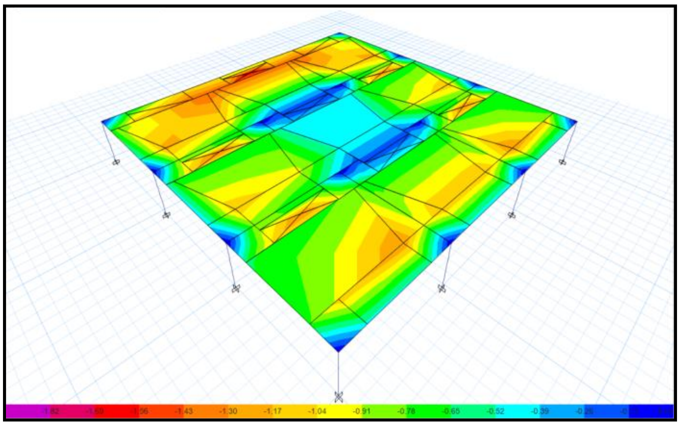

Fig -4: Displacement Contours of Voided Slab with U-Boot Beton

Here we can observe that the deformation due to self-weight of concrete in voided slabs with U-Boot Beton is less than Flat Plate Slab, the unnecessary concrete in middle strip of slab is replaced by voids created by the U-Boot Beton and thus reduced floor weight causes less deformation due to dead load in case of voided slabs with U-Boot Beton.

5. CONCLUSIONS

1. By removing the unnecessary concrete and reducing self-weight of slab, the longer spans can be achieved in voided slab system.

2. The ability of voided slabs to achieve longer spans leads to more beneficial open space and allows us for more design flexibility as fewer columns are required.

3. Lighter Floor Slabs means smaller columns and less reinforcing steel, Smaller columns can also lead to large reduction in overall amount of concrete and steel used in building, consequently allowing for larger savings in structural costs of the building.

4. Reducing weight of slabs can lead to a large reduction in overall seismic force, as weight is a leading factor in determining the seismic force.

5. U-Boot Beton is made up of recycled polypropylene and also its ability to save material allows building to have smaller impact on the environment, all these aspects lead to a high degree of sustainability and an environment friendly design.

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