UDC 69.07

RATIONAL DESIGN OF AN ENERGY-EFFICIENT FOUNDATION SLAB WITH VOID FILLERS

Author – Valerii Dunda[1], Postgraduate Student
Scientific supervisor – Artem Sopilniak[2], PhD, Assoc. Prof.
Language consultant – Kateryna Sokolova[3], PhD, Assoc. Prof.
[1]karridared@gmail.com,[2]sopilniak.artem@pdaba.edu.ua,
[3]sokolova.kateryna@pdaba.edu.ua

Prydniprovska State Academy of Civil Engineering and Architecture

The rational design of energy-efficient foundation slabs with void fillers is an important aspect of sustainable building design. The use of void fillers can reduce the amount of concrete required, which results in lower embodied energy and a reduced carbon footprint.Foundation slabs are an integral part of building construction and have a significant impact on the energy performance of a building. The rational design of energy-efficient foundation slabs with void fillers is essential for reducing energy consumption and greenhouse gas emissions. Energy-efficient foundation slabs with void fillers have become increasingly popular in sustainable building design.

The same hollow slab principle of creating voids within the concrete slab to lighten the building structure was developed in South Africa in 1997 and is called cobiax system. Although the cross-section of the cobiax is more complex compared to a solid plate, its bending calculation does not cause major problems. However, if we consider the shear construction, then the spherical void formers used in the cobiax system cause such fluctuations in the concrete that change not only the depth of the section, but also the distance of the voids in the horizontal direction. No code of practice has specific design recommendations for the cobiax system. Extensive research on cobiax shear resistance was carried out in Germany. In this system, decks form the bottom of the slab, and reinforcing steel must be placedas the bottom layer. The voids are locked in steel wire meshes which can be altered to fit the particular application. The top layer of steel reinforcement can be placed after the bundles are in place. Then concrete is poured in two lifts. The first concrete pour covers the bottom reinforcement and a portion of the voids and holds the voids in place as the concrete becomes stiff. The second lift is poured after the first lift is stiff but still fresh, finishing the slab. This method requires more formwork and on-site labour, but requires less transportation of materials.[1]

To decrease the transportation cost and CO_2 production,a new system of hollow formers was patented in 2001 by an Italian engineer Roberto Grande. U-

Boot Beton, or Uboot, is a voided slab system from the Italian company Daliform. U-boot does not use spherical void formers like previous systems but uses truncated-pyramid-shaped void formers instead. These void formers create many grid-shaped beams making up the slab (U-boot Beton, 2011). The U-boot system is similar to the Cobiax system in terms of construction because it should be cast entirely on-site using formwork. After the forms are erected, the steel and void formers are placed before the concrete is poured into two lifts. In addition to a lot of design benefits that all voided slab systems provide, the U-boot system has one benefit over systems that use spherical void formers - the shape of the Uboot void formers allows them to be stacked efficiently during transportation to the site, saving space and potentially leading to reduced shipping costs compared to spherical former systems [2].

The shear strength of the slab mainly depends on the effective mass of concrete, as the special geometry shaped by the ellipsoidal voids acts like the famous roman arch, hence enabling all concrete to be effective.In any flat slab, design shear resistance is usually critical near columns. The shear stress that occurs in the columns decreases rapidly outside their zone, this has been proven by experiments and calculations. Longitudinal shear load is within the limits of the capacity of voided slabs to restrain it. Near the columns, bubbles are left out so in these zones a bubbledeck slab is designed the same way as the solid slab [3].

Hollow core slab systems are an excellent alternative to solid concrete slabs for many applications. With plastic voids, weight, and cost savings as well as architectural flexibility can be achieved. Research has proven that hollow core slab technology is more efficient than a traditional biaxial concrete slab.

References

1. J. Ožbolt, J. Bošnjak, G. Periškić, and A. Sharma. 3D numerical analysis of reinforced concrete beams exposed to elevated temperature. *Eng. Struct.* Vol. 58, pp. 166–174, 2014.
2. D. Byrne. The analysis of shear and load transfer in void form flats lab systems, through in-situ measurements from buildings and numerical modelling. PhD Thesis, College of Engineering andInformatics, National University ofIreland Galway, 2014.
3. A. Zaidi, R. Masmoudi and M. Bouhicha. Numerical analysis of thermal stress-deformation in concrete surrounding FRP bars in hot region. *Constr. Build. Mater*. Vol. 38, pp. 204–213, 2013.