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The examination of the slabs formed with hollow plastic modules

Boşluklu plastik ünitelerle yapılan döşemelerin incelenmesi

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Abstract

There are various slab systems in reinforced concrete buildings, and these are slabs settling on beams or shear walls and operating in one or two ways, one- or two-way ribbed (cassette) slabs, t-beam slabs, mushroom slabs, and pre-tensioned or post-tensioned slabs. Apart from these, the hollow core slabs are of distinct importance. Among these slabs that settle on the ground, there are ones with hollow cores and also ones with closed-cells. Such slabs are able to protect human health against the negative effects of water, moisture, and ground gases. In this study, the difference between Cobiax slabs (bubble deck slabs) and hollow core slabs settling on the ground was revealed. The principle of the systems in question is pouring of concrete on open-cell or closed-cell voided plastic components in the slab. Both in the open-cell module slab systems or in closed-cell module systems concreted by placing plates on them, advantages such as prevention of moisture through ground ventilation, reduction of building's load, contribution to sound and heat insulation, and release to atmosphere of radon ground gases, which are hazardous on human health, are ensured.

Keywords: Structure, slabs settling on the ground, hollow core slabs, hollow core plastic modules, hollow plastic modules.

Özet

Betonarme binalarda çeşitli döşeme sistemleri vardır. Bunlar; bir doğrultuda ya da iki doğrultuda çalışan kirişlere veya perdelere oturan döşemeler olabildiği gibi tek veya çift yönde nervürlü (kaset) döşemeler, tablalı kirişli döşemeler, mantar döşemeler, ön gerilmeli ya da art gerilmeli döşemelerdir. Bunların dışında boşluklu döşemeler ayrı bir öneme sahiptir. Zemine oturan bu döşemelerin, altı boş olanları ve ayrıca kapalı hücreli olanları da vardır. Bu tür döşemeler, zeminden gelecek su-rutubet ile zemin gazlarının olumsuz etkilerinden insan sağlığını koruyabilmektedir. Bu çalışmada, zemine oturan kapalı boşluklu (Cobiax döşeme sistemi) plastik ünitelerle yapılan döşemelerin, altı açık döşemelerle olan farkı ortaya konulmuştur. Söz konusu sistemlerin esası, döşemede açık hücreli veya kapalı hücre boşluklu plastik elemanlar üzerine beton dökülmesidir. Gerek açık hücreli modül döşeme sistemlerinde ve gerekse üzerine plak konularak betonlanmış kapalı hücreli modüllü sistemlerde zeminin havalandırılarak rutubetin önlenmesi, yapının yükünün azaltılması, ses, ısı yalıtımına katkı sağlanması ve insan sağlığı için zararlı olduğu belirtilen Radon zemin gazlarının havaya atılması gibi yararlar sağlanmış olmaktadır.

Anahtar Kelimeler: Strüktür, zemine oturan döşemeler, boşluklu döşemeler, altı boş plastik modüller, içi boş plastik modüller.

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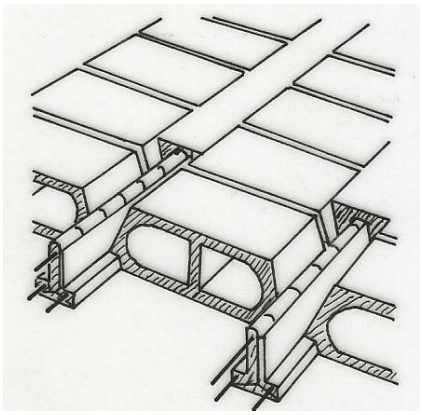
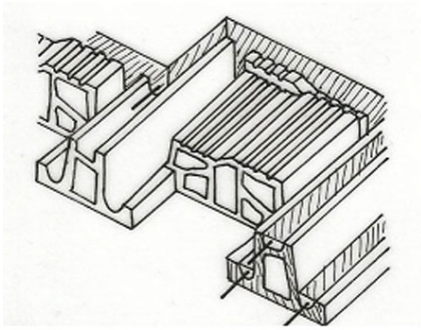
1. Introduction

Reinforced concrete slabs have varieties. These are slabs settling on beams or shear walls and operating in one or two ways, one or two-way ribbed (cassette) slabs, t-beam slabs, flat slabs, mushroom slabs, pre-tensioned or post-tensioned hollow core slabs, and truss slabs or space truss slabs. The referred slabs have positive and negative features compared to each other. Designers trying to build long-span buildings have used special hollow blocks on the roof (Figure 1) in order to prevent the formation of an overload for the building [1].



a. Rabit Reks slabs; prefabricated reinforced concrete beam slab; filler components have no effect.



b. Slab assembly consisting of prefabricated reinforced concrete voided beam and hollow brick components.

Figure 1. Samples of hollow core slab [2].

2. Material and method

This study was carried out through literature review using the open sources. The content of the study covers applied/applicable technology, and sensitivity to human health.

3. Findings

The most serious issue with slabs settling on the ground is the threat to human health that they pose due to water, moisture, and ground gases (radon gas). The principle is the ability to release the radon gas and the moisture into the atmosphere, which form in the gaps to be formed under the slab and are hazardous to human health (Figure 2). For this purpose, hollow core slabs can be built using single-use, open-celled plastic disposable formwork modules with ground ventilation. Another hollow core slab system is the closed-cell voided Cobiax slab system. The principle of the system is placing plates on Cobiax slab components and pouring concrete on them. Thus, the earthquake resistance of the building is increased by decreasing its load, and high flexibility regarding the change of use is ensured. The Cobiax plate system is a suitable alternative for making the slab less costly and improving its behavior. This system is very popular worldwide, and it is deemed ideal for faster and more economic post-tensioning practices [3]. The Cobiax system consists of hollow (closed-cell) slab components, plastic components that are circular and torus-molded hollow molders, and top and bottom support layers of a concrete slab with light metalworking.

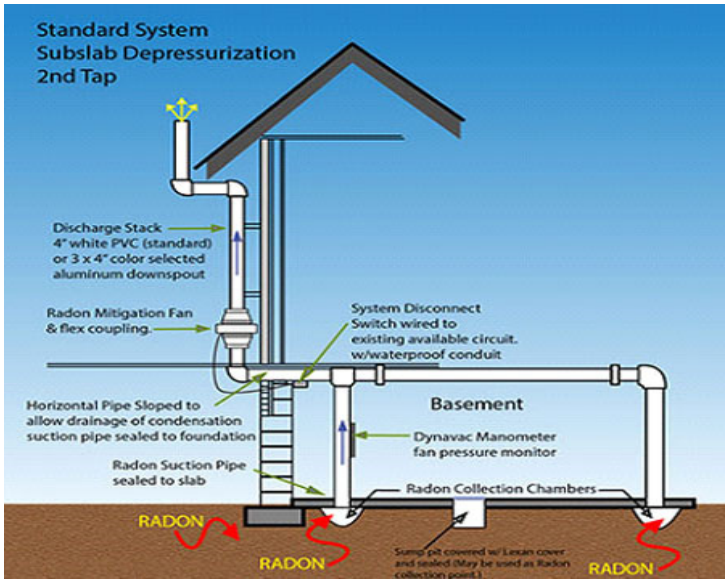


Figure 2. Release of Radon gas from the ground into atmosphere [4].

The most extensive research on plastic voided beamless slab systems was done by Albrecht et al. [5] and by Schnellenbach-Held and Aldejohann [6]. In the referred studies, the shear strength, the punch strength, and the rigidity of the plastic voided beamless slab system under the bending effect, its frequencies under dynamic loading, and its sound and heat conductivity were examined [7].

3.1. Application of reinforced concrete hollow core slabs settling on the ground and having ground ventilation

As there are various methods concerning elevated hollow core slabs with ground ventilation, two different types of applications are given in this section. The first one is the system in which the modules produced from recycled plastic are assembled side by side on the ground and which includes disposable formwork by which the air pockets under the modules are connected to the atmosphere through a vent pipe. Thus, the radon gas, which arises from the ground and is hazardous to human health (it is a colorless, odorless, radioactive gas that is present in the earth and can cause lung cancer), and moisture are released out to the atmosphere, and a healthier environment is formed. This system can also be used in gardens formed by landscaping earthfill on a reinforced concrete slab (Figure 3). Installations such as electrical installations, air-conditioning installations, and ventilation installations may pass through the elevated slabs. Moreover, it also contributes to soundproofing in multi-story buildings. The size of the modules is about 50x50 cm [8].

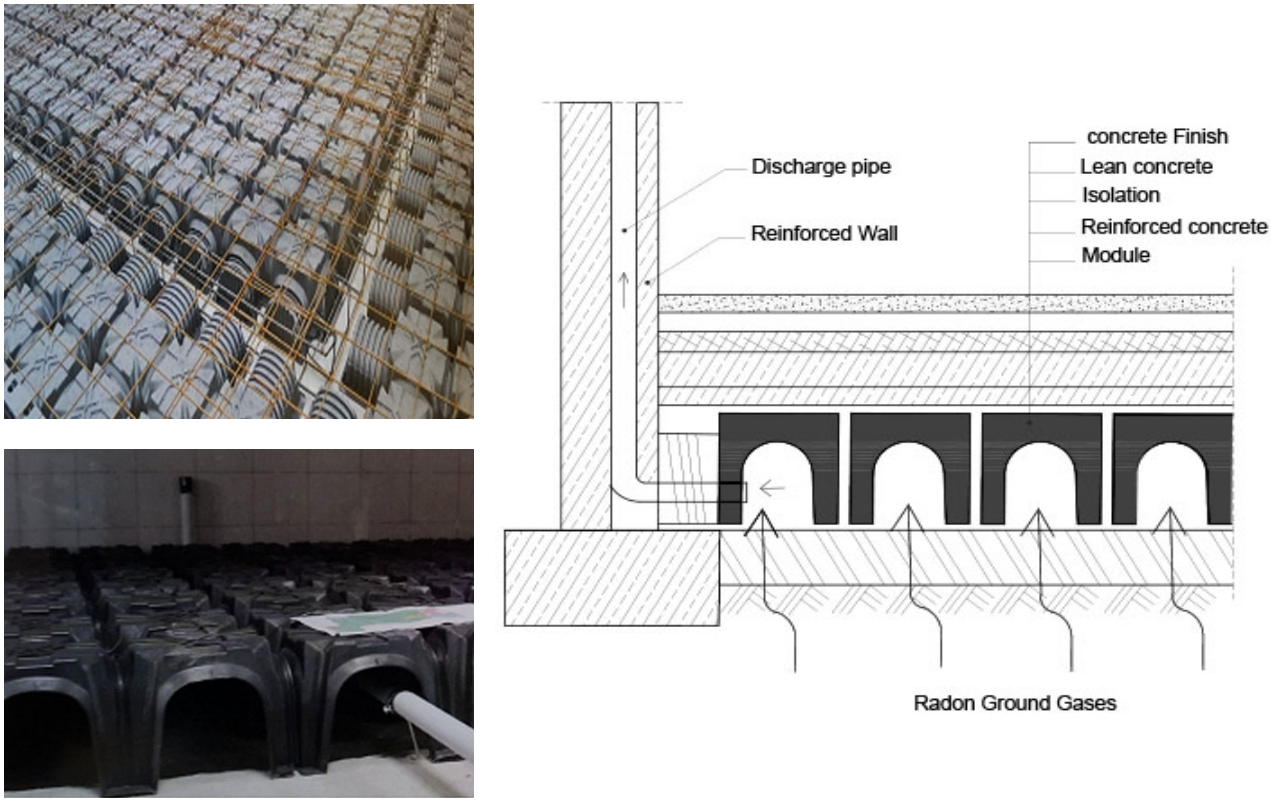


Figure 3. Elevated slab with air pockets between the ground and the concrete/reinforced concrete slab [8].

The second one is the system consisting of slabs with disposable formwork that are produced from Eolo constructed with recycled plastics, and that are formed with convex modules on four feet (Figure 4).

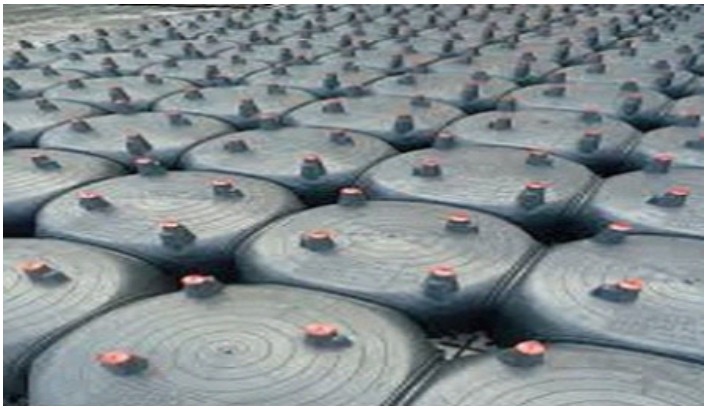


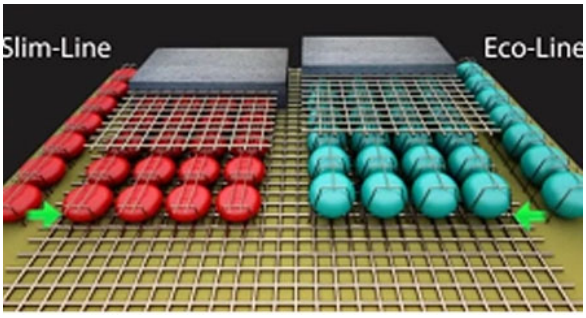
Figure 4. Slabs with disposable formwork which are produced from Eolo constructed with recycled plastics, and which are formed with convex modules on four feet [7].

In this system, porous floors are formed to eliminate odors through ventilation and bio-filtration. Such slabs can be used in composting, waste leveling, and ventilation of food product storage from the slab by the nozzles punched axially, vertically, and asymmetrically. It is based on the principle of releasing air under the slab through the slab holes. It is also statistically resistant to heavy vehicles [7]. The third one is the system of application of Cobiax slabs.

3.2. Application of Cobiax slabs

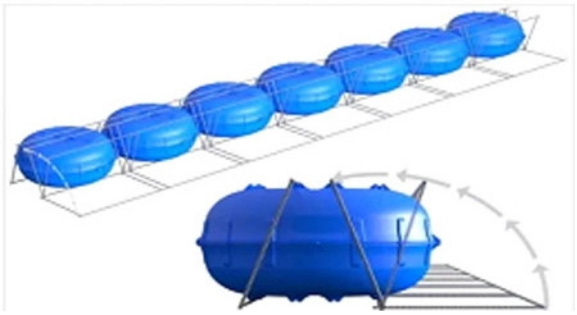
The most significant disadvantage of conventional slab systems is their excess weight when transversing the long-spans. The new generation slab systems developed to address this issue are 35% lighter than the traditional slabs. In the studies on the plastic voided beamless slab system, which is a new generation slab system, it was observed that this system provides excellent advantages [9].

Cobiax is a closed-cell module material produced from recycled plastics. Circular and torus-molded hollow plastic components are assembled on the slab with the help of light metals between the top and bottom support layers of a concrete plate. The referred materials have two types: slim-line with an elliptic (oval) shape and eco-line with a spherical shape (Figure 5a,5b). The molds with an oval shape make possible the laying of slabs with hollow double-sided plates of lower thickness. For ease of assembly of fittings between the Cobiax components, there is a new mold type named “Slim-Line-Click" (Figure 5c), and another model named CLS. The outer shape of the CLS molds is square, but when combined together, the pockets in the concrete structure take an elliptic shape (Figure 5d).



a) Cobiax Slim-Line Cage Modules

b) Cobiax Eco-Line Cage Modules

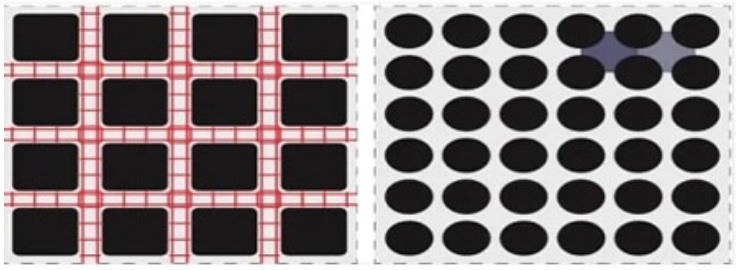


c) Slim-Line-Click type

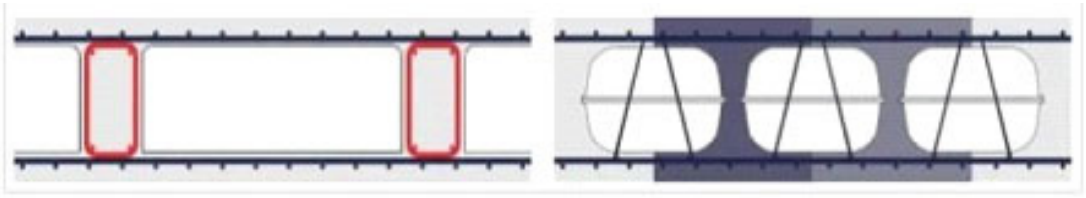
d) Cobiax slab modules and their positions

Figure 5. CLS type Cobiax slab modules [9].

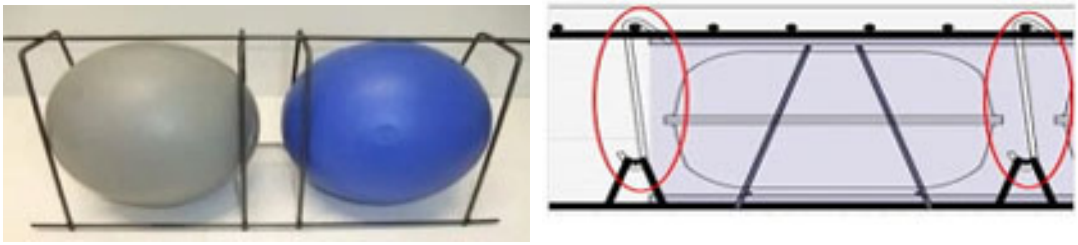
These Cobiax slab materials may be used on ceilings, walls, and columns. Moreover, due to economic reasons, they may be used at office buildings, hospitals, schools, car parks, trade centers, and multiple-star block residences [1]. Long-spans and complex column distributions are optimized, as is dead weight reduction, with the Cobiax slabs. Moreover, they provide an advantage in adding floors to a building designed with a specific number of floors. It is also possible to lay the Cobiax slab modules on mold on the terrace roof. In the picture, the black ones indicate the points where the molds are assembled. Mesh reinforcement intermediate components were used at the bottom and top parts of the Cobiax slab components. The system has steel “carriers” and “pins or seam hooks” that interconnect and hold together the Cobiax slab modules. X-shaped void spaces resistant to loads form between the two Cobiax slabs. Regarding the hollow core slab system in the construction industry, generally, holes form in the slab, and the optimization of the performance of concrete is neglected. To prevent the displacement and elevation of modules on the mold, the pouring of concrete is performed in two stages. However, the two-stage concreting is not required in applications with semi-prefabricated modules [10]. In Figures 6a, 6b, and 6c, the interior of the Cobiax slab arrangements is shown; in Figure 7, concreting on Cobiax modules is shown.



a) Cobiax slab arrangements



b) Cross-sections



c) Application of pin rebar

Figure 6. Cobiax slab cell modules arrangements and cross-section on slab [9].

Figure 7. Concreting on Cobiax modules [11].

4. Conclusions

In this study, the comparison of hollow core slabs made with plastic units and Cobiax slabs both settling on the ground was made. The cross-section of slab systems settling on the ground and having ground ventilation reveals free air circulation and the release of such air to the atmosphere via a vent pipe. Thus, concerning the slabs settling on the ground, the adverse effects of water, moisture, and radon gas, which arise from the ground and are hazardous to human health, can be prevented.

In Cobiax slab systems formed with closed-cell modules, free-moving air between the top and bottom plates is not a subject, and they provide advantages such as reduction of slab weight by about 35%, reduction of column size by about 40%, and fast and easy assembly on the mold. Through this application, the costs can be reduced [3]. Using recycled plastics with closed-cell modules, an energy saving of about 22% is obtained, and long-spans are formed in the designs. Thus, the adverse effects of conventional slab systems on the environment are reduced (reduction of CO2 consumption by about 20%).

5. Author contribution statement

Mina Deghan Haddad and Sabit Oymael have contributed equally in wiritng, preparation, and revision of this manuscript.

6. Ethics committee approval and conflict of interest statement

This study does not need ethics committee approval and authors declared that this article has no conflict of interest.

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