**International Academic Institute for Science and Technology**

International Academic Journal of Innovative Research
Vol. 2, No. 1, 2015, pp. 42-48.
ISSN 2454-390X

**International Academic Journal of Innovative Research**

www.iaiest.com

# An analysis on new Cobiax roof

Seyyed Ali Mousavi Gavgani[a], Babak Alinejad[b]

[a] *Student of civil engineering, university of maragheh, Iran.*

[b] *Civil Engineering Ph.D., University of maragheh, Iran.*

## Abstract

Studies in the field of lightweight construction and inefficient concrete removal were founded since 1985 at universities in Germany and voided biaxial slab roof technology companies in 1997 by collaboration of the experts and engineers from Switzerland and other Europe Union countries. Construction in many countries including Iran has involved in major issues hindering their efficiency. Due to the earthquake in Iran and the excessive extent of construction within the zone of active faults, this issue is of great importance. Further, reinforced concrete roofs due to the need to control of formations and cracks have been highly drawn into attention and sometimes restricted to minor openings. Now, if it can improve section of reinforced concrete roofs especially slabs in a way to provide the monitoring regulations and provide them with less weight than the same slabs, it can achieve new procedures in performing reinforced concrete slabs. voided biaxial slab roof technology refers to a method which causes reduction in the non-structural dead load and rise of lightweight construction by removal of inefficient concrete in the roof. Further, voided biaxial slab roof system has been a suitable thermal and acoustic insulation, followed by increase of speed at procedure, reduction of materials consumption and reduction of costs. Descriptive-analytical method has been used as the research method and the library and documentary method has been used as the data collection method. The present research intends to introduce voided biaxial slab roof system and examine structural, architectural and economic features in voided biaxial slab roof system to let the individuals in the construction industry enjoy it and fulfill their projects with the least time and cost.

**Keywords:** voided biaxial slab roof, lightweight construction, economic saving, voided slab, roof

## Introduction:

Nowadays, with advancement in science, the engineers have introduced new methods for construction industry. In these methods, numerous factors including use of less energy and materials, less time and cost, resistance against earthquake and wind, more accuracy and so forth are taken into consideration. In new methods, an attempt is made to use the prefabricated components in the factory so as reduce the executive error to a large extent besides increase of execution speed and decrease of construction time. Selection and use of the structures well suited to the industrialization approach in the construction should have been made through recognition of their structural, functional and behavioral capabilities and executive techniques of each of them (Mahmoudi, 2012, Hesami & Mohammad zadeh, 2012, construction research center, 2011). With regard to the areas of most of regions of country subjected to the high risk earthquake, importance of lightweight construction to reduce the forces and use of lightweight construction technologies are specified (Rezaei Namdar et al. 2010). Voided biaxial slab roof refers to one of the modern technologies with favorable features form architectural, structural and economic perspectives. The present research introduces the structure and advantages of voided biaxial slab roof.

## Voided biaxial slab roof

Cobiax technology is based on the structural roof with the feature "2-way ceiling slab" the same as the two-way reinforced concrete slab with this difference that the central concrete core in the areas without structural application are replaced with hollow spheres. These spheres are made of polyethylene or recycled polyethylene, such that these spheres are placed between the upper and lower steel mesh. Since there is not the shear force tolerance in the two-way concrete slabs, the problem in design of such roof has lied on removal of a part of the middle concrete and function of two-way slab(construction research center, 2009). In Cobiax technology, 2-axis load bearing feature remains by removal of non-structural dead load. Further, it can consider suitable bearing for this slab by formation of reinforced concrete membrane in the upper and lower of slab together with formation of internal piles in two sides under placement of the spheres along the middle space of concrete slab. In Cobiax system, the roof slab members include concrete, armature, plastic hollow spheres, and the reinforced shelves. Hollow spheres have been placed at the central core of the reinforced shelves, created a reinforced modular shelf. This reinforced Cage has been placed between two upper and lower armature layers, caused lightweight construction by removal of non-load bearing concrete in the slab. In this structure, the resistant system against the lateral forces of structure includes the combination of slab and column and the concrete shear wall with average ductility (Mansouri & Sayebani, 2014).

## Voided slab

Voided slab are divided into three groups regarding their construction status:

1. Simple voided slabs that their construction process is fully carried out in the workshop.
2. Prefabricated voided slabs that their construction process is carried out in the factory, then carried to the construction workshop for use.
3. Prefabricated voided slabs in which the lower facet has been implemented with the prefabricated concrete layer and this layer has been replaced with the horizontal section in the building.

Cobiax technology enables us to change the use of the considered building after a while, because having architecture maps with large openings and the concrete slab roof cause to pave the way for flexibility in change of probable uses. Compared to the Cobiax roofs, Solid slabs experience severe deflections and to

date performing large openings has been possible only via post tensioning techniques which this requires high costs of design and construction. Biaxial voided flat slab is a cheaper alternative to access the structure with less deflection in larger openings. Cobiax is made at two methods which have been separated from each other via the height, so that it is made at thickness of 20 to 30 cm and at thickness of 35-60 cm in another type (Motavali zadeh & Dashti, 2014).

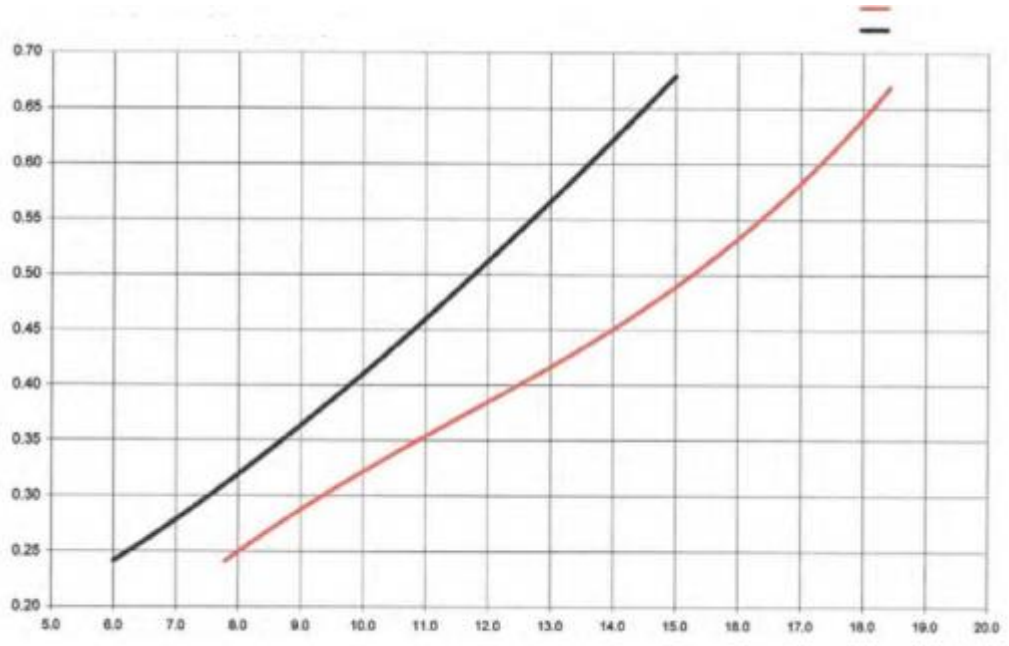



**Figure 1.** Comparison of Cobiax roof and solid sla
b

## Implementation methods for roof of the building via the Cobiax system

Concerning thickness of roof, sizes including 230, 280, 340, 390 and 450 mm have been mentioned as the most common ones. From executive perspective, Cobiax roof is divided into three major types:

Type A(Reinforced Modules): it is in form of a prefabricated solid network that concrete aggregate is made at the roof except for the lower layer at the work area. This implementation method is suitable for most of projects, required for fixed and mobile cranes for the movement of parts.

Type B(Filgree Slab): this refers to a type of implementation in which the lower part of the solid network has been prepared at the factory with the concrete layer 60 to 70 mm and placed at the building with underlying scaffolding. This implementation method is suitable for the places with limited access which the parts are replaced normally.

Type C(Finished Slab): in this implementation method, the roof is made at the factory and installed on the beams at the building, used for the balconies(Mansouri & Sayebani, 2014).

## Make Cobiax roof via industrial method

In this method, firstly the plastic balls are placed on steel meshes by distance; with regard to the employer's request, the necessary opening is provided and the concrete aggregate is made at the bottom of the mold to the one third of the balls and then carried to the curing area via Palletts and carried to install to the structure area after gaining 60% of the resistance. It is placed on the structure at the installation area and the candles are installed beneath it to keep the system. Then, the required connections are embedded and the thermal Armature is installed and ultimately the concrete aggregate is made after final control on them(Mansouri & Sayebani, 2014).

## Industrial construction stages

-Embed Shipping container profiles
-Install lower longitudinal reinforcement
-install preservatives
-Place hub
Implementation [8]
The usual method of hub roofs after transportation from the factory is as following:
-Install temporary storage piles at a distance of 1.8 to 4.2 meters
-place prefabricated parts by means of crane
-place connections between parts and columns in temporary
-concrete casting and vibration
-collection of temporary piles
Advantages of Cobiax roof(Mansouri & Sayebani, 2014, Hosseini & Ekhlasi, 2011, Falah & Mofidi, 2003, Moslehi & Pousti, 2012, Kheir al din et al. 2010, Saba & Gholi zadeh, 2012)
a-advantages of architecture
-Freedom in design and shape
-Ease of change in horizontal and vertical use
-The applicability of modular designs and diversity in architectural designs
-Flat lower surface of the roof with no bar and no need for false roof
-Increase span length in columns and panels
-Reduce the number of columns and increase space
- Remove the braces, inhibitors, additional girders and load bearing walls
-Shorten the height of building and create more classes in the specified height
-The possibility of executing the console to 7 meters
-Existence of the opening in the roof with possible sizes and sizes
-The ability to pass objects from roof thickness
**Structural advantages**
-twin shaft bearing
-Less weight to 35 percent reduction in dead weight of the roof
-Optimization of the stiffening elements (reduce horizontal loads)
-Reduce the overall height of the structure due to optimization of height of roof and the possibility to create more stories
-Optimization of vertical elements such as columns and shear walls
-Optimization of slab and foundation (reduced loads on foundations and slabs up to 30% lighter)

-Increase resistance to earthquakes due to weight loss
-Considering the same mass compared to solid concrete roof, the rigidity of hub roof is three times rigidity of solid concrete slab
-The ability to use pre-tensioning and post-tensioning at too long opening
-Ease of maintenance and repairs
-Compliance with common construction regulations
-High resistance to corrosion and termite attack
-Long-term sustainability

**Time**

-High speed
-Reducing construction time to about 20% to 40 %

**Cost**

-Reduce construction costs
-35 to 50 percent reduction in aggregate consumption
-Reduced foundation sizes
- less Steel and cement consumption
-Reducing the consumption of concrete and replacing 1 kg plastic with 100 kg concrete
-reduce transportation cost
-increase the building's lifespan

**Implementation**

-The need for skilled and specialized manpower
-Simply install and run method
-The possibility of dismantling and reuse
-Ease of transportation and storage
-Rapid coverage of roof surfaces in the joinery
-No need for reinforced network installation in the workshop
- Reduce the time to install and run
-Suitable quality control facilities for the factory pieces
-Reducing the need for experts due to the reduction of workload in the workshop

**Environmental**

-Lack of environmental pollution
-The ability to re-use of materials after complete destruction
-Saving energy consumption in production, transportation and execution
-A significant reduction in waste materials
-Acoustic and thermal insulation because of the voided space
-Reducing noise pollution during installation

**Safety**

-Fire Safety
- Safety against humidity due to low permeability
- Safety against Earthquake due to reduced structural weight

**Conclusion**

Cobiax roof as the prefabricated roofs can bring about numerous advancements in Iran; Cobiax roof due to the features of lightweight, more security, speed and resistance and less error than conventional roofs and ceilings piles can be a suitable alternative for these roofs. In the areas where soil resistivity is low, lightweight feature causes saving in addition to other important features, because there will be more reduction in dimensions of foundation in this state, and as a result there will be more resistivity by reduction in use of construction materials. With regard to ease of implementation and installation of Cobiax roofs, this method can encompass a major part of the construction industry. Lack of sufficient awareness from new construction materials and methods is one of the problems in developing countries. On the other hand, it is believed that such novelty causes increase of costs. In this regards, the experts are responsible for giving necessary notification to the practitioners at construction sector. It can pave the way to meet the dwelling demand in movement towards construction industrialization, affecting quality, construction cost and speed of construction. With regard to the disadvantages in traditional construction systems, use of modern construction systems such as Cobiax roofs will caused use of the advantages such as energy consumption efficiency, reduction of construction time, reduction of construction costs, reduction of weight of the building, suitable resistance in the earthquake, sound and thermal insulation. With regard to the advantages of this method and limited energy resources and placement of most cities in the earthquake-prone areas, use of this system can raise more sustainability in building and energy saving and construction costs.

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