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Waffle and U-Boot Concrete Slabs

An introduction to technology

Hollow Slabs (U-Boot)

One of the modern technologies used in the construction industry is permanent polypropylene molds between slabs and the elimination of excess concrete, thereby reducing slab weight and rebar and concrete consumption in the structure. The above technology creates a hollow slab with double-sided joists using permanent molds.

Waffle Slabs

Waffle ceilings are another type of ceiling that acts as a double-sided slab. It is different in terms of the weight of the ceiling being less than other conventional methods such as slab and beam, joists and blocks, composite and steel, and hollow decks. As a result, it has many technical and economic advantages.

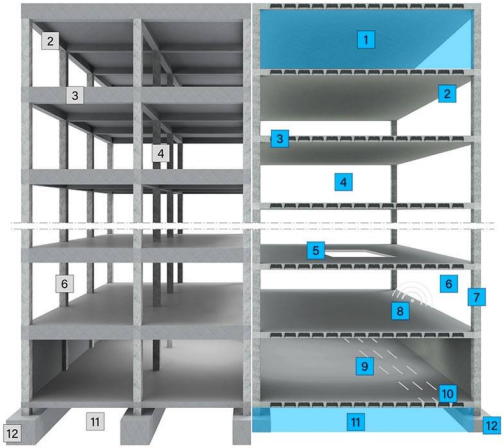
The Advantages of Hollow slab and Waffle slab systems

1. INCREASED NUMBER OF FLOORS
Possibility to gain floors at the same building height (towers) and building volume.

2. LACK OF RISING BEAMS
Flat soffit for greater flexibility when installing systems.

3. REDUCED SLAB THICKNESS
Thinner slabs but with equal loads and clearances, or bigger clearances with an equal thickness.

4. LARGE SPAN AND GREAT ARCHITECTURAL FREEDOM
Larger spaces. Less architectural restrictions. Freedom of future reconversion of the environments from an architectural-functional



5. FLEXIBILITY IN THE REALIZATION OF OPENINGS AFTER THE EXECUTION OF THE SLAB

6. REDUCTION IN THE NUMBER OF PILLARS
Facilitated use reallocation. Wider bays.

7. OPTIMISATION OF THE SECTION OF PILLARS

8. IMPROVED ACOUSTIC BEHAVIOUR
Less acoustic transmittance.

9. POSSIBILITY OF PASSING UTILITIES IN THE THICKNESS OF THE SLAB

10. POSSIBILITY TO USE IT WITH POST-TENSION

11. REDUCED FOUNDATIONS
Lower costs for foundation excavations. Less excavation.

12. REDUCTION IN THE OVERALL LOAD OF THE STRUCTURE WEIGHING ON THE PILLARS AND THE FOUNDATION.

ECO FRIENDLY

Technical comparison of U-Boot & Waffle slabs with other slab systems

Technical specification of ceilings	Waffle	u-boot	Composite & steel deck	Pre-stressed	Joist-block	Slab with beam	cobiax
Ability to cover long openings	●	●	●	●	●	●	up to 10m
Resistance to sound transmission	Moderate	High	Low	Moderate	Moderate	Moderate	High
No need to implement a false ceiling	●	●	●	●	●	●	●
Speed and ease of implementation	High	Moderate	High	Low	Moderate	Low	Low
Fire resistance	●	●	●	●	●	●	●
Rigidity	High	High	Low	High	Low	High	Moderate
No Vibration	●	●	●	●	●	●	●
Cost of implementation	Moderate	Moderate	Moderate	High	Moderate	High	High

The amount of material used in construction depends on factors such as seismic zone, number of floors, shear wall adequacy, plan layout, type of lateral load system, and so on. In general, the hollow and waffle slab system for building with openings greater than 6 meters can be economically justified. for this reason, we offer initial consulting for each project to choose the optimal system.

The following table is an estimation of materials in the structures. The followings are average values of the results obtained for projects implemented in moderate seismic conditions and the opening is between 9 and 11 meters.

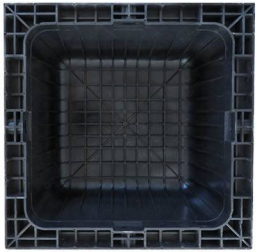
		u-boot		waffle	
Uses of building	Number of floors	Rebar weight	Concrete valume	Rebar weight	Concrete valume
Residential	3	45	0.40	40	0.36
	5	50	0.44	44	0.40
	8	56	0.48	48	0.44
Commercial	3	48	0.42	43	0.38
	5	52	0.46	46	0.42
	8	60	0.50	50	0.47

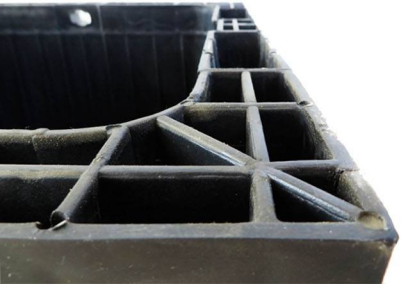
Non-permanent mold (Waffle)

The waffle slab is a system that is used to construct one or two-way orthogonal concrete joists. This technology is a suitable and optimal replacement for conventional roof systems and is used to cover long spans is structures.

In this type of roof, plastic molds are used. These molds can be reused after the completion of the concreting. Depending on whether the molds are longitudinal or squared, the roof has one or two-way bearing capacity.

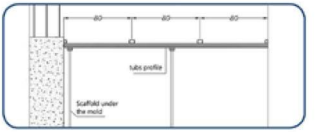
these molds are made of polypropylene and lightweight plastic and the Polished surface of which exposes the underlying concrete facade.



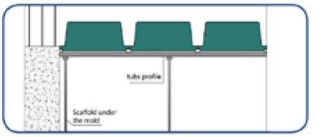


Steps to implement waffle slabs using non-permanent molds

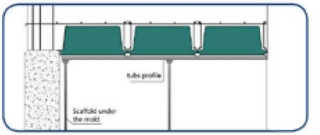
1
Foundation



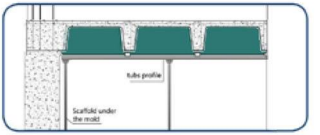
2
Molding



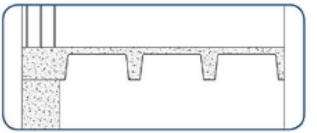
3
Joist and temperature Reinforcement



4
Concreteing



5
Opening molds



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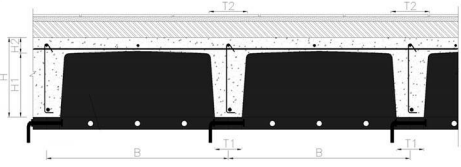
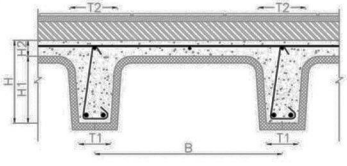
Two-way waffle roofs specifications

Two-way waffle	Mold height	Centerline distance	The width of the joist at the heel	The width of the joist at the top	Ceiling thickness	Ceiling concrete weight (kg/m^3)
	H1 (cm)	B (cm)	T1 (cm)	T2 (cm)	H2=7cm	H2=7cm
Waffle 60*60 H18	18	60	10	13	25	325
Waffle 60*60 H25	25	60	10	13	32	385
Waffle 60*60 H30	30	60	10	13	37	425
Waffle 80*80 H28	28	80	12	18	35	405
Waffle 86*86 H25	25	86	15	20	32	395
						Specific weight of concrete 2450 kg/m^3



One-way waffle roofs specifications

One-way waffle	Mold height	Centerline distance	The width of the joist at the heel	The width of the joist at the top	Ceiling thickness		Ceiling concrete weight (kg/m^3)	
	H1 (cm)	B (cm)	T1 (cm)	T2 (cm)	H2=5cm	H2=7cm	H2=5cm	H2=7cm
Waffle 60 H25	25	60	12	14	30	32	260	310
Waffle 60 H30	30	60	12	14	35	37	285	335
Waffle 70 H25	25	70	12	14	30	32	240	290
Waffle 70 H30	30	70	12	14	35	37	265	310
								Specific weight of concrete 2450 kg/m^3



The benefits of an ideal mold; **Waffle Locker**

– In this design, the molds are attached to each other by a lock, preventing the concrete leakage from slipping through the molds, creating a beautifully exposed ceiling.

– The lock makes it easy to implement and automatically aligns with the waffle molds.

– The lock makes the molds correlate with each other, ensuring the safety of workers during the implementation of the waffle roof.

– The lock between the molds is a wrench, and after concrete placing, is used to remove the molds under the roof.

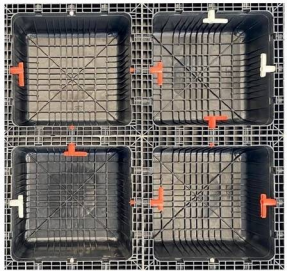
– The thickness of the edge of the mold is 5cm, which is 2-3cm in other waffle molds. The increased thickness of the mold is combined with a metal mold. This waffle mold can be constructed with metal sheets, Russian wood boards, plywood, and any other tools of contractors and does not impose more cost. This increase in thickness also multiplies the resistance to pulling out the mold with the crowbar.

– Holes embedded in the wall and edge of the mold make it easy to remove the mold under the roof without damaging the mold.

– Lock prevents mold from rising and falling in stormy weather.

– The low curvature dome on the upper surface of the molds strengthens and prevents mold from falling during concrete placing or passing through.

– At the edge of the mold surface, the bulge is embedded in a 1cm width and 3mm thickness, which creates a beautiful exposure below the ceiling.



U-Boot

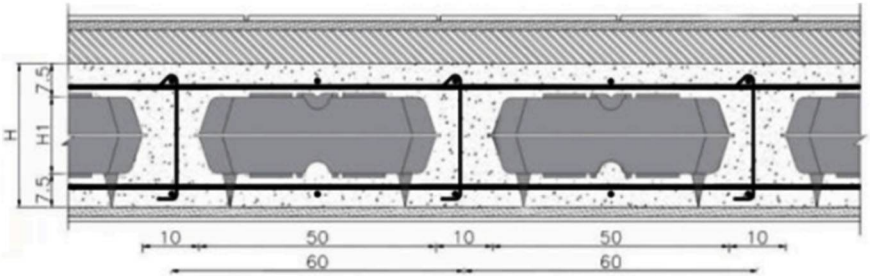
The U-Boot roof is a hollow two-way slab-type structural system located between the upper and bottom rebar networks. the bottom of the slab is perfectly flat on the U-Boot roof.

Thanks to the conic elevator foot, immerging the U-BOOT formworks in the concrete casting will create a gridwork of mutually perpendicular beams closed from the bottom and the top by a flat plate that is created with a single casting; this results in a considerable reduction in the use of concrete and steel.

* The length of U-Boot stand are variable between 6 and 10 cm

Hollow slab technical specification

U-Boot Block	Mold height	Ceiling thickness H(cm)	Used span	Ceiling concrete weight (kg/m^3)
	H1 (cm)	Upper and lower concret thickness = 7.5cm	Without middle beam (m)	Upper and lower concret thickness = 7.5cm
52*52*16	16	31	7-10	470
52*52*20	20	35	8-11	520
52*52*24	24	40	9-12	570
52*52*28	28	45	10-13	600
52*52*32	32	48	11-14	630
52*52*36	36	52	12-15	660
52*52*40	40	56	13-16	690
				Specific weight of concrete 2450 kg/m^3



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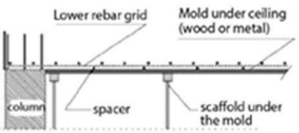
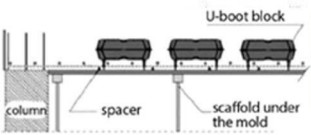
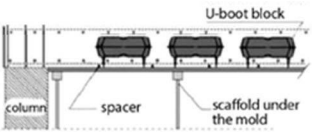
Steps to implement a U-Boot hollow Slab



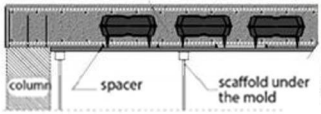
Molding and sub-block grid reinforcement



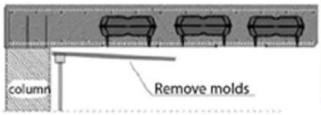
Sort blocks



Reinforcing grid on block



Concrete placing



Removing the mold

The advantages of our U-Boot over the conventional products

- Reduce concrete volume and slab weight compared to modified Cobiax u-boot slab.

- Increasing the thickness of the joist's web, and the shear and bending strength of the slabs.

- Block stand production in sizes 10, 9, 7.5, and 6 cm, which prevents the bottom grid rebar from adhering to the mold surface and honeycombing of the slab due to the weight of the top grid rebar and ease of movement of the executive team on the blocks grid rebar and ease of movement of the executive team on the blocks.

- Preparation of spacers for precise rebar placing and preventing block displacement.

- A cavity in the middle of the block greatly increases the strength of the block against the stresses such as impact, concrete pump, sunlight heat stress, and worker weight.

- Superplasticizer removal due to complete penetration of concrete from the middle cavity.

- Removing the problem of hair cracks under the ceiling due to concrete placed without plasticizer.

- Prevent honeycombing under the ceiling due to the middle cavity.

- Equipped with a quality control unit and Loading test device.

- A distance between blocks and effective width of concrete joists.

- Economic loading and unloading of blocks.

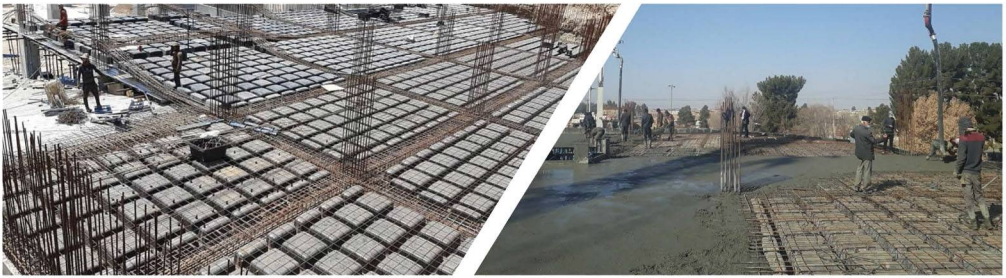
- High-quality products

Nakhl - Residential
Terhran - Iran

Built-up Area: 200.000 m^2
Two-way waffle 60*60*18

Ghasr Aseman twin tower - Commercial
Mazandaran - Iran

Built-up Area: 35.000 m^2
Two-way patterned waffle 60*60*25



Fajr - Entertainment Complex
Kashan - Iran

Built-up Area: 13.000 m^2
Two-way locked waffle 80*80*28

Khalij e Fars - Commercial
Ganaveh - Iran

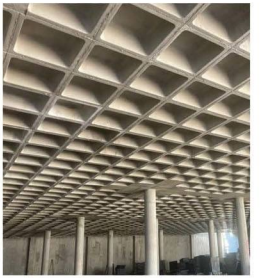
Built-up Area: 13.000 m^2
Two-way locked waffle 80*80*28

Persian Gulf - Residential
Tehran - Iran

Built-up Area: 22.000 m^2
Two-way locked waffle 80*80*28

Farmanieh - Residential
Yazd - Iran

Built-up Area: 17.000 m^2
Two-way locked waffle 80*80*28

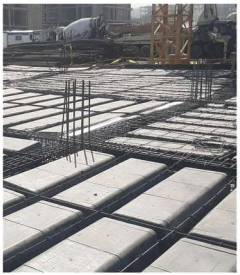


Parvin Parking - Service
Esfahan - Iran

Built-up Area: 14.000 m^2
Two-way locked waffle 80*80*28

Rouzhano - Residential
Yazd - Iran

Built-up Area: 14.000 m^2
Two-way locked waffle 80*80*28



Mozhan - Residential
Esfahan - Iran

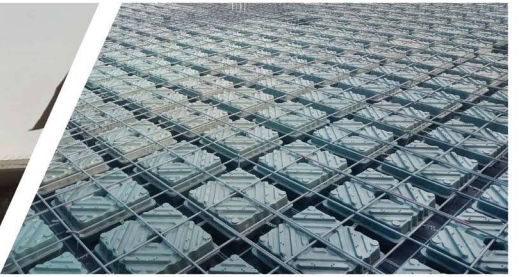
Built-up Area: 14.000 m^2
One-way waffle 70*25

Wazir Bagh
Tabriz - Iran

Built-up Area: 44.000 m^2
One-way waffle 70*25

Protein Market - Commercial
Shiraz - Iran

Built-up Area: 65.000 m^2
U-Boot 52*52*16



ALikhani - Commercial & Administrative
Esfahan - Iran

Built-up Area: 18.500 m^2
U-Boot 52*52*24

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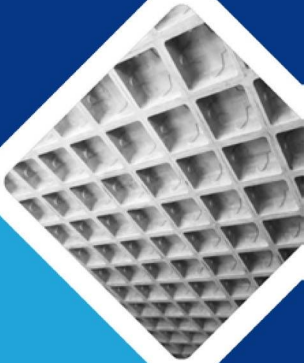
Design and Implementation of more than 2 million square meters of MODERN ROOFS

#	Location	Application	Built-up Area	Tallest Span	System
1	Sari	Commercial Administrative Service / Sari Mall	170000	15	Waffle
2	Shiraz	Commercial / Protein Market	65000	12	Uboot
3	Baghdad - Iraq	Commercial / Al-Hayat Mall	60000	11	Waffle
4	Sulaymaniyeh - Iraq	Commercial	52000	13	Uboot
5	Qum	Commercial Administrative Service / Mahour Project	50000	12	Uboot
6	Babolsar	Ghasr Seman Twin Towers	35000	10	Waffle
7	Kathimayn - Iraq	Commercial	30000	11	Waffle
8	Najaf - Iraq	University	30000	10	Waffle
9	Kahrizak	Residential	30000	10	Waffle
10	Babolsar	Residential Commercial / Mahestan Imperial	23000	11	Waffle
11	Esfahan	Commercial Administrative / Khorram	22000	9	Waffle
12	Kurdistan - Iraq	Commercial	20000	10	Uboot
13	Tehran	Commercial and Parking	18000	9	Waffle
14	Tehran	Residential	16000	13	Uboot
15	Chabahar	Service / Ocean Gate Hotel	15000	13.6	Waffle
16	Yazd	Residential	15000	13.5	Waffle
17	Qazvin	Industrial / Factory warehouse	12000	9	Waffle
18	Mashhad	Service / Javad Alam Hotel	12000	10	Waffle
19	Tehran	Residential	11000	11	Waffle
20	Dehloran	Service / Passenger terminal	10000	12	Waffle
21	Bandar Abbas	Commercial	10000	13	Uboot
22	Tehran	Commercial Residential	8500	10	Uboot
23	Shiraz	Residential	6000	12	Uboot
24	Sari	Commercial / City Center	6400	14	Uboot
25	Save	Residential	5500	11	Waffle
26	Bandar Abbas	Residential	5500	15	Uboot
27	Baghdad - Iraq	Commercial	5500	12	Uboot
28	Chabahar - FreeZone	Residential	4000	12	Waffle
29	Tehran	Residential	4000	12	Uboot
30	Abadan	Commercial / Traditional Fidos Market	3500	9	Waffle
31	Bane	Commercial	3500	11	Uboot
32	Jajrood	Industrial	3100	10	Waffle
33	Langerud	Administrative / Amphitheater	3000	14	Uboot
34	Khomein	Recreational / Welfare (food court) Basil Collection	2500	11.5	Waffle



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