

# THEORITICAL STUDY OF U-BOOT TECHNOLOGY IN CONSTRUCTION

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## ABSTRACT

U-boot beton is a boxlike formwork structure made of recycled polypropylene, which is a biproduct of industries, designed to create lightened void slabs and raft foundations in reinforced concrete. The use of U-boot formworks helps us to reduce the amount of concrete and steel used in laying the slabs. U-boot are inserted into the concrete casting. Thus, a grid of orthogonal beams, superiorly and inferiorly closed by plane slabs of different heights, is obtained without executing two distinct concrete castings, all that implies a remarkable saving of concrete and reinforcement. U-boot beton helps in laying mushroom pillars where the beams are completely absent. U-Boot Beton is used to create slabs with large span or that are able to support large loads without beams. It is very easy and quickest process to lay U-boot betons as they are lightweight and simple to understand the process. Thanks to its chemical properties, it will not react with any material we use in preparing of concrete.

**KEYWORDS:** Mushroom pillars, orthogonal beams, raft foundations, recycled polypropylene, saving of concrete.

## 1.INTRODUCTION

U-Boot Beton is a recycled polypropylene formwork that can be used to create two-way voided slabs and rafts. It is implemented in Italy for the first time. U-boot beton is the simple solution for most problems in laying slabs and laying foundations where the capacity of the layer soil is very low. It can be used as a replacement for raft foundation where slabs were used to distribute the loads to the deeper soils. But we use U-boot betons for transferring loads to deeper soils in U-boot technology. Disposable formwork for two-way voided slabs in

reinforced concrete cast on site. U-Boot Beton is used to create slabs with large span or that are able to support large loads without beams.

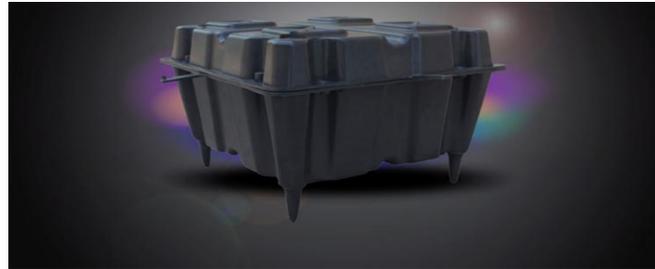


Figure:1:U-boot beton box

U boot beton is consist of two different types of betons. They are single u-boot beton and double u-boot beton. The single u boot beton is generally used while laying single reinforced slabs where as we use double u-boot beton for laying of double reinforced slabs. Single U boot beton is generally an open type polypropylene box which can be closed by using a closing plate to resist the entry of concrete into the beton. Double U boot beton consists of two boxes which are closed against each other. The width between shuttering and u-boot is called as spacer consist of sharp edges which can be fixed into the lower reinforcement. Spacer helps u-boot not to move aside when concrete is placed.

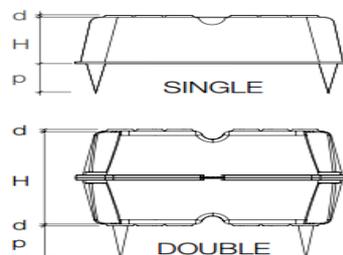


Figure:2:Types of betons

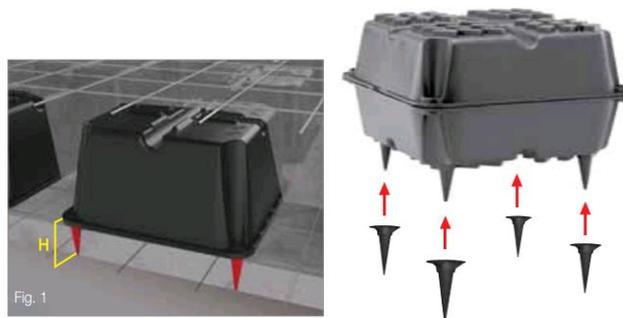


Figure:3: Single and double U-boots with spacers

## II.PARTS OF U-BOOT

U-boot beton is a combination of different parts. Spacer joint is used to join two or more u boot betons while fixing on the shuttering so that there cannot be any change in the distance between gaps of U-boot betons. Closing plate is used to close the u-boot beton box which can resist the flow of concrete into box. The closing plate and its quality plays a major role as it cause problems if concrete tends to move into beton from damaged plate after concrete is placed, the connection bridge is necessary in order join two betons longitudinally wherever the length of the beton needed to be increased.

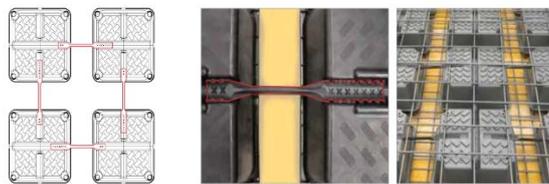


Figure:4: Spacer joint connecting two betons



Figure:5:Connection bridge

## III.SIZE OF U-BOOT

The sizes of U-boot beton varies based on the mode of work and based on the load acting on the beton. The general working cross sectional dimensions of the U-boot beton is 53\*53cms. The length of the beton can also be increased by connecting them with a connection bridge based on the necessity of the work. The height of the U-boot can vary from 10cms to 56cms based on the mode of slab whether it is singly reinforced or double reinforced. The spacer height which is needed to be placed into the lower reinforcement as explained earlier, is of the uniform measurement of 8cms. The weight of the beton also changes with change in dimensions of the beton.

		10	13	16	18	20	20	22	23	24	25
Working dimensions	cm	52 x 52									
Height H	cm	10	13	16	18	20	20	22	23	24	25
Foot height p	cm	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10	0-5-6-7-8-9-10
Spacer height d	cm	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8
Weight per piece	Kg.	1,150	1,240	1,430	1,610	1,660		1,720		1,730	1,780
Piece volume	m <sup>3</sup>	0,0213	0,0279	0,031	0,036	0,039	0,0426	0,043	0,049	0,047	0,048
Pallet dimensions	cm	110x110x240	110x110x250								
Pallet pieces	pcs./PAL	720	600	440	460	460		460		440	440
Pallet weight	Kg./PAL	840	920	850	750	790		800		860	795
Composed of U-Boot UP	cm						10		13		
Composed of U-Boot DOWN	cm						10		10		

\*Volume related to one possible combination "UP + DOWN".

Figure:6: Different dimensions of U-boot betons

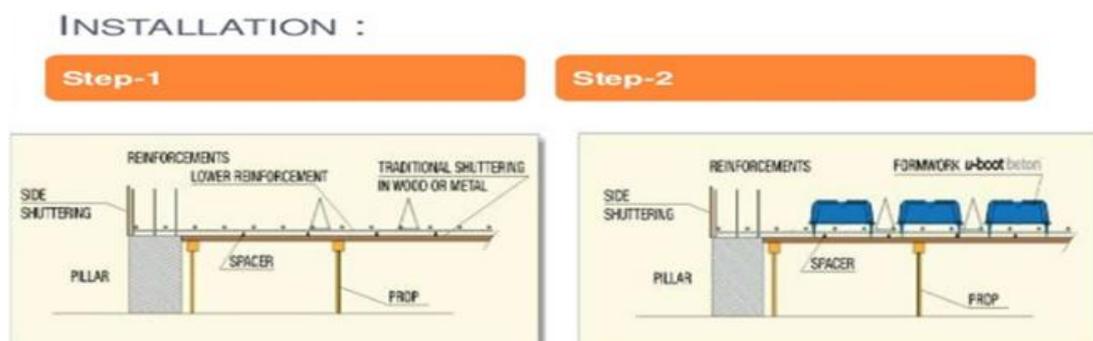
#### IV.POLYPROPYLENE (C<sub>3</sub>H<sub>6</sub>)<sub>N</sub>

Polypropylene is a recycled material which is obtained by a recycled plastic industrial waste. It is a by-product of plastic industry. It is discovered in the middle 1950's by italian scientists. Since then, it is being used as a versatile material throughout the world. It contains three carbon molecules and six hydrogen molecules. Due to its chemically inert nature it does not react with any of the materials like water, cement, admixtures etc when it is placed in concrete. It has high melting point and hence, it can be used in construction industry. As it is a flexible material, it is resistant to cracks and stress. Thanks to its durable nature, it can withstand daily wear and tear. The polypropylene has very low density and it is the reason for the light weight of the slab constructed using u-boot beton.

#### V.POLYSTYRENE (C<sub>4</sub>H<sub>8</sub>)<sub>N</sub>

Polystyrene is also the thermos plastic polymer which contain four carbon molecules and eight hydrogen molecules. It can also be used as a construction material, but it is not used because it emits very dangerous toxic gases into the atmosphere at room temperature. The melting point of the polystyrene is also very low. Hence it cannot be used due to these restrictions.

#### VI.INSTALLATION



The installation of the U-boot slabs is a very easiest process, but it is needed to be handled with care while placing concrete. If U-boot betons move to aside when placing concrete, then there may arise cracks after the setting of concrete. The process of installation consists of a step by step process. The first step in this process involves fixing of shuttering properly which is the basic process in any construction. Then lower reinforcement, which acts as compression reinforcement, needed to be placed on the shuttering and then the U-boot betons are placed top of the lower reinforcement such that spacers are fixed into the lower reinforcement, such that it cannot be moved to aside.



After placing, these betons are fixed to each other by using a spacer joint. If there is any need in increase of length of the beton, then two betons are connected or fixed using connection bridge. Than upper reinforcement needed to be placed on the U-boot betons, which acts as a tension reinforcement for the slab.



After placing of upper tensile reinforcement, we need to place concrete on the shuttering. Initially, concrete is placed on the shuttering such that, only the spacers of the U-boots are filled with the concrete. Total slab area needed to be placed in this way and when the concrete placed starts to set, we need to restart the placing of concrete totally on U-boot betons, such that they are completely dipped inside the concrete. This is because, if we place concrete completely at once, then there is a danger of movement of betons to aside. If we follow this step by step process, then the concrete which is placed initially resist spacers from movement. Than after the final setting time of the concrete, the shuttering can be removed.

### VILDISTRIBUTION OF LOADS

In any civil construction or civil structure, the distribution of loads plays major role for withstanding of the structure. It is necessary to design the structure, such that the loads are properly distributed throughout the structure. In the slabs where we use U-boot technology, the loads are completely transferred by betons and

columns. There will not be any beams in the slabs constructed by U-boot betons. This helps us to get the spans of larger cross-sectional area.

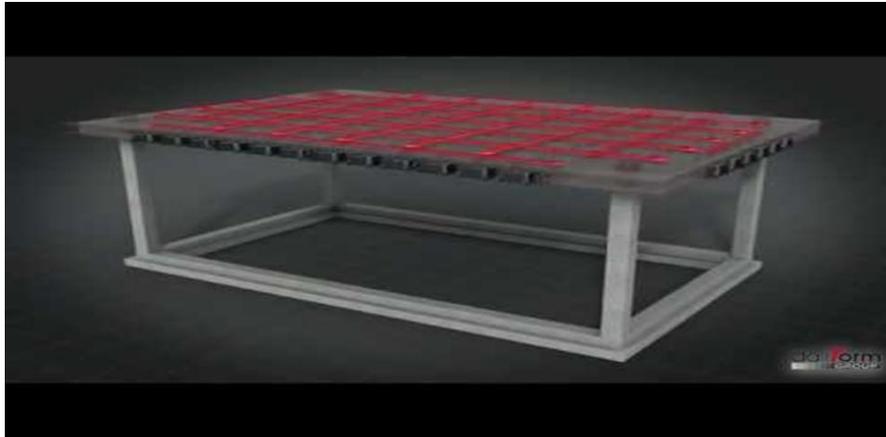


Figure:7:Distribution of loads of slab

In foundations where we use this technology, complete area is placed with lower reinforcement, then U-boot betons and then upper reinforcement, so that the load transferred by the structure are distributed uniformly throughout the land.

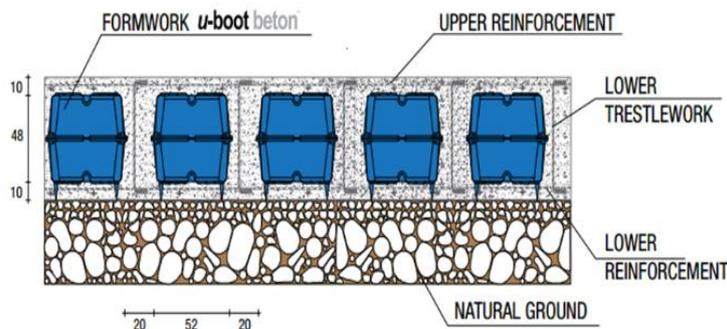


Figure:8:Distribution of load on the ground

## VIII.APPLICATIONS

This technology is mainly applied in the construction where we need larger space areas with more centre spacing between each columns like parking areas, auditoriums, malls etc:- as we have freedom of placing columns at our will, without beams.



Figure:9:Car parking slot using U-Boot technology

This technology is also used in laying mushroom pillars where we don't have beams. The mushroom pillars mainly used for architectural look. The absence of beams in this technology, helps us to lay mushroom pillars at will.



Figure:10:Mushroom pillar

The self-weight of the structure can be reduced considerably as there is a loss of heavy amount of concrete and steel. This helps owners to build the project even where the soil bearing capacity (SBC) of the soil is low.

Column spacing c/c	Thickness of the proposed slab with imposed load of 500 kg/m <sup>2</sup>	H Upper	H U-Boot	H Lower	Void slab moment of inertia	Solid Slab moment of inertia	Equivalent percentage loss of height	Void slab volume	Solid slab volume	Weight savings
m	mm	mm	mm	mm	x10 <sup>4</sup> mm <sup>4</sup> /m	x10 <sup>6</sup> mm <sup>4</sup> /m	%	m <sup>3</sup> /m <sup>2</sup>	m <sup>3</sup> /m <sup>2</sup>	%
7x7	260	50	160	50	122,364	146,467	5.85	0.1930	0.26	26
8x8	300	70	160	70	200,897	225,000	3.73	0.2330	0.30	22
9x9	340	50	240	50	246,063	327,533	9.12	0.2385	0.34	30
10x10	360	100	160	10	364,697	388,800	2.14	0.2930	0.36	19
11x11	380	70	240	70	375,796	457,267	6.36	0.2785	0.38	27
12x12	420	50	320	50	429,513	617,400	11.43	0.2861	0.42	32
13x13	440	100	240	100	628,396	709,867	4.02	0.3385	0.44	23
14x14	460	70	320	70	623,247	811,133	8.44	0.3261	0.46	29
15x15	500	50	400	50	673,542	1,041,667	13.56	0.3315	0.50	34
16x16	520	100	320	100	983,847	1,171,733	5.70	0.3861	0.52	26
17x17	540	70	400	70	944,075	1,312,200	10.43	0.3715	0.54	31
18x18	580	50	480	50	989,345	1,625,933	15.30	0.3770	0.58	35
19x19	600	100	400	100	1,431,875	1,800,000	7.38	0.4315	0.60	28
20x20	620	70	480	70	1,349,478	1,986,067	12.13	0.4170	0.62	33
21x21	680	100	480	100	1,983,678	2,620,267	8.90	0.4770	0.68	30

Table:1:Comparison with normal concrete structure

The concrete and steel material used in construction of slab can be greatly reduced as the betons which are inserted in the concrete are placed empty. Due to the high stiffness of the U-boot material, the structure gives the same amount of capacity.

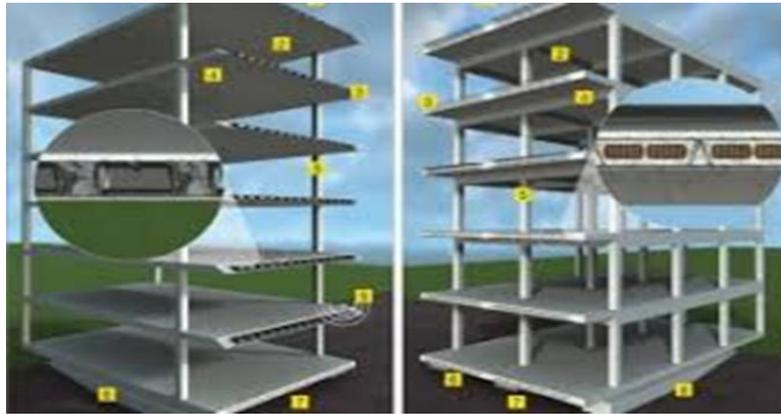


Figure:12:Comparing number of floors

The thickness of the slab is also reduced considerably, which helps in construction of tower buildings where we can get an extra floor with the same height of the tower.

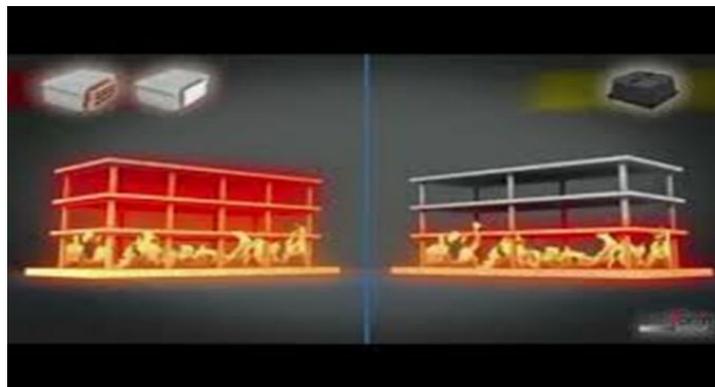


Figure:13:Fire resistant

Thanks to the chemical property of the polypropylene, as the melting point of the polypropylene is very high up to 230<sup>0</sup>c, the structure can be thermally and fire resistant. It can't catch the fire so easily.

## IX.RESULTS

As we study about the u-boot technology, we come to know that using polypropylene gives many advantages than using polystyrene. Polystyrene cannot be used as it evolves large amount of toxic gases at room temperature. When the slab with polystyrene catches to fire, it releases gases and if we don't arrange any vents, there might be a chance of blasting of slab.

## X. CERTIFICATIONS

- Environmental Compatibility Certification (CCA).
- Member of the Green Building Council Italia
- \*Certified for Fire Resistance under REI 180 for U-Boot Beton® issued by the CSI institute in Bollate (MI).
- certified for load test on a sample with U-Boot Beton® issued by the University of Darmstadt.
- Acoustic test according to the standard UNI EN ISO 140-6.
- Loading and breaking test certified by the University of Padua.

## XI. CONCLUSION

The U-boot technology is a very advanced, economical, architectural and fastest method of construction of a slab. The usage of U-boot technology is very rare due to lack of awareness in our country. As we all have responsibility of saving natural and renewable resources for our future generations, this technology should be utilized more.

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