HOLLOW-CORE SLAB PRODUCTION PLANT

HOLLOW-CORE SLAB PRODUCTION BY EXTRUDER

Key words: Hollow-core production plant, Prestressed hollow-core slabs, Extruder, Precast flooring, Flooring
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1. Introduction

1.1. Advantages

Prestressed hollow-core slabs are among the most advanced products in the precast concrete industry, especially with regard to their high quality and low consumption of materials.

Hollow core slabs are the most widely used type of precast flooring. This is due to the highly efficient design and production methods, choice of unit depth and capacity, smooth underside and structural efficiency.

Hollow core slabs have longitudinal cores, which main purpose is to reduce the weight of the floor. They are mainly used in buildings with large spans such as office buildings, hospitals, schools, shopping centers, industrial buildings, etc. Another common application is apartment buildings and houses because of the favorable cost rate and the fast erection.

Generally, prestressed hollow-core units have no reinforcement other than the longitudinal prestressing strands at the bottom. Hollow-core slabs do not have or need any transversal reinforcement. Upper strands are used in cantilever slab solutions or against loads caused by handling.

Prestressed hollow-core slabs are normally 1200 mm wide and up to 20 m long. Standard slab heights vary between 150 to 500 mm.
Prestressed hollow-core units are manufactured using either long line extrusion or slipform processes. The steel beds are usually 1200 mm wide and 80 to 150 m long.

The degree of prestress, strand pattern and depth of units are the main design parameters.

The Elematic manufacturing process deploys dry mix concrete, which means less cement is needed compared to conventional processes.

The voids save roughly 50 % concrete compared to massive slab with same thickness; that is 27.500 tons a year (when production 100.000 m² 200 mm deep slabs).

The prestressing process reduces the consumption of steel. When spans are over 3.5 m saving can be 50 % even more. That means several thousands of tons in a 100.000 m²/a capacity factory. Benefits are more substantial compared to reinforced concrete slab production.

With the production process using modern state-of-art Elematic machines and experienced crews, you can achieve saving of 25 – 30 % in labor hours compared with conventional slab production. You can manufacture 1.5 to 2.5 m² hollow-core slabs with same material, energy and labor costs you need to produce 1 m² slabs with equivalent depth.
2. Production process

**PRODUCTION CYCLE**

1. Cleaning and oiling the bed
2. Strand pulling
3. Tensioning strands
4. Lifting extruder on the bed (not shown)
5. Concrete mixing (not shown)
6. Concrete transportation
7. Concrete dosing to extruder (not shown)
8. Extruding
9. Draw openings by plotter (not shown)
10. Making openings
11. Covering of slab
12. Curing of slab
13. Recovering of slab
14. Cutting of slab
15. Lifting of slab
16. Drilling of drainage holes
17. Transportation to storage
18. Handling of slabs in storage
19. Transportation to site

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2.1. Cleaning of beds and pulling of strands
Prestressed hollow-core slabs are produced on casting beds. Before casting, the beds are cleaned and oiled. Then the strands are pulled and spread by a special device, BedMaster, which simultaneously cleans the pallet with a rotating brush. When the BedMaster returns to the active end, it lifts the strands on the casting bed and oils the bed with form oil.

2.2. Tensioning of strands
All of the strands for one bed are tensioned simultaneously (or single strands can be individually tensioned). A special unit has been developed for this purpose. The unit moves transversely at one end of the hall so that each casting bed can be handled by the same machine.

Casting bed specific stressing cylinders can be used as alternative stressing method.

2.3. Concrete transportation
Concrete is transported from the batching and mixing plant by an overhead transport system. A shuttle brings the concrete batch automatically to correct place over an overhead bucket gantry, which discharges the batch into the extruder.
2.4. Extruding
A high-performance extruder is the key component in the production process. It extrudes the slabs as continuous process.

2.5. Draw openings by plotter
All openings to be made in slabs are marked with the plotter. Also point where the slab is cut or splitted, recesses and needed slab identification data are marked with the plotter. Slab data needed for plotting is loaded in the plotter in advance.

2.6. Making of openings (if needed), covering of slab
Recesses can easily be made after the casting process whilst the concrete is still green. Openings can be with a machine or by hand. When the process has been completed, the cast slab line is covered with tarpaulins to minimize evaporation.
2.7. Cutting on the bed
After curing, tension of the strands is released and the slab is cut according to measured markings. Cutting operation is carried out with a diamond-tipped saw that travels on the same rails as the extruder.

2.8. Lifting of slab, drilling of drainage holes
After the cutting, slabs are lifted from the casting bed by an overhead crane with clamps. The slabs are then transferred to an automatic drilling device that drills drainage holes in both ends of the slab.

2.9. Transportation to storage
Slabs, which are set on transfer wagons, now undergo quality control, after which the voids are fitted with sealing plugs and the slab ends marked with project numbers, etc. Then the wagons proceed to the storage.
2.10. Handling of slabs in storage
An overhead crane equipped with lifting clamps is used for handling the slabs in the storage and loading them e.g. on trucks for dispatch to the building sites.

3. Production facility requirements
The production hall is like a normal industrial hall. The hall has to fulfill the local requirements and its structures needs to carry vertical loads and bending moment of normal loads and loads from factory equipment like cranes, shuttles, tracks etc. Length of the production hall is about 20 m + bed length + 30 m. For optimal casting, the ambient temperature should be around +20°C.

Electricity; normally the plant get its power from the local electric company, but sometimes a plant’s own generator is used. The total power input can be 500 kW, normally 3-phase and 50 Hz (all depends on the plant size, equipment and other facilities).

The heating plant serves for heating of water in a boiler with a burner that uses fuel oil or natural gas. Hot water is used for heating of concrete, casting beds and production hall and other facilities like usage water, office etc. The needed heating power for a plant with 4 casting beds is approx. 450 kW and 700 kW for a plant with 8 beds.

Water comes usually from a local water supplier. Water can be divided to so call drinking water and process water (not drinkable). Process water is used for machinery cleaning etc.

Wastewater treatment plant is now quite common. Recycled water is reused for machinery cleaning, washing etc.

Waste concrete and rejected slabs are normally stored in a storage area and when a pile is high enough, the waste concrete is crushed into smaller pieces. This crushed product cannot be normally used for hollow core-slab production, but it can be used for filling purposes. Steel is separated during the crushing and supplied to steel mills for recycling.

Storage area is normally an open area located at the end of the production hall. There are gantry cranes, overhead bridge or A-frame loading systems. The cranes lift single slabs or bundle of slabs onto transport wagons, make storage piles, truckloads, load trucks etc. Roughly calculated, storing of 10-15m² of slabs require 1 m² ground area, driveways for truck and out door transportation wagons take also their share of the ground area.

A rack for slab testing i.e. for carrying out 1:1 full-scale strength and bending tests, can be located in the storage area. Also an area for re-cutting the slabs, which are usable but need some additional work (a shortening or an angle cut etc) is needed.
4. Technical data

Construction of a production plant normally starts by making the feasibility study taking into account the market, needs, construction circumstances, building types, financing etc requirements.

The production capacity of a floor production plant is calculated based on annual capacity.

The smallest production plant contains just one single casting bed, but it is not very economical and biggest plant can have several production halls while one hall may have 8 – 12 casting beds.

Annual capacity

- Required annual production capacity is 200,000 m², with one casting per day and with 250 working days
- The calculated daily capacity is \((200,000 \text{ m}^2 / 250 \text{ d}) = 800 \text{ m}^2 / \text{d}\). This gives \(800 \text{ m}^2 / 1.2 \text{ m} = 666.7\) lineal meters of slab.

\[ 6 \text{ lines of beds (111.1 m + 6m)} \approx 117 \text{ m} \]

\[ \Rightarrow \text{ with 6 x 6m x 1.2m = 43.2 m}^2 \text{ of waste or} \]

\[ 5 \text{ lines of beds (133.3 m + 6m)} \approx 139 \text{ m} \]

\[ \Rightarrow \text{ with 5 x 6m x 1.2m = 36 m}^2 \text{ of waste.} \]

We choose 5 casting lines each 144 m long

- This gives an annually capacity of \((5 \times (144 - 6) \times 1.2 \times 250) = 207,000 \text{ m}^2\) cast once a day, and if two full 8-h shifts are used, it is possible to cast 2-3 beds twice a day and increase the capacity

Some casting beds can be cast twice a day (depending on the cement quality (hardening time), process cycle time and working times). As average, if the production capacity must be increased with existing bed capacity, the capacity can be calculate so that the daily casting factor is 1.2 – 1.5, but the cycle and daily working time must be checked. Also the plant type determines, how the casting is possible i.e.
when two casting machines can cast parallelly, it is easier to cast some beds twice compared to one casting at a time.

The product type (thickness of the slab) also affects the casting cycle and times, smaller (i.e. thinner) products can be cast faster than thicker ones. Also other things like quantity of opening, recesses etc will affect the casting time.

![Work schedule for four-bed hall with one casting machine where casting is done once a day.](image)

**5. Additional information**
**Elematic** is a leading supplier of precast concrete machinery and equipment as well as the only supplier capable of delivering complete production plants anywhere in the world. Elematic’s superior technology and industry expertise is currently in use in more than 100 countries across five continents. Elematic is headquartered in Toijala, Finland.

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