Immobiliare Centro Nord S.p.A., 37050 Belfiore (VR), Italy

Innovative technology for hollow core production

The only one of its kind with a unique production technology from the casting to the cutting of floor slabs with depths from 160 to 1200 mm: this is the innovative production plant of the Gruppo Centro Nord near Verona, Italy, covering an area of 90,000 square metres.

Since its beginning, just after start-up on September 2003, the new production site has reached in less than one month the first step of the required capacity of about 1,400 sqm per day to cover the current market demand capacity (1,050 sqm of standard hollow core stabs and 350 sqm of jumbo elements). The final capacity only requires the installation of a second mixer and a concrete bucket conveyor already foreseen in the plant design.

The main innovations introduced in the new production site concern a variety of technological, productive and environmental aspects:

- Manufacture of hollow core slabs and beams with depth up to 1,000 mm
- Translating casting beds
- Fixed cutting station with double saw operation
- Prestressing strand pre-cutting and the new prestressing system and control
- Discharge water recycling and treatment system

Elements are produced with heights up to 1,000mm

The step forward in quality compared to traditional production plants lies in the many innovations included in the production cycle: operations that are traditionally performed at the same time in the whole production area are now located in different separate areas.

The result has been noteworthy savings in labour costs and advantages connected with environmental well-being, with a reduction in cleaning costs due to concentration of "dirty" operations in special areas,

The new factory run by Immobiliare Gruppo Nord S.p.A.

The 350 m long hall is subdivided into the production area (front) and the curing area (rear)

while traditionally the entire plant had to be cleaned. All processes have been highly automated.

The products

Traditional and well-known hollow core floors come in depths from 16 to 50 cm. Their daily manufacturing schedule calls for the production of six beds of these hollow core slabs (over 1,000 m^2/day).

The large FORAP, PAV and MAGNUM pieces, whose depths vary from 60 to 100 cm, are used as bridge slabs with spans from 14 to 24 metres and for heavy loads suitable for road building (viaducts and artificial tunnels), for commercial buildings and underground works (underground car parks and services). They are produced with a new slipformer supplied by Nordimpianti System for special 1,000 mm depth hollow core slabs.

FORAP elements are rectangular in section, with three large voids to limit weight; this makes their application more flexible in the case of heavy loads. They are often used in underground constructions.
PAV upside-down "T" beams for bridges and viaducts have for years been the strongpoint of Gruppo Centro Nord in the road-building field.

MAGNUM elements are characterized by a fairly light "U" section of prestressed concrete closed at the top with a corrugated steel plate that supports the in situ casting. These allow spans up to 18 m with limited dead weight and not too heavy loads; they are therefore ideal for the erection of large shopping centres and multi-storey car parks.
Now produced with depths up to one metre and with increased prestressing, their performance has been greatly improved and they are becoming more and more interesting from an economical point of view.

Every day two beds of these elements are produced; this represents about 350 m^2/day and 40% of total production in terms of turnover – an excellent example of the remarkable profitability of this kind of product.
The range of products described above calls for the mixing of 240 - 260 m^3 of concrete, class R 60 MPa, on average per day.

Longitudinal movements of products with translating casting beds

The 350-metre long building has been divided into two sections for different manufacturing phases. In the first section there are seven casting beds with a length of 150 metres; at their extremities there are the anchoring blocks for the prestressing tendons designed for tensions up to 500 tons each. In the second section, likewise, there are seven curing beds with a length of 150 metres which are aligned with the casting beds.

The mobile casting plate and its special separating system represent the innovative heart of this plant and are protected by international patents which are the property of Gruppo Centro Nord.

Separating, casting, curing and cutting operations, and fast reuse of the prestressing units ensures two production operations per day and bed. The operations that are traditionally performed at the same time in the whole production area are now located in different areas.

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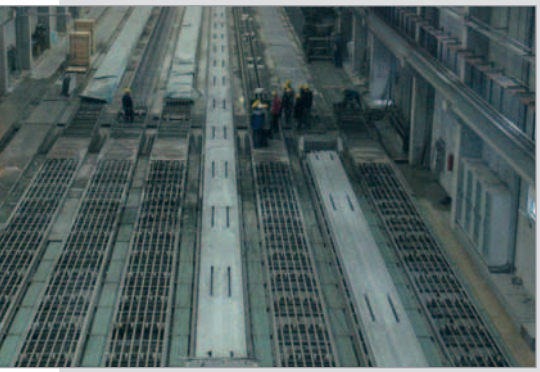
Dr. Eng. Giorgio Della Bella, born in Milan in 1939. Degree in Civil Engineering by "Politecnico di Milano" year 1965. Technical General Director of "Gruppo Centro Nord", Italy. Chairman of "Assap" (International Association of Hollow Core Producers) since 1981



Production of elements with a total length of 150m (top of pictures). As soon as a sufficient strength has been reached, a complete, 150 m long "prefabricated element" is moved to the curing facility (lower part of pictures). At the same time, the steel plate is separated from the concrete by slightly bending it and moving it under (!) the curing facility. As soon as the entire 150 metres have reached the curing facility, the steel plate is moved back to the production unit. This way the next production cycle can be started immediately

The result have been noteworthy savings in labour costs and advantages associated with environmental aspects, with a reduction in cleaning costs due to concentrations of "dirty" operations in limited areas, while traditionally the entire plant had to be cleaned.

The idea consists of separating the stationary, traditional casting bed from its upper part: the casting plate. The mobile casting plate of steel is lying on its bed during the casting stage, but it can be raised by a multitude of wheels on the inside of the bed and moved longitudinally.

The axles of each casting bed can be raised simultaneously for a few centimetres by means of small oleodynamic cylinders, while the curing bed axles are fixed and have coated wheels to support the concrete element without damaging its intrados.

Each monolith produced, 1.2 metres in width and slightly less than 150 metres in length, is cast on the steel plate composed of a series of sheets welded head to head. The seven casting plates are mobile and run longitudinally to and from the curing beds.

In the casting phase the plate lies on the casting bed where it remains until the concrete has reached the minimum required strength for the application of prestressing.

Following this, the steel plate, together with the just hardened concrete element, is transferred from the casting bed to the curing bed, passing over the intermediate steel plate bending device.

The purpose of the latter is to separate the steel plate from the concrete piece by bending the plate gradually downwards so as to lead it onto a horizontal plane below the curing bed.

As soon as the concrete piece has been transferred, the empty plate returns to the casting bed, once again crossing the bending device.

This transfer offers the possibility of removing the element from the casting bed quickly so as to be able to use it once again for a new cast in the shortest possible time. This also permits a high degree of flexibility in the manufacturing process by separating casting, curing and cutting operations.

The piece can in fact remain as a whole in the curing stage prior to cutting it into single slabs. Thus we have the two-fold advantage of being able to make two casts per day on each of the seven beds while the cutting of the element, and thus the prestressing of the single slabs, is postponed until the concrete has reached a good degree of hardness and strength.

In this way, both the camber and the differences in camber that are often observed in installed hollow core floors are limited. The results obtained with this plant are far superior to all expectations.

It is interesting to observe the expressions of surprise and admiration when visitors witness these operations, since nothing of this kind has ever been seen in the field of concrete prefabrication.

Machine for the positioning of long elements for cutting

When the concrete has hardened completely on the curing bed, the 150 m long piece must be moved horizontally some distance at a time for cutting it into single sections by the transversal cutter at the fixed cutting station.

Transversal or oblique cutting lines have already been designed to obtain the single slabs. The element must be moved carefully to align the cutting line precisely with the cutter's diamond disk.

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In the planning stage, this operation was the cause of more than one worry since there was no precedent in any industrial sector for the moving of masses in the order of 100–150 tons with precision arrest at a tolerance level of ± 10 mm. Movement of the element now takes place by means of a special positioning machine – an operation which has tuned out to be fully successful.

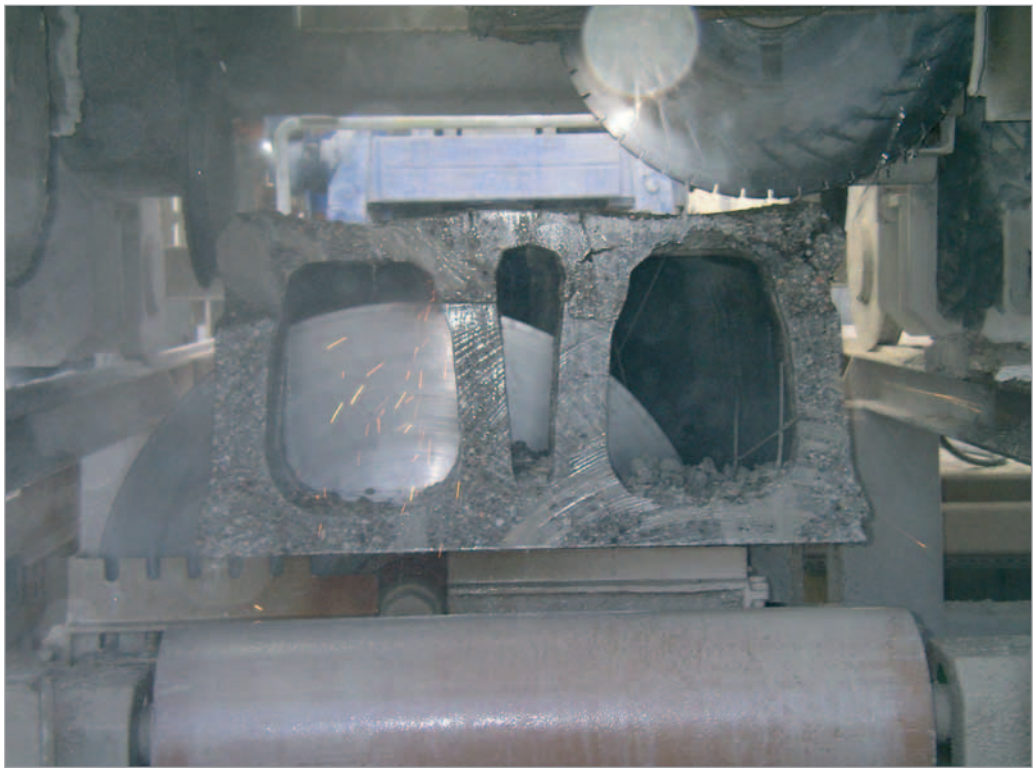
By means of hydraulically powered rubber wheels, the machine moves, accelerates, slows down and brings to a stop the elements weighing even more than 150 tons with an unbelievable delicacy and precision.

This machine is already designed to work automatically with optical recognition of cutting lines.

The cutting station and the upside-down cutter

The final section of the building, behind the curing area, is dedicated to the fixed

A special machine ensures optimal positioning of the elements for the subsequent cutting operation



The cutting station is equipped with two blades to ensure that cutting can be carried out from above and below

and isolated cutting plant where the long concrete monoliths are cut to size into single slabs as they move step by step from the curing bed to the cutting station.

In traditional plants, the diamond disk cutting machines moves along over the entire length of the cured piece on the casting bed and cuts it into single slabs, thus producing a great deal of cement mud, dust and loud noise.

Cut slabs have to be removed by a lifting device to free the casting bed. In the new plant the cutting machines work in a single place set aside specifically for this purpose and isolated from the rest of the plant; single slabs are transferred to an external area for storage, sliding on rollers that eliminate all need for lifting.

It must be taken into account that the diameter of a diamond cutting disk must be almost three times the depth of the piece to be cut. Thus a piece 600 mm in depth requires a ø 1.7 m disk and a piece 1,000 mm in depth requires a ø 2.8 m disk, a size no longer feasible both in terms of the cost of diamond disks and the size of the cutting machines.

Since the new plant was designed for the production of slabs up to 1,200 mm in depth, cuts are made with two diamond disks: one cuts half the thickness from above and the other cuts the other half from below by means of a novel upside-down cutting machine specifically designed and produced by Nordimpianti.
In this way we have succeeded in keeping sizes and costs of cutting disks and machines within reasonable limits.

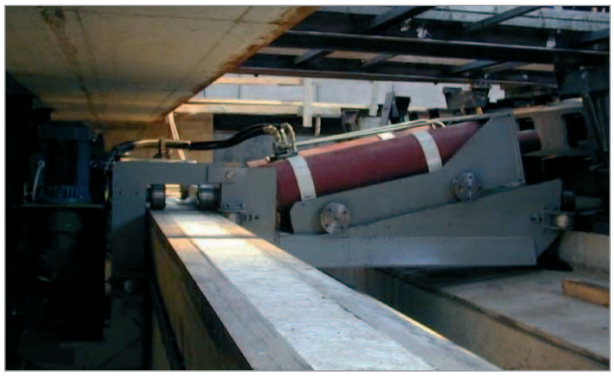
This innovative cutting method was made possible simply by having the piece to be cut slide on rollers from the curing bed to the fixed cutting area. In traditional plants, the cutting operation from the bottom upwards is impossible.

The entire cutting section was designed for the future installation of two more cutting machines.
One will be for longitudinal cuts both on top and bottom of the monoliths and the other will be another special machine capable of cutting the heads of floor slabs of greater depth to create Gerber-type saddles.

Under the curing facility, already prepared prestressing strands already cut to length are waiting. As soon as they are needed, they are pulled out of the zinc pipes to the production unit. This way, any problems that might occur when pulling the strand from the coil are prevented.
As soon as a strand is needed and the zinc pipe is empty, it is replaced with the next strand cut to length so that the required prestressing strands are available at all times

Tendon laying

The laying of prestressing tendons is performed in a very special plant consisting of a bundle of normal zinc pipes below the curing beds as long as the distance between the two tendon-anchoring heads.



The movable prestressing unit can pull up to 500 t

A normal tendon-inserting machine is placed at one end of the pipe bundle while the other end is at the anchoring head.

Tendons are inserted in the machine and pushed through all the pipes until their extremities emerge from the other end. When needed, a conventional tendon-laying machine pulls the strands out of the zinc pipes onto the aligned casting bed. Because the strands are precut with the correct length needed, and because they are positioned straight in the zinc pipes below the curing area, the pulling operation onto the casting beds can be carried out is operated rapidly. As soon as a zinc pipe is unloaded, a special strand pushing machine loads it again with a strand of the correct diameter and length.

In this way the pipe bundle is always loaded with strands of different diameters in the right position for stressing them together on the casting bed and anchoring.

Prestressing and control system

Another innovative apparatus is the system for stressing the tendons: it is a perfect merger of electronic, oleodynamic and IT engineering.

The plant of stressing jacks is truly functional: it consists of a pair of large oleodynamic cylinders assembled on a complex self-propelled unit which, by means of remote controls, moves transversally to face each of the stressing heads of the seven casting beds.

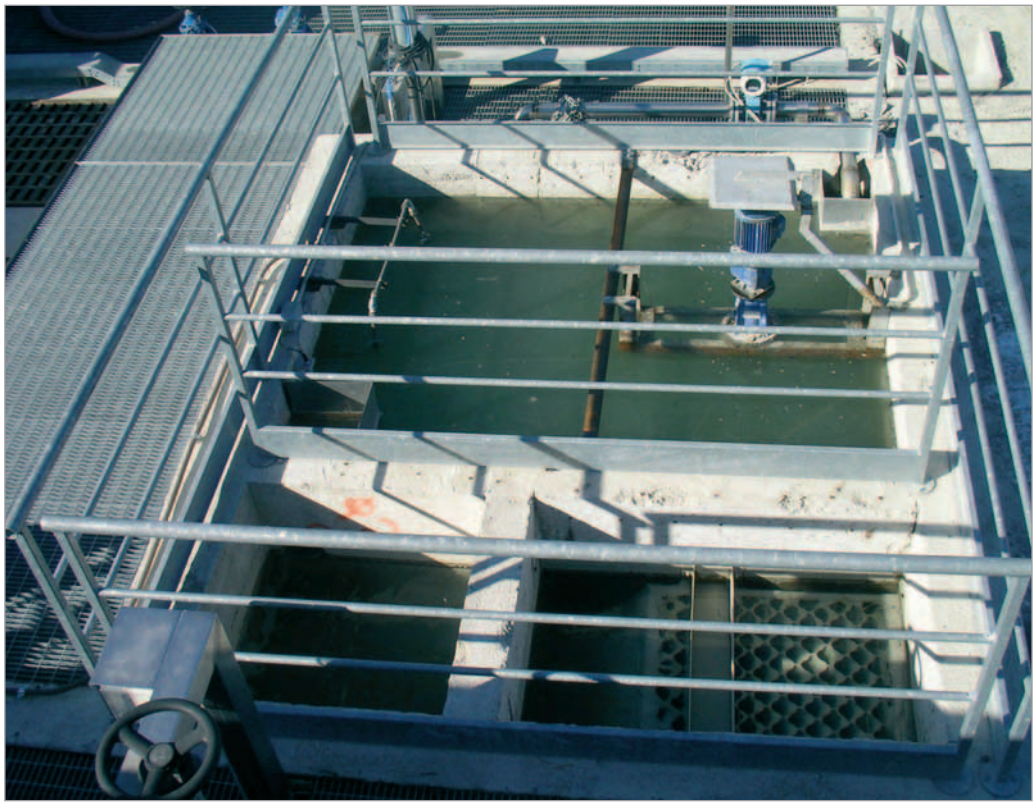
Remote-controlled by the operator, it performs all stressing operations with extreme delicacy and reliability.

Stressing of the tendons on a bed takes place simultaneously and the central control computer records all operations to compare them with the requirements of the job as given in the order.

Each of the two tendon anchoring blocks at the ends of the casting beds is equipped with jacks that regulate the tension of the steel throughout the heat curing period of the concrete piece.
At the end of a cycle they slowly release the prestressing tendons at both ends of the casting bed at the same time.
The oil pressure in the jacks is continually monitored on the control panel and a computer records variations every few minutes and supplies a graph of the tension on the prestressing steel on each bed throughout the heat treatment. ▶

The Simem mixing tower…

… and the Skako mixer are optimally harmonized



Water recycling was of special importance to ICN

Since the computer also records the temperature of the concrete at the intrados of the piece during the same time interval, it is possible for the first time in the field of heat-cured prestressed concrete to analyse the tension development in the reinforcement together with the temperatures during the heat cycle. The graphs also supply data on the time and degree of concrete shrinkage in the curing phase.

Concrete mixing

The completely automatic concrete mixing tower is a masterpiece of cooperation between the Italian company Simem and the Danish company Skako.

Simem supplied the metal structure of the tower over 30 m in height, including the system of introducing and raising the aggregate, the cement silo, and the cement distribution system.

Together with Skako, Simem also designed and supplied the feeding hoppers of the mixer and the self-propelled hopper that receives the mixed concrete and places it in the concrete slave hopper mounted on a special bridge trolley.

Skako supplied and installed the system for aggregate measurement, a two cubic metre Apollo mixer of the latest generation and the complete electric, electronic and IT systems for perfect, completely automated control of the entire mixing plant, starting from discharge of aggregates from the conveyor system to the feeding of the slipformer or the extruder. The result is a perfect concrete mix. To achieve the final design of the plant, an additional mixer has been included in the planning. Batching orders are remotely given by the casting machine operator. Thus the control room is entered only to start the operation of the plant, to change the batching ratios and to intervene when a cement or aggregate silo is empty.

Water reuse

When designing the plant, special attention was paid to the working environment and quality. Water and sludge from production facilities, from the channels passing alongside, and at the ends of the casting beds and cleaning area are recycled and reprocessed, separating dirty water and clean aggregates.

Rain water from all storage areas is also sent to a big underground transversal reservoir channel that is 170m long, 5m wide and 3m high, with suitable capacity for the most severe rainfall in order to allow de-oiling, neutralization, separation and clarification of the water to be reused in the plant or to be discharged to the agricultural channel beside the plant.

Conclusion

The success of the many innovative features in the new production centre described above has underlined that the substantial investment made has turned out to be an economic success.
The plant's productivity at a highest possible level has been confirmed, even in the face of strong competition.

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