

Nordimpianti System Srl, 66100 Chieti (CH), Italy

# The importance of automation in pre-stressed hollow core slab production

The automation of prestressed concrete element manufacture is now a fundamental requirement in production plants – helping to reduce manual labour costs and minimising the so-called "human factor" that can affect the quality of the finished product and possibly the entire production process, thus keeping the production of defective finished products to a minimum and in the final analysis lowering the price of the finished product. Nordimpianti offers various options throughout its product range that give its customers access to the highest levels of automation within the continuous production process of pre-stressed concrete elements. Nordimpianti is always looking to improve the performance of its machines and the scope of the automation at every stage of production, minimising the manual labour requirement within the entire process.

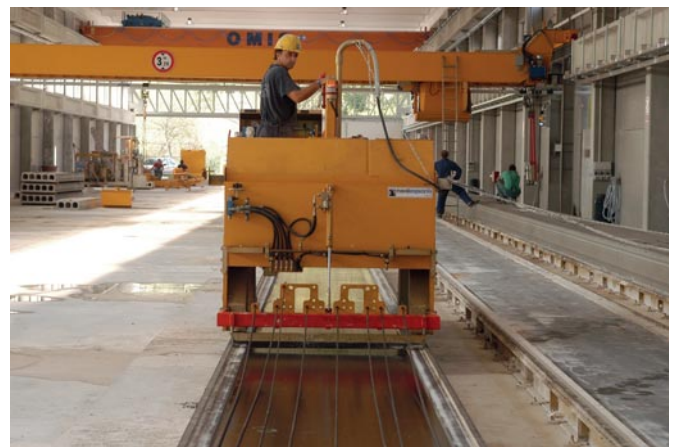
## Production bed preparation

This part of production does not have high levels of automation, requiring only that the operator drives and controls the multifunction bed preparation machine.

However the machine itself already represents a significant step forward in speeding up the production process and reducing the manual labour required. With this machine the operator can clean the production bed of any residual concrete, spray the detaching oil onto the bed as well as efficiently pulling all the pre-stressing wires in one pull from one end of the bed to the other where they can be fixed.

The use of this machine not only saves the company employing, at least, another 1-2 people but also decreases the time required to prepare the bed. Not only that but the machine far out performs manual labour in leaving the production bed well cleaned and uniformly oiled. Manually pulling the pre-stressing wires along the length of the production bed is very heavy work and since the casting bed is oiled can be very risky for the operators. The weight of just one ½" (12 mm) wire, 120 m long is 90 kg. The multifunction machine, with its strength and traction ability makes light work of this, pulling all the cables from one end of the bed to the other in one trip.

Another factor that should not be overlooked is keeping the production area as clean and as tidy as possible. Element cutting pro-



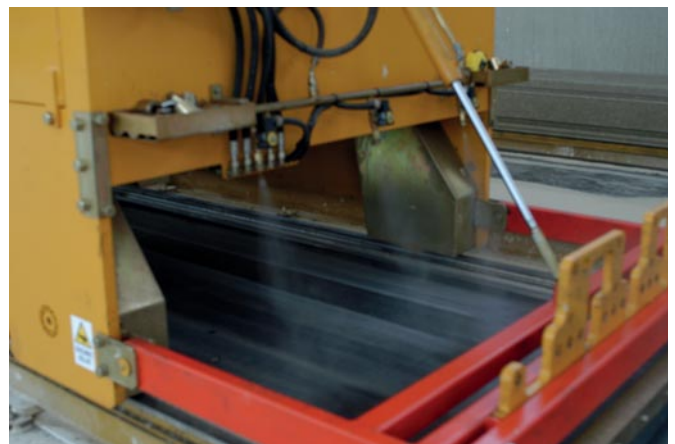
... and pulling all the stressing cables.

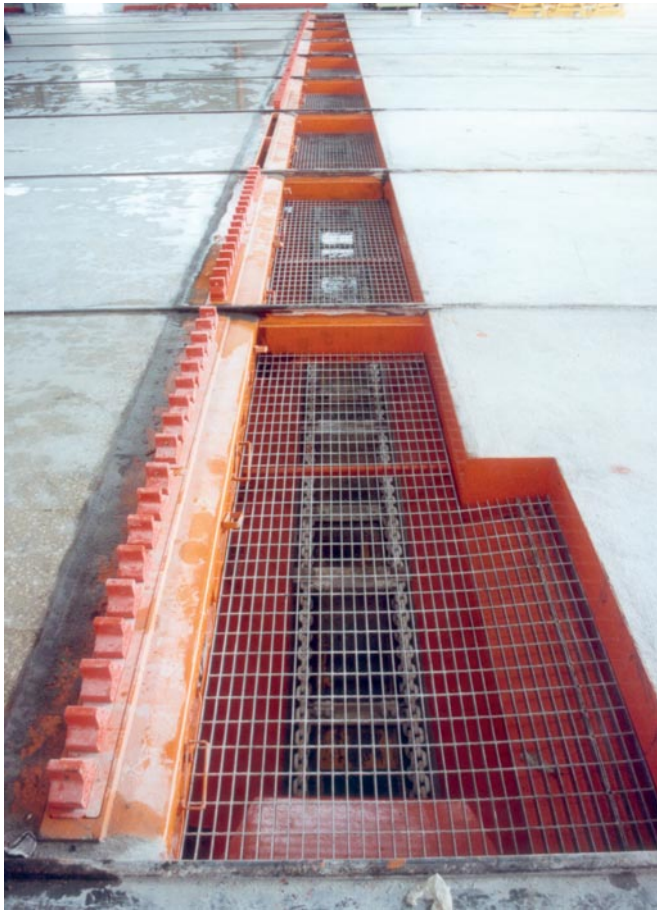
duces a lot of debris mixed in with the disc cutting water. To remove the concrete debris and water from the production bed Nordimpianti supplies, as an option, a debris conveyor chain system mounted at the lower end of the beds and running perpendicular to them. The conveyor system takes this debris and water away from the production area and into a settling slurry tank, with the minimum labour.

Without this debris conveyor it would fall to operators to undertake strenuous daily cleaning operations to remove the excess water and debris.



The multifunction bed cleaner cleaning and oiling the production bed ...





*The debris conveyor mounted at the ends of the production beds*

## Element Casting Phase

The choice of casting machine largely depends on the type of prestressed elements being produced. Nordimpianti offers a wide range of casting machines based on Extruder, Slipformer and Wet casting technologies.

Within these the Extruder offers the highest level of automation for the production of floor slabs and wall panels. The production method of the extruder, combining a large capacity hopper with a forming insert that compacts the concrete whilst at the same time driving the extruder forward along the bed means that the extruder does not require the constant attention of an operator.

Nordimpianti's extruder is also equipped with a hopper sensor which constantly monitors the amount of concrete in the hopper. This means that, automatically, when the concrete level falls below a pre-determined value, the machine stops in order to wait for more concrete and thus avoids any compromise the quality of the product on the production bed.

Compare this to the slipformer where, during casting, an operator needs to be vigilant at all times in overseeing all aspects of the machine, the various delivery hoppers, the speed of the machine and must always be present to adjust various parameters depending on the concrete mix design received from the batching plant.

The same can be said for a machine using wet casting technology. An operator must carefully monitor the quantity and the quality of the concrete being delivered from the hopper to maintain a constant gravity feed pressure to form the concrete element and react further

by adjusting the speed and the vibration of the machine according to the humidity of the concrete. Not balancing these parameters during production could have a detrimental effect on product quality.

More automation can be found on the extruder by way of an automatic compaction control system. This system consists of having load cells mounted on the rear axle of the machine which constantly monitors the load on the wheels during the casting process.

At the very start of production before the slab has started to form, the load cell senses that most of the pressure is coming from the machine. The software will increase the speed and oscillation of the screws, forming tubes sideformers and the smoother.

As the product begins to form, the load cells detect that pressure exerted by the machine starts to fall as the pressure exerted from the already produced panel begins to rise. The software adjusts the parameters of the mechanical parts to achieve the correct compaction. If the extruder is working with dryer concrete the rear of the machine will have a tendency to rise up and the load cell will read a lowering of pressure. As a consequence the software will react to this lowering of pressure by slowing down the speed of the screws and adjusting the oscillation of all the components proportionally. On the other end if the concrete is too wet the compaction will automatically adjust itself in the opposite manner.

This compaction system ensures excellent product quality without the need of constant operator attention and furthermore will prevent premature wearing or the mechanical failure of the wear parts.

## Concrete Distribution

A very important phase of the production process is the distribution and transport of the concrete from the concrete mixing plant to the casting machine. For this part of the process Nordimpianti's machine can be incorporated into a concrete distribution system that allows the operator of the casting machine to simply communicate to the batching plant operator the amount of concrete and the mix design required. The automated distribution system also makes it possible to plan a weekly schedule whereby the operator, having already received the technical characteristics and the amount of concrete required for the product geometry, can program the total volume of concrete necessary for the work cycle.



*The work sequence showing the completely automatic concrete distribution, the extruder in the casting phase and a plotter for the traceability of the final product.*





*Fly bucket transporting the concrete automatically from the batching plant to the casting machine on the production bed.*

After which the system will work independently from concrete mixing to the delivery of the concrete to the casting machine at the point required on the production bed. The fly bucket will automatically stop close to the concrete distributor crane hopper waiting for the signal: when the bucket receives the signal that the concrete distributor crane hopper is empty the fly bucket will transfer and discharge the concrete into the distributor hopper. Using sensors, the concrete distributor crane hopper will move to the extruder casting machine automatically. The extruder's hopper senses when the concrete level is low and the hopper is refilled from the concrete distributor crane automatically. This process is carried out throughout the entire length of the production bed. This system means that there is no need for a bridge crane operator or a dedicated person to constantly monitor and check the quantity of concrete available into the extruder hopper.

### Element Marking

Element marking is required to draw cut lines and print product identification data on the elements. The cutting line can be done manually by an operator with a measure and a length against which to draw the cut line but the ability to print product information on the manufactured elements is very limited. However both these operations can easily be achieved automatically using a single plotter machine on freshly cast concrete. Information data to be



*The plotter marking elements on the production bed.*



*Example of production data printed by the plotter on the hollow core slabs.*



*Automatic cutting saw with laser positioning device.*

printed by the plotter is sent to the machine via WIFI or through a USB key.

The plotter automatically follows the casting machine along the production bed using proximity sensors that control the forward movement of the plotter as a function of the forward movement of the casting machine. The operator needs only to position the plotter at the beginning of the production bed and to start the machine. All marking operations are then carried out automatically along the entire length of the production bed. Other information that might be printed in addition to that already mentioned might include sequential numbering to aid on-site assembly, the location of required holes, angular cut lines and bar codes.

The use of a plotter is increasingly recommended for plants with large production volumes where efficient production and the minimising of human error are paramount and require monitoring. This machine is indispensable for quality control reason to those companies where product data marking is obligatory for traceability.

### Concrete Curing

The process of concrete curing can be highly automated using a maturity control system with temperature sensors linked to a hot water heating plant. The maturity control system is provided by a PLC via a touch screen control panel which means that the operator only has to start the heating cycle program, the rest is done automatically.

The system automatically adjusts the boiler, valves and water pumps to achieve the correct temperature of the production bed surface for the correct length of time in order to cure the concrete in the most efficient way possible. Automation of the curing system also prevents the overheating of the produced elements which may cause surface cracking. Furthermore controlling the curing time of the concrete is important in the complex production cycle as well as being a way to optimise the energy costs of heating the production bed.

The system also has the facility to data log and graph the information so that production can be analysed, allowing production to be fine tuned and repeated, meaning that a consistent high level of output quality can be achieved.

### Element Cutting

Once the concrete elements are cured they are ready to be cut to length. Even to what is considered to be a manual operation Nordimpianti is able to offer various levels of automation to the cutting procedure from the semi-automatic operation cycle of each cut to the complete automatic cutting operation of an entire production bed using a combination of high level software control and a laser positioning device.

It is only necessary for the operator to check the cutting operation periodically. This level of automation not only allows you to reduce labour time by up to 80% but also means that the operator does not have

to remain close to the cutting machine during the entire cutting time.

There are also many other aspects to automation that Nordimpianti engineers into its systems in order to reduce risks, the use of remote control, hazard warning systems, on board protection systems and a machine alarm system for troubleshooting. All the automation of Nordimpianti's machines can be further managed and optimised through a separate software management tool dedicated to the production of pre-stressed elements. The software allows control of other aspects of the production chain such as element calculation and dimensioning, production planning, stocking area organisation and element transport scheduling.

Automation is at the forefront of pushing down costs, raising production quality and increasing worker safety to drive long term growth. ■

### FURTHER INFORMATION

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