Production Plant for Flexible Production of Slab-Shaped Reinforced Concrete Elements

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The founding of the company Boot Beton, 2450 AA Leimuiden/ Netherlands goes back to the year 1915. In 1988 the company joined the Struyk Group which in turn was taken over in 1992 by the Irish concern CRH which for many years before that co- operated with the firm Verwo in the Netherlands. Today, they add up, among others, to more than ten concrete and pre-cast concrete works with around 800 employees in the renowned Struyk-Verwo- Group.

In the past years were carried in the Boot Betonwerk in Leimuiden extensive modernisation measures. To this is added also the rationalisation of the entire batching and mixing technique. To- day, each of the three production halls has a separate concrete preparation plant which in each case reflects the latest level of technology. The distribution of the concrete from the mixer to the concreting place is provided by bucket conveyors.

In the production of different concrete components is operating in one of the production halls for many years now a Humarbo plant which is at present being converted to the production of a new product. In order to organise the production even more economically in view of the significant extension of the production programme and the prevailing market conditions, the works management decided in the spring of 1993 to set up a new production facility for the production of slab-shaped concrete units. The many years of favourable experience with the existing plant led finally to the decision to conceptualise and then to construct with the machinery maker Humarbo, 8171 MC Vaassen/Netherlands a largely new plant adjusted to the works conditions.

Fig. 1

Fig. 2

List of requirements
The set criteria included, among others, the following requirements:

- A compact production plant for the universal production of high quality slab-shaped concrete and reinforced concrete construction components right up to about 4 m long and 1 m wide
- One should be able to produce elements in series as well as concrete construction units in individual moulds with the use of "wet concrete", that is concrete with a higher water cement ratio
- High flexibility in the working mode and a rapid production switch
- Combination of an automatic and manual controls of the work processes
- Humane working conditions for the performance of manual jobs
- Low manning levels for the operation and supervision of the plant

The installed Humarbo production plant (Figs. 1) consisting of many combined machinery units subdivides, in general, into four work stations:
1 .Vibrating table with rail track-supported charging truck and supplementary equipment
2. Programmed multi-handling machine
3. Pallet circulation system and curing line
4. Receiving station
In view of the manifold production with around 50 standard programmes and additional variants the following approach is taken: The respective working processes carried out by machines are manually triggered and fully automatically controlled. At first, the process is simulated and tested on a PC. Thus is obtained for every product a programme which fixes under a recipe number all characteristic features and data. To this belong e.g. the technical data about the product, concrete type and quantity, the actual speed of the machine, vibration time and intensity, work subdivisions e.g. in the fixing of reinforcement among others.
These characteristic features about the product and the production are secured on the hard disc in accordance with the programme and are introduced by the PC into the SPS controls. This means, the plant operates independently of the PC programme with the SPS controls. The computer in the production hall serves the purposes of simulation, testing and feeding the respective programmes into the SPS controls. As has occurred in practice, it is thereby also possible at short notice to effect an alteration in the production programme so that e.g. in one day two different types of product can be made.
Parallel to the production data the commercial and works management has at all times access to the output data of the plant. Which product is where e.g. in the production? How many of the elements are being produced? What quantity of concrete and reinforcing steel has been used up in what time and many other things. In this way production management and administration obtain direct information about the efficiency of the plant and at the same time a basis for cost calculation and recalculation.

Introduced machines and production process
The heart of the plant represents the new multi-handling machine type MPS 425 from Humarbo (Figs. 2) which has found application for the first time in the Boot pre-cast concrete works. It carries out a large number of movements and work operations and determines at the same time the rhythm of the continuous production process. The machine, which rests and travels on a sturdy gantry construction, is, therefore, suspended off the ground. In this way is ensured a quiet running of the multi-handling machine as well as the exact execution of all movements or of the braking process. The basis of all movements is the displacement measurement. The individual work operations are manually triggered and fully automatically

controlled by the SPS. The movement drive works with a frequency converter. The hoisting, the lowering and tilting over of the turning frame, provided with hydraulic actuators, grabs and clamps is achieved by proportional valves. In this way jerk-free movements are guaranteed.
The production plant operates on the principle of the pallet circulation. There are 78 steel pallets in operation with dimensions 4,250 mm x l' 100 mm. The pallets are of two types. The lower pallet has rollers while the pallets stacked up on top have steel legs so that they can be stacked up one on top of the other. The produced concrete elements can have a max. length of 4.20 m whereby the full pallet width is utilised. On the basis of the intended programme, the product height is restricted to a max. of 20 cm. At the present time there are more than 20 moulds in use. A cycle begins with the placement of the mould by the handling machine on top of the vibrating table. At the time of the visit especially developed concrete slabs we re being produced with dimensions of around 1,500 mm x 500 mm and of those two per work cycle. The concreting in the longitudinal direction is carried out by a hydraulically powered charging truck moving on rail tracks and having a concrete silo of 2, 750 I capacity (Figs. 1 and 3). The concrete arrives from the silo by a belt conveyor into the distribution container over which the placement width is adjustable by bulkheads of 0.6-1.2 m and distribution height is continuously adjustable. In the operative mode of the charging truck there are several variants. Firstly, the entire concreting procedure can be programme-controlled i.e. with pre-adjusted concrete height. Secondly, it can be operated subdivided into several phases.

Bild 3/Fig. 3

As a rule, the produced elements are steel reinforced concrete construction components, in which at first is introduced and compacted a lower concrete layer, followed by the placement of the reinforcement and then the filling of the upper layer with simultaneous final compaction. For the purposes of the smoothing of the top surface of the concrete .there is provided underneath the conveyor belt a rotating finishing plate which, after an appropriate compaction, ensures a plain and clean concrete surface.
The vibrating table possesses two shafts with eccentric weights which are driven by two electric motors. The frequency regulating system has electronic controls. By this means the rotational speed can be varied and set in the case of each individual product for optimal compaction. The adjustment system of both vibration shafts in the range of 30-90 Hz can also be integrated into the SPS controls. With this are, therefore, also taken into account to a very large extent the important aspects of concrete technology.

A peculiarity of this production method is that the vibrating table and the mould are bolted together into a single unit. It is also possible to achieve this by an hydraulic interlocking device. Both fixing methods have their justification. With a greater production series -as was the case here with Boot Beton -the bolting together facilitates a more rapid work cycle. On the other hand, with the use of individual moulds and concrete of the "wet" variety, a clamping together is recommended. Here also is clearly evident the flexibility of the production plant.
Once the concreting and compaction process is finished, the multi-handling machine places a pallet on top of the occupied mould. The thus created unit comprising the vibrating table, occupied mould and empty pallet is then hydraulically clamped together, is raised, turned, placed on the de-moulding table and de-moulded automatically by means of hydraulics (Figs. 4).

Fig. 4

Fig. 5

While the de-moulded element may be subjected to an optional finishing process, the multi-handling machine brings the vibrating table with the empty mould back to the concreting station so that a new work cycle can begin. The occupied pallet with the completed concrete element is then taken over by the multi-purpose machine from the de-moulding station and transported and deposited in the first stack of the curing line. The Boot pre-cast concrete works operates, as a rule, with stacks of 7 pallets each. In the next step of the multi-handling machine follows the removal of a new pallet from the pallet return conveyor, its turning and transporting to the waiting position.

The occupied pallet stacks on the curing line are pushed forward in a continuous manner by a hydraulic advance unit until they reach the reception station. The lifting is effected manually. By means of a lightweight hoisting device, the pallets with the hardened element are raised to a convenient reception height, separated by a cramp and stacked up (Figs. 5).
After that the lightweight hoisting device brings the empty pallet to the pallet return conveyor which is situated above the curing line. In the return roller conveyor with a fall of around 1.5-2° is arranged a mould oil application station. The cleaned and oiled pallets arrive automatically back to the application place where they are again received by the multi-handling device and are forwarded to the concreting station.
The entire production plant requires only a small production space of around 30 m in length. The width of the curing line, with a generously designed gangway on both sides, measures around 7m.
As the practical experience of the works confirms, the average work cycle duration of the plant is around 5 min. Understandably, this depends on the degree of complication of the concrete element in question. The output deserves recognition as on the average 12 work cycles per hour are achieved and this with only three operators. Two of the operators are on the concreting side and one operator looks after the reception and the stacking of the concrete elements. Apart from the flexibility and the efficiency of the production plant, the high product quality and the humane working conditions are, above all, worthy of notice. Also, in the Greater Amsterdam area it is not always easy to find the right type of labour force. With this is thereby also satisfied the list of requirements put forward at the inception stage for an economic and universal production of slab-shaped pre-cast concrete elements.