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Largest solid part element production facility in Denmark put into operation at Boligbeton

The company Boligbeton in Denmark produces the entire range of precast concrete elements for the Danish civil engineering market. For more than 40 years, hollow core slab ceilings, solid walls, facades, pillars, trusses, balconies and other precast concrete elements have been manufactured at the site in Løsning covering an area of approximately 270,000 mÇ. The Danish construction market has developed extremely well in recent years, but now it is reaching a standstill, and demand is expected to slacken off over the next few years.

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Already more than 300 m²/per day of high-quality elements were being produced in 2004 for construction of multi-storey apartment blocks, using traditional tilting table production methods with very high wage costs in comparison with the EU. Within the framework of overall company planning, possibilities of increasing capacity and productivity were already being considered in 2004 for the entire production range. The following requirements were defined together with the company Reymann Technik :

- Dimensions of the precast elements: up to max. 13000 mm length and 3700 mm height, a maximum element weight of 25 to and up to a thickness of 1000 mm in particular cases.
- A production facility for the different grades of complexity of the elements
- Combination of circulation manufacturing and stationary production
- Very varied types of surface treatment, and also the possibility of creating sandwich elements and elements with facings
- Use of self-compacting concrete as a basic prerequisite
- Modular shuttering technology, which allows simple changeover between products, and also optimises the joints between existing prefabricated elements.

Some parts of these individual requirements had already been met in different factories throughout the whole of Europe; however there was no reference factory which could be used as a basis for planning.

There followed a 9-month-long analysis and layout planning phase, in which the entire current and possible future product range was considered with regard to the very different degrees of complexity and processing times involved, and in which the products were subjected to classification. From this phase resulted a layout which does not focus on the number of pallets produced per hour or on performance in terms of square metres produced, but on the net added value per pallet produced. When CEO Carsten Varneskov and his Technical Director Tom Kristensen could identify with the solution which had been reached and had accepted it with enthusiasm, the company Reymann Technik was commissioned as general contractor for the entire investment.

This commission not only involved the supply, assembly and commissioning of the plant, but also supporting site management, supply and installation of the elements into the foundation slab, supply and installation of staircases, platforms and safety fences, employee training, linking to the existing CAD system and also development of an alternative joining method for the precast elements.

All in all, Reymann Technik was engaged to oversee the entire project, leaving Boligbeton free to pursue its core business.

The plant which was created is provided with a wealth of details which enable the requirement profile to be fulfilled in all its complexity. However, a fundamental characteristic, which has not been fulfilled at many sites up to now, is that the plant fulfils cycle times of 15 minutes just as well as complex shuttering constructions which have a cycle time of 2 days – also when working in mixed production. The basis for this is a layout which links stations which are dependent on cycle times with independent stations by means of special suspended storage and retrieval system (Fig. 1).

This system, developed jointly with a partner who also builds storage and retrieval systems for the automotive industry, having a carrying capacity of 40 to is the central element within the plant, and allows the following working areas to be linked:

Suspended storage and retrieval system with entrance to hardening chamber

Flexible shuttering systems with connecting reinforcement

Shuttering changeover- shuttering storage

- De-shuttering line
- Standard shuttering area
- Special shuttering area
- Concreting area
- Smoothing area

Shuttering handling crane during shuttering

Shuttering handling crane during de-shuttering

Shuttering station with shuttering storage

A large portion of the walls to be produced possess wall jointings, which need consistent linking details. This can be achieved either by means of cable loop connections or rigid connections which pass through the shuttering and require shear profiling of the shuttering (**Fig. 2**). The wall thicknesses in the case of standard elements vary between 150 mm and 200 mm.

The following tasks had to be fulfilled by the shuttering system to be used, and a completely new system based on magnets was developed accordingly by the company Ratec, the sister company of Reymann Technik.

This system, named Ratec Standard Automatik Modular Flex SAS-MF, fulfils the requirement for flexibility with add-on modules of steel and wood. It is provided with special features for releasing the shuttering from the concrete elements and can also be cleaned automatically. The basic element of the SAS-MF shuttering which contains the magnets is the same for all the elements to be produced. Its function is

Lifting station with inloader pallets

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Tilting passing station

Concrete distributor with tandem scraper

Smoothing of the concrete surface with radio-controlled smoothing equipment

to accept the add-on modules both for transverse and longitudinal juts. These add-on modules can be covered by means of simple screw connections with different shuttering skin types such as wood, steel-smooth or with tongue and groove, steel or wood with shear key as well as steel or cable connection in the pouring channel.

In the course of this shuttering development, the two companies also together developed a cable loop solution which is simply inserted into the add-on modules of the shuttering and which reduces the costs of this connection element by more than 30 %. In this process, an injection moulded part is moulded onto the normal cable loop, which is then simply inserted into holes which are provided in the shuttering. In the de-shuttering line, the shuttering is separated from the precast element and fed to the shuttering conveyor by means of a specially-developed handling device. The conveyor transports the shuttering through the cleaning machine – which cleans the different shuttering elements from all sides using 7 brushes – into the standard shuttering area.

The handling device is based on electrically-switchable permanent magnets can manipulate components up to a weight of 180 kg with great ease (**Fig. 3**). The entire control system of the shuttering handling crane is ergonomically integrated into the cross beam. No matter at what level of the shuttering the operator finds himself (pallet or shuttering conveyor), he can always work conveniently. Because of the intelligent shuttering platform directly at the edge of the pallet, the operator also always moves at the same level (**Fig. 4**). This equipment makes it possible to work precisely and is also used in the shuttering area, in order to place the shuttering on the pallet at one of the laser-equipped shuttering stations either directly from the conveyor or from the shuttering storage facility. The shuttering area, including polystyrene and wood processing, as well as the shuttering storage, are within access distance of the shuttering handling crane, which means that the distances employees have to cover could be reduced to a minimum.

A tilting passing station was provided between the de-shuttering line and the shuttering area (**Fig. 5+6**), as well as an option for a 2nd tilting passing station and a mobile pallet cleaner. The mobile pallet cleaner, which is downstream of a buffer station, means that the pallet can be cleaned several times, which is particularly useful when retarding paste is used.

The layout in the shuttering area then makes it possible to separate the pallets into different lines, and depending on the product complexity and controlled by the central computer, they are sent to different shuttering add-on, built-in part and reinforcing stations before they are again gathered together in the large-scale concreting area.

The concrete distributor is supplied directly from the mixer via a stationary intermediate silo. In the first step, this mixer is filled with aggregates from a conveyor and from a mixing plant in the immediate vicinity. This intermediate solution leaves all options for future expansion and modification open.
Consistent use of self-compacting concrete meant that a separate compaction station was not needed. The concrete distributor is additionally provided with a scraper, so that initial surface treatment is possible directly after concreting (**Fig. 7**). As further stations follow on from the concreting station, and it is possible to access the hardening chamber and the operating equipment for the racking independently through two entrances from these, it is easily possible subsequently to add items to the products in this area. For example, wall anchors can be inserted, upstands can be concreted on, etc.

Following a period which is set by the central computer, a certain proportion of the

elements are transported from the hardening chamber into a smoothing area where they can be smoothed at three stations. The stations are equipped with two smoothing portals which use plates and blades (Fig. 8).

The planned plant still offers the potential for expansion in order to fulfil the requirements of the future. In addition, the fact that the plant can be used universally differentiates it from other precast element production systems in a positive sense.

As Reymann Technik bore overall responsibility for the plant as general contractor, the periphery was also planned in detail and efficiently implemented. The last stage of the project was to provide training in the use of the equipment in parallel to actual production; this training was carried out by a specialist from Reymann Technik who offered instruction and support to the current production manager in all aspects of the plant during the first weeks after commissioning.

This plant layout has been realised in parallel by Reymann Technik in a company in Australia in a slightly modified manner (not shown). Here again, the potentials and performance of the equipment are put to full use and appreciated by the new operator.

Intelligent planning, implementation which is independent of the company's own machines, a supply team which worked excellently together, and also the fact that one general contractor was responsible for the entire project meant that the trust which Boligbeton placed in Reymann Technik was totally justified by the result. In fact, this first project was such a success that a further project is already being planned in order to develop and strengthen the position of Boligbeton on the Danish market yet further.

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