Equipment for prefabrication
Modern Production System for Concrete Precast Parts

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1. Introduction

In 1995, there have been produced more than 9 million tons big-sized floor slabs and wall elements as concrete precast parts up to a value of 2 billions Deutsch Marks [1].
In 1979 it was only 3 million tons and a value of 500 million Deutsch Marks, respectively [2].
That means, the produced quantity was increased by 300 percent in 16 years or nearly 20 percent per year.
The need for concrete precast parts increases in times of a difficult market. Competitive prices, high quality, intelligent solutions in products and reliable delivery times are guarantees for success in the market and short term construction periods compared with construction on site.
The development of production technologies and machinery in the last 15 years is the basis of such a success.

Today, concrete precast parts can be manufactured in a way, which seemed nearly impossible with regard to productivity and quality by means of well known, but improved industrial production systems and with the support of the whole range of the C-technics.

2. Survey

With regard to the quantity, the floor slab is the most important precast part in all variations. It became more important in the beginning of the sixties and kept ist position until now. In the seventies, especially the shuttering capacities have been adapted according to the increasing requirements, the mechanisation of single process cycles especially the distribution of the concrete was important and was enforced.
At the end of the decade, progressive manufacturers tried to take the ideas of the automobile industry and other large quantity producers by means of the circulation technology.
But only the beginning period of computers made possible the quantum jump in the automated manufacturing of precast concrete parts.
In 1985, the first plant in the world for the production of element floor slabs was built, which produced just-in-time floor slabs, planned by means of CAD and produced by machinery, controlled by CAM. No doubt, this plant is working competitively until today.

There followed many further plants, improved in details, which achieved solutions for special problems. Today, we can count much more than 100 of them.

3. State of Art

With the following two examples, I would like to present you the topic situation in technology with regard to the production of big-sized precast parts.

In the following video screen you can see one of the most modern plants for the production of solid walls and floor slabs made of light weight concrete. Due to a high degree of mechanisation and automatisation, we are now in the position to serve the booming market for precast parts and complete house building systems in an efficiency and quality not possible until today.

Video:

Production of Solid Walls and Floor Slabs made of Light and Heavy Weight Concrete

Faster, better, and more economical. Put simply, those are the requirements made of industrial companies on a daily basis. Meeting these requirements by utilizing future-oriented technology is the only way to have lasting success in the market. Work processes involving manual labor do still exist, however - and the creation of solid walls in situ is one of them.

The time was really ripe here for a technological leap forward into the 21st century. For an innovation that would truly revolutionize the market.

Weckenmann Anlagentechnik presents....

...the first fully-automatic plant for manufacturing solid walls and floor slabs made of light and heavy weight concrete.

This plant gives precasters the opportunity not only to react to today's market requirements but also gives them access to hitherto untapped markets.

Solid walls and floor slabs made of light and heavy weight concrete can be made to order, in a single production flow. A consistently planned, fully automatic logistics system guarantees the smooth transportation of standard pallets through all production units. Mixing mode cycle times are around 20 minutes.

A central computer at production planning transfers the individual wall and floor slab measurements to a shuttering robot online. The robot takes whatever components are required from a modular system of standardized formwork elements, and then erects the shuttering around the pallet with unrivaled quality and speed. The shuttered pallets then travel past all the necessary stations via an interconnected system of logistics. Formwork extension, inser assembly, reinforcement, fully-automatic concreting, compaction, screeding, rolling, curing, and shuttering removal all the way to rack

storage in made-to -order transportation crates that are driven directly to the building site. A complete system, which imposes no limitations at all within the dimensions of 3.0 m x 12.5 m. In mixing mode the manufacturer thus achieves a production capacity of approximately 500 square meters per eight-hour day, with minimal personnel deployment, unparalleled quality and in a flexibility that has so far been impossible to achieve.
Let's take a closer look at the individual stations involved:

The Shuttering Robot.

We'll begin with a bare pallet still dirty from the last circuit. As it enters the shuttering robot it passes automatically through the pallet cleaning facility, where it gets thoroughly cleaned and oiled.

Parallel to this, previously-used magnets and fromwork elements also travel into their own respective cleaning devices via special transportation routes.

While the pallet is heading for it, the robot is already occupied with magazining the formwork elements.

When the pallet enters the shuttering station, the dimensions pertaining to the respective wall or floor slab are fed directly into the robot from the master computer. The robot now begins its work immediately.

Firstly all coordinates where the robot does not remove shuttering - locations with window frames or door frames, for instance - are plotted on the pallet. Dimensional errors for manual formwork extension are thus ruled out.

Then the robot puts down magnets which represent the location-determining elements in the formwork system. The robot's speed and precision here would be impossible to achieve manually with the same economical benefits. The tolerances amount to approximately one millimeter - a figure that speaks for itself.

From the extensive magazine of individual formwork elements, the robot now places the components according to the parameters provided by the master computer. With an average production capacity of 500 square meters i combined wall/floor slab operation, the robot moves approximately 20 tons of shuttering material in 8 hours, replacing around 2000 operations that would otherwise have had to have been performed manually. These are impressive statistics too, and when it comes to personnel saving they speak for themselves.

From the shuttering robot the pallet now travels to the Formwork Extension Station.

Unusual products that require longer to process can be parked at a siding without any detrimental effect on the overall flow. Formwork extension refers here to manual extension of the modular system via telescopic metal components or additional support magnets.

The pallet travels on once more now, to reach Assembly Extension of Inserts.

At this station, inserts such as roller shutter containers, window frames, door frames, empty pipes and also parts for fixtures and transportation are mounted.

The next station is Mounting of Reinforcement.

Here prefabricated reinforcement units are mounted by hand. The pallet is now fully shuttered and is driven to the maintenance station in front of the concrete spreader.

At the moment the plant is designed for a production line. It can be extended to two lines operating parallel to each other at any time, however, because the concrete spreader can be driven along both lanes. At this stage let's take a quick look at the pallet transportation system.....

Concrete Spreader

Concreting can take place at a total of 6 pallet locations. Two silos for the swift transfer of buffered concrete are at the ready. The concrete spreader has a standard double chamber which enables immediate processing of various different concrete recipes.

Concreting can either take place fully automatically or manually. Tried-and-tested in constant use all over the world, the Weckenmann concrete spreader has a convincing spread pattern with many different kinds of formwork elements and thickness parameters. The spreader settles on the individual formwork element on each pallet, thereby ensuring that only as much concrete as is needed by the respective wall or floor slab is actually prepared. So during this phase too, quality and economy speak for themselves.

Compaction and Surface Treatment

After concreting, the pallet travels to the respective station for compaction. Here the pallet settles on to four locking elements, which raise it. Now shaking can take place, enabling optimal compaction. This procedure is also an innovation. The shaking is electronically controlled and guarantees optimal results. Moreover, everything happens extremely quietly - no comparison with the deafening sound of conventional vibration stations.

The pallet now travels to the final station on the line, the Rolling Station.

The aim here is to achieve absolutely optimal surfaces - so the no-fines concrete is compacted once more. The rolling station, which can also be individually controlled, takes over this last processing step.

The pallet can now be transported away for Curing.

First it travels through the curing chamber and arrives inside the fully-automatic rack storage appliance. This system is also computer-controlled, yet completely autonomous. It stores new pallets in the curing chambers and removes them at the correct time, process-controlled. It's impressive that this unmanned rack system doesn't just act intelligently, it places and moves the large and very heavy pallets in a total of 45 curing chambers with a safety and precision only achieved by numerous innovative details.

Once the product has set, it leaves the buffer area of the rack storage system and arrives at the Shuttering Removal Station.

With the shuttering already partially removed, the formwork and magnets are laid on the respective conveyor belts which immediately take them back to the shuttering robot for further use.

The pallet with the completed product arrives at the Lifting section.

Floor slabs are transported directly to transportation crates via lifting devices, while walls are taken to the automatic tipping station. From there, they are also packed to order inside the transportation crates.

The empty pallet is now driven back to the station in front of the shuttering robot for the next run, while the transportation crates with the completed products are driven directly out of the hall. From there they can be taken by truck straight to the respective construction site.

The entire plant with ist tried-and-tested individual components represents a revolution in wall and floor slab manufacture from light and heavy weight concrete.

The advantages are obvious:

massive savings on personnel
unequaled production capacity on just one production line
extension to a second production line possible any time without additional investment
unequaled high product quality of the concrete parts

Weckenmann - that is setting new standards with this production plant. Their decades of experience in automation technology for the concrete industry provide you with all the expert advice and security that is absolutely essential for projects like these.

With this technology, nearly all kind of big-sized concrete precast parts can be produced:

- Floor slabs, solid, with hollow parts or as half-finished parts
- Walls, solid, or double walls, made of heavy and light weight concrete
- Facades, also with functional surfaces (exposed aggregate concrete, smoothed or coloured surfaces, natural stone or ceramics and so on)
- Sandwich elements

and even prestressed elements as floor slabs and girders are produced in the circulation technics by means of a high degree in mechanisation and automatisation.

Very modern plant in Japan

Within the next 6 months, there is constructed a production plant for solid floor slabs and walls in Japan, where the idea of automatisation is progressed again. Mounting parts as threaded inserts and connecting parts for the erection of the elements and the completion of the interior are placed and fixed on the pallet sized 15 x 3.5 meters by means of a CAD/CAM controlled robot. Furthermore, it puts in standardized and reusable shutters. Totally 20 various types are available at the same time.
The setting frequency is 5 seconds per part as far as the threaded inserts are concerned.
Two supplementary robots in portal construction effect the handling and putting into the magazine of the shutters as well as the setting into the right position of the fixing magnets.

The final product is a house system consisting of walls and floor slabs ready for mounting, developed by Messrs. Taisei for the Japanese market.

Plastering machine

Another example for prefabrication with high efficiency demonstrates Messrs. WeberHaus. In their plant in Rheinau, they produce approx. 550-600 prefabricated houses per year. The houses made of wood are plastered on the outside walls with mineral plaster. This procedure had to be effected until 1996 conventionally after the erection on site. Messrs. WeberHaus intended to increase the degree of prefabrication of their walls by the plastering in advance in the plant. Considering this, they decided on a plastering plant by Messrs. Weckenmann Anlagentechnik.

By means of such a plant, a surface plastering capacity of 50 up to 100 squaremeters per hour with 1 up to 2 workers is possible. It does not matter, wether this is a wall made of timber with basis plate or a wall made of concrete or other material, able to be plastered. All kind of plastering material can be used, which can be handled in conventional proportioning pumps. The advantages of such a technic in short form:

- **Decreased consumption of material**
- **Less waste,** the horizontal plasterin supports this in general.
- **Reduction of transporting volume**, as the dry plastering material is supplied directly to the plant and not to several sites. The silo is installed stationary and must not be transported from site to site.
- **Improved optics**, as there is no non-plastered house delivered on the site.
- **Independent from weather.** Formerly there was the problem, that walls were mounted, but could not be plastered during winter season. In spring time, this delay had to be made up.
- **Improved quality,** as the surfaces are absolutely even and the elements are of constant thickness.
- **Reduction of labor** costs due to the achieved rationalisation.

- **Reduction of material costs.** The plastering material is cheaper.

This economizing measure leads to a decrease in costs of about 1.5 million Deutsch Marks per year. The expenses for this plant were redeemed within 1 year.

4. Presumption and Summary

To be in the position to meet the requirements of the continuously expanding market for concrete precast parts, the possibilities of mechanisation and automatisation must be used consequently. Only this can lead to short constructing times, competitive prices, adequate quality and a maximum in sparing of resources. Furthermore, the labor in the production plant becomes more attractive and human.
But on e thing must be considered in furture, to let precast parts become what their name promisses: A completely finished constructing part.
The planning of a building must achieve a different form of quality and quantity than it is usual today. The robot lives by data and loves systems, and the more it gets, the more it can handle and realize. With regard to this, both, the production engineer and the building enterprise are enforced.

References:

[1] Beton- und Fertigteil-Jahrbuch 1997: Bauverlag GmbH, Wiesbaden u. Berlin, 45. ed.
[2] Beton- und Fertigteil-Jahrbuch 1983: Bauverlag GmbH, Wiesbaden u. Berlin, 31. ed.

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