FBW Fertigbau Wochner GmbH & Co. KG, 72358 Dormettingen, Germany

Highly automated precast plant sets new standards

One of the most modern precast plants in Germany was put into operation at the start of 2011 at FBW (Fertigbau Wochner). FBW, a Vogel-Bau Group company, produces sophisticated precast concrete elements at its site in Dormettingen with a largely fully automatic production facility. In addition to structural precast elements of all kinds, FBW's products also include concrete walls made using the solid or sandwich construction method. The new plant is intended above all for the production of solid walls, sandwich elements and other flat concrete products such as floor elements etc.

The initial project studies for the planning of the new plant by Prilhofer Consulting began in 2007. The contracts were awarded to the plant manufacturers in mid-2010 and commissioning took place in mid-2011. The plant has been in full operation since October 2011 and is capable of producing an area of around 85,000 m² per year with average part complexity, requiring only 3.5 man-hours per cbm of precast concrete elements. Hence, the plant is considered a trend-setter for the flexible production of solid and sandwich elements with regard to machines and efficiency.



The new plant at FBW Fertigbau Wochner, which belongs to the Vogel-Bau Group, has been in full operation since October 2011

Flexible mixing plant adapted to the customer's requirements

A Liebherr mixing plant of the type Kombimix was specially adapted to the customer's requirements for the central supply of concrete. The mixing plant is equipped with two ring pan mixers, a RIM 2.25-D with dual agitator system and a RIM 1.0-M with mono agitator system. These mechanical agitators achieve very high concrete qualities in a short mixing time. Short emptying times are a further advantage of the ring pan mixers. These mixers are particularly well suited to the mixing of special concretes with the addition of dye or additions.

The mixing plant possesses a concrete inline silo as an active store for 15 different aggregates with a total stock of 540 m³. The in-silo is filled by a belt bucket conveyor with a spur belt and a mobile, reversible rotary distributor belt. All chambers of the in-line silo dose via 10 closures and 5 belts onto a weigh belt. Further special granulations can be transferred directly onto the weigh belt via two interchangeable steel tanks. Each ring pan mixer has an after-silo which can take up a batch and discharge it directly into the concrete distributor. A rotary distributor is attached to every second mixer closure for discharging the concrete selectively into the concrete distributor or into a truck mixer or into the cleaning hopper of the recycling plant.

Three silos with a total storage capacity of 300 tonnes in 5 chambers are available for cement and fillers. In addition to separate white cement scales, the mixing plant has scales for microsilica slurry, colour slurry and admixtures.

Concrete residues resulting from the cleaning of the mixing plant or the concrete distributor are taken up by a Liebherr recycling plant type LRS 606 sunk directly underneath the mixing plant. This recycling unit separates grey and coloured residual water in two agitator tanks and is capable of filtering out Liapor residues. The entire concrete mixing plant is integrated completely into the concrete building and is thus heatable and fully suitable for use in winter.

Master computer and control technology

The brain of the complex plant is the UniCAM master computer from Unitechnik. It manages the orders, fills the pallets, coordinates and visualises the production, generates the NC data for the formwork robot,



Two ring pan mixers from Liebherr achieve high concrete qualities in a short mixing time



Rotary distributors under the mixers convey the concrete selectively to the concrete distributor, into a truck mixer or into the cleaning hopper of the recycling unit.



A total of 40 shuttering pallets measuring 14.00 x 4.60 m are used at FBW

controls the laser projectors, manages the hardening chambers and ensures correct stack formation. In addition it forms the interface to the Betsy ERP system and to the DICAD CAD workstations in the technical office. Information can be retrieved by the employees not only from the control centre, but also via the network from office workstations.

The time required for manual work steps varies a great deal due to the large variety of individual products, which are produced on five production lines. In order to prevent bottlenecks and to achieve optimum plant performance, the system operates with work schedules. The order in which the individual stations of the variable plant layout should be driven to is defined for different product types. At present the plant is operating with 19 different work schedules. The complete plant is equipped with stateof-the-art safety-orientated control technolo-

gy. Touchscreen operating terminals in the plant provide for intuitive operation and fast error analysis. A Beckhoff controller is used for controlling the robot.

Production sequence

A total of 40 shuttering pallets from Weckenmann measuring 14.00 x 4.60 m with a maximum production width of 4.20 m are used at FBW. The shuttering sheeting

PRECAST CONCRETE ELEMENTS



Persistent contamination is removed by an additional cleaning unit on the pallet cleaner

has a thickness of 10 mm and is finely and evenly aligned and polished several times for the achievement of perfect concrete surfaces. Mounting holes enable the mounting of fixed edge shuttering. The pallet is designed for a 40-tonne payload, which defines a new standard.

In the longitudinal direction the pallets move by means of a frequency-controlled friction wheel conveyor system over roller blocks and in the transverse direction by means of cross-lifting truck pairs between the individual work stations. Vollert supplied the cross-lifting trucks with an intelligent synchronisation system in which an absolute value encoder controls the constant regulation of the truck feed. As soon as a deviation is measured, the control system regulates the speeds of the cross-lifting trucks, each of which transports one shuttering pallet to the next work process.

Pallet cleaning

For the cleaning of the pallets Weckenmann has installed a stationary pallet cleaner that has an additional cleaning unit for the removal of persistent contamination, e.g. facing paint. If there are fixed superstructures on the pallet, the cleaner is lifted by means of electric motors for free passage. Fine dust on the pallets is vacuumed off automatically.



The M-Basis/M-Top shuttering system before and after assembly. The transponders are located in a protected place on the faces of the profiles

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The Twin-Z shuttering robot makes extremely fast cycle times possible when positioning the shuttering on the steel pallets



In order not to hinder the pallet cycle, this procedure takes place at a second working level above the circulating system.



To this end hydraulic scissor-lift trucks lift up the shuttering pallets at a total of three positions to the individual post-processing stations at a lifting height of 2.80 m.



The three post-processing stations are equipped with laser projection units from Unitechnik

M-Basis/M-Top shuttering system

The M-Basis/M-Top system from Weckenmann consists of a base profile with integrated magnets onto which one or more profiles of various heights, but the same length, can be simply placed. The profiles can be locked to the base profile and the switchability of the magnets can be forwarded to the top side of the shuttering via a coupling element.

This shuttering system was used on a large scale for the first time at FBW. With 10 different base profiles and 2 different top elements, up to 27 different shuttering heights can be assembled within the range of 100 - 500 mm. The shutterings were built in 4 lengths from 750 mm to 3,000 mm.

During the realisation the question quickly arose of how the individual assembled elements can be reliably identified in automatic use in a robot environment. The previous method using sensors that sensed the length and the height of the profile no longer worked here, because it is quite possible for a shuttering height to be realised by different combinations of individual shuttering profiles. The Weckenmann engineers therefore decided to use RFID technology. For the clear identification of the shuttering parts they are equipped on both faces with RFID chips.

A RFID system consists of a transponder, which is located in the shuttering and contains an identifying code. All RFIDs of the assembled shuttering are read at an identification station and the characteristics of the combination shuttering are derived from this. The control technology from Unitechnik manages this universal shuttering system and thus regards assembled shutterings as a single shuttering.

Information that serves the control of production and the organisation of maintenance can additionally be written to the transponder within the production process if need be. In this way it is possible, for example, to determine the number of circulations of an individual shuttering profile and to send it for checking or overhaul after a certain number of uses.

Shuttering robot

The Twin-Z robot from Weckenmann has direct access to the shuttering magazine with about 150 magazine compartments, which can take up to 20 shutters on top of one another depending on the shuttering height. The positions of the individual posts are adjustable, which permits re-allocation of the magazine at all times. The robot fetches the very heavy shuttering profiles, which can be up to 500 mm high and 3000 mm long due to the combination possibilities described above, and places them quickly and precisely on the pallet. The work area measures 17.5 x 9.5 m. Due to the double Z-axe, which grips and switches the shutterings directly by the two integrated magnet units, the cycle time is only about 60 % that of conventional robot technology.



The pallets are subsequently taken to three independent parallel production lines for the manual placement of the reinforcement and the installation of the insulation



The concrete distributor is designed as a swap bucket system, each bucket having a capacity of 3 m³

Manual additional shuttering procedure at a raised working level

After the shuttering profiles have been positioned by the robot for the outline of the later precast concrete element, the pallet is taken for the manual placement of further special and built-in components, e.g. electrical wall sockets or timber frames. In order not to hinder the pallet cycle, this procedure takes place at a second working level above the circulating system. The engineers from Vollert developed a solution for this that makes it possible to decouple individual pallets from the circulation. To this end hydraulic scissor-lift trucks take the shuttering pallets out of the circulation in a fully automatic work process and lift them up at a total of three positions to the individual post-processing stations. As soon as the lifting height of 2.80 m is reached, the preinstalled extendable protective railings on the upper level are lowered and the pallet is freely accessible for the manual shuttering process. Weckenmann supplied three tool trolleys for the manual post-processing stations. Each trolley is equipped with a glue gun and a manual oiling device, for which the form oil is drawn from a central form oil tank. The three post-processing stations are equipped with laser projection units from Unitechnik, which provide for bright and sharp lines, but are designed such that working without safety glasses is possible. The laser projectors are controlled directly by the UniCAM master computer.

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Dave (54) gets his precast concrete elements to the right place at the right time. Integrating design and detailing with manufacturing and project management enables control from sales to erection with zero errors and efficient change management. Sharing the Tekla model allows all the project team members to stay in the building information loop real-time.



IWLAN antenna on the concrete distributor



The concrete is compacted after the concreting procedure by means of a combined shaking/vibrating station

That allows maximum control with regard to the information to be projected. The laser projection is used mainly for the positioning of electrical outlet boxes and load anchors. Once the pallet is released again, the fall protector drives back to its initial position and the pallets are lowered again and put back into the actual circulation.

Installation of the reinforcement on three parallel processing sections

After being lowered, the pallets proceed further to three independent parallel production lines, in each case to the next working position. There, the reinforcement, the insulation and the remaining built-in components are installed; further laser projection units from Unitechnik are attached above two of the stations for the placement of builtin components. Distribution to three processing sections ensures that, for example, special parts with particularly time-consuming work processes do not hinder the circulation cycle and lower plant productivity. As soon as the work procedure is completed here, the prepared pallets are taken to the concreting station.

Concrete distributor with data communication via IWLAN

The concrete distributor was designed by Weckenmann as a swap bucket system for grey and facing concrete, each of the two concreting units having a capacity of 3 m³, with spiked roller dosing for the processing of different types of concrete.

The swap buckets take up the concrete separately from the various mixers. To this end they drive out of the bridge extending in the longitudinal direction of the pallets onto two branch lines, on which the cleaning and maintenance also takes place. The concrete containers can be moved hydraulically by 1000 mm in a vertical direction, so that they can be adapted optimally to the different component heights. 'Industrial Wireless LAN', or IWLAN for short, from Unitechnik was used for the first time in the area of the concrete distributor. The concept with two buckets on a crossbeam serving two places requires a communication system with many degrees of freedom that nevertheless meets the requirements for real-time communication and makes safety functions possible. The IWLAN system from Siemens meets these requirements.

Weckenmann also supplied a floor-driving smoothing trowel, which can switch between the two concreting stations by means of a cross-drive and which is likewise equipped with a height-adjustable work platform. This allows the operators to carry out any necessary work on the already concreted slab without having to directly step on it, for example to carry out supportive compaction using an internal vibrator for complicated element geometries.



A floor-guided storage and retrieval device (SRM) with a wing traverse places the pallets into storage in the hardening chamber and removes them again fully automatically.



To this end the rack doors are opened first by a segment door opener and the pallets are then placed into or removed from the desired pallet compartment via friction wheels and a gear rack pusher



At the smoothing station the elements are post-treated several times if necessary, depending on the required surface quality



The tilting station from Vollert is designed for a maximum load of 50 t and enables the vertical lifting off of the concrete components over different angles of tilt

Compaction stations for different precast concrete elements

The concrete is compacted after the concreting procedure by means of a combined shaking/vibrating station from Vollert. Optimum surface and edge quality is thus achieved. The low-frequency vibrating movement is generated by four unbalanced drives, thus compacting the concrete. The unbalanced masses are synchronised differently, depending on the weight. This makes an optimum, circular shaking movement with low noise possible. The desired compaction can thereby be precisely adjusted. Considerably stiffer concrete can also be processed here. By lowering the water-cement mixing ratio while maintaining a constant early concrete rigidity, the cement proportion can be reduced by about 10 %. The concrete is additionally compacted by an integrated, high-frequency vibration station. For this the vibration energy of the eight external vibrators is transmitted to the pallet via the roller blocks.

For solid walls with upturn beams or with installed insulation, the concreting unit has a further vibrating station which is integrated into the parallel working line. The frame of the vibrating station lifts the shuttering pallet pneumatically out of the circulation for this. As a result, the effect of the 12





The loading solution supplied by Vollert allows the deposition frames to be taken up by a run-off truck and then transported further to the outdoor area



At the shuttering cleaning station the shuttering is cleaned, oiled and subsequently fed back to the magazine of the shuttering robot in accordance with its identification

external vibrators is also directed toward the centre of the pallet and provides for the necessary, high frequency compaction of the concrete. The vibrating station was fitted with an additional vibration decoupler in order to reduce noise emissions.

Hardening chamber with storage and retrieval machine and smoothing station

The insulated hardening chamber which, like the storage and retrieval machine (SRM), was supplied by Vollert, is heated and consists of four rack towers, each with 12 pallet storage compartments arranged one above the other. The floor-guided SRM with a wing traverse places the pallets into storage in the hardening chamber and removes them again fully automatically. To this end the rack doors are opened first by a segment door opener and the pallets are then placed into or removed from the

desired pallet compartment via friction

wheels and a gear rack pusher. In order to

keep the running and maintenance costs low, protection against rope breakage was increased for the SRM. By means of the appropriate dimensioning of guide rollers, rope drums and ropes as well as high-quality materials, the life span is extended by up to five years. Vollert uses rope suspension gear here with a spring system that absorbs the developing tensile force in a spring assembly, thus preventing rope breakage. A further special feature of the SRM is a light barrier that measures the height of the incoming precast concrete element and stops the work step by means of an automatic start/stop mechanism if the maximum permitted overall height is exceeded, for example in the case of protruding reinforcements or incorrectly attached built-in components.

After a hardening time of about three hours, the concrete elements are first taken out of storage by the SRM and then transported to the smoothing station on the opposite side, which is situated on an overhead work platform and is separated by fully automatic roller shutters. At the smoothing station, which was supplied by Weckenmann, the concrete surfaces are mechanically smoothed both with the disk and with trowels at three stations arranged in parallel. All drive movements and the speed of the smoothing tool are infinitely adjustable via radio.

The setting angle of the trowels can be adapted by electric motor to the respective concrete consistency. Depending on the required surface quality, the pallets are taken one or more times to the hardening chamber for pre-hardening between the smoothing procedures.

As soon as the final hardening time has been reached the pallet proceeds via a separate discharge compartment to the demoulding procedure. The passage is completely encapsulated so that no heat can escape from the hardening chamber.



For quality assurance a photo is automatically taken of each pallet before concreting using an industrial camera



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Tilting station for lifting off the precast concrete elements/run-off truck

In order to achieve the desired production capacities, the engineers from Vollert banked on optimum loading processes. "The tilting station is designed for a maximum load of 50 t. Vertical lifting off can take place at various angles of tilt, at an inclination of 72° or 75°, or even at an inclination of 80°, which is necessary in particular with special parts. The tilting station additionally has a hydraulically movable support beam designed to take the weight of the precast concrete elements. In the case of pallets with no fixed edge shuttering, the support beam moves beyond the edge of the pallet, thus preventing the concrete element from slipping during the tilting procedure", explains Björn Brandt from Vollert.

Deposition frames, on which the precast concrete parts are initially placed, are installed for the following loading process. These stand on deposition bolsters equipped with a special track-guided superstructure. This solution supplied by Vollert enables the deposition frames to be taken up by a run-off truck with two cross-lifting trucks and subsequently to transport them further to the outdoor area for loading.

Transport and cleaning of the shuttering

The shuttering is removed from the pallet by means of a bracket crane and a safe transport spreader bar and placed on a roller conveyor about 30 m in length. The shuttering is transported on this conveyor through the cleaner and oiler, supplied by Weckenmann, and subsequently identified by RFID readers. A lowering station then takes them back to the approximately 1.5 metre lower transverse cycle conveyor, which is located in the robot work area.

Quality assurance is written in capital letters at FBW

Particularly high importance is attached to the subject of quality assurance in the entire plant at FBW. A photograph is taken of each pallet before concreting. To this end an industrial camera was attached by Unitechnik at a height of 12 m above the workstation. The triggering and the transmission of the image file take place via the network. The UniCAM master computer takes care of control and archiving. Using the picture the condition of the pallet before concreting can be reproduced in the case of a complaint. In this way it is possible to document whether all built-in components and reinforcement elements were integrated and, to a certain degree, the dimensional accuracy of the pallet can also be verified

A second quality assurance step was installed by Unitechnik before the lifting off of the elements. After the shuttering has been removed from the pallet, the pallet drives through a measuring gate in order to reach the tilting table. While driving through the gate the elements on the pallet are measured three-dimensionally. The image of the produced element is now compared with the CAD data.

The graphic image of the elements is displayed to the employee on a monitor. Edges that lie outside the tolerance are marked red. Hence, faulty elements are recognised promptly and are not even delivered to the building site, which saves expensive complaint costs.

FURTHER INFORMATION



FBW Fertigbau Wochner GmbH & Co. KG An der Bräunegrube 2, 72358 Dormettingen, Germany T +49 7427 770, F +49 7427 77500 info@wochner.de, www.wochner.de



Prilhofer Consulting Christian Prilhofer Münchener Str. 1, 83395 Freilassing, Germany T +49 8654 69080 F +49 8654 690840 mail@prilhofer.com, www.prilhofer.com

Unitechnik

Unitechnik Cieplik & Poppek AG Fritz-Kotz-Str. 14, Industriegebiet Bomig West 51674 Wiehl, Germany T +49 2261 9870, F +49 2261 987510 info@unitechnik.com, www.unitechnik.com



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Vollert Anlagenbau GmbH Stadtseestr. 12, 74189 Weinsberg, Germany T +49 7134 520, F +49 7134 52203 info@vollert.de, www.vollert.de





Weckenmann Anlagentechnik GmbH & Co. KG Birkenstraße 1 72358 Dormettingen Germany T +49 7427 94930, F +49 7427 949329 info@weckenmann.com www.weckenmann.com







Before the hardened elements are lifted off, the pallets pass through a measuring gate in which the dimensions of the finished elements are documented and checked by means of industrial lasers