

Alabniah Precast Concrete Buildings Factory

Flagship Factory for the Precast Industry of the Kingdom of Saudi Arabia

Being the official production start date of Alabniah Precast Concrete Buildings Factory the 1st of January 2010 is a date not only starting a new decade but also a date where the Saudi Arabian precast concrete industry sees the most advanced and largest factory of its kind in the Kingdom starting off. The factory located in the Second Industrial Area of Dammam is the first of its kind in Saudi Arabia offering the combined advantages of state of the art modern production technology, high capacity and wide product range to deliver complete building systems and precast components into the market.

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Alabniah is a company founded in late 2005 with its headquarter in Al Khobar and it is a branch of the Adraj Holding Company. The chairman of the company is a strong believer in European technology and the necessity of creating a clean and modern working environment for the staff in the factory to ensure precast concrete products with top quality can be produced with high efficiency and at competitive prices. The aim was to set up a factory which delivers this objective on a long term basis and which is more than one step ahead of the other precast factories in the Kingdom producing mainly on stationary tables rather than using pallet circulation systems.

The factory offers 23.000 m² covered production area built on a site with a total of 112.000 m². The facility comprises not only the factory building but also spacious office building, canteen and prayer room. After foundation of Alabniah, a newcomer into the precast concrete business, a period of detailed market analysis and planning for the new factory began. This process was supported by Prilhofer Consulting who helped Alabniah to get an overview of available production methods and techno-



Factory Building

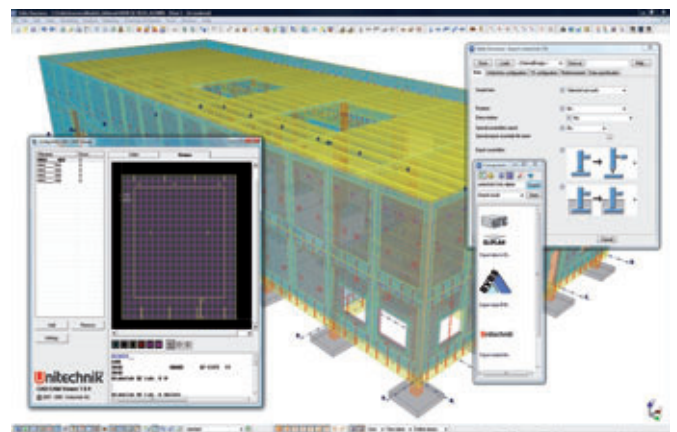
logies available in the market. This covered all aspects from low automated traditional methods to fully automated solutions integrating pallet circulation systems, shuttering robots and fully automated mesh making facilities. It became very clear during this process that a demanding market like Saudi Arabia with its large scale and high volume construction projects requires a facility to deliver a high output of quality precast concrete products within short delivery schedules. Therefore the task was for Prilhofer Consulting to design a factory that allows Alabniah to provide exactly this required capacity, quality and range of products. At

the same time the factory needed to be flexible enough to adapt to the needs of job related change of the product specification. The conclusion was to plan for high automated production processes, reducing manpower requirements and allowing for better control over delivery schedules and product quality. Furthermore it was a requirement by Alabniah to implement European standards on health and safety to provide a good and safe working environment which again has direct impact on product quality.

With the results of the initial market study and the clearly defined requirements for the



Office Building



Screenshot from Tekla Structures to Unitechnik Export

factory a layout for the factory was developed by Prilhofer Consulting and an equipment specification for all factory components was set up. After completion of the specification the tender packages were sent out and the equipment supplier proposals were received. Following a period of evaluation and negotiation the partners for the project were selected by Alabniah. In the end the project involved 17 different key companies and equipment suppliers to deliver a complete and working precast concrete factory.

The first period was an intensive design period coordinated by Prilhofer Consulting where all equipment supplier design information was received and translated into construction drawings for the factory building like foundations, steel superstructure, crane tracks, mechanical & electrical services, HVAC, IT network etc. This period involved Radicon Gulf Consult, a multi-discipline consulting firm for building and infrastructure design, Arcon as general contractor for the construction works and Zamil Steel for design and provision of the steel superstructure of the building.

Crane load information was delivered by Saudi Cranes supplying all external and internal cranes. Internet based document handling and project meetings held in Bahrain and in Saudi Arabia on a regular basis ensured that the design process went quickly through the required iterative design steps required to achieve the suitable designs for construction.

The Alabniah Precast Concrete Buildings Factory consists of the following production units

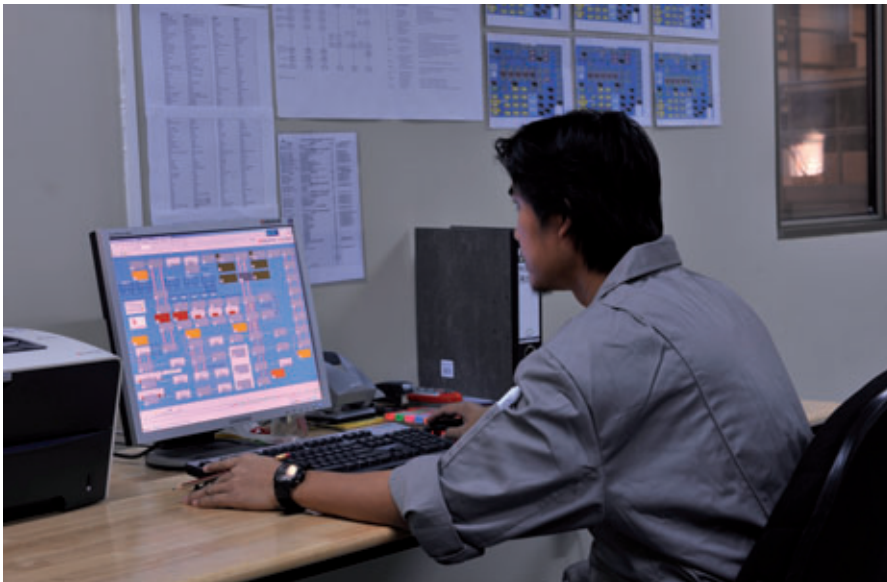
- Pallet circulation system for production of solid walls, sandwich walls, lattice girder floor slabs and double walls
- Reinforcement preparation with fully automated mesh welding machine, lattice girder welding machine, link bender, shear line for rebar, mesh cutting and mesh bending devices, cage assembly area
- Special elements area for pre-stressed double T-slabs, pre-stressed beams up to 40 m length, columns including foundation, stairs and other volumetric products
- Hollow core line for hollow core slabs up to 500 mm thickness.

Pallet Circulation System

The main part of the new Alabniah precast factory is the pallet circulation system specifically designed for the needs of Alabniah and the product requirements of the Saudi Arabian construction market. The circulation system delivered by Unitechnik, Vollert and Weckenmann is using pallets of 12.5 x 4.5 meter length and can produce panels up to 12 x 4.2 meters. Daily production capacity of the circulation system is up to 110 pallets per day, equalling to approximately 3.500 m² placed concrete every day.

Full integration of all factory components into the IT concept was an essential requirement. The circulation system, shuttering

robots, concrete spreader, mesh and lattice girder welding machines are fed with production data created in the Alabniah engineering department on specialized CAD software. The Tekla Structures software package allows the designers to develop the designs for the buildings and related precast elements in a full parametric computer model and with full 3D visualisation. This allows a quick design process and ensures that all panels required to build a building will fit together. All reinforcement details, connection details between the panels and all built in parts are modelled on the Tekla software. When design is completed and all collision checks and quality control routines have been carried out the created designs are exported into CAM files in the Unitechnik format 6.0. This is the standard interface description between the CAD design software and the machines in the precast factory. The design packages also comprise the workpapers for the staff in the factory in pdf-format and material lists for material procurement and preparation purposes. The design data are received and managed by the Unitechnik master computer in the circulation system. The master computer is used to carry out the daily production planning using the design data received and scheduling information of the ERP system. First step in the production sequencing is the pallet nesting procedure where the master computer is arranging the single elements onto the pallets according to a number of pre-set parameters, one of them the best possible use of the available pallet surface. The master computer also offers a



Unitechnik Master Computer in Main Control Room

full visualisation of the pallet circulation system and is managing the production data for the single work steps and automated machines. The master computer is also the link to the connected reinforcement machines to trigger the production start of the meshes and lattice girders, again specifically made to fit for each individual panel to be produced, and it also initiates the handover of mesh and lattice girders when the pallets arrive at the reinforcement handover stations.

The production process in the circulation system follows the same steps as in most other pallet circulation system. The steps are

- placing shutters by robot system
- manual completion of formwork, installation of window / door frames and other inserts like electro boxes
- placing of tailor made mesh reinforcement in one, two or even three layers depending on product type and specification
- completion of reinforcement and installation of fixings like lifting anchors, wire loops for wall connections, mounting parts, etc.
- concrete pouring and compaction
- wet surface finish
- curing of concrete in insulated curing chamber

- stripping of shutters
- product unloading
- surface finish like sandblasting or exposing aggregates
- delivery of complete transportation units to the stockyard

Specific Features of the Pallet Circulation System

The production process starts in the shuttering robot which is placing the shutters according to the element specific CAD data for each single element produced in the factory. The robot is working over two pallet positions. The layout allows continuous working of the shuttering robot without standstill times caused by pallet changeover processes. Shutters for solid and sandwich walls are provided by a separate storage robot which is placing the required shutters for the next pallets onto a conveyor belt feeding the shutters into the shuttering robot area. The shutter transportation, cleaning, identification and feeding units are built as independent units for solid wall shutters and floor slab/double wall shutters. This allows a full flexible mix of products in the circulation system by decoupling the process of stripping shutters in the stripping area from the process of placing shutters in the shuttering robot.

After the shuttering robot has completed a pallet with placing the shutters and plotting the additional required information the pallets are transported to the stations for manual completion of formwork. Upon arrival of a pallet at the manual workstation the pallet



Pallet Circulation System - Overview

occupation sheet showing arrangement of elements on the pallet together with basic element data and single element sheets with detailed information of the single elements are printed online and automatically from the printer installed at the manual workstations.

From the shuttering robot the pallets are distributed according to preset priorities into three production lines for the following processes. Depending on the actual product mix these three lines can either be used equally for the same product and therefore allow a high throughput of one product or alternatively the three lines are split for manufacture of different products. This logic provides a high flexibility for variations in the product mix. Even the combination of

high runners like lattice girder floor slabs in combination with sandwich walls will have no negative effects on the overall output of the pallet circulation system. In this case one or two lines are acting as the fast lines and one (or two) lines are dealing with the slower product e.g. sandwich walls which have a higher manual work content to be completed at each workstation.

A big percentage of the products will be sandwich wall panels and solid wall panels with a face shell of white concrete or concrete with special aggregates like marble chips. For this purpose the carousel system is equipped with two casting and compaction areas. The concrete supply is done by two separate concrete shuttles which deliver the concrete to two different handover

positions into the concrete spreaders used in these areas. A configuration like this is absolutely necessary to allow for clearly separated processes required for a high throughput and to avoid any quality issues on the product due to contamination of the concrete delivery and pouring equipment. The downtime due to wash down of equipment is also reduced to a minimum.

For sandwich wall panels a return line from the first casting process back into the mesh placing area is foreseen. The sandwich wall panels will get the one or two layers of mesh reinforcement in the structural shell automatically handed over by the mesh handling crane and will then run in max. two of the three available process lines through the remaining processes to complete the product.



Shuttering Robot



Process Lines



Casting Area

Most of the wall panels will have an exposed aggregate or sandblast finish on the external side of the wall. For the internal side of walls or for partition walls it is required to achieve a smooth, ready to paint surface finish. For this purpose a separate wet surface finishing area is foreseen in the circulation system. After concrete pouring and levelling by screed the pallets will be transferred into the finishing area where two helicopter smootheners are available to work on a total of eight pallet positions. With an achievable concrete age of approximately 150 minutes the layout provides enough pre-curing time required for the final surface finish. Considering the ambient temperatures in Saudi Arabia throughout most of the year the installed function of sending pallets into the curing rack for pre-curing is to be seen as worst case backup scenario to support a proper surface finishing process.

Alabniah decided to plan also for the equipment to produce double walls in the circulation system knowing the product double walls is not yet known in the Saudi Arabian market. Convinced of the advantages of the double wall and lattice girder floor slab system it has been requested by Alabniah to design a layout that implements the feature of producing double walls using the vacuum turning process. For this purpose Prilhofer Consulting planned for an area in the layout in such a way it will not affect the processes for other products neither if no double walls are produced nor if a big quantity of double walls is produced. Also a nearly exclusive use of the circulation system for producing double walls would be possible without negative effects on the plant's efficiency.

In a factory producing such a variety of products and offering a high flexibility on the product mix one of the most important aspects is the shutter removal and product unloading area. In many factories the main focus is on the robotic processes in the beginning but all efforts on these areas are badly affected by insufficient solutions at the back end of the precast panel production process. It is essential to have processes installed for each type of product without suffering from negative impacts between the different processes. A smart arrangement of pallet lines, process cranes for shutter handling, shuttering conveying systems, cranes for lifting wall panels and floor slabs and product deposit areas provides exactly this feature in the Alabniah factory.

At the end of the process many products require a sandblasted surface finish or exposed aggregates finish. The factory layout includes also an area for this process inside of the covered production facility.



Surface Finishing



Shutter Stripping Line



Product Unloading Area

It is necessary to integrate the surface finishing into the processes of the factory to enable compilation of complete transportation units inside of the factory to avoid double handling of precast panels on the stockyard. The ready made transportation units are delivered by a so-called run-off truck into the stockyard area where they are handled by a 32 ton forklift truck or by the stockyard cranes. For site delivery only one lift is sufficient for truck loading.

Reinforcement Area

To provide the required mesh reinforcement into a pallet circulation system as described above it is necessary to have mesh welding plant able to produce tailor made mesh nearly just in time. To decouple the mesh welding machine from the pallet circulation production flow a mesh buffer store has been designed to hold meshes for a maximum of ten pallets in the circulation system. The Filzmoser mesh welding line is linked to the master computer in the circulation system which is providing the current status

of pallets and related production units to the mesh welding line. The master computer is also setting the trigger points for mesh production and mesh delivery into the circulation system.

The mesh welding line can produce meshes up to maximum dimensions of 4.2 x 12 meters with bar diameters from 6 to 16 mm in both directions. With an hourly production capacity of 500 m² of special mesh the mesh welding line is a business on its own for Alabniah. Alabniah has already taken large scale delivery orders for tailor made meshes.

Complementary to the mesh welding line Filzmoser and EVG have delivered other equipment such as a lattice girder welding line for lattice girders up to 400 mm height required for manufacture of lattice girder floor slabs and double walls, a link bender for single links and stirrups, shear line and mesh cutting and bending machine. These components are required to deliver the reinforcement complementary to mesh reinfor-

cement in the pallet circulation system but also for the special elements area. In a dedicated cage assembly area the reinforcement for the special elements will be prepared.

Special Elements Area

For industrial and infrastructure construction projects the Alabniah precast factory includes an area for special structural elements. One part of this area is a flexible mould system for pre-stressed beams with a length of up to 40 m and a height of up to 2.2 meters.

The mould is supplied by Technoplan and is currently under installation. Pre-stressing equipment from Paul will be used on the beam mould as well as for the 80 m double T-slab mould provided by Weckenmann who are also supplying a twin column mould for columns up to 24 m length including a column foundation of maximum size 3 x 3 meters. For the element delivery to the stockyard two delivery platforms with 25 tons carrying capacity each are used.



Mesh Welding Line



Hollow Core Line



Stockyard

Hollow Core Line

The Saudi Arabian construction industry is consuming huge quantities of hollow core

slabs. To benefit from this enormous demand Alabniah has installed a hollow core production line with 6 beds of 150 m length and the possibility to extend the fac-

tory building for another bay sufficient to install of up to 8 additional beds of 150 m length. The Elematic equipment used for hollow core production is specified to make slabs of up to 500 mm thickness.

Concrete Batching Plant and Concrete Delivery System

The product variety of the Alabniah precast concrete factory sets very specific requirements to the concrete batching plant. Every production unit consumes big amounts of concrete which needs to have different properties for each of the products. For this purpose Prilhofer Consulting has specified a batching plant configuration with 3 mixers with two outlets each where one mixer is dedicated to mass grey concrete for pallet circulation and special elements area. A second mixer is dedicated to the hollow core line and a third mixer is to batch the special concrete types like white cement concrete and concrete using special aggregate for architectural requirements. The cement feeding from the four cement silos into the mixers offers the flexibility to produce every type of concrete in each of the three mixers. Two independent aggregate



Batching Plant and Concrete Delivery System

storage and feeding units with independent weigh belts and skip hoists ensure a high output and flexibility of the plant. Special aggregate can be used from the large storage bins or in case of smaller amounts required from big bags.

The Liebherr batching plant is connected to the concrete delivery system from Kübat using 4 concrete shuttles supplying to 7 handover positions to concreting equipment in the factory.

The concrete delivery system from Kübat is using 4 concrete shuttles supplying to 7 handover positions to concreting equipment in the factory. Each of the 4 shuttles can pick up concrete from each of the three mixers.

The batching plant configuration as described above (cf. Liebherr article in CPI 1-10) is not only offering a high output and flexibility but also a perfect fail-safe strategy. In case of failure of one component there is always a working replacement available so that the precast factory will never have to completely stop because of breakdown of the concrete supply.

A fully integrated concrete cooling plant supplied by KTI-Plersch including water chiller and flake ice system is ensuring healthy concrete temperatures also during the hot summer months.

Conclusion

Alabniah Precast Concrete Buildings Factory is starting up exactly at the right time to supply into one of the most vital markets for

precast concrete products worldwide. On top of this the enormous construction activities in Saudi Arabia are even topped by the fact that the Saudi Arabian government has launched a number of huge infrastructure projects like schools, universities, hospitals and others. This is generating a perfect environment to lead this project and Alabniah Precast Concrete Buildings Factory to great success in the near future. ■

FURTHER INFORMATION



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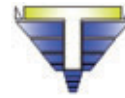
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