Progress Group GmbH, 60549 Frankfurt am Main, Germany

Singapore relies on precast concrete elements

Highly automated factories producing precast concrete elements have been initiated by the state to increase usage of precast concrete in Singapore construction industry. The slogan: out with time-consuming and labour-intensive traditional construction methods, in with maximum pre-fabrication. Straits Construction Group, one of the largest construction companies in Singapore recently commissioned such a plant. It produces not just wall and floor panels, but also pre-stressed solid slabs and 3D kitchen and bathroom modules - all this on several levels. The associated plant and software solutions have been developed by companies in the Progress Group. The subsidiary company, Ebawe Anlagentechnik assumed the principal responsibility for the overall concept and installation.

For some years now, Singapore has been promoting industrialisation and automation of its construction industry by means of numerous guidelines and incentives. The city state's objective is to optimise land use, to improve productivity and quality and to create new, more highly skilled jobs.

Precast concrete element technology for building space and rejuvenation of the city

In this context, precast concrete element technology takes on a particular significance. This is why the state building authority, the Building and Construction Authority (BCA) is encouraging construction companies to invest in this forward-looking technology. By means of tendering processes it is making land available for highly automated production plant and is inviting tenders for projects, which are then realised by private firms. These factories, known as ICPH (Integrated Construction and Prefabrication Hub), are intended to play a part in creating new buildings space in a fast, cost-efficient manner and thus to rejuvenate the building infrastructure in the coming years and decades.

A second ICPH (Integrated Construction and Prefabrication Hub) opened

At the beginning of October last year, the inauguration of the second ICPH was celebrated. Constructed by Straits Construction Group, one of the largest construction companies in Singapore, in close cooperation with companies in the Progress Group, the highly automated plant on 5 levels ensures the company's in-house supplies in prefabricated concrete walls and ceilings and entire room modules

From the left: Mr Ryan Lim (Assistant General Manager, Greyform Pte Ltd), Mr Hugh Lim, (BCA CEO, Singapore Government), His Excellency Dr Ulrich A. Sante (Ambassador of the Federal Republic of Germany to Singapore), Mr Wong Chee Herng (Group MD & CEO, Straits Construction Group), Mr Heng Swee Keat (Minister for Finance, Singapore Government), Mr Wong Swee Chun (Chairman, Straits Construction Group), Mr Lee Fook Sun, (BCA Chairman, Singapore Government), Ms Sim Ann (Senior Minister of State, Ministry of Culture, Community and Youth & Ministry of Trade and Industry, Singapore Government), Mr Kenneth Loo (Executive Director, Chief Operating Officer, Straits Construction Group), Mr Koh Yeong Kheng (Director for Finance, Straits Construction Group).

Minister for Finance: "ICPHs important for Singapore"

At the opening ceremony, which was held on 3rd October 2017 in the new works in the presence of the Minister for Finance, Heng Swee Keat, the Ambassador of the Federal Republic of Germany in Singapore, Ulrich A. Sante and the entire top management team from Straits Construction Group, it was generally felt that this technology has a secure future. In his speech, the Singaporean Finance Minister stressed the importance of such highly automated plants. "ICPHs are significant developments, housing exciting innovations and technologies that can raise productivity and bring new energy to the building industry." [1] Heng Swee Keat's opinion is based on four crucial points: firstly, ICPHs will optimise land usage, since several construction processes would be amalgamated in one place; secondly, such plants increase labour productivity, since less time and a smaller workforce are required to produce precast concrete elements; thirdly, the controlled production conditions make a significant contribution to improving the quality of prefabricated elements; and finally, new, more highly skilled jobs would be created, which would meet the increasing demands of the population.

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Photo: Greyform Pte Ltd

On 20.000 m² building land Straits Construction has constructed a twelve-storey dormitory block (in front) and a precast concrete element factory on a total of four levels with attached high-bay warehouse.

Straits wins bid for 20,000 m² land

In September 2014, after Straits Construction Group was awarded the tender for the 20,000 m² of building land in Kaki Bukit, the work for the new ICPH began. The new build comprises a four-storey factory and a twelve-floor dormitory block. In conjunction, Straits Construction Group has founded its own subsidiary company Greyform Pte Ltd, to operate the works.

Production on 4 levels

The factory building with its attached high-bay warehouse for floor and wall panels is unique in concept and form. On the ground floor the carrousel plant has been installed by Ebawe Anlagentechnik and lines for the production of pre-stressed elements have been installed by Echo Precast Engineering. The first floor houses the entire system from Progress Maschinen & Automation for the manufacture of made to measure mesh, while on the second floor the Tecnocom shuttering moulds for stationary manufacture have been housed. Bathroom and kitchen modules are finished on the third floor; these are then stored on the fourth and last floor.

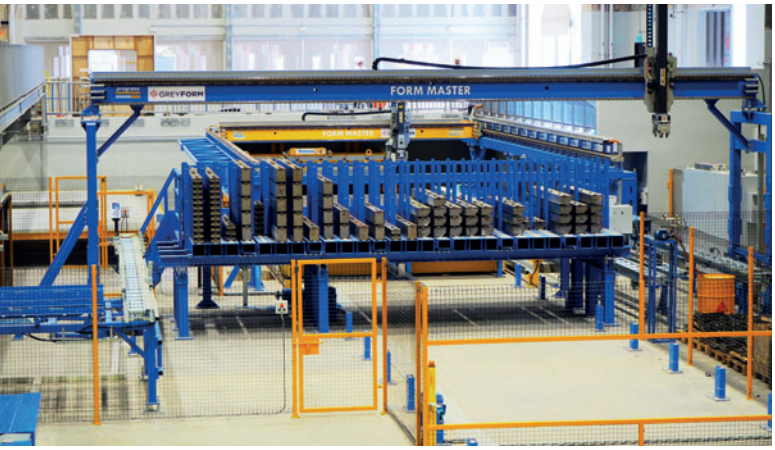
Ground floor: highly automated carrousel plant

The highly automated carrousel plant occupies the greater part of the ground floor of the factory. Ryan Lim, Greyform's Assistant General Manager stated, "This plant is the first in Singapore to use automated robot technology." He continued, "With its flexible design it not only ensures the highest efficiency, but also guarantees that delivery times are rigorously adhered to - even where the elements are totally different."

A total of 48 pallets circulate on the circuit. At the start of every production cycle these are loaded with the appropriate shutters by the Form Master shuttering and deshuttering robot. Once the made to measure mesh has been inserted, the fresh concrete is accurately spread by an automatic concrete spreader and compacted. A levelling and vibrating beam ensures that the elements' surface quality is optimal. Finally, a pallet stacker places the precast concrete elements in one of a total of 38 shelf compartments for curing. When the finished wall and floor panels have been removed and transported to the high-bay warehouse, the shutters are removed, cleaned and automatically replaced in storage by the deshuttering robot. Once the pallets have been cleaned, the cycle begins afresh.

Automatic delivery of the fresh concrete

Even the fresh concrete is delivered automatically to the carrousel plant. A bucket conveyor transports the material directly to the concrete spreader from a ground-batching plant, supplied by Wiggert & Co. GmbH. A second bucket conveyor system ensures that slipformer production is supplied with drier concrete.



The highly automated carrousel plant (in the picture the shuttering and deshuttering robot) allows Greyform with only a small workforce to meet precise delivery periods and the highest quality requirements.

At the end of the production cycle the finished solid walls or floors are removed from the pallet and automatically transported to the warehouse.

Even the fresh concrete is delivered automatically to the production lines by means of various bucket conveyors.

Innovative high-bay warehouse for 5,800 t precast concrete elements

The plant's special feature is the high-bay warehouse. Because of the scarcity of space in Singapore, the warehouse has not been planned horizontally, as is usual, but vertically. It is fully automatic and in 3 towers on 7 different levels it offers space for a total of 5,800°t of sold walls and floors, pre-stressed elements and hollow core slabs. In addition, entire racks, rather than individual concrete elements are stored and retrieved. This massively reduces standby time for the HGVs and therefore delivery time.

This degree of automation has a major impact on the productivity of the plant. "Within 10 days a workforce of 60 persons is able to produce precast concrete elements for 48 four-room dwellings. On traditional construction sites three to four times the number of employees and twice as much time would be required," said Assistant General Manager Lim with satisfaction.

Photo: Greyform Pte Ltd

Because of the demands on limited space, the warehouse has not been constructed horizontally, but vertically. The precast concrete elements are stored fully automatically on complete racks on one of the 7 levels and withdrawn again as required.

Greyform uses an S-Liner T40 slipformer on three beds for the manufacture of hollow core slab and pre-stressed elements.

Slipformer for the manufacture of hollow core slabs and pre-stressed elements

Greyform uses the S-Liner T40 slipformer from Echo Precast Engineering for the production of pre-stressed precast concrete elements. By means of three different slipformer moulds not only is it possible to produce hollow core slabs 7-40 cm in height and 120 cm or 240 cm in width on the 84 cm long production lines; pre-stressed solid slabs 7-20 cm in height and 100 cm or 210 cm in width can also be produced. Additional equipment, such as two different saws, a multi-functional trolley and the associated lifting equipment complete the plant. "The hollow core slabs allow us to cover longer span with single elements – in addition, it is possible to work on the construction site with less columns," explains Ryan Lim.

First floor: Production of made to measure mesh

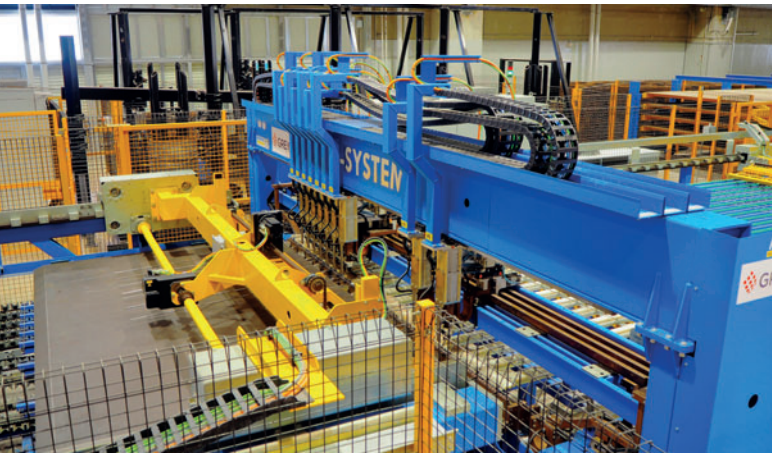
The steel mesh for all the production lines is produced on the first floor. "Here we have installed four different systems from Progress Maschinen & Automation, with which we are able to manufacture all the products required," says Lim with satisfaction. "This set-up allows us to react with a high degree of flexibility and to produce more than 100°t bespoke mesh, cages, bars and stirrups per day."

An M-System Evolution mesh welding plant is used here for the manufacture of bespoke mesh in various moulds and with bending run-off. The machine has been developed for flexibility in use and therefore blends in perfectly with Greyform's production concept. When the mesh has been produced, a crane automatically stores it in a buffer, from where the pallet circuit is supplied. Cage production is delivered and pre-stressed ceilings are manufactured by manual processes.

Bars, bars with bending run-off, stirrups and 3D stirrups are manufactured by the second system, an EBA S16 Plus 3D automatic stirrup bender. Fast, automatic wire change and fully automatic setting of the straightening rate ensure that production is fast and continuous. In addition, a Shear Line bending machine for individual rebar and a cage welding machine have been installed.

Staircase and 3D shuttering moulds on the second floor

The second floor has been reserved for stationary production. In addition to the three staircase shutters and in cooperation with the Northern Italian prefabricated bathroom specialists, Bathsystem S.p.A. four 3D shuttering moulds and the associated four production tables for the manufacture of bathrooms and kitchens have been delivered to Greyform. The 2.8 m high shuttering moulds are remarkably flexible, since both the wall shuttering and the floor slab are adjustable. This means



The made to measure mesh required is manufactured on the first floor of the factory building. The M-System Evolution mesh welding plant has been developed to make production as flexible as possible and blends perfectly into the overall concept.

An EBA S16 Plus 3D automatic stirrup bender is used for the manufacture of bars, bars with bending run-off, stirrups, and 3D stirrups.

Greyform uses four 3D shuttering moulds to manufacture room modules, which are fitted out as pre-fabricated kitchens and bathrooms.

that 3D elements can be produced in a variety of dimensions. Each module is manufactured in two sections, then placed together on one of the production tables, and provided with a floor.

Reduced costs thanks to pre-fabricated bathroom and kitchen modules

Because the pre-fabricated bathrooms and kitchens are up to 90% pre-fabricated, it is possible to reduce costs significantly. Sanitary equipment, electricity systems and furnishings are installed as part of the production process at Greyform. Thereafter the elements are loaded onto HGVs and delivered just in time to the construction site, where a crane places them in their final position. The company is thus able to comply with the 65% quota for pre-fabricated bathroom modules imposed by the BCA.

The pre-fabricated bathrooms and kitchens are 90% prefabricated. This considerably reduces both the time and cost required for installation.

Industry-specific MES and ERP systems improve productivity and quality

The software plays a large part in ensuring that the production processes run smoothly. The ebos® and ProFit MES systems, developed by Progress Software Development, consistently accompany all the aspects of the production process in the pallet circuit and manufacture of made to measure mesh. These integral systems thus replace a multitude of partial software solutions. This avoids interface problems and the employees can perform their entire work process in one homogeneous, user-friendly system. erpbos®, a solution developed specifically for the precast concrete industry, has been installed as the superordinate ERP system. It serves the planning and control of all business and production processes - starting from sales, calculation, project management through production and installation planning to logistics, materials management, controlling and Human Resources. The Assistant General Manager, Ryan Lim declares himself satisfied with the Progress Group's complete software package. "All these systems ensure a seamless flow of data, which increases not only our productivity, but also the quality and precision of our products."

Greyform: Focus on automation, in order to secure the future

The overall concept of the system is thus in perfect harmony with Greyform's objectives. Lim sums up, "We are concentrating completely on digital technologies and automation, in order to secure our ability to compete in the long term. We want to bring new, young skills into this old industry, in order to make it fit for the future." ■

Source

[1] http://www.mof.gov.sg/news-reader/articleid/1909/parentId/59/year/2017

Straits Construction

1969: Straits Construction founded by Wong Swee Chun
1982: first public housing construction project
2014: awarded contract for the construction of an ICPH (Integrated Construction and Prefabrication Hub)
2017: the fully-automated Greyform factory is opened

Figures and facts on the works

Operator: Greyform Pte Ltd
Location: Kaki Bukit, Singapore
Total surface area: 20,000 m²
Built area: 32,000 m²
Floors of dormitory block: 12
Works levels: 4
Off-premises storage levels: 7
Products: wall elements, floor elements (loosely reinforced and pre-stressed) hollow core slabs, made to measure mesh, staircases, 3D modules for bathrooms and kitchens
Production volume: 80,550 m³/year
Employees: 60 (production)

FURTHER INFORMATION

Greyform Pte Ltd
21 Kaki Bukit Road 6, #01-01 Greyform Building, Singapore 415806
T +65 6812 7777, F +65 6812 7779
info@greyform.sg, www.greyform.sg

Straits Construction Singapore Pte Ltd
16 Jalan Kilang, #05-01 Hoi Hup Building, Singapore 159416
T +65 6222 6722, F +65 6222 6033
enquiries@straitsconstruction.com, www.straitsconstruction.com

EBAWE Anlagentechnik GmbH
Dübener Landstraße 58, 04838 Eilenburg, Germany
T +49 3423 6650, F +49 3423 665200
info@ebawe.de, www.ebawe.de

Progress Maschinen & Automation AG
Julius-Durst-Straße 100, 39042 Brixen, Italy
T + 39 0472 979100, F + 39 0472 979200
info@progress-m.com, www.progress-m.com

Tecnocom S.p.A.
Via Antonio Zanussi 305, 33100 Udine, Italy
T +39 0432 621222, F +39 0432 621200
info@tecnocom.com, www.tecnocom.com

Echo Precast Engineering NV
Industrieterrein Centrum Zuid 1533, 3530 Houthalen, Belgium
T + 32 11 600800, F + 32 11 522093
info@echoprecast.com, www.echoprecast.com

Progress Software Development GmbH
Julius-Durst-Straße 100, 39042 Brixen, Italy
T +39 0472 979328, F +39 0472 979999
info@progress-psd.com, www.progress-psd.com