

Intelligent magnetic shuttering solutions for precast concrete elements with connecting reinforcement and complex geometries

Connection technology represents a particular challenge to planners and manufacturers in precast concrete construction. Numerous modern connection solutions are available for this. The choice of connection solution influences the requirements for the shuttering. It is primarily the connecting reinforcement that has far-reaching consequences for the formwork technology employed. As a specialist and innovator in magnetic shuttering technology, Ratec has developed various shuttering solutions for the problem of connecting reinforcement, which can be used in manual or automated handling or as a hybrid solution.

Several current solutions are presented in this article in order to demonstrate the numerous possibilities offered by intelligent shuttering technology for the manufacture of elements with connecting reinforcement without losses in quality or productivity.

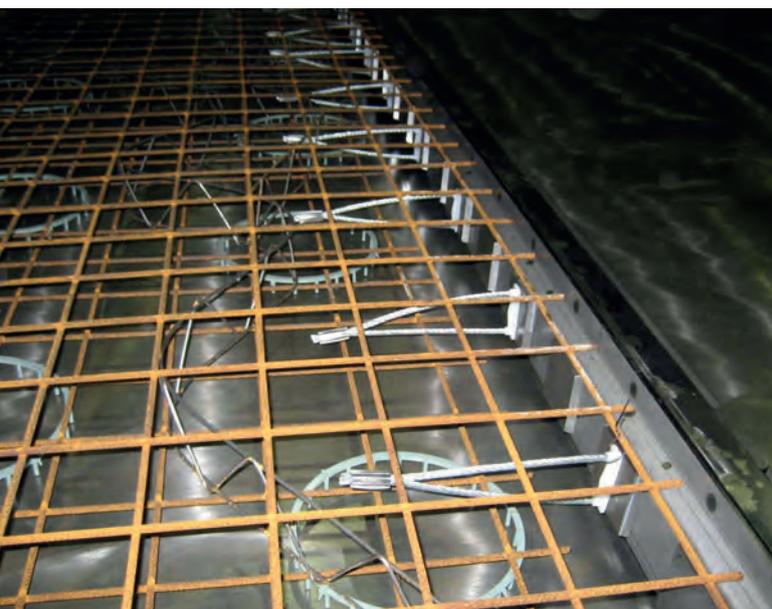
There are different reasons for the choice of the correct type of connection and the decision to use connecting reinforcements:

1. Building standards/norms
2. Structural reasons or requirements
3. Cost aspects (labour costs, shuttering costs vs. costs of the connecting material)

Solutions for elements with connecting reinforcement represent a particular challenge on account of the continuously growing demand for automatable shuttering solutions as a result of the increasing use of shuttering robots in precast production. Moreover, an important aspect is the problem of sealing and handling in conjunction with shuttering solutions for continuous reinforcement.

The goal here is always to obtain an intelligent compromise between the structural requirements and the objective of increasing the element quality and cost-effectiveness.

One tried and tested solution is the SAS-MF shuttering system from Ratec, which consists of a steel basic module to which



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SAS-MF shuttering system with connecting reinforcement or loop solution and shear key



Finished elements

various add-on modules can be attached. Connecting reinforcements, even with grouting groove and/or shear key, can be realised with the help of cut-out slots in the basic shuttering and the add-on modules. The customer can save the costs of a complete wire rope loop box through the use of a wire rope loop insert.

Special solution for loop connection

Shuttering with integrated wire rope loops held in the shuttering by means of a PE insert was developed for a project in South America. The PE holder can be pulled out of the shuttering for stripping, subsequently removed from the loop and reused for the next concreting procedure. Here too, the ob-



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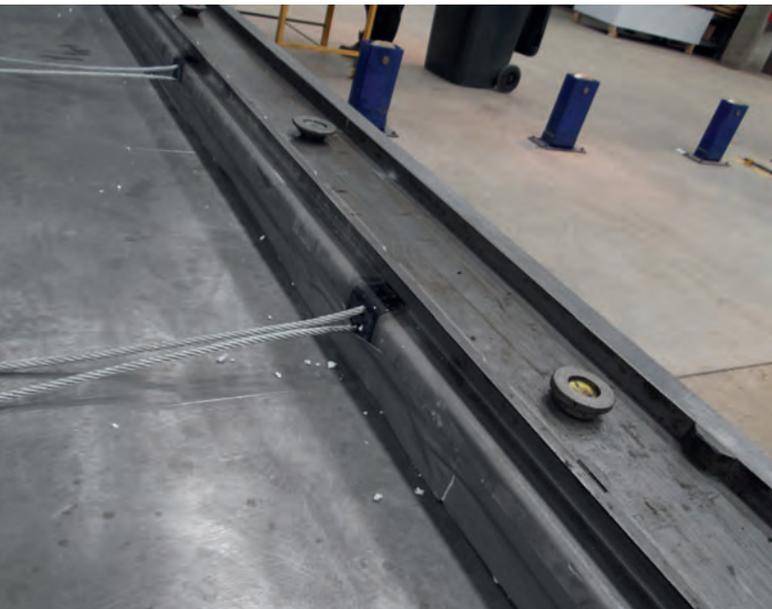
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Shuttering with integrated loop

jective was to reduce the costs for complete wire rope loop boxes.

A magnetic grouting groove for fixing to the pallet and a magnet box for erecting, also with an integrated loop, were developed for the realisation of corner-joint connections.

The static approval of the connection solution, which was confirmed in the specific project, was decisive here. The shuttering was virtually refinanced by the saving of costs for the wire rope loop connections.

Restriction of building standards/norms: social housing construction in Singapore

Singapore is one of the regions in Asia with the strongest booms in precast construction and has some of the most modern precast plants in the region.



Horizontal grouting groove with wire rope loop boxes

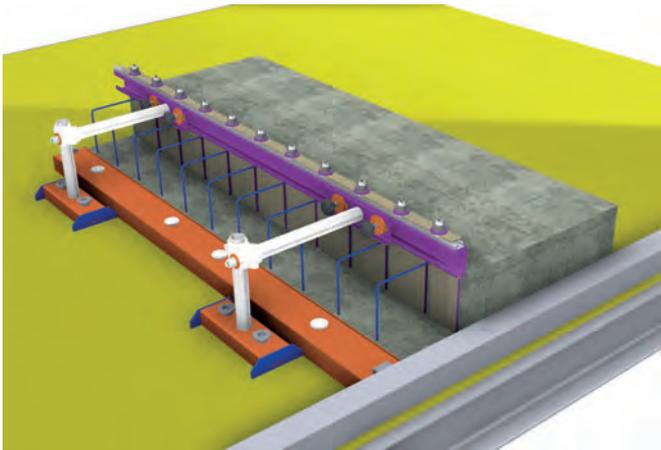
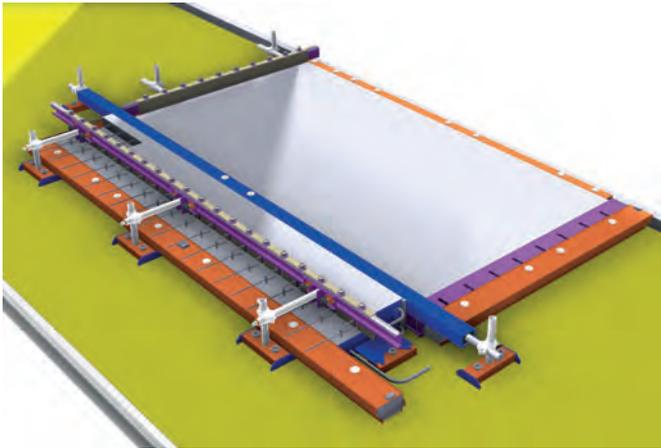
The Singapore Housing Development Board (HDB) issues standardised structural specifications for precast concrete elements for social housing construction. Up to 70 % of the structure of a typical HDB residential building consists of precast concrete elements. The element catalogue presents manufacturers with the challenge of implementing the complex connection specifications with connecting reinforcements with the highest possible degree of automation and minimum manual effort. Ratec developed a suitable hybrid solution for a customer in Singapore that contains both robot-compatible shuttering components and manual additional components. The core is a newly developed magnet adaptor which, although simple to use, reliably and intelligently solves most of the problems presented by the complex element geometries. The magnet height is flexibly and infinitely adjustable. A cross bar serves as a holder for various add-on modules, for example C-rails for formwork timber as well as fixed and flexible chamber modules for continuous reinforcement.



UAR universal adaptor with fixed comb module for connecting reinforcement



Flexible comb module with reinforcement



Shuttering examples with robot-compatible standard shuttering elements and universal adaptor

The robot initially sets a large contour in place using standard shuttering elements as far as possible. All magnet adaptors for fastening the comb modules for the connecting reinforcement can subsequently be attached to the shuttering, making additional measurement unnecessary.

The comb module can be configured individually or with fixed distances in order to implement various distances between the rebars. The front side of the comb plates is profiled for the sealing of the reinforcement slots. The rough surface profile left behind in the element also serves as a sort of shear key later on when grouting the butt joint on the building site. The majority of the standardised elements can be realised through the combination of robot-compatible transverse and longitudinal shuttering elements and the adaptor for the moulding of upstands/supports with connecting reinforcement. The aim was to provide the customer with a shuttering construction kit containing largely standardised components.

Special shuttering for Forest City mega-project– maximum flexibility with reinforcement penetration

Only a few kilometres from Singapore as the crow flies lies Johor in southern Malaysia, where the green light has been

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given for a highly ambitious development project: Forest City. This is the largest city development project in Asia and is intended eventually to offer new homes to about 700,000 people in an extensively greened, sustainable "smart city". Several precast plants are being built for the construction of the greened, architecturally sophisticated residential buildings and the first of these plants recently went into operation. Ratec magnetic shuttering technology is used here. Apart from robot-compatible standard shuttering for the production of wall and floor slab elements, the Ratec engineers have also developed a new shuttering solution to meet the specific customer requirements for the realisation of the sometimes complex element details.

The difficult shuttering challenges can be solved quickly and easily with the new Easy Form shuttering system. The system consists of a basic carrier with a height of just 25 mm, which is built up vertically via ribs and clad with timber. Ribs of various heights enable a smooth change in the shuttering height. Continuous reinforcements from a height of 25 millimetres can be realised with the flat base. Easy Form has been designed as a construction kit that is easy to expand and supplement and is already very flexible in use with few components. Thanks to the wide range of accessories, this system provides the solution to all shuttering problems. Even complex geometries with upstands and protruding reinforcements can be realised in an uncomplicated way. Here too, the previously mentioned universal adaptor is used for supports and setbacks with connecting reinforcements in the element. Due to the flexible options for bolting robot and crane attachments to the basic carrier, Easy Form - once assembled - can be manipulated simply by crane or spreader bar. Sealing parts optimised to the reinforcing steel are available for the sealing of the reinforcement penetration. Although it requires manual effort for the assembly, Easy Form also enables a flexible reaction to different requirements with just a few shuttering components. The system can be configured individually to suit requirements and offers a high degree of flexibility. In combination with robot-compatible standard shuttering elements, it is suitable for use as a hybrid solution for production with large numbers of variants.

Application has been made for a patent for the system.

Automated shuttering solution for elements with connecting reinforcement

A robot-compatible solution was developed for a customer in Austria for the production of elements with connecting reinforcements and floor slab supports. The goal here was to reduce manual work and the consumption of formwork timber in future. A solution was realised in the form of standardised magnetic shuttering profiles and a special floor slab support crate with slots for the connecting reinforcement. The shuttering is profiled with a round shear key, which additionally reduces the shuttering costs. The magnetic stop ends can be handled by spreader bar or shuttering robot by means of gripping knobs; the floor slab support crates are manipulated with an electromagnet. Rubber profiles in the shuttering take care of sealing. It was important here for the special stop ends



Easy Form in combination with universal adaptor for complex element details with connecting reinforcement



Shuttering with shear key and reinforcement penetration and finished element

to be able to use the same interface for shuttering transport and shuttering cleaning as all other automated shuttering. A suitable stripping aid for the magnetic stop ends was also developed. The solution is currently in the testing and further development phase, but is intended to gradually replace the shuttering used so far.

Conclusions

Connecting reinforcements usually mean a great deal of time and effort for the shuttering technology and high consumption of shuttering material such as timber or polystyrene and the associated additional costs. The enormous expenditure



Shuttering with floor slab support crate and finished element



of time is one reason why the desire for smart shuttering and production solutions is growing.

Provided the number of different variants lies within a reasonable range, automation can already be achieved to a great extent with a shuttering construction kit and a suitable shuttering solution. Manual work can only be entirely eliminated in rare cases, but it can be reduced through the use of intelligent shuttering components. Efficient hybrid solutions can thus usually be realised without problems. A central component in this is the individual evaluation of the boundary conditions and a holistically oriented consideration of the upstream and downstream processes in the plant. ■

FURTHER INFORMATION

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