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Potentials for automation in precast plants – Part 2

The "Potentials for automation in precast plants" series introduces automation solutions for operations that are currently still carried out manually in most precast plants. The first part of the series, which was published in the last edition of CPI, focused on automatic positioning of electrical box magnets. The fast and exact production process enabled by this automation technology can offer significant benefits for operators of precast plants. The current part of the series introduces a further automation solution.

Automatic placement of threaded sockets and recess bodies

The second part of the series introduces a sophisticated system for automatic positioning of threaded sockets and recess bodies that was implemented by the companies Unitechnik and Vollert|Weckenmann at Yamax in Japan.

Motivation

Current practice on Japanese construction sites is to screw all cables and lines including electric, water, heating, gas, waste water and ventilation ducts under the ceiling. The whole installation is then concealed by a suspended ceiling. This installation practice necessitates a large number of dowel-holes and ceiling perforations. However, Japanese building regulations forbid holes to be drilled in finished ceilings, not to mention larger openings. The risk of cutting through reinforcement steel, thereby weakening the structural characteristics of the ceiling, is deemed too great. For this reason in Japan all ceilings have to be preconfigured with all required fasteners and openings. The company Yamax supplies slabs with cast-in threaded sockets and recesses of different sizes. The threaded sockets come in different colours to identify different trades. For example, plumbing contractors use the blue sockets while electrical contractors use the red sockets. The colour coding therefore prevents mistakes during assembly. Openings may be round or square and have different sizes. A prerequisite for efficient working on the building site is thorough planning. The layout drawings must show all pipe and line routes in precise detail. The fixture and slab piercing positions are then specified along these routes.

Task

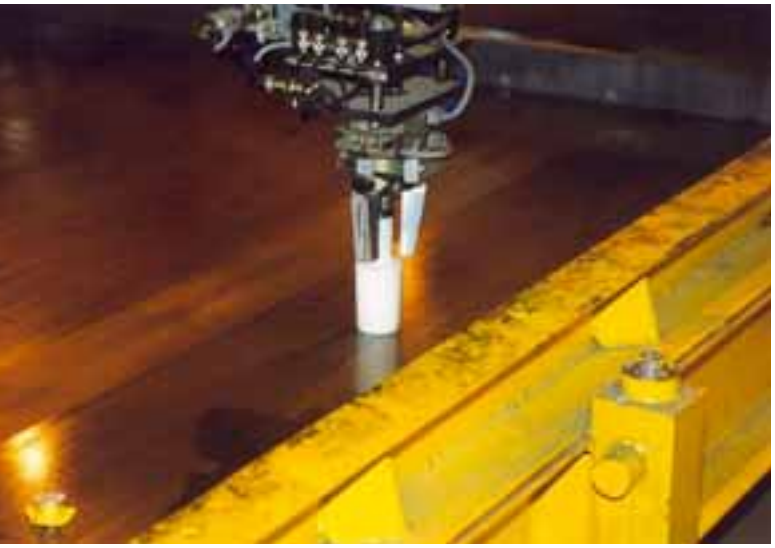
Automated production of such intelligent slab elements was implemented in a state-of-the-art pallet circulation plant north of Tokyo. The system realised by Vollert|Weckenmann and Unitechnik was designed for the production of semi precast slabs precast slabs and solid walls. The innovative insert robot is a novelty in this sector. The implementation of this station required stringent specifications to be meet. The automatic system was required to have access to 10 different threaded sockets and 10 different recess bodies. In order to be able to place around 100 inserts (threaded sockets and recess bodies) on a pallet without reducing plant performance the system also had to meet stringent requirements in terms of cycle time. The time between two insert positioning operations had to be significantly less than 10 seconds.

Implementation

The inserts are supplied via a conveyor sheet. The conveyor sheet has recesses or bolt to ensure precise positioning of the inserts. A rotary table with 2 levels can hold 20 such conveyor sheets. If certain inserts required a shuttle travels to the rotary table and automatically picks up the corresponding tray. The shuttle travels parallel to the long side of the pallet and always positions itself at the level of the insert robot.

The insert robot, a portal robot with automatic gripper changing system, positions the threaded sockets and recess bodies on the pallet. Optimised gripper systems were developed for the different inserts. Three different gripper types are used in the plant. Round recess bodies have a narrow round shaft and are held with a three-jaw gripper. They feature permanent magnet on the underside in order to ensure a secure connection with the pallet.

Threaded sockets are picked up via an electromagnet. They are fastened on the pallet about using special adhesive that is



The insert robot positions a recess body

The insert robot positions threaded sockets

Reinforced pallet with recess bodies and threaded sockets

The shuttle ensures short travel paths of the insert robot

even suitable for oiled pallets. The travelling shuttle is equipped with a hot-melt-applicator for applying the adhesive. A circular adhesive patch is applied below the threaded sleeve. The robot then positions the sleeve precisely at its target coordinates. Here too the cycle time between inserts is significantly less than ten seconds.
The third gripper type is a special gripper with 2 electromagnets. It is used for positioning large recess bodies.

The control system indicates when a conveyor sheet is about to run out of stock and has to be replaced. This exchange can take place at two circular table positions. The UniCAM master computer receives the position data for all inserts from the CAD system and controls the travel paths of the robot and shuttle such that the cycle time is optimised.

The recess bodies are removed from the finished slab elements, cleaned and returned to conveyor sheets. The threaded sockets naturally remain in the precast concrete component.

Conclusions

With a large number of standardised built-in components it is worth having a dedicated robot for positioning these components. In order to be able to handle the high number of positioning operations within the required cycle time frame, each system has to be optimised for the respective application.

The question whether slab elements with such a high degree of prefabrication could successfully be sold outside Japan cannot be answered easily. A prerequisite would be very detailed construction engineering on the part of the contractor. All contractual phases would have to be exactly defined at an early stage. The benefits are faster construction progress on site and enhanced quality through precisely defined pipe and cable routing.

The shuttle fetches a conveyor sheet with threaded sockets from the rotary table

FURTHER INFORMATION

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