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# Manufacturing sandwich walls in a battery mould

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**A sandwich wall is composed of three layers: a facing layer, an insulating layer and a load-bearing layer. These walls are typically made horizontally and have a formwork-smooth main visible side, usually the facing layer, and a rough main visible side, usually the load-bearing layer. In a new production process using battery formwork, sandwich walls can also be manufactured with a formwork-smooth, or ready-to-paint, load-bearing shell, which reduces follow-on costs on construction sites.**

Until now, manufacturing sandwich walls in battery formwork was deemed difficult to perform and inconvenient in terms of production. It is difficult to maintain dimensional accuracy with the individual layers and setting up all components in an upright and dimensionally accurate manner is time-consuming and involves the use of cranes. On top of that, the insulation has to be secured against floating up from its position. These disadvantages have been eliminated in a new two-stage process. As part of a test series, sandwich walls were manufactured in battery mould using a single-stage and a two-stage procedure.

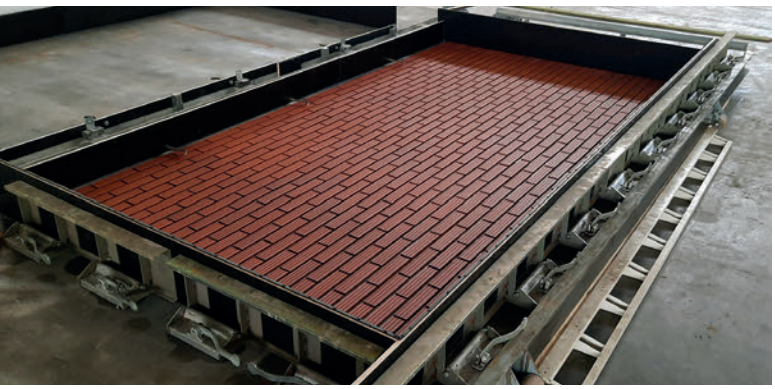
## Manufacturing sandwich walls in a single stage

In the single-stage procedure, the formwork was fixed and sealed upright in the battery mould. After release agent had been applied, a reinforcement layer for the facing shell, a compression-resistant insulation layer with ThermoPin composite anchors and another reinforcement layer for the load-bearing shell were placed one after the other in the formwork. The insulation was additionally secured against floating. The ThermoPins have to fulfil the function of spacers in addition to their function as connecting elements between the facing and the load-bearing shells. In this case, the rebar carries two collars with large support plates that facilitate fixing the insulation in its intended position. The composite anchors are configured in such a way that they abut the formwork surface with their pushed-on cap. After closing and bracing the formwork, it was filled with concrete, keeping the filling levels on both sides of the insulation similar to prevent the insulation from shifting against a formwork face of the battery mould.

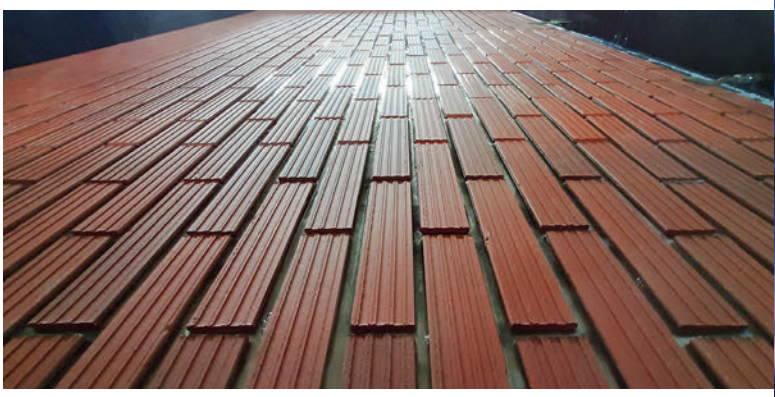
The result is a sandwich wall with formwork-smooth main facing sides on both sides. The great manufacturing complexity and its associated reduced cycle times for the battery mould as well as the high number of tie bars needed to hold the insulation layer in position must be considered in this procedure.

## Manufacturing sandwich walls in two stages

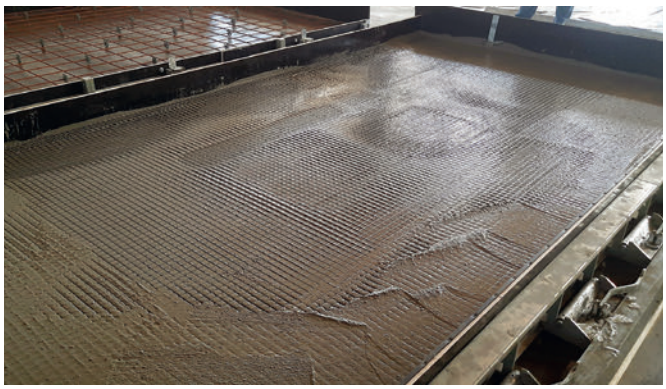
Sandwich walls were produced in a butterfly formwork in the two-stage process. For this purpose, the butterfly form-



*Unfolded butterfly formwork, prepared with perimeter formwork made with MultiForm and MagFly AP. Clinker brick strips were laid on one half of the butterfly formwork*

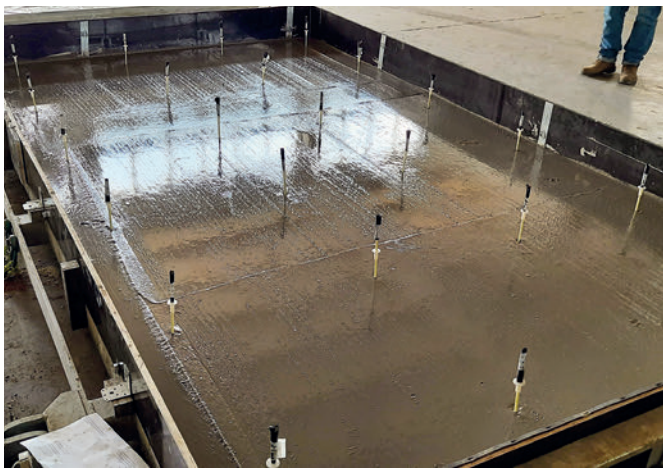


*Clinker brick strips, fixed in the formwork with LiquidForm, a transparent, colourless grouting compound*



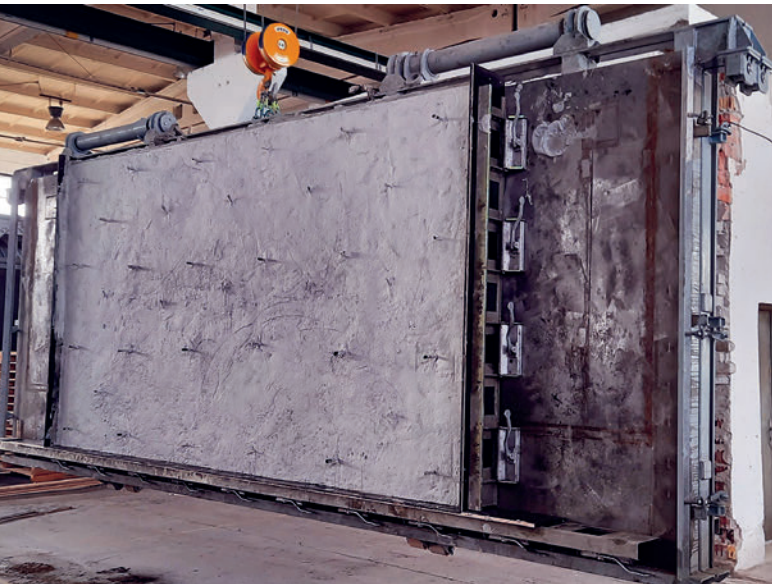
*Half-concreted facing shell with fitted carbon scrim from Hitexbau.*

*Front: Carbon reinforced facing shell with laminated carbon scrim. Rear: steel-reinforced facing shell of a sandwich wall during concreting.*



*Carbon reinforced wall with ThermoPins fixed in place*

*Hasit POR foam mortar as mineral insulation flows unproblematically around the ThermoPins*



*Butterfly formwork suspended from a crane, covered on both sides with the facing shells and insulation layers of a sandwich wall*

work is set down in an unfolded position and the formwork is measured and fixed on both sides of the butterfly formwork. In principle, these operations are compatible with common robot technology. After release agent application, the facing shells were concreted and insulation layers were applied to the fresh concrete. PU insulation blocks were used as insulation on the one hand and innovative mineral foam on the other.

Further innovations were tested whilst producing production sandwich walls in the butterfly formwork. Clinker brick strips were positioned on the formwork to create the outer facing shell surface of the sandwich wall. The empty spaces between the brick strips were filled with LiquidForm, a grout that can be applied in liquid form, is harmless and can be easily washed out later. LiquidForm was dissolved as a powder in warm water and poured between the brick strips to fill cavities. Within 15 minutes, LiquidForm had formed a solid matrix and concrete could be poured onto the brick strips. In the case at hand, a thin layer of fresh concrete was applied to the fixed clinker brick strips and removed. An HTC 21-80-80 carbon scrim made by Hitexbau was laid on the thin concrete

layer and laminated with a second layer of fresh concrete. In this way, thin, textile-reinforced facing shells can be easily produced in the battery mould. ThermoPins were integrated into the fresh concrete of the facing layer as a connecting element between the facing layer and the load-bearing layer. POR mineral foam from Hasit with a density of 150 kg/m³ was applied within a few minutes to the still fresh concrete as insulation. This mineral foam is free-flowing and effortlessly enclosed the ThermoPins and integrated components. After the textile-reinforced facing shell and the mineral foam insulation had hardened, the butterfly formwork was picked up by crane and the butterfly, which was covered on both sides, was suspended in the battery mould. The battery mould was then closed and the mould filled with concrete to create the remaining load-bearing shell. The result is a formwork-smooth sandwich wall on both main sides or a sandwich wall decorated with brick strips on its surface.

It could be demonstrated in the production series that precast concrete elements, ranging from very simple to highly complex, can be produced unproblematically with the butterfly formwork and associated battery mould. Sandwich walls produced in this way are dimensionally accurate and can be finished using standard machine technology.

## Butterfly formwork in a circulation system

In the present case, the butterfly formwork was suspended in the battery mould by means of a crane. In future systems, the insertion of the butterfly formwork will be automated and, if preferred, performed "from below". In such cases, battery moulds can function as part of a circulation system in which the butterfly formwork is moved from station to station, as in a horizontally operated pallet circulation system, and is fed to the battery mould in the final step. Sandwich wall production is easy to implement in systems in which a position can be provided where the concrete can harden on butterfly formwork outside the circulation system itself. The product variety of precast concrete elements that can be manufactured using battery moulds will then have been extended to include sandwich walls.

## Thin-walled load-bearing shell despite shear force loading

Sandwich walls manufactured in this manner are shear-loaded walls in their construction state that can be loaded quickly

*Fitting a compartment of battery mould with MultiForm und MagFly AP formwork. A reinforcement layer for the load-bearing shell and compression-resistant insulation with pre-installed ThermoPin connecting bars had been positioned in the formwork*

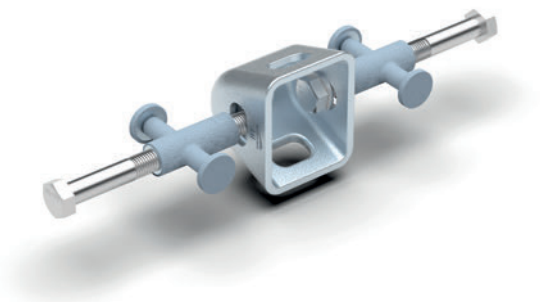
*Butterfly formwork suspended in the battery mould. Before closing the compartment, the supporting shell reinforcement was installed in front of the insulation*

*Finished sandwich wall with decorated facing shell surface and a formwork-smooth rear side directly after stripping the formwork*

*View of the surface of a finished sandwich wall with textile-reinforced clinker brick facing shell, mineral foam insulation and steel-reinforced load-bearing shell. LiquidForm residues will be removed with a high-pressure cleaner*

after assembly, yet still have thin load-bearing shells in order to save resources. To meet these requirements, the innovative BT Q anchor was used in combination with a BT Spannschloss (turnbuckle). Thanks to its lateral tie-back points, the BT-Q anchor can introduce shear forces very deeply into structural elements, so that concrete can be utilised very efficiently as a surrounding matrix with high shear forces being safely transferred even with thin concrete shells.

At the B.T. innovation GmbH stands at bauma 2022, (Hall B1 / Stand 325 & B3 / Stand 102) you can get an overview of both the results and the products used. ■



*Wall elements are connected to each other by means of BT Spannschloss (turnbuckles) and BT Q anchors*

## FURTHER INFORMATION

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