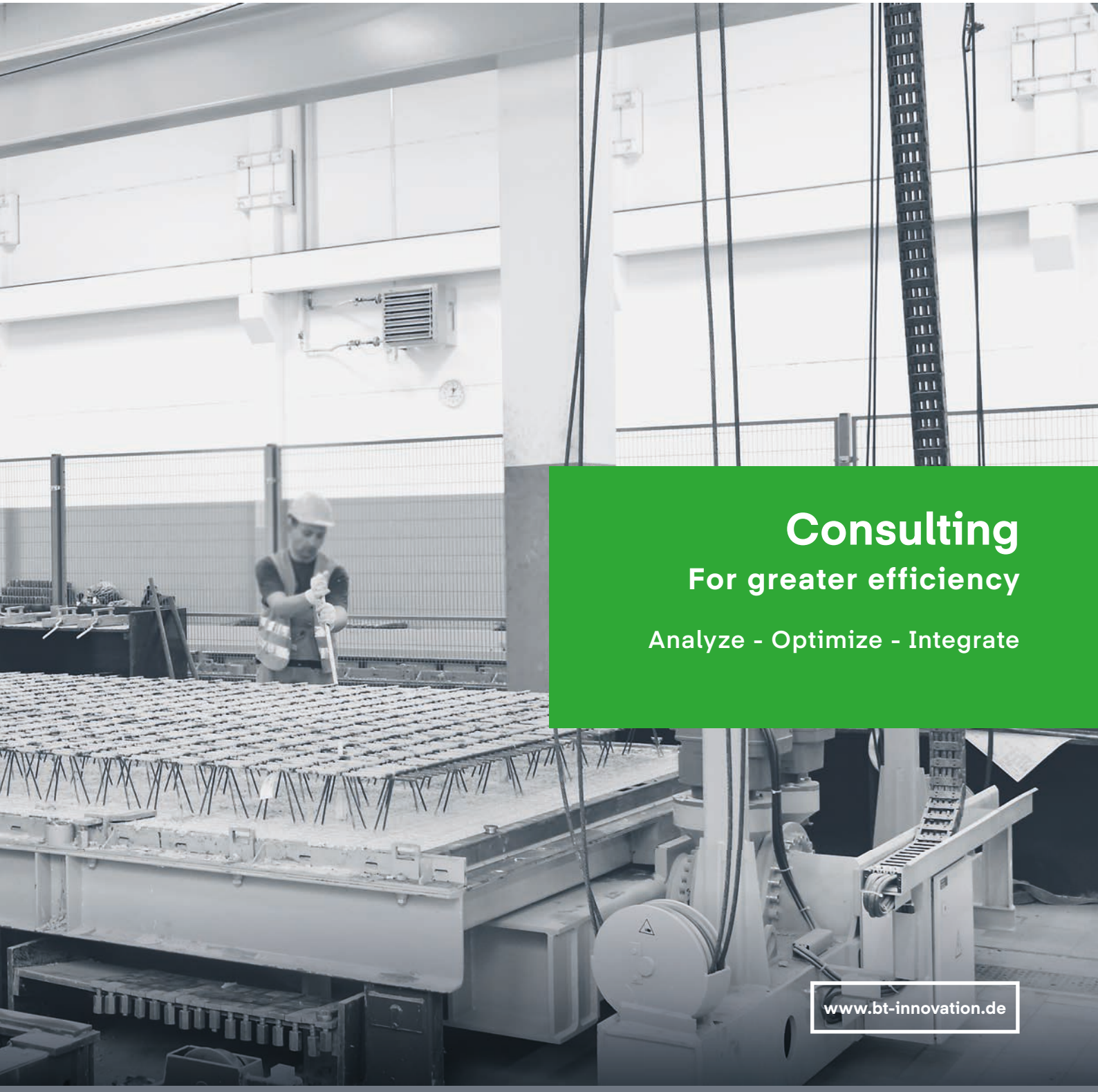
English

For faster construction

BT innovation



Consulting

For greater efficiency

Analyze - Optimize - Integrate

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BT INNOVATION – FOR FASTER CONSTRUCTION

Consulting – for greater efficiency

SINCE ITS ESTABLISHMENT IN 1991, B.T. innovation GmbH has undergone an extraordinary transformation. Originally operating as a regional wholesaler and foreign trader for special building products, the company has developed from a simple trader to a modern producer of innovative products and an internationally operating, competent supplier and service provider for the construction and precast concrete industry. Due to its diverse business relationships, BT innovation has evolved into a reliable partner for customers and dealers from North and South America, Africa, Europe, as well as large parts of Asia and Oceania. As a team of experienced engineers and business economists, BT innovation can develop technically feasible and economically viable solutions for any precast plant. We know the industry and have frequently demonstrated the ability to find practical solutions to your problems. The high number of certifications, building inspectorate approvals, utility models and patents are an impressive proof of this. In addition to consulting, planning and realisation of new constructions and conversions of precast concrete plants, we offer our customers a wide range of products. Our product portfolio ranges from magnet technology, complete formwork systems and the corresponding accessories to a wide range of other products and inexpensive spacers. Despite the rapid development of the company, we have not forgotten our origins: Time and again, we have been able to deliver innovative and unique products for the construction site. Our know-how, our knowledge of the market, our regular, constructive dialogue with our customers and business partners and our unwavering courage to innovate are the foundation of our performance. And for you as our customer, the benefit is obvious: Through the direct implementation of all offered services and products, you receive first-class advice and highly sophisticated products from a single source.

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We will be happy to send you further information on request or prepare an offer specially tailored to your requirements:
projects@bt-innovation.de

Alternatively, you can use the download section on our website:
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B.T. INNOVATION GMBH

Profile

BT innovation has been active in the construction and concrete industry for over 30 years - both as a consultant and a supplier. Alongside the development, production and distribution of innovative products, we also provide independent and competent advisers and consulting services for the precast concrete industry. In terms of consulting, in a nutshell, our range of services includes the analysis, planning and realisation of modern production facilities for the diverse range of clients in this industry.

WHO WE ADVICE

Target groups

Precast Concrete Plants

We provide consultation services for operators of precast plants who want to expand their capacities in a targeted and sustainable way, and who strive to improve quality levels. Our consultations are always designed with the aim of increasing the client's profitability, and thus improving their competitive edge. To that end, we optimise the relevant processes in collaboration with the client. When a client wishes to expand their portfolio for a specific target group, we are also there to offer expert guidance.

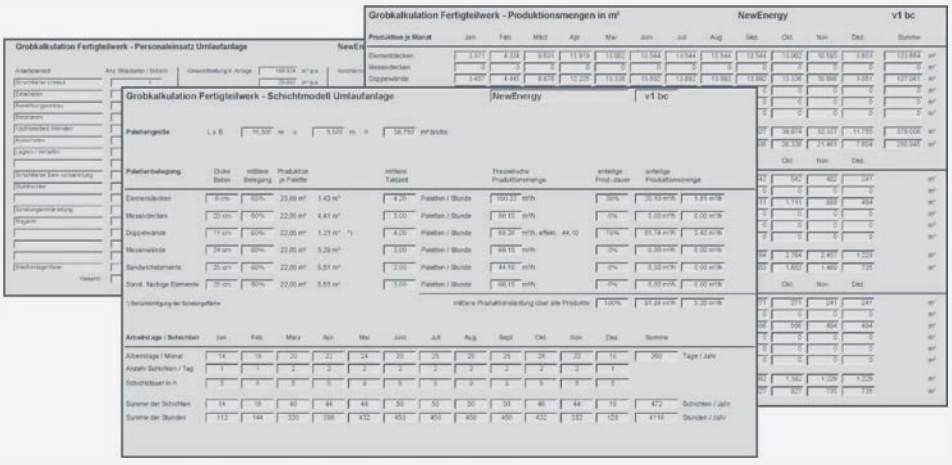
Where clients are planning to invest in new systems, our consultants help them to avoid poor investments, by suggesting the appropriate equipment as the result of a comprehensive, independent analysis of modern production systems, and with a view to optimum efficiency. For the purchase of new equipment, we stand by our motto of only ever suggesting technology, which is genuinely necessary; we don't simply calculate the maximum technology possible. When implementing projects, meticulous planning and expertise help you to avoid unnecessary additional costs from the outset.

Construction Companies and Classic Concrete Plants

Amongst our clients are a variety of construction companies who either have very little or no expertise in the field of precast production, but having worked with related products have started to take great interest in expanding into this business sector; to extend their supply chain, for example. We organise and realise the transition towards modern, efficient manufacturing of precast concrete.

Facilities, Establishments, Private Individuals

We prepare evaluations of the productivity and value of systems for organisations and institutions such as banks, so that non-specialists can rely on sound and reliable information when making a decision. Investors and lenders from other business sectors who would like to successfully invest in the construction of precast production also find solutions in our expertise and integrated concepts.



WHAT WE BELIEVE IN

Our Philosophy

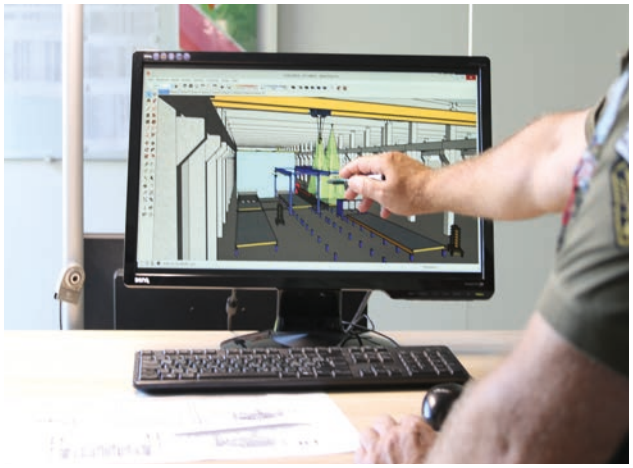
BT innovation-Consulting has an excellent reputation amongst its clients. This is partially due to the results of our hard work, but also to our philosophy and the high standards we set ourselves, which are reflected in every project.

Expertise, Experience und International scope

Our experienced consultants are specialists in the field of precast concrete production. Expert scientific and engineering knowledge coupled with international practical experience help to ensure the competitiveness and effectiveness of each company in this industry. We share our consultants' in-depth knowledge with our clients. The design and construction of efficient precast plants is a part of our everyday work; we have gained expertise in building technology in over 70 countries around the world, and our success can be seen across the globe, in the projects we have implemented. We understand the specifics of not only the European market, but also the international one.

Joining forces for success - a complete solution

Our consultants will manage your project plans from start to finish. They act as an interface between the client and the supplier; every responsibility and process is clearly defined. Depending on your business plans and goals, we can provide both a total solution as well as individual, modular consulting services from our consulting portfolio. Our philosophy is to offer a one-stop solution - from initial briefings through to project completion, and if desired, also a total solution for implementing your project.



Relevance and Independence

It is a well known fact that knowledge has a short half-life in technology-based industries. This also applies to the precast concrete industry. Continuous knowledge development and consultant training is therefore a large part of our day-to-day operations. Through our various partnerships with technical universities, we always have a finger on the pulse of the latest trends and developments, and also on the latest proven practical solutions. For customer-specific issues, we are also able to implement „non-industry" solutions.

Our advice is always given independently to that of machine manufacturers. We are a solution-orientated consulting service that places the emphasis on the client's requirements and is committed to the client's objectives.

Interdisciplinary, expert network

Our team is multinational, so we are able to provide intensive support in many local languages. We also realise a wide range of tasks and systems via our interdisciplinary network of specialists. Both our consultants and partners have an excellent knowledge of the sectors related to creating value - from precast plants to assembly on site - all stemming from our own practical experience.

In short: We are your reliable partner for the optimisation, modernisation and realisation of your precast plant.

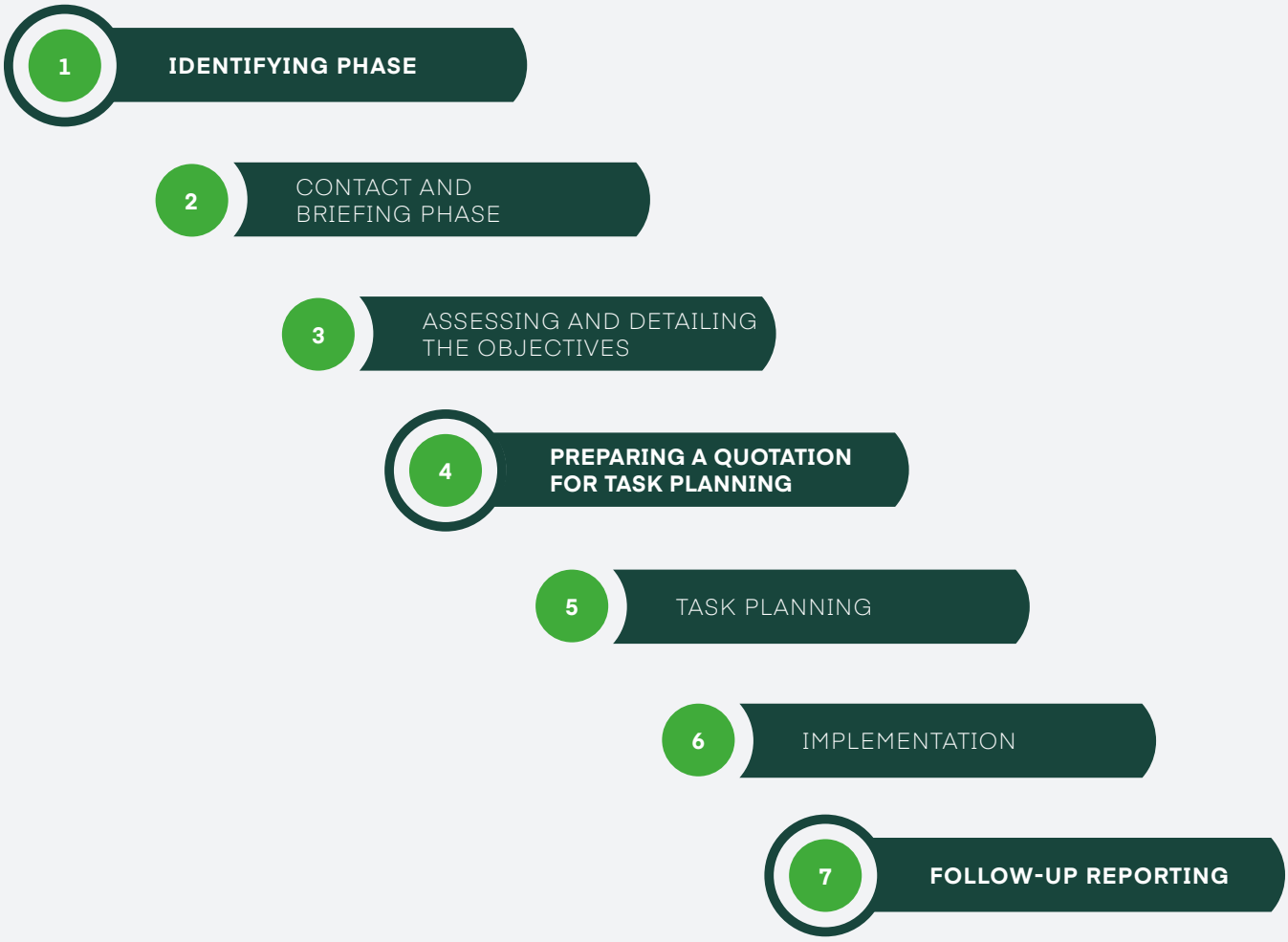
SIMPLE, TRANSPARENT UND SUCCESSFUL

The BT-Consulting-Process

Consulting for your precast plant.
A joint consultation process with your success in mind.

Customers interested in our consulting services often ask about the operational progression of our projects. Questions such as: “Who directs each process?”, “Who takes on the essential roles in terms of over all project management?”, “Who is responsible for decision-making?”
Therefore, we would like to demonstrate our approach using the following example.

Our Process chain: 7 collective steps to a successful project



The Starting Point

1. Identifying Phase

As the client, you identify the need for external consultation to achieve a specific project, because you:

- … are tackling a project that exceeds your own resources.
- … would like to objectively modernise technical systems; independently of manufacturers.
- … would like to optimise your systems.

2. Contact und Briefing Phase

You make contact with our consultants, and explain your plans and the objectives your project is to achieve. Within the framework of a constructive discussion, our consultants explain which information you need for the initial valuation of your project, providing the cornerstones of a well-grounded initial briefing. Here, our consultants also consider whether the services we provide are suitable for your plans and aims. Where your project plans fall outside the boundaries of our expertise, we will decline the contract, and where possible put you in touch with other consulting services who will be able to help. If we are confident that we can fulfil the goals presented to us, we will arrange a personal meeting with you on-site.

Upon request, based on where your interest has sparked, we can make a joint visit to a flagship German precast plant demonstrating the latest, state-of-the-art technology. Here you can gain ideas and insights about how your plant will work in the future. You will also receive some initial information about our procedures and the consulting fee.

The Analysis

3. Assessing and Detailing the Objectives

Equipped with the knowledge gained from personal discussions and the briefing documents you have provided, we will visit you on site and assess your production facilities or discuss your project in detail. Depending on the size of the project, this may require several days in some cases.

Is it not unusual for new ideas and plans to arise, or for the current objectives to be refined through the discussions with our consultant. Notes are recorded on the topics discussed, and these are then incorporated in a structured way into the first briefing. In this way a set of legitimised, written objectives can be created through the collaboration between client and consultant, on the basis of which a sound action plan can be put into place.

The Implementation

4. Preparing a Quotation for Task Planning

When the details of the clients' objectives have been established, we will create a quote for a "Plan for the Achievement of Objectives".

5. Task Planning

Our consultants will create a detailed plan for the optimal achievement of your objectives. When this planning is complete, we will present the process to you, and upon your approval, begin with implementing the programme.

6. Implementation

Implementation of the project will begin in accordance with the fixed schedule set out in the plan. We will keep you up to date on the progress of the project through regular reporting, until the project is complete. In addition, we will hold regular meetings with the client or their on-site delegate, so that the client is always fully-involved in every step of the process.

7. Final Report / Follow-up Proposal

Upon project completion, we will summarise the results and provide a project assessment. Here we will set out some additional insights that might be useful to you beyond the scope of the current project, including project reports, technical descriptions, drawings, plans and calculations.

WHAT WE OFFER

Range of Services and Expertise

Due to their extensive project involvement, our consultants have a very broad practical knowledge. Nevertheless, over the years, certain consulting focuses have arisen, which represent our current core expertise.

1. Advice on the Design and Realisation of Precast Plants

The optimisation of organisational and production processes within the precast plant is becoming increasingly significant. Regardless of whether it is a question of reviewing and improving organisational processes, IT structures, material and information flow, planning capacity expansion or the construction of new production facilities - with our extensive technological knowhow and personal experience, we can help you to develop customised solutions for your project - efficiently and independently of manufacturers.

Excerpt for our Service Portfolio

- Feasibility studies
- Identification of needs and production capacities
- Individual & integral plant design for precast plants
- Plant structuring/arrangement of production halls, storage areas, etc.
- System layout/arrangement of machines and systems
- Calculation of staffing requirements
- Cost estimates and economic feasibility calculations
- Creation of machinery and equipment lists, technical specifications
- Realisation - either as a consultant or main contractor
- Obtaining and examining bids
- Preparation of tender documents and specifications
- Coordinating the selection of machinery manufacturers
- Coordination and supervision of assembly and initial operation
- Information procurement and transfer of information during construction
- Interface descriptions
- Training measures for managers and workers
- Process analysis/analysis of critical points in production and administration
- Constant monitoring of project progress

Benefits

- Often, when developing a new concept, machine suppliers will simply draw upon their own resources. We note the exact specifications involved, and obtain several quotes for comparison. We strive for the optimal, most cost-effective combination of machine and plant technology from the view of the client and in line with their business objectives.
- We have years of experience at our fingertips, and help you to avoid beginners' errors.
- Upon request, we also implement solutions with used machinery and draw upon technologies from outside the industry.
- We are aware of the strengths and weaknesses of each of the machinery suppliers, and create concepts that draw on a range of suppliers. In this way, we are able to achieve a representative range, whereas a machinery manufacturer is only interested in promoting their own machines.
- We are your experienced partner, and represent your interests with regard to machinery manufacturers.

2. Advice on Construction Systems

Making the best economical use of the building material concrete is dependent on various factors: The effects of weathering, increasing skills shortages and a downturn in efficiency due to incorrect working procedures are all problem areas that must be addressed. Here at B.T. innovation, we see the key to success in building with precast elements - so-called prefabricated or precast concrete components - and have therefore developed significant expertise in this domain, in order to help you always make the right decisions when choosing the most effective building system.

The list of possible questions is extensive:

- Whether to build using skeleton-frame construction or load-bearing walls?
- Whether to build with precast elements or with semi-finished products? Or with a combination of onsite concrete and precast elements?
- Whether to design wall elements as solid walls or with retrofitted heat insulation, as sandwich panels, as double walls, etc.?
- Whether to design ceilings using solid ceilings, hollow core slabs, ribbed slabs, etc.?
- Whether to design access zones (e.g. staircases, lift shafts) or supply/disposal areas etc. with a modular construction, or using individual components?
- How should surfaces be formed, and which materials should be used?
- During assembly, should the elements be affixed „wet“ (e.g. with mortar) or „dry“ (e.g. bolted or welded)?

Investors, construction companies or precast plants are often faced with the complex question of which construction system is most suited to their particular objectives and target markets. This is exactly where our specialists and consultants come in.
Within the framework of our consulting services, we provide an analysis of your construction plans. We discuss with our clients the advantages and disadvantages of the different precast element systems, taking into account the local conditions. If desired, we provide architects and precast element designers who can adapt your existing architectural or building plans to entail a construction method with precast elements that is perfectly suited to your market. We will have taken time to ensure that these precast elements are optimised from a manufacturing standpoint and are of course subsequently also suitable for the efficient operation of a precast plant.

Excerpt from our Service Portfolio

- **Support in solving issues regarding design options, manufacture, supply, construction times and costs**
- **Architectural adaptation of plans to include precast element construction**
- **Support in choosing CAD/CAM systems**
- **Support in planning component types and affixing technology with regard (amongst others factors) to minimising costs**
- **Advice regarding different building systems, taking local conditions into account**
- **Procurement of engineering and planning offices**

AROUND THE GLOBE

Selection of Completed Projects

GERMANY

MAX BOEGL FERTIGTEILWERKE

- Design and establishment of a new multifunctional carousel plant for solid walls, sandwich walls, double-walls, wood concrete hybrid panels and other flat concrete slabs (e.g. platforms, balconies, etc.) as General Planner
- Introduction of new technologies, e.g. ergonomic and economic alternatives to robot systems.
- Introduction of modern in-house logistics concepts (just in sequence) for formwork and reinforcement.

DIPL. -ING. FR. BARTRAM GMBH & CO KG

- Construction of a new maufacturing hall for the production of rod-shaped parts.

GROETZ BETONWERK GMBH & CO. KG

- Optimisation of a garage production.

FUCHS FERTIGTEILWERKE GMBH

- Relocation of the Fuchs production site in Dormagen to Dorsten.
- Optimisation of plant equipment and the entire plant logistics.
- Renewal of the concrete distributors in a distribution plant for the production of solid walls.
- Planning and construction of a recycling plant and a filter chamber press.
- Construction of a new bucket conveyor.
- Planning and construction of a concrete supply system with a transport truck.

W. MARKGRAF GMBH & CO KG

- Planning and construction of a new mixing plant.
- Planning and construction of a new production hall for production on tilting tables.
- Construction of a new bucket conveyor.

BAUSTOFFWERK LIMEX VENUSBERG GMBH

- Planning and tendering for the production of wall panels / angular supports.

BETONFERTIGTEILE SPUERGIN GMBH & CO. KG

- Optimisation of plant equipment and entire plant logistics.
- Tender for special transport wagons.

BAUUNTERNEHMUNG GLOECKLE MONTAGEBAU GMBH

- Optimisation of plant equipment and entire plant logistics.

MUELLER-ALTVATTER BETONFERTIGTEILE GMBH

- Process and bottleneck analysis in precast plant with a high degree of automation.
- Optimisation of the production process and logistics resulting in increased production capacity by more than 15 percent.

MEIER

- Restructuring of workflows in administration and technical offices.
- Supervision of new ERP software set-up.

RUSSIA

GATCHINSKYY SSK

- Training of technical and managerial staff in German precast plants and at the client's plant.
- Verification of factory planning in regard of design, technical equipment, capacity.
- Technical support during erection and start-up of the production line.

BETFOR

- Expertise about machinery and equipment.
- Process analysis and preparation of strategic concept to increase capacity more than 30 per cent

SWEDEN

ATTACUS BETONGHUSHUS AB

- Construction of a carrousel system for the production of solid walls.

CZECH REPUBLIC

W. MARKGRAF STAV S.R.O.

- Tendering of various formworks (e.g. column formworks, etc.).
- Optimisation of plant equipment and the entire plant logistics.

RIEDER BETON, SPOL. S.R.O.

- Optimisation of plant equipment and the entire plant logistics.

AUSTRIA

BETONWERK RIEDER GMBH

- Optimisation of plant equipment and the entire plant logistics.

ICELAND

LOFTORKA

- Demand analysis, design of a carrousel system for sandwich and solid walls.
- Delivery of the commissioning as general contractor.

EININGAVERKSMIDJAN

- Conception for the relocation of a precast concrete plant and production expansion with a pallet circulating system for sandwich and solid walls.

ROMANIA

BOG´ART

- Design of a production line for 'Lightrail' tramway track panels.
- Development of specialized machines for a field factory.

CROATIA

ZAGORJE TECHNOBETON

- Expertise for used equipment.
- Layout for the installation of used equipment in existing hangars.

SYRIA

NAHAS GROUP

- Feasibility study for a housing project with 34,000 units based on industrially produced precast concrete elements.

JORDAN

ROYAL ENGINEERING DEPARTMENT OF THE ROYAL HASHEMITE COURT

- Improvement measures for a field factory.
- Advice on construction systems.
- Introduction of new concrete mixing technology.

KAZAKHSTAN

GOVERNMENT OF KAZAKHSTAN

- Officially accredited as an independent consultancy firm under the government's „Productivity 2020" programme for complex project planning and expertise in the precast concrete industry.

COLOMBIA

CONCONCRETO

- Feasibility study with work-planning and cost estimation for a new precast concrete plant for reinforced and prestressed concrete elements.

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CUSTOMER SATISFACTION

Our References

In the course of our consultation practice, our services have been the subject of a number of professional articles. Below you can find a selection of articles on finished projects. Happy reading!

PRECAST ELEMENT PRODUCTION → Project report

Beton-Fertigteil-Union (BFU) increased its production output while improving product quality and process reliability by implementing the new B.T. innovation plant design. At the core of this new setup is a butterfly battery mold complemented by two workstations equipped with laser projection systems.

Mit dem neuen Anlagenkonzept von B.T. innovation konnte die Beton-Fertigteil-Union (BFU) ihre Produktionskapazität, Produktqualität und Prozesssicherheit erhöhen. Herzstück des neuen Konzeptes ist eine Schmetterlingsbatterie, ergänzt durch zwei Bearbeitungsstationen mit zwei Laser-Projektionssystemen.

At BFU, butterfly battery mold sets new standard for precast elements with five smooth sides

Schmetterlingsbatterie setzt neue Maßstäbe bei der Herstellung von fünfseitig glatten Fertigteilen bei der Beton-Fertigteil-Union (BFU)

Text: Bernd Schreyer

Implementing the new plant design developed by B.T. innovation GmbH enabled Beton-Fertigteil-Union (BFU), a precast producer headquartered in the German Black Forest region, to achieve several objectives in one go, namely increasing its production output and improving product quality and process reliability. At the core of this new setup is a butterfly battery mold complemented by two workstations equipped with laser projection systems. BFU uses the new production line primarily for manufacturing precast walls, but also balconies and smaller columns, to an unprecedented quality standard. This endeavor is supported by using self-compacting concrete (SCC).

During a plant visit and inspection of precast elements put to outdoor storage, Volker Koch, BFU Managing Director, took pride in presenting the impeccable precast wall panels. "Previously, we had already been able to produce walls with two smooth sides on our existing battery system, but this new, enhanced quality was simply unachievable for us – the surfaces couldn't be

Office building of Beton-Fertigteil-Union

Bürogebäude der Beton-Fertigteil-Union

Figure: B.T. innovation

Mit dem neuen Anlagenkonzept der B.T. innovation GmbH konnte die Firma Beton-Fertigteil-Union (BFU) aus dem Schwarzwald gleich mehrere gewünschte Vorgaben erfüllen: Erhöhung der Produktionskapazität, der Produktqualität und der Prozesssicherheit. Herzstück des neuen Konzeptes ist eine Schmetterlingsbatterie – ergänzt wird die Batterie durch zwei Bearbeitungsstationen mit zwei Laser-Projektionssystemen. BFU stellt in der neuen Produktionsanlage hauptsächlich Massivwände, aber auch Balkone und kleinere Stützen in bisher nicht erreichter Qualität her. Unterstützt wird dies durch den Einsatz von selbstverdichtendem Beton (SVB).

Bei einer Besichtigung der Fertigteile auf dem Lagerplatz präsentierte Volker Koch, der Geschäftsführer von BFU, voller Stolz die makellosen Massivwände. „Wir haben bisher in unserer bestehenden Batterieschalung auch schon beidseitig glatte Wände hergestellt. Aber diese Qualität war bisher nicht zu erreichen. Besser könnten die Oberflächen kaum sein". Durch den Einsatz des von BFU optimierten selbstverdichtenden Betons in Kombination mit den Schalungen von B.T. innovation können sowohl die Flächen als auch die Kanten und die Aussparungen in absoluter Sichtbetonqualität hergestellt werden. Zusätzlich zu dieser Qualitätssteigerung geht Koch davon aus, dass BFU die Produktivität durch diese neue Anlagentechnik mehr als verdoppeln kann. „Wir sind uns sicher, dass wir mit der neuen Investition nicht nur die Qualität erhöhen, sondern auch die Aufwandswerte entsprechend reduzieren können."

Die Schmetterlingsbatterie ist in eine der beiden 2019 von BFU neu errichteten Produktionshallen integriert. Der Platzbedarf für die Anlagentechnik beträgt nur ca. 450 m^2.

Neues Anlagenkonzept

Das von B.T. innovation für BFU entwickelte Konzept besteht aus einer Schmetterlingsbatterie und zwei Bearbeitungsstationen. Beide Stationen sind jeweils mit einer hydraulisch betriebenen sogenannten Auf- und Zuklapp-

Figure: B.T. innovation

The butterfly battery mold developed by B.T. innovation

Die Schmetterlingsbatterie von B.T. innovation

any better". Combining BFU's optimized self-compacting concrete recipe with B.T. innovation's formwork makes it possible to produce surfaces, edges and blockouts to an unrivaled architectural concrete standard. Beyond this quality improvement, Koch assumes that BFU will be able to more than double its productivity thanks to the new equipment. "We are confident that our new investment will not only improve product quality but also reduce our labor consumption rates accordingly".

The butterfly battery mold was installed in one of the two new factory buildings that BFU completed in 2019. The system footprint amounts to only about 450 m^2.

New plant design

The plant design that B.T. innovation developed for BFU comprises a butterfly battery and two workstations. Each of these stations is equipped with a hydraulically operated folding and unfolding system. This system makes it possible to open or close the butterfly forms as required. For this purpose, the butterflies need to be removed from the battery using a custom lifting beam developed by B.T. innovation in combination with the overhead crane, and placed on top of the folding and unfolding systems. In the next step, the formwork panels connected to each other by a massive swivel joint are folded up or down from the vertical to the horizontal position. This process is reversed for the subsequent storage of the finished shuttered and reinforced butterfly elements.

As usual in circulation systems, the unfolded butterflies rest on roller blocks and friction wheels allowing them to be moved between the workstations. All required work steps can thus be completed in a horizontal arrangement of the butterflies convenient for the operator, which also eases the use of laser systems. In this way, installation of the formwork, blockouts and the entire reinforcement can be optimized and carried out in a time-saving process. The required installation

vorrichtung ausgerüstet. Mit Hilfe dieser Vorrichtungen können die Schmetterlingsschalungen aufgeklappt bzw. geschlossen werden. Dazu müssen die Schmetterlinge mittels einer speziellen von B.T. innovation entwickelten Traverse und dem Hallenkran aus der Schmetterlingsbatterie entnommen und auf den Auf- und Zuklappvorrichtungen aufgesetzt werden. Anschließend werden die durch ein massives Drehgelenk miteinander verbundenen Schaltafeln von der senkrechten in eine waagerechte Position aufgeklappt bzw. abgelegt. Zur späteren Einlagerung der fertig eingeschalten und bewehrten Schmetterlinge erfolgt der Vorgang in umgekehrter Reihenfolge.

Die aufgeklappten Schmetterlinge liegen, wie in Umlaufanlagen üblich, auf Rollenböcken und Reibrädern. Dadurch können sie zwischen den Arbeitsstationen verfahren werden. Alle notwendigen Tätigkeiten können dadurch in einer für die Bediener angenehmen waagerechten Anordnung der Schmetterlinge und daher sogar laserunterstützt durchgeführt werden. Somit kann der Einbau der Schalungen, der Aussparungen sowie der gesamten Bewehrung

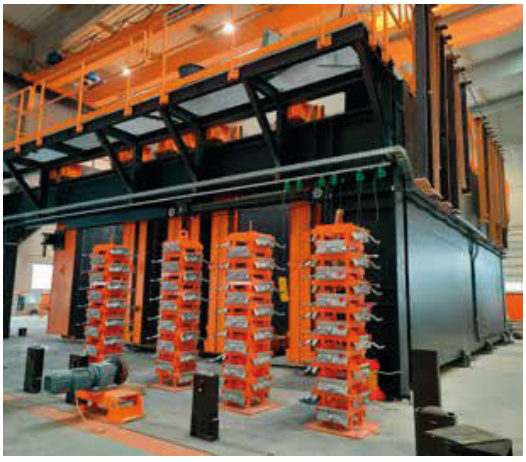

Figure: B.T. innovation

Butterfly battery mold with MagFly magnets

Schmetterlingsbatterie mit MagFly-Magneten

Figure: B.T. innovation

Insertion of a butterfly into the battery

Einlagern eines Schmetterlings in die Batterieschalung

Figure: B.T. innovation

View of the control computers, unfolding stations and laser systems

Ansicht der Steuercomputer, der Aufklappstationen und der Lasersysteme

parts and auxiliary materials can be stored in the immediate vicinity of the two stations.

B.T. innovation headquartered in Magdeburg delivered the plant components and the complete formwork system. Wiggert & Co. GmbH designed and implemented the control systems for the butterfly battery, the folding and unfolding systems, the workstations and the roller conveyors used for butterfly transport. Z-Laser GmbH supplied the complete range of laser equipment.

Production process

Battery formwork is nothing new to BFU. Previously, the company had been producing precast walls with two smooth sides on a battery system that had been installed a long time ago. “Since all work had to be done

optimiert und zeitsparend durchgeführt werden. Die benötigten Einbauteile und Hilfsstoffe können in unmittelbarer Nähe der beiden Stationen gelagert werden.

Die Anlagenkomponenten sowie das gesamte Schalungssystem kommen von B.T. innovation mit Hauptsitz in Magdeburg. Die Steuerung der Schmetterlingsbatterie, der Auf- und Zuklappvorrichtungen, der Arbeitsstationen und Rollengänge für den Transport der Schmetterlinge wurde von der Wiggert & Co. GmbH realisiert. Die gesamte Lasertechnik lieferte die Z-Laser GmbH.

Der Produktionsprozess

Das Konzept von Batterieschalungen ist für BFU nicht neu. Bisher wurden in einer seit längerer Zeit vorhandenen Batterieschalung beidseitig glatte Massivwände herge-

Closing a butterfly

Zusammenklappen eines Schmetterlings

Figure: B.T. innovation

on the vertical bulkheads, this was a very arduous and time-consuming activity for our employees," reports Volker Koch. B.T. innovation's concept of horizontal preparation thus convinced BFU right from the start. This manufacturing arrangement is very efficient and cost-effective and takes up very little floor space in the factory building.

The addition of laser systems improved the accuracy of formwork installation and reinforcement significantly. This new setup prevents errors during these activities while shortening shuttering times. In addition, the formwork system has been specially designed for use in battery units. It is based on the exceedingly lightweight MultiForm system while also using MagFly magnets supplied by B.T. innovation. "In our case, the usable areas of the individual butterfly halves are 8 × 3.5 m each," says BFU Managing Director Koch. "Optimized planning currently enables us to achieve a utilization rate of up to 70%."

After completion of all manual operations, the butterfly is folded from the horizontal to the vertical position using a specially designed lifting beam and the hydraulic folding and unfolding station newly developed by B.T. innovation. The butterfly is then hooked into the supporting structure of the butterfly battery from above using the overhead crane.

When the battery is fully loaded, the butterfly forms and bulkheads are hydraulically braced with the fixed

Figure: B.T. innovation

Custom MultiForm for the butterfly battery mold

Sonder-MultiForm für die Schmetterlingsbatterie

stellt. „Da alle Arbeiten an den senkrechten Schottwänden durchgeführt werden müssen, war dies für unsere Mitarbeiter eine sehr beschwerliche und aufwändige Tätigkeit", berichtet Volker Koch. Daher hat BFU das Konzept der liegenden Vorbereitung von B.T. innovation von Anfang an überzeugt. Dieses Herstellungskonzept ist sehr effizient bzw. kostengünstig und beansprucht in der Produktionshalle nur sehr wenig Nutzfläche.

Die Genauigkeit für das Einschalen und für das Bewehren konnte durch den Einsatz von Lasern entscheidend verbessert werden. Dadurch können sowohl Fehler bei diesen Tätigkeiten verhindert als auch die Einschalzeiten verkürzt werden. Des Weiteren ist das Schalungssystem speziell für den Einsatz in einer Batterieschalung angepasst

PRECAST ELEMENT PRODUCTION → Project report

Figure: B.T. innovation

Custom lifting beam for butterflies

Spezialtraverse für Schmetterlinge

and movable tensioning walls. "Using six hydraulic cylinders for the butterfly system provides a much more effective seal compared to our previous battery unit," Koch explains. The positions of the cylinders were chosen such that hermetically closed bracing is ensured regardless of the type of occupancy and number of panels.

At BFU, concrete is poured into the forms through either a crane-operated concrete spreader or a concrete pump. After the drying phase, the butterfly battery is "opened". For this purpose, the tensioning and bulkhead walls as well as the butterflies are moved individually using hydraulic cylinders. The crane then lifts the cured precast elements directly from the suspended butterflies.

Increased production output

The new butterfly battery mold supplied by B.T. innovation enabled BFU to enhance the quality of its products significantly while also increasing production output considerably: "I am fairly sure that we will easily be able to double the output in the near future

worden. Basis sind die sehr leichte MultiForm-Schalung sowie die MagFly-Magnete von B.T. innovation. „Bei uns sind die Nutzflächen der einzelnen Schmetterlingshälften jeweils 8 × 3,5 m groß", sagt BFU-Geschäftsführer Koch. „Mit einer optimierten Planung erreichen wir derzeit eine Belegung von bis zu 70 %."

Nachdem alle manuellen Tätigkeiten abgeschlossen sind, wird der Schmetterling mit einer speziellen Traverse und der von B.T. innovation neu entwickelten hydraulischen Auf- und Zuklappstation von der waagerechten in eine senkrechte Stellung zusammengeklappt. Anschließend wird der Schmetterling mittels Hallenkran von oben in die Tragkonstruktion der Schmetterlingsbatterie eingehängt.

Wenn die Batterie voll bestückt ist, werden die Schmetterlingsschalungen und Schottwände mit der festen und der beweglichen Spannwand hydraulisch verspannt. „Durch den Einsatz von sechs hydraulischen Zylindern dichtet die Schmetterlingsschalung wesentlich besser ab als unsere alte Batterieschalung", berichtet Volker Koch. Die Lage der Zylinder wurde so gewählt, dass unabhängig von der Art der Belegung und der Anzahl der Elemente eine hermetisch dichte Verspannung gewährleistet werden kann.

Das Betonieren der Schalung erfolgt bei BFU entweder über einen Kranbetonverteiler oder über eine Betonpumpe. Nach der Trocknungsphase wird die Schmetterlingsbatterie „geöffnet". Dazu werden die Spann- und Schottwände sowie die Schmetterlinge einzeln mit Hydraulikzylindern verschoben. Die ausgehärteten Fertigteile werden dann mittels Kran direkt von den eingehängten Schmetterlingen entnommen.

Erhöhung der Produktionskapazität

Mit der neuen Schmetterlingsbatterie von B.T. innovation konnte BFU die Qualität seiner Produkte wesentlich verbessern und auch die Produktionskapazität deutlich erhöhen: „Ich gehe davon aus, dass wir die Menge dank der

Control unit for the folding and unfolding stations, butterfly transport and laser systems

Steuerstelle für Auf- und Zuklappstation, den Transport der Schmetterlinge und der Lasersysteme

Figure: B.T. innovation

Balcony slab with five smooth sides produced on the butterfly battery system

Fünfseitig schalungsglatter Balkon, der in der Schmetterlingsbatterie hergestellt wurde

Figure: B.T. innovation

thanks to the butterfly battery," says BFU Managing Director Koch confidently. BFU is currently operating the butterfly unit in a single shift. The precast panels cure overnight and are stripped of their formwork the next morning.

Summary

B.T. innovation GmbH succeeded in further developing the well-known battery formwork system and launching it under the "butterfly battery" brand name. This design enabled the company to combine the advantages of battery-based production with those of stationary or circulation systems.

It is generally possible to modify the plant design of the butterfly battery such that concreting can be performed in three or four stages in three shifts within 24 hours. After only about four hours, the concrete will have reached an early strength of 3 to 8 N/mm² so that the butterflies can be removed from the supporting structure. It is then possible to put the butterflies to interim storage in a suspended position until the precast elements inside have hardened completely. At the same time, newly prepared butterfly forms can be hung back into the supporting structure for the next concreting stage. One other option, for example, is to prepare or process the butterflies on a "downstream" circulation system involving several workstations and machines. It is always possible to integrate machines known from circulation systems into this process. This plant layout allows for producing precast elements with five smooth sides thanks to the equally smooth formwork – to an unprecedented quality standard and in a quantity that had previously been impossible to achieve on battery formwork.

Schmetterlingsbatterie in naher Zukunft locker verdoppeln können", ist BFU-Geschäftsführer Koch zuversichtlich. Aktuell produziert BFU mit der Schmetterlingsbatterie im Einschichtbetrieb. Die Fertigteile härten über Nacht aus und werden am nächsten Morgen entschalt.

Fazit

B.T. innovation GmbH gelang es, das bekannte System der Batterieschalung weiterzuentwickeln und unter dem Markennamen „Schmetterlingsbatterie" auf den Markt zu bringen. Mit diesem Konzept ist es dem Unternehmen gelungen, die Vorteile einer Batterie- mit den Vorteilen einer Stand- bzw. Umlauffertigung zu verbinden.

Grundsätzlich ist es möglich, das Anlagenkonzept der Schmetterlingsbatterie so zu verändern, dass drei bzw. vier Betoniervorgänge im Dreischichtbetrieb innerhalb von 24 Stunden durchgeführt werden können. Bereits nach ca. vier Stunden hat der Beton eine Frühfestigkeit von 3 bis 8 N/mm² erreicht, sodass die Schmetterlinge aus der Tragkonstruktion entnommen werden können. Anschließend kann man die Schmetterlinge in ein Zwischenlager einhängen, bis die darin befindlichen Fertigteile komplett ausgehärtet sind. Gleichzeitig können in die Tragkonstruktion wieder neu vorbereitete Schmetterlingsschalungen für den nächsten Betoniervorgang eingehängt werden. Die Schmetterlinge können z. B. auf einer „nachgeschalteten" Umlaufanlage mit mehreren Bearbeitungsplätzen und Maschinen vorbereitet bzw. bearbeitet werden. Dabei ist es jederzeit möglich, Maschinen, die man aus Umlaufanlagen kennt, in diesen Prozess zu integrieren. Mit diesem Konzept ist man in der Lage, fünfseitig schalungsglatte Fertigteile in einer bisher nicht erreichten Qualität und einer bisher bei Batterieschalungen unmöglichen Quantität herzustellen.

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PRECAST CONCRETE ELEMENTS

BT innovation, 39116 Magdeburg, Germany

Increasing process and product quality as well as production capacity with new hydraulic butterfly battery mould

Christian Jahn, CPI Worldwide, Germany

Higher process quality, higher product quality and doubling of production capacity – the precast concrete manufacturer Beton-Fertigteil-Union (BFU) in the Black Forest region of southern Germany achieves all this with a new hydraulic butterfly battery mould and the associated two work stations with laser projection system. With the plant equipment from manufacturer BT innovation, BFU produces mainly solid walls, but also balconies and even columns for construction sites in southern Germany and Switzerland. With the exception of the filling side, the precast elements made of self-compacting concrete are absolutely smooth all around and of excellent quality.

"A surface cannot be smoother", Volker Koch runs his hand over a solid wall that has just been produced and set up vertically in the production hall. The surface is even, no formations of air bubbles are visible, the colour is even throughout. "The quality of edges and surfaces of the window recess is also flawless. That really impressed me positively," says the Graduate Engineer and Managing Director of the precast producer Beton-Fertigteil-Union (BFU), based in Schramberg-Waldmössingen in the Black Forest region of southern Germany. Koch is very satisfied with the product quality – and especially with the new plant equipment that makes this high quality possible in the first place. In the production hall, which was completed in 2019, the new plant currently occupies just under a third of the usable space in one of two 1,750 m² hall bays.

The plant consists of the so-called butterfly battery mould and two work stations arranged directly next to it. Work station one is equipped with a device for automatically opening and closing the two formwork panels of the so-called butterfly formwork (the two formwork panels are connected to each other by a robust hinge), which was previously removed from the battery mould by an indoor crane and transported to the work station.

After the butterfly formwork has been opened on work station one, it is transported from there with the help of roller conveyors/friction wheel drive to work station two, where the preparatory work is carried out and shuttering parts, built-in parts and reinforcement are placed.

All plant equipment components come from manufacturer BT innovation, headquartered in the German city of Magdeburg, and are painted in orange and black, the corporate colours of precast concrete producer BFU.

Fig. 1: German precast producer BFU successfully commissioned the new butterfly battery mould with butterfly formwork from BT innovation at his production site in Schramberg-Waldmössingen at the beginning of 2021.

Fig. 2: The BFU headquarters in Schramberg-Waldmössingen was built in 2013 – of course using precast concrete elements from the company's own production.

The butterfly battery mould has its own control panel; likewise, the two work stations together with the roller conveyors have their own control panel. The entire control technology was supplied by Wiggert.

Process and product quality

"With the new plant equipment, we wanted to achieve two quality goals in particular: Firstly, we wanted to further automate the production process and achieve greater precision in the implementation of the production steps," says Koch. We were able to successfully implement this plan because with the butterfly battery system, all preparatory work is carried out on the horizontally positioned formwork panels. This in turn makes it possible for laser projectors to project the positions of shuttering parts, built-in parts and reinforcement from above onto the formwork panels with high precision.

"Secondly, we have succeeded in increasing the already very high quality of our products even further," says Koch.

This was achieved thanks to the outstanding quality of the formwork panels of the butterfly formwork – the steel panels are manufactured seamless and butt-free from one piece, finely levelled, blasted and ground according to the agreed roughness; they enable the production of perfectly smooth precast element surfaces. Thanks to the aforementioned laser system even the outer contours of the precast elements have an optimal geometry with minimal tolerances.

Fig. 3: Managing Director and Graduate Engineer Volker Koch of German precast producer BFU in front of a 3.48 m high wall – the highest wall the company has produced so far with the new butterfly battery mould.

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Fig. 4: Frontal view of the still unclad, movable tension wall of the butterfly battery mould; four hydraulic cylinders on the lower, longer edge of the tension wall ...

Fig. 5: ... and two hydraulic cylinders attached to the frame of the battery mould guarantee a tight closure of the casting compartments.

BFU also produces all precast elements in the butterfly battery mould from self-compacting concrete. The SCC has a high proportion of fine aggregates and is self-de-aerating – both of which contribute to the excellent surface quality of the precast elements, without cracks, gravel pockets or visible formations of air bubbles. With the exception of the filling side, the manufactured precast elements are absolutely formwork-smooth (fair-faced) all around, on five sides, including the edges and surfaces of recesses.

Production process

Battery moulds have been around since the 1960s. They are used for the simultaneous production of several flat precast concrete elements in a vertical position. For this purpose, concrete is poured from above into the casting compartments, which are formed from the bulkhead walls of the battery mould. The production method requires little floor space in the production hall and is considered efficient and cost-effective.

Fig. 6: The control panel for the two work stations, with a butterfly formwork each lying open (immediately to the left and right behind it) and the side view of the battery mould in the background – the battery mould has its own control panel.

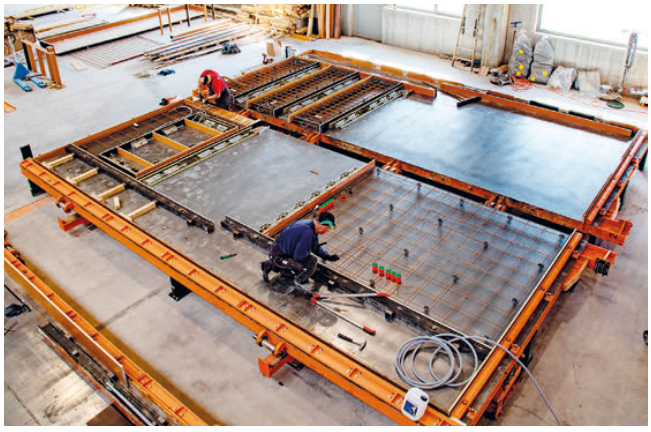

Fig. 7: View from the side catwalk of the battery mould down to the two work stations with the butterfly formwork lying folded out – on the right-hand panel of the completely visible butterfly formwork, the shuttering for three columns for the interior of a building is visible.

Fig. 8: For use in production at the manufacturer Beton-Fertigteil-Union, the profile of the MultiForm formwork beam was adapted and reinforced; it was also designed so that more MagFly magnets can be placed at smaller distances from each other. The shuttering can thus withstand high pressure when concreting vertically in the butterfly battery mould.

The plant manufacturer BT innovation succeeded in further developing the technology of the battery mould system and launched its new version on the market in 2016 under the brand name "butterfly battery mould" (see CPI Worldwide 02/2017). The innovation: so-called "butterfly formwork" is suspended in the frame of the butterfly battery mould – a butterfly formwork consists of two formwork panels, each of which is connected to one another on one of its long sides by a robust hinge (hence the comparison with a butterfly: the hinge reminds of the centrally arranged body, the two formwork panels on the left and the right of it remind of the wings). The casting compartments, into which the concrete is later poured from above, are created together with bulkhead walls already present in the battery as well as side and bottom shuttering parts, which are attached between the butterfly formwork and the bulkhead walls.

The design of the butterfly formwork has the decisive advantage that the formwork can be unfolded on a work station next to the battery. The two formwork panels of the butterfly formwork then lie next to each other and can be conveniently prepared in the horizontal plane at working height by the production workers for the subsequent concreting and provided with shuttering parts, built-in parts and reinforcement (similar to the preparation process at a tilting table).

"In our case, the formwork panels are each 8 x 3.5 m in size," says BFU Managing Director Koch. With optimised planning

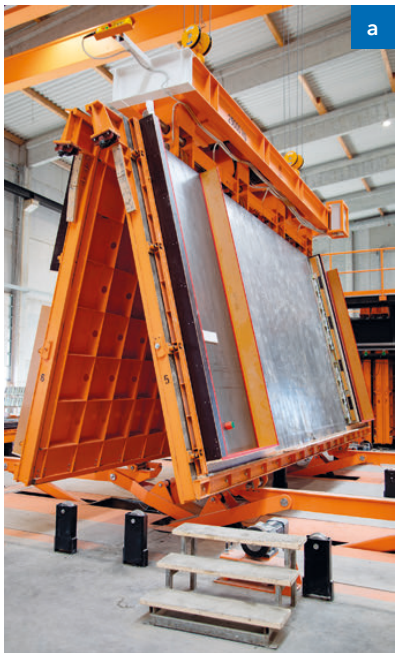

Fig. 9a+b: A lifting beam is connected to the hinge of the butterfly formwork.

Detailed view: When the butterfly formwork is lifted off the workstation, the arms of a special device gently guide the two formwork panels together; when the butterfly formwork is lowered onto the workstation, the two arms of the device guide the formwork panels apart.

using software from Precast Software Engineering, BFU is currently achieving an occupancy rate of up to 70 % of the surface space of the panel. The highest wall that BFU has produced so far with the butterfly battery mould stands in the courtyard in front of the administration building. "It has a height of 3.48 m – so, concerning the width of the formwork panel, the occupancy was of course optimal in this case," says Koch.

High-precision positioning of built-in parts using lasers

BFU uses two LP-HFD2 laser projectors with a green laser source from the manufacturer Z-LASER GmbH to project the positions of shuttering parts, built-in parts or lattice girders with high precision onto the surface of the formwork panels of the butterfly formwork. The lasers are mounted in the hall at a height of 10 m above the surface of the formwork panels. In order to be able to project a thin, easily recognisable line onto the surface from this height, the projectors are additionally equipped with tele-optics.

The laser projectors are integrated into the computer-controlled processes of work stations one and two via special software. From the CAD/CAM data, which are created at BFU from the planning software of Precast Software Engineering, the data required for the laser projection are selected project-related and manually by the system operator at the Wig-

Fig. 9c-e: Two Abus indoor cranes, each with a load capacity of 12.5 tonnes, lift the prepared butterfly formwork until the backs of the two formwork panels touch (the prepared formwork panels face outwards).

Fig. 10a+b: Hovering and positioning of the closed, prepared butterfly formwork above the battery mould. In the middle of the upper photo, directly next to the battery mould, the maximally extended, orange-coloured arms of the device for opening or closing the butterfly formwork can be seen.

gert control panel and loaded into the so-called LPM software of Z-Laser. Work stations one and two at BFU do not have a device for centring the butterfly formwork. Therefore, the laser system provides for the positioning of the laser drawing of the respective wall elements to be produced on the formwork panel by infrared remote control. In this way, the optimal pallet layout generated in the Precast Software Engineering software can be precisely mapped on the surface of the formwork panel.

The production workers can easily recognise the outlines of the parts to be installed, which are clearly projected onto the surface of the panel with a green laser line and set the parts effortlessly.

Once this work is done, the indoor crane pulls the hinge again and lifts the butterfly formwork with its two formwork panels off work station one. The formwork panels fold together (the two formwork panels prepared for concreting face outwards). The crane transports the butterfly formwork to the battery frame and hangs it there between two bulkheads. With only one butterfly formwork and its two outward facing formwork panels and the formwork panels of the bulkhead walls to the right and left of the butterfly formwork, two casting compartments can be formed at the same time.

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Fig. 11: Freshly demoulded walls – with the exception of the filling side, all five sides and the edges and surfaces of the recesses are absolutely smooth.

Hermetic sealing of the casting compartments

When the butterfly battery mould at BFU is fully loaded, the butterfly formwork and bulkheads are braced with the fixed tension wall (end panel) and the movable tension wall so that the casting compartments withstand the hydrostatic pressure during concreting.

For hermetically tight bracing, the butterfly battery mould at BFU has a system with a total of six hydraulic cylinders – four cylinders attach to the longer lower edges of the fixed and movable tension walls (see Fig. 4); another cylinder attaches to the upper end of each of the shorter right and left edges of the fixed and movable tension walls (see Fig. 5).

Doubling the capacity

BFU produces with the butterfly battery mould in one-shift operation – the precast elements cure overnight for around twelve hours and are demoulded by the early shift.

In principle, however, the butterfly battery mould from BT innovation allows up to three concreting operations in three-shift operation and within 24 hours. This is because after only four hours, the SCC has reached an early strength of 3 to 8 N/mm² and the butterfly formwork can be removed from the battery mould and stored in the hall until the precast element inside has completely hardened. At the same time, another prepared butterfly formwork can be placed into the frame of the battery mould again for the next concreting process – concreting is also to be automated in the near future with the help of a concrete pump.

Beton-Fertigteil-Union – the company

The precast concrete producer Beton-Fertigteil-Union (BFU) is based in Schramberg-Waldmössingen, in the Black Forest region of southern Germany, about 90 km southwest of "Porsche city" Stuttgart.

BFU sees itself as an innovative and quality-oriented manufacturer of precast concrete elements. Customers are private builders, commercial investors and the public sector in the segments of residential, industrial and commercial construction.

The company produces precast concrete elements (walls, ceilings, stairs, special parts), structural precast concrete elements (columns, beams/joists, balconies, sandwich panels) and architectural precast concrete elements in various colours and with different surface structures and finishes.

References from BFU include the ice hockey stadium in Villingen-Schwenningen (completed in 2020), the Intersport Gruner shop building with a striking precast concrete façade in the city of Constance on Lake Constance (2009) or the BFU administration building in Schramberg-Waldmössingen (2013; see Fig. 2). BFU sells its products mainly in the southern German state of Baden-Württemberg and in neighbouring Switzerland, where the company also implements numerous projects with partners using the BIM approach.

With around 90 employees (of which around 63 work in production), BFU produces precast concrete elements with a volume of 16,000 m³ per year. According to Managing Director Volker Koch, the company's turnover in 2020 was around 16 million euros.

Fig. 12: Ready for transport – with BFU's own trucks and inloaders from Faymonville, the high-quality, fair-faced precast concrete elements reach the construction sites in the southern German state of Baden-Württemberg and in neighbouring Switzerland.

PRECAST CONCRETE ELEMENTS

With the new butterfly battery mould from BT innovation, the medium-sized precast concrete manufacturer BFU can decisively increase the quality of its processes and products, and its production capacity is also growing: “So far, we produce around 16,000 to 18,000 m² of wall per year. I assume that we will be able to easily double this quantity in the near future thanks to the butterfly battery mould,” says BFU Managing Director Koch confidently. The interest of customers in the sales regions of Baden-Württemberg and Switzerland in the high-quality precast concrete elements from Schramberg-Waldmössingen is already gratifyingly high. ■

FURTHER INFORMATION

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Pallet circulation system for the production of solid walls and other flat, circulation-suitable precast concrete elements

Attacus Betonghus AB from Sweden has so far only produced wooden system houses for the Swedish market. In order to be able to manufacture concrete system houses in the future, an existing precast concrete plant in Hammerdal was purchased in 2016. At the beginning of 2017, B.T. innovation GmbH was commissioned with the planning for the construction of a modern "upgradeable" circulation system. A particular challenge was to design the desired circulation system for the existing hall, since a large part of the hall was or is built with a basement.

The pallet circulation system was to be designed for special products for the Swedish market. These are primarily sandwich walls with completely installed windows, doors and ventilation units. In addition, all circulation-suitable precast concrete elements that are required for the system houses are to be produced in the plant.

The focus of the investment was therefore on the most economically expedient equipment of the plant for the portfolio described above. Should there be shifts in the product mix or increased demands on quality or capacity during later operation, individual circulation stations can be retrofitted with automated machines and/or robot technology.

The production plant was housed in a largely existing hall with two hall aisles. Next to the two production halls there is a much lower hall aisle which was to be used for the production of reinforcement and for work preparation (Fig. 1). All three halls were extended by approx. 13 m. An area for a curing chamber with two towers and an upstream storage and retrieval machine was provided at the side of one of the two production halls. Due to the deadline pressure, the plant had to be realized in two or three sections.
In the first phase, two tilting tables were purchased and installed to gain experience with the new products. In this phase many optimisations were developed and tested on the different products. However, for the later sections, these two tilting tables also had the additional task of producing parts that are not very suitable for production in a circulation system.

Fig. 1: Exterior view of the production halls

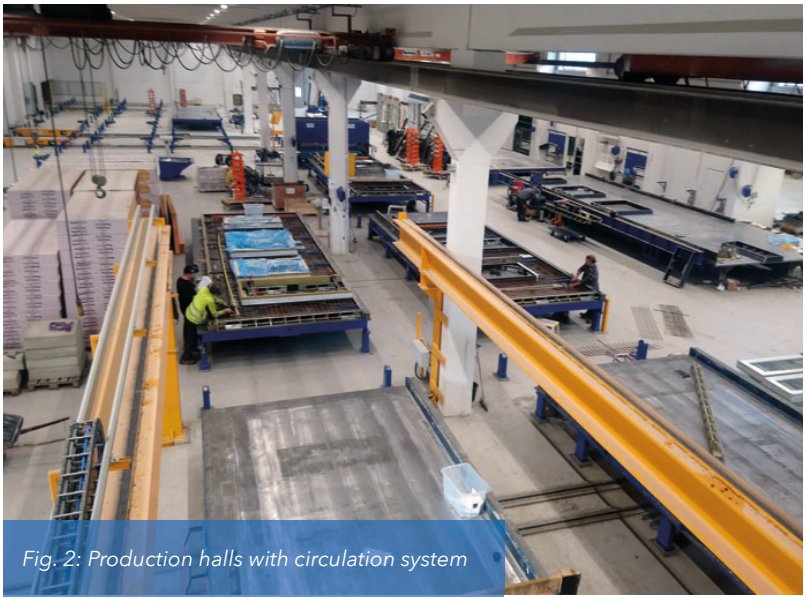

Fig. 2: Production halls with circulation system

Fig. 3: Recycling tank in the cellar

The second phase included the construction of the entire circulation system, without the storage and retrieval machine and the curing chamber (Fig. 2). In addition, the entire mixing plant control system was renewed and a modern residual concrete recycling plant was installed during this phase. Due to the very long and cold winter periods in Sweden, the recycling tank was integrated into the existing cellar of the production hall (Fig. 3).

In the third construction phase, the storage and retrieval machine, the curing chamber, two additional working stations and the necessary cross-lifting trucks were retrofitted and integrated into the existing circulation system (Fig. 4).

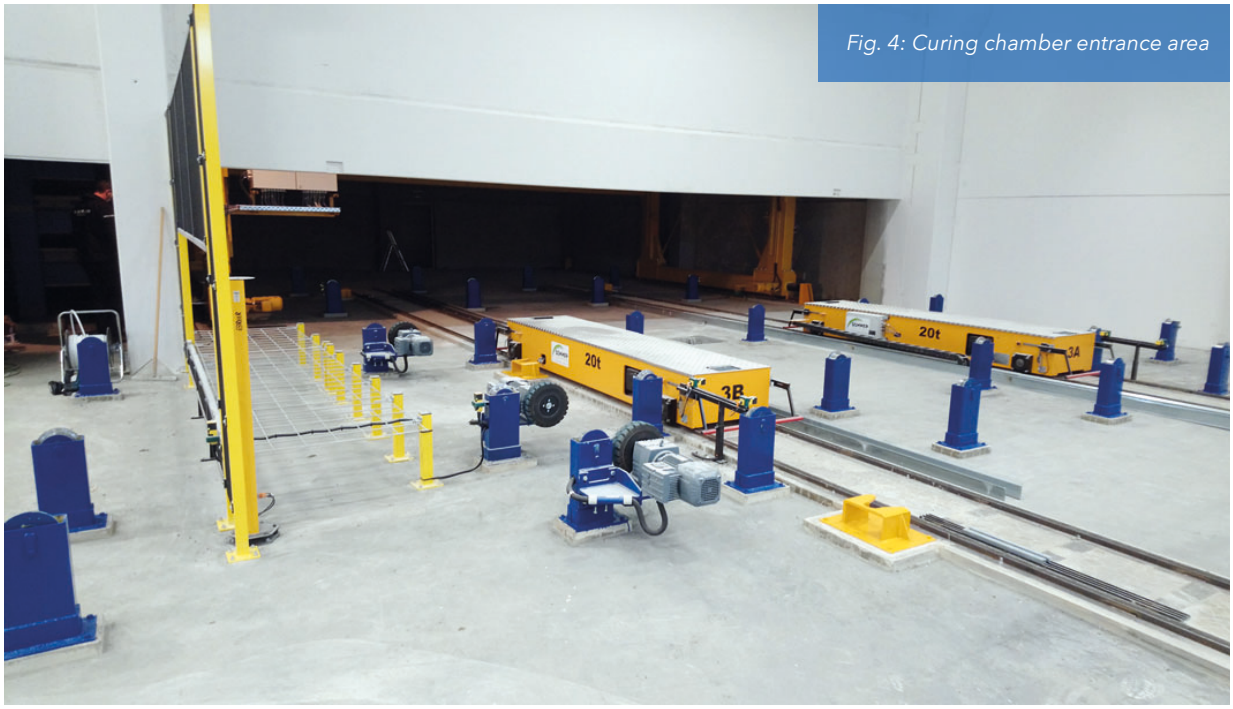

Fig. 4: Curing chamber entrance area

The production process begins at the shuttering station with a clean pallet. Since the circulation system produces systematised components, the element thicknesses and dimensions do not change very often. Heavy steel shuttering and an expensive shuttering robot have been deliberately dispensed with. Instead, this station is equipped with a laser projection system. The shuttering and magnets are removed from the pallet at an upstream station and hung on the side of the pallets in special folding holders. This allows them to be transported with the pallet from the deshuttering station through the pallet cleaner to the shuttering station. At the shuttering station, the shuttering and magnets are then removed from the folding holders and placed on the shuttering surface (Fig. 5).

The shuttering for solid elements on the basis of the Multi-Form shuttering carrier system and the magnets are from B.T. innovation GmbH. “We liked the idea of this shuttering transport right from the start”, explains Andreas Bold, production manager of the Attacus company in Hammerdal. “This solution was able to relieve our employees enormously.”

The shuttering is quickly and accurately aligned with the laser lines in just a few steps. The same applies to windows and doors and the corresponding shuttering. The electrical boxes are also already installed at this station.

After the shuttering is erected, the pallet moves to the next processing and reinforcement stations. Here, if applicable, shuttering components are complemented and prefabricated reinforcement inserted. The logistics for the reinforcements also follows an idea from the automotive industry. “Just in sequence”, prefabricated reinforcements, windows and doors

Fig. 5: Folding receptacles for shuttering transport

are provided outside the circulation at exactly the right time and in the right order (Fig. 6). For this reason, cycle time fluctuations in the circulation are very small despite very different degrees of difficulty.

Fig. 6: Window installation in the pallet

If, contrary to expectations, a shuttering or reinforcement should not fit or be incomplete or be delivered too late, the affected pallet can be removed in a diversion station located on the front side.

The pallet then moves into the concreting station, where a bridge concrete spreader with half width and eight frequency-controlled discharge screws operates in manual mode. The spreader is also equipped with a height-adjustable smoothing device (Fig. 7). It is fed from the central mixing plant directly above the pre-silo. The area for concrete transfer also serves as washing place. This is not only generously dimensioned, but is also equipped with a residual concrete recycling plant with a washout capacity of up to 6 m³/h. When the mixer is washed out, the washing water is fed directly into the recycling plant via a pivoting hopper.

The concrete elements are compacted with vibrating compactors. Through horizontal vibration in the x and y direction, the solid elements are compacted almost without noise emission.

At the following processing stations, the insulation is applied to the fresh concrete and joined to the concrete by means of suitable connectors. A laser indicates the exact position of the connectors to the employees (Fig. 8). "As a result, the processing time for applying the insulation has been significantly reduced," says Andreas Bold.

A curing chamber with two shelf towers and a total of 30 usable compartments is available for curing the elements. The pallets are moved into and out of the area of the storage and retrieval machine by means of cross-lifting trucks. The pallets are gripped from above by the lifting traverse, thus avoiding a pit. After being removed from the curing chamber, the pallets are moved to the other processing stations by means of cross-lifting trucks. Here, the shuttering and magnets are

Fig. 7: Bridge concrete spreader with smoothing device

Fig. 8: Installation of the insulation by means of a laser

Fig. 9: Tilting station

already removed from the shuttering surface and hooked into the lateral, fold-out holders. At these stations further additions to the elements can be added or installed.

To lift off the elements, the pallet is moved by means of a cross-lifting truck to a tilting station with a fixed stop beam, where the precast elements are preferably tilted to about 80° and stored in storage racks in the hall (Fig. 9).

The emptied pallet travels onwards to a stationary pallet cleaner. The pallet surface as well as the stationary edge shuttering are cleaned in a continuous process in one operation. First a scraper bar removes coarse dirt, followed by fine cleaning by means of a brush roller (Fig. 10). A dust extraction system can easily be retrofitted if required. After cleaning, the empty and clean pallet is ready for the next production cycle. "As Attacus paid great attention to standardised work processes in the previous production of wooden houses, this was a clear requirement for the planning of the new circulation system. This concerned both the optimisation of the concrete elements and many details in the circulation system and the adjacent areas of work preparation," explains Bernd Schreyer, the planner responsible for this project at BT innovation. "The climatic conditions as well as the requirements due to the existing halls, especially the partial basement, were additional challenges that had to be taken into account."

With the new circulation system, Attacus has set the course for the future at the Hammerdal site. Attacus is therefore able to offer both timber and concrete houses on the Swedish

Fig. 10: Stationary pallet cleaner

market. The significant increase in the quality of concrete houses contributes to the ability to implement demanding customer requirements in a high-quality, flexible and satisfactory manner.

Participating companies

B.T. innovation GmbH from Magdeburg took overall responsibility for the concept, planning and coordination. Sommer Anlagentechnik GmbH from Altheim supplied the production boards and the entire machine technology. The circulation plant controller and visualisation are also from Sommer. The laser projection system, the shuttering and the magnets were all part of the BT innovation package. ■

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PRECAST CONCRETE ELEMENTS

For the usability of foam concrete in battery mould

Standing production of a foam concrete wall at storey height

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Benjamin Schwaiger, Hasit Trockenmörtel GmbH, Germany

Today, hardly any modern building can do without insulation. Many techniques for the construction of insulated buildings are common: Classic sandwich construction with an insulating layer between the load-bearing and facing layer, core-insulated double walls or insulated structures with curtain walls are just a few possibilities.

Materials such as EPS, XPS, PU and mineral wool in the form of small-format boards in single- or multi-layer panels are frequently used as insulating materials. Laying the insulation is a time-consuming process, especially in areas of recesses or penetrating built-in components such as sleeve sandwich panel anchors. In times of a shortage of skilled workers, the work step of applying the insulation represents a time-consuming process step that requires optimisation.

In addition to the material and the laying performance, the disposal of the insulating material is also part of the full cost consideration for the cost-effectiveness of the individual insulating materials. The recent past has highlighted the problem of insulating materials that are expensive to dispose of, especially plastic-based insulating materials. The optimum is 100 % recyclable insulation materials.

Requirements to the manufacturing technology

What is desirable is a technology that makes it possible to produce dimensionally stable, insulated concrete structural elements with any manufacturing technology, virtually free formability and the simplest possible application and high insulating performance. Recyclability should be 100 % and compliance with the highest fire protection requirements, without additional flame retardants, is also desired. Many insulating materials often do not meet these requirements. Soft insulating materials also do not function reliably in standing production because the concreting pressures are too high and the insulation is simply compressed and, as a result, may no longer be able to perform its planned insulating performance.

The requirements formulated above are largely met by liquid applied, mineral, insulating materials.

From BT innovation's point of view, the application of a suitable insulating material in horizontal and vertical production of precast concrete elements is the goal. The standing production represents the greatest technological challenge: The pressures resulting from the dead load during the production process are high and can have a negative effect on the insulation. Formwork construction can also be very complex. As standing production is the more technologically demanding approach, BT was looking for a project partner capable of using a mineral foam in standing production and found one in Hasit. Hasit has proven in projects that it can introduce foam mortar storey-high up to approx. 2.70 m in in-situ concrete construction. In order to prove the usability of foam mortar in battery mould, the technology was tested in a cooperative experiment between BT innovation and Hasit. In the following text, foam mortar is also referred to as foam concrete.

BT's own battery mould was used as formwork. The casting comartment used was shuttered to a height of 3.50 m and the casting compartment was divided in such a way that the element to be produced had a width of 4.5 m. A width of 25 cm was set by the formwork. This results in a volume of the element to be produced of approx. 4 m³. Hasit's requirement was that no drop of water should drip from the formwork to ensure the stability of the foam. To meet this requirement, the casting compartment was shuttered with the MultiForm shuttering system and the associated MagFly® AP magnet. As this formwork system efficiently presses the shuttering boards against the formwork, this requirement posed no problem. The joints of the shuttering boards and the transition between the shuttering board and the formwork skin of the battery mould were additionally sealed by silicone or a rubber lip. A glass fibre plastic mat was used as reinforcement and transport aid.

Test description

The experiment was performed at an ambient temperature of 7°C. In order to meet Hasit's temperature requirements, the complete battery mould was enclosed and preheated to 12 °C. Thus, the lower tolerance range for the surface temperature of the formwork skin was fulfilled. To be on the safe side,

the process water had a temperature of 20 °C in order to compensate for any excessively cold binder in the peak. At the start of the test, the Hasit mixer was adjusted to produce a foam concrete with a low dry bulk density. After setting, the foam concrete was filled into the battery mould within nine minutes and two seconds, which corresponds to a filling speed of 0.44 m³ per minute. The maximum drop height of the foam concrete was approx. 2 m; with increasing filling level the drop height was constantly minimised. No segregation or collapse of the foam could be observed during the filling process. A sample was taken before and after filling the formwork. After the filling was completed, the battery mould was enclosed again and kept at the right temperature. Compaction would have been an obstacle at this point, since the structure of the foam must not be impaired. In order to have a comparison, a 25 cm high formwork on a tilting table was also filled with foam concrete in parallel. This formwork was not tempered.

Our results

20 hours after the filling, the foam concrete had solidified and developed very well and was steadily increasing in strength. The horizontally manufactured element was solid and could be demoulded without any problems. The standing manufactured element also had sufficient strength to open the battery mould. When the battery mould was opened, four days after the foam concrete had been filled, a crack-free foam concrete wall with a record-breaking height of 3.50 m was successfully cast in one casting (Fig. 1).

There was no reinforcement mat in the middle, at this point a crack about 2-3 mm wide formed after a short time. The foam concrete began to relax on the reinforced surfaces, and a large number of small cracks followed at intervals of about two weeks, which occurred arbitrarily at a distance between 15-25 cm and were usually significantly less than 0.5 mm wide. With regard to the function of the foam concrete wall as an insulating element, however, the small cracks are highly unlikely to represent a restriction. If one thinks of insulation in the form of plates, this shows a much more intensive joint pattern than the crack pattern described above.

The following evaluation generally distinguishes between the density of the material without drying, the so-called wet bulk density (NRD), and the density of the material after drying, the so-called dry bulk density (TRD).

As described, samples of the material were taken before and after the production of the wall in order to determine the material properties. The NRD and TRD of the material was determined from the samples taken during production. Three 4 cm x 4 cm x 16 cm specimens were cut from each of these samples. The averaged NRD

Fig. 1: Left: View into the open battery mould with the hardened foam concrete wall. Right: Traced crack pattern.

PRECAST CONCRETE ELEMENTS

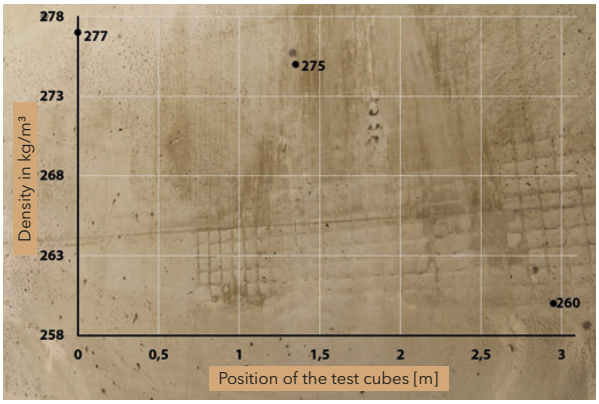

Fig. 2: Left: Five test cubes were cut out of the foam concrete wall at the bottom, middle and top to determine the density. The position of the cubes corresponds to the distance from the lower edge of the cut cube to the lower edge of the cast foam concrete wall. As a result, the highest pressure prevailed at the 0 m position. Right: Test cubes cut out of the finished wall were used to determine density and compressive strength. The sample cubes and the background of the left diagram provide information about the surface texture of the material.

of the samples taken was 200 kg/m³. The average TRD was determined after drying at 45 °C and was 180 kg/m³. The average compressive strength of the material was determined to be 0.44 N/mm² in sample 1 and the average flexible tensile strength to be 0.09 N/mm². The average modulus of elasticity of the sample was 124 N/mm². The experimentally determined and averaged parameters of sample 2 were 0.42 N/mm² compressive strength and 0.18 N/mm² flexible tensile strength. The modulus of elasticity of the sample was 111 N/mm².

After six weeks of storage at approx. 10 °C, 15 sample cubes were cut from three different heights out of the foam concrete wall, which had been produced vertically. From these cubes the averaged NRD was determined and the NRD course was determined as a function of the position of the cube in the foam concrete wall (Fig. 2). The glass fibre reinforced plastic was also weighed. In the upper area, at an average height of 2.95 m, an averaged NRD of 260 kg/m³ (± 5 %) was determined. The average NRD of the material is just below the centre of the wall, at 1.35 m, 275 kg/m³ (± 5 %) and on the floor 277 kg/m³ (± 5 %). After drying at 45 °C, the TRD was determined to be 190 kg/m³ and 200 kg/m³ from two test cubes of the vertically manufactured wall.
For the horizontally manufactured wall (Fig. 3), a mean NRD was determined experimentally using five sample cubes of 253 kg/m³ (± 5%). After drying the sample, the TRD was 190 kg/m³. These values prove that the density in the vertically manufactured wall and the horizontally manufactured wall correspond well, as do the desired and experimentally achieved values. The foam was only minimally crushed in standing production due to its own weight and it is therefore possible to produce a homogeneously insulated wall element standing above 3.50 m in height. The error range of ± 5 % is assumed to allow for larger pores and inaccuracies in the cut cubes. The compressive strength of each of three cubes was determined. This is 0.20 N/mm² in the upper range, 0.27 N/mm² in the middle and 0.28 N/mm² at the bottom.

The colour distribution on the complete wall element is almost homogeneous, as is the existing pore pattern. In a few places colour brightening is visible. The pores are mostly very small with a diameter of considerably smaller than 1 mm, especially in the material itself. Few very large pores with a diameter of 1-2 cm were present on the surface, in direct contact with the formwork skin.

Transfer to butterfly formwork technology

The battery mould technology was enriched by an application through the completed experiment. With regard to further manufacturing technologies, a wide range of possibilities can be derived. For example, it is possible to use battery mould to produce precisely fitting insulation panels. The shape and geometry of these can thus be adapted precisely to the respective building projects and can, for example, also be used directly as large-format, insulating external wall elements on the building site. The mineral foam elements can also be fed into the process as precisely fitting insulation panels, for example in sandwich wall production. A sandwich wall production with formwork-smooth visible sides on both sides using butterfly formwork technology is also possible. In a butterfly formwork, for example, the facing layer of a sandwich wall can be concreted horizontally and the foam applied to the fresh concrete. After hardening, the butterfly formwork with the semi-finished concrete element is lifted into the battery mould and the load-bearing layer is concreted in the closed battery mould.

Prospects

The Hasit foam mortar is mineral, non-combustible, 100% recyclable and well insulated - very good supplement for serial wall production with BT innovation butterfly formwork. The insertion of foam concrete insulation can probably be automated. In a circulation system, for example, a process step can be incorporated into the production process in which the

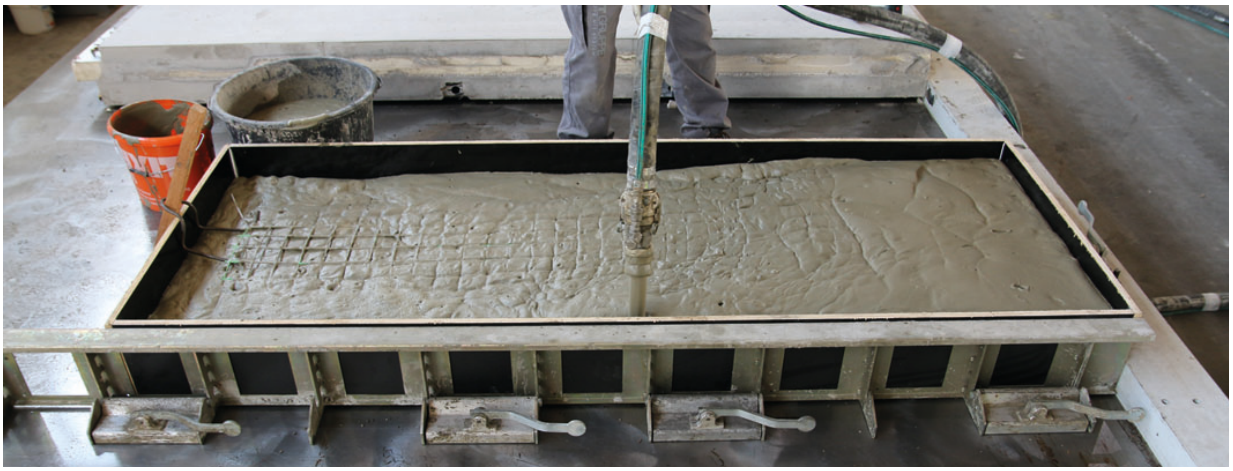

Fig. 3: Horizontal production of a foam concrete wall. The wall had a thickness of 25 cm and was used to determine reference values for the vertical wall.

foam is applied to the fresh concrete by an automated distributor after the concrete of the first layer has been compacted. There is no need for time-consuming laying and cutting of the insulation, so that the specialists can focus on the remaining process steps.

The B.T. innovation GmbH takes unusual paths, in order to make the building simpler, faster and more economical. ■

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Integral construction – a competitive advantage for precast plants

Integral construction is decisive for a cost-efficient project procedure. BT innovation has taken on the task of developing corresponding solutions and has been researching into integral technologies since the turn of the millennium. That could lead to considerable competitive advantages for precast plants.

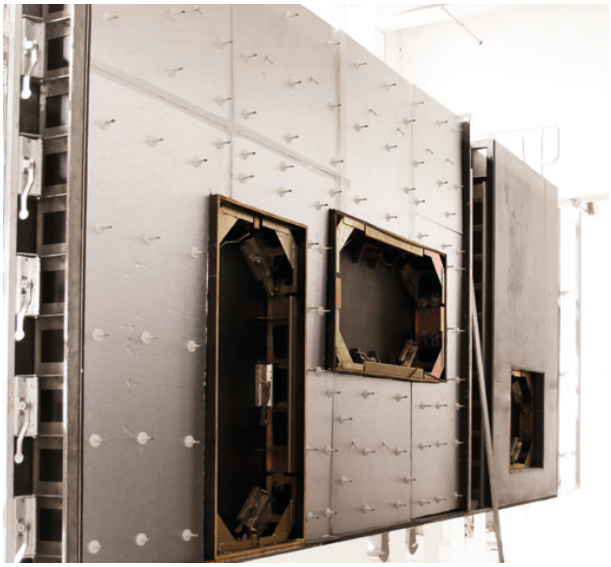
A comprehensive approach is required in order to be able to carry out increasingly complex construction tasks. The involvement of all technical planners and trades at an early stage makes a holistic approach possible. The emphasis here is placed not on partial aspects, but on the interaction of the largest possible number of factors and their integral concepts. Precast plants are thus integrated at the start of the entire value chain and can play a major role in shaping it.

Precast elements have to be sealed and connected on the building site. The precast plant can secure itself competitive advantages over in-situ solutions if it considers these trades from the very beginning. In the past years there have been decisive developments in this respect at BT innovation.
The development of the BT-Spannschloss (turnbuckle) for the dry connection of precast concrete elements is regarded as the first of its kind and accelerates the construction process on many building sites today, for example in the construction of a 15-storey hotel building at London's Heathrow Airport in 2018. Started as an in-situ concrete building site, the contractor switched to dry-connected precast elements from the fourth floor upwards and was thus able to shorten the planned construction time by several months.

The combined use of the BT-Spannschloss (turnbuckle) with a butyl rubber sealing tape such as RubberElast® enables dry precast element connections to be sealed immediately to a pressure of 5 m water column – even on building sites in winter. Polymer-modified bitumen tapes such as SynkoElast® and virtually shrinkage-free joint sealants such as InnoElast® enable a combination of in-situ concrete with precast elements and the assembly of precast elements virtually independent of the weather.

The integration of the façade insulation in steel reinforced precast concrete elements in the factory usually meets the ever increasing demands for better insulation of buildings more effectively than in-situ solutions. Shear connectors made of glass fibre reinforced plastic such as the ThermoPin® set

BT-Spannschloss®



Wall structure with core insulation and GRP shear connector

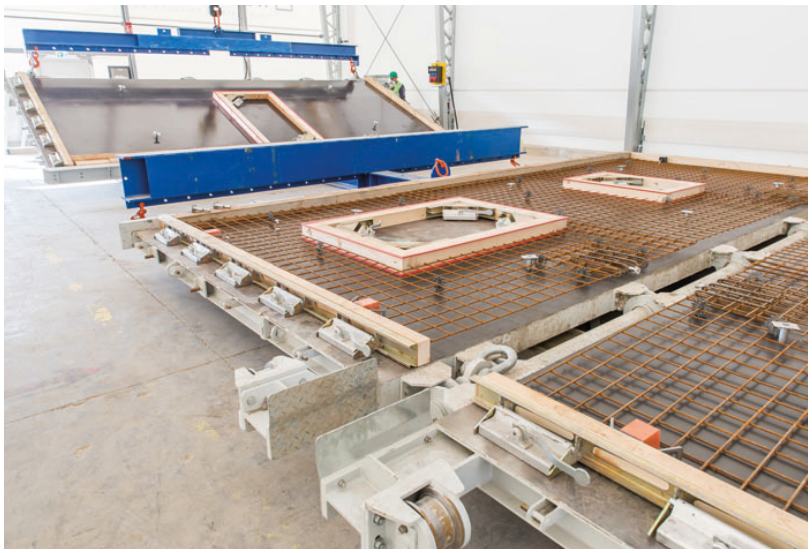
standards here in the connection of the concrete shells through the insulation. It is important that the glass fibre rods are optimised for fast processing. In addition, the shear connectors must be capable of absorbing movements in every direction so that the susceptibility to cracking of the exterior shell in the sandwich wall is reduced almost to zero.

The value chain can also be integrally optimised inside the precast plants. Magnet technology found its way into production many years ago. However, the real performance capability only results from supplementing the magnets by a precisely matching formwork system. The first gain in time results from the simple insertion of the magnets into the formwork without the necessity of a screwed connection. The foot/spring system of the MagFly®AP magnet enables easy movement of the formwork and fast shuttering. The adhesive force of the magnets, which is activated after positioning, pulls the formwork against the steel table and reliably seals the joint through pressure. With an adhesive force of 22,000 N and a weight of only 5.5 kg, the MagFly AP magnet from BT innovation offers a convincingly high-performance system together with the matching MultiForm shuttering support. Today, thousands of precast plants use the combination of high performance magnets and matching formwork system in order to set up their formwork in a matter of minutes.

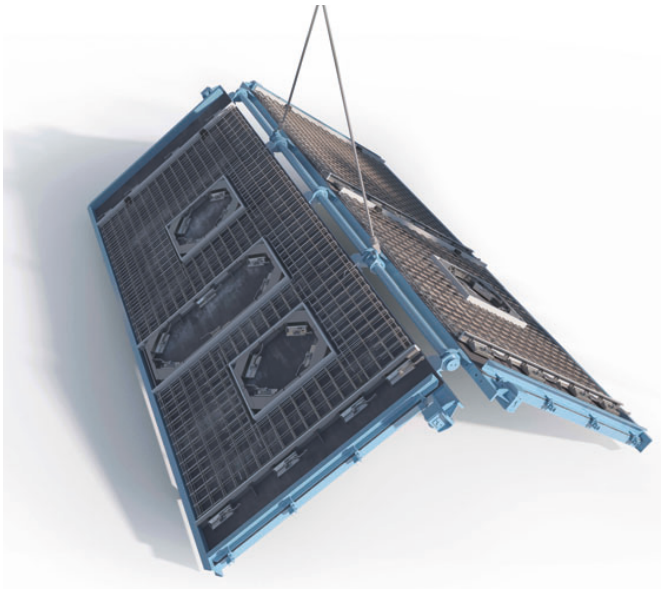
The production of five-sided formwork-smooth precast elements integrates the added value of in-situ plastering work directly in the plant. Wall elements manufactured upright with five-sided fair-faced quality ready for painting not only save the costs of on-site plaster application, but also minimise construction moisture and shorten the construction time.

The use of battery moulds for vertical manufacturing has been increasing for several years now. The Magdeburg-based company BT innovation introduced the butterfly formwork about two years ago. At that time the globally patented development solved the two main problems from which even high-performance battery moulds suffered. One is the dependence of the frequency of use of the battery mould on the lifting strength of the precast elements and the other is the comparatively high amount of manual work required for the formwork construction, reinforcing work and electrical installations on the vertical shuttering surfaces in a normal pocket battery.

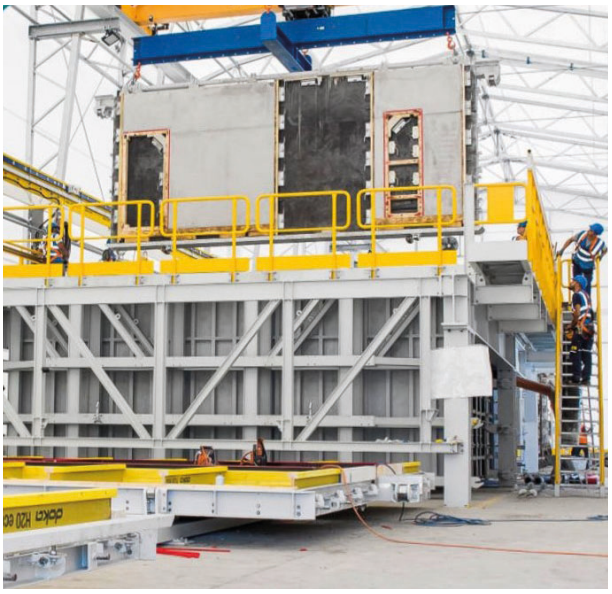
Since its market introduction, the butterfly formwork has combined the advantages of horizontal preparation with upright production. The battery formwork is faster, more economical and more flexible as a result.



Horizontal preparation of the butterfly formwork



Erecting the butterfly formwork



Five-sided formwork-smooth precast wall elements in the production process

The butterfly formwork can also be made similar to a circulating pallet. The battery mould thus becomes part of a circulation plant. This makes larger output volumes possible and thus more residential units per month. In the case of infrastructure building sites where time is critical, this capacity can displace in-situ manufacturing in favour of the precast plants. These and further technologies for integral construction can be seen at the bauma 2019 in Munich at the BT innovation booth in Hall B3, Booth 115 and at the MAX-truder booth in Hall B1, Booth 325. ■

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PRECAST CONCRETE ELEMENTS

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The battery mould becomes a circulation plant

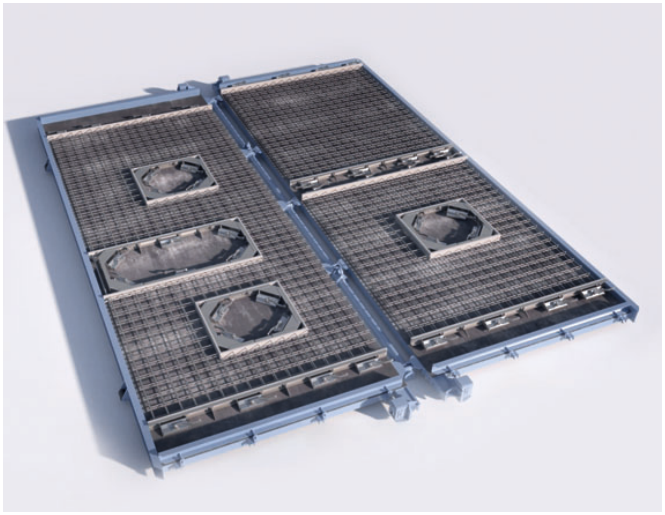
Since its market introduction, the butterfly formwork has combined the advantages of horizontal preparation with upright production. The battery formwork is faster, more economical and more flexible as a result. The patented folding formwork can now also be integrated into a pallet circulation plant. The battery mould thus becomes a circulation plant.

Circulation technology has been increasing the effectiveness of precast concrete element production for many years, for example for solid walls, sandwich elements, balcony slabs and special parts, and reducing production times through optimised machine technology and specialised work processes. With the integration of the patented folding formwork into a circulation plant, the battery mould becomes compatible with circulation plants. A high degree of automation and a highly efficient overall process is thus possible for the battery mould. New approaches for cost optimisation thus arise for sandwich walls or brick precast elements with a formwork-smooth interior face. The integration of the battery mould into a circulation concept links the process advantages of the circulation technology with 5-sided fair-faced requirements and the high capacities of the battery mould.

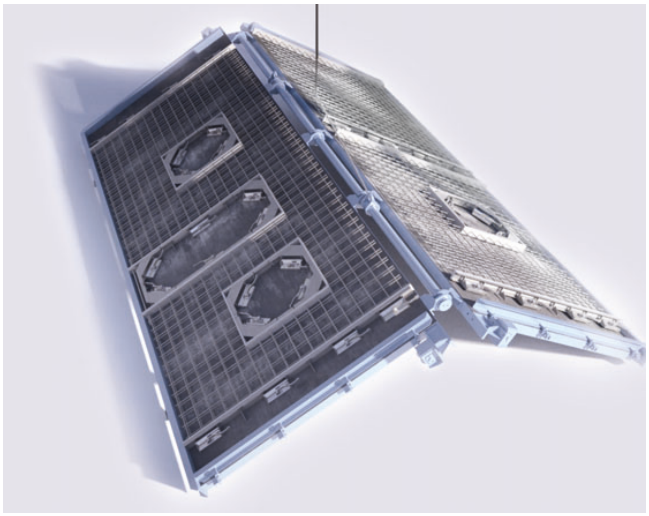
The Magdeburg-based company BT innovation introduced the butterfly formwork about two years ago. At that time the globally patented development solved the two main problems from which even high-performance battery moulds suffered. One is the dependence of the frequency of use of the battery on the lifting strength of the precast elements. The other is the comparatively high degree of manual effort required for formwork construction and reinforcement work on the vertical formwork surfaces in a pocket battery.

The first challenge was overcome through the butterfly technology, as the precast elements could be lifted out together with the butterfly formwork just a few hours after concreting and stored outside the battery for hardening. The necessary waiting times are shortened if the precast elements do not have to bear their own weight when lifted. The precast elements can already be removed from the battery together with the butterflies from a strength of 5 – 8 N/mm². Thus up to four concreting procedures are possible per day.

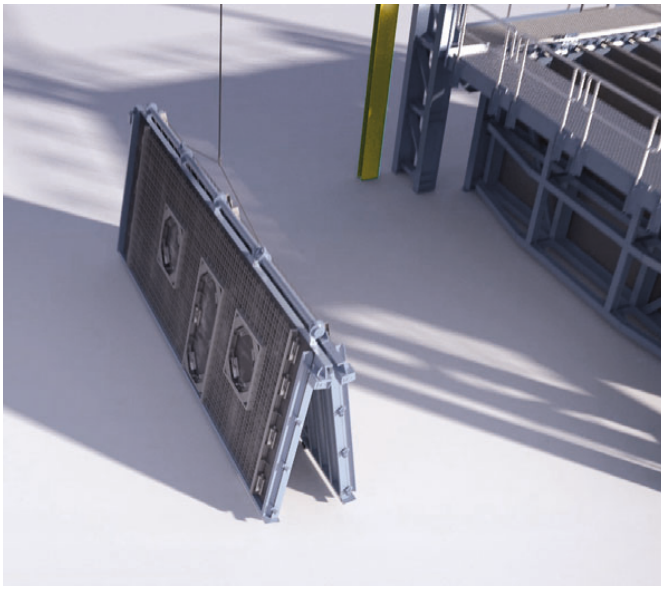
The second disadvantage of the pocket battery – the high effort required for the formwork construction and the reinforcement work on the vertical formwork surfaces inside a cramped battery formwork – was considerably reduced by the newly developed formwork chambers. They are removable and can be horizontally positioned outside the battery. All work steps prior to concreting can thus be performed in a horizontal position just as effectively as on tilting tables or circulation plants,



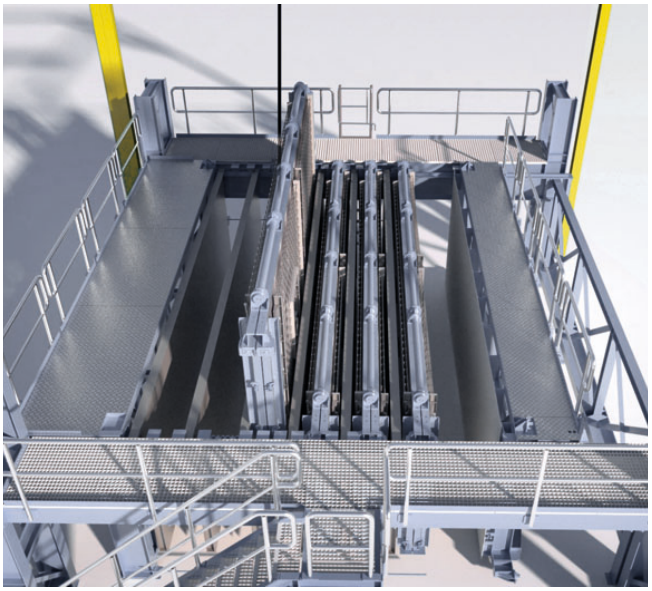
Preparation of the butterfly formwork in the horizontal position



The fully shuttered and reinforced butterfly is lifted up



The butterfly folds together



The butterfly formwork is placed in the battery

including laser projections for the exact positioning of shutters, cutouts, reinforcement, built-in components, conduits and magnets. Especially the laser display of the production data for the precast concrete elements at the push of a button leads to error avoidance, reduced setup times and more effective production.

The butterfly principle in particular was new at the time of the market introduction. The formwork surface is twice as large as the chamber in the battery. On completion of the preparation, the butterfly is suspended in the battery mould with the crane. It folds together in the middle on being lifted. The two formwork surfaces thus move from the horizontal preparation position to the vertical position for concreting.

Several market leaders now use the butterfly technology; three systems are located in Germany, one in Austria and one butterfly battery was sold to South America. Since the end of 2017 the patent rights have been held by the Umdasch Group in Austria, which focuses on the construction and operation of mobile field factories. The Magdeburg-based company BT innovation received the licences for the stationary precast plants.

Decisive further developments took place in 2018; these are to be installed in a further precast plant in the first quarter of 2019. Structural elements larger than 8.0 x 4.0 metres can now also be produced in precast plants using this technology. In future it will also be possible to move the formwork areas, which are removable from the battery, between the individual work stations outside the battery, like the pallets in a circulation plant.

At present the company has completed the production planning of the first development stage for an element-optimised butterfly circulation plant for the manufacture of individual solid wall and sandwich elements with 5-sided fair-faced requirements. Precast concrete elements containing a large number of built-in components and installations, high quality sandwich walls and facades with architectural requirements are to be produced. In the second development stage it will be possible to remove the machining centres from the pure transport sequence and, after entirely different machining times, to reinsert them into the production sequence.

Both companies will present the butterfly technology at the important trade fairs in 2019. BT innovation can be found at the forthcoming bauma in Hall B1 / Booth 325. ■

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