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Case study

Building the future with Combar

Schöck products made of glass fibre composite material: building the CUBE using non-metallic reinforcement

Innovative material for a futuristic look: the CUBE, the world's first building constructed entirely of carbon concrete, opened on the campus of the Dresden University of Technology in September 2022. It has a visually striking, boldly curved roof/wall construction arching over a simple cube. Only non-metallic reinforcement was used in the CUBE to provide the necessary structural strength. Schöck Isolink and Schöck Combar made of glass fibre composite material are also used to safely transmit loads in the composite walls, sandwich walls, foundation and roof.

The CUBE is the brainchild of the Institute for Solid Construction at the Dresden University of Technology, represented by Manfred Curbach, chair of the board of the association C³ - Carbon Concrete Composite e.V. Since its founding in 2014, the association has been dedicated to the development of carbon concrete – an umbrella term for concrete with non-metallic reinforcement which is considered to be a building material of the future. The concept for the CUBE was designed by HENN. For the design, the architecture office combined a rectilinear BOX as the body of the room with roof/walls constructed from carbon concrete shells with multiple curves known as the TWIST. These two heavily contrasting elements effectively demonstrate the versatility of non-metallic reinforcement.

Less volume, high tensile strength

Carbon concrete is a composite material consisting of concrete reinforced with non-metallic material, such as a carbon-fibre mat or fibreglass rods. Schöck has been using fibreglass rods as reinforcement and as a component of various products for over 25 years. Under the name Combar, this is the only fibre composite material to have been approved by the building authorities since 2008. The bars can be straight or curved, which offers flexibility in terms of component geometries. Furthermore, the glass-fibre reinforcement has a high load-bearing capacity and is 100 percent corrosion-resistant. This makes the material much more durable than conventional reinforced concrete. It also has a higher tensile strength and is less dense than steel, which lowers the volume of material. Much slimmer and lighter concrete walls can be constructed without compromising stability.

Schöck Combar: essential modular element of the CUBE

The planners selected Schöck Combar to make the reinforcement cages, wall corners, stirrups, ring beams and the foundation connection reinforcement for the BOX and TWIST modules. Glass fibre composite rods and stirrups were used to reinforce the edge beams of the TWIST module. The range of different rod shapes lent stability to the load-bearing structure of the unusual building geometry.

Combar in the TWIST

During construction, it became apparent that the qualities of Combar take the design potential to a whole new level: The double-curved, twisted shell in exposed concrete segues from the horizontal to the vertical in a continuous twirl of roof and wall. The formwork for the structure which is joint-free consisted of a specially made wooden base on which shotcrete and carbon fibre reinforcement meshes were applied in layers.

First, a load-bearing shell 25 centimetres thick was fabricated in multiple layers: Next, a carbon concrete solid shell 3 to 4 centimetres thick was constructed, followed by polystyrene blocks as void formers to reduce the volume of concrete used and the weight. This was topped by another carbon concrete solid shell 3 to 4 centimetres thick. The shells are

connected by vertical concrete bars, roughly 6 centimetres wide, with 80 centimetre centre-to-centre distance in one direction and 44 centimetre centre-to-centre distance in the other.
The two TWIST shells rest on structural steelwork and are supported on the ground by a foundation. The glass-fibre composite material Combar was incorporated as the connecting reinforcement and shotcreted to produce the supporting shell.
Combar is much lighter than conventional steel reinforcement, weighing only approx. 30% of the weight of steel, which also makes it easier to handle during installation. Structural engineer Hans-Hendrik Ritter from Assmann Beraten + Planen remarked: "During the construction of the CUBE, we gained a great deal of experience that we can apply in future projects."

Schöck Isolink reliably fixes the roof/wall construction

The load-bearing and weather shells were connected using Schöck Isolink elements. The glass fibre rods were glued into the pre-drilled holes according to the structural requirements. Then, the 14-centimetre-thick thermal insulation elements were pushed on to these and bonded over their entire surface. The protruding ends of the Schöck Isolink units provide a reliable hold for the 4-centimetre-thick carbon concrete weather shell. This innovative roof/wall construction is 27 centimetres thick overall.

Schöck Isolink secures core-insulated concrete façade

The two-storey BOX with rectangular plan view demonstrates the potential of non-metallic reinforcement for cost-effective construction methods suitable for mass production. The element walls and sandwich walls were prefabricated using the usual process in a precast concrete plant and delivered to the construction site on schedule. The innovative insulation and slim concrete shells only 4 centimetres thick made it possible to construct walls only 27 centimetres thick in total – as a rule, walls of reinforced concrete buildings are usually 44 centimetres thick. Schöck Isolink provides a reliable fixing for core-insulated concrete façades.

Reliable thermal insulation, high degree of freedom for the design

Isolink is used as a connecting element that reduces thermal bridges due to the low thermal conductivity of the material. It also allows light filigree concrete components to be used, as shown by the slender walls of the CUBE. The rods also act as spacers in the cavity that is filled on site by in-situ concrete as is customary.

Almost 170 square metres of wall and ceiling were built in this way. Roughly 10 Isolink were used per square metre, totalling around 1,700 units for the entire BOX.

Paving the way for imitators

Thanks to the commitment and expertise of the companies involved, the example of the BOX shows the huge potential of non-metallic reinforcement for structural engineering and design. Construction work is complete – now it will be put to the test in everyday life. Over the next few months and years, special sensors installed in the concrete will provide important data on aspects such as moisture, deformation or cracking. At the same time, the partners of the C³ association are developing processes to increase the level of automation in production to make construction with carbon concrete even more attractive to the general public.

www.schoeck.com

Project information

Construction period: January 2021 to September 2022

Principal: Manfred Curbach

Concept design: HENN GmbH

General planning: AIB GmbH Architekten Ingenieure Bautzen, Bautzen, Germany

Structural engineering: Assmann Beraten + Planen GmbH, Dresden branch, Germany

Prefabricated part production: Betonwerk Oschatz GmbH, Oschatz, Germany

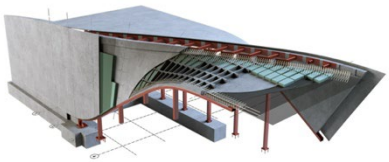
Joint venture: Bendl Hoch- und Tiefbau Sebnitz GmbH & Co. KG, Hohnstein; Hentschke Bau GmbH, Bautzen, Germany
Products: Schöck Combar, Schöck Isolink

Info box

Combar integrated in FRILO and RIB design software

Combar by Schöck is the first fibre composite reinforcement to be approved by the building authorities and has now been integrated into FRILO and RIB. This means that the unusual reinforcement element can now be sized in the familiar software environment as longitudinal reinforcement or as stirrup reinforcement. A wide variety of cross-sections (rectangular, circular and T-beam cross-sections) is available for straightforward sizing of Combar in various structural and civil engineering applications.
For more information, go to: www.schoeck.com/en/combar

Graphics



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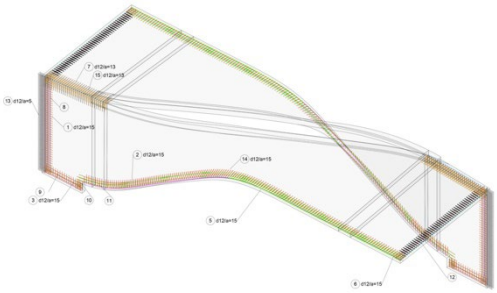
Sectional drawing



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Images

[Schoeck_The-Cube-Dresden_1]

The CUBE in Dresden, the world's first carbon concrete building, was constructed entirely without steel reinforcement.
Photo: © Moritz Bernoully

[Schoeck_The-Cube-Dresden_2]

The different shapes of the Combar® lent stability to the load-bearing structure unusual building geometry.
Photo: © Moritz Bernoully

[Schoeck_The-Cube-Dresden_3]

The CUBE consists of two parts – the TWIST and the BOX. It is an experimental building and at the same time a vehicle for researching the long-term suitability of carbon concrete in terms of structural design, structural engineering and building physics.
Photo: © Moritz Bernoully

[Schoeck_The-Cube-Dresden_4]

Schöck Combar is used as connection reinforcement in the foundation of the BOX, and absorbs the load of the external walls.
Photo: Marén Kupke

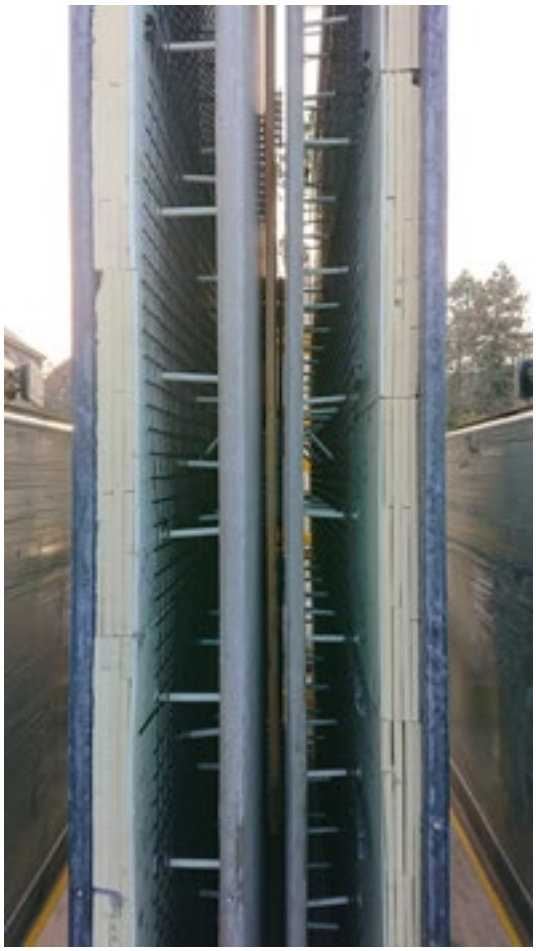
[Schoeck_The-Cube-Dresden_5]

The energy efficiency of the roof is ensured by 14 centimetres of thermal insulation and Schöck Isolink façade anchors, which minimise thermal bridges.
Photo: Marén Kupke

[Schoeck_The-Cube-Dresden_6]

To use Schöck Combar to reinforce walls at the corners, the required bending radii had to be adapted to the requirements of the slender wall structures.
Photo: Marén Kupke

[Schoeck_The-Cube-Dresden_7]



The structure of the composite walls is clearly visible here. The cavity is filled on site with in-situ concrete.
Photo: Marén Kupke

[Schoeck_The-Cube-Dresden_8]

Edge beams were formed in the roof area of the TWIST. Schöck Combar reinforcement cages also guarantee reliable load transfer here.
Photo: Marén Kupke

[Schoeck_The-Cube-Dresden_9]

Schöck Combar is the only fibre composite material on the market, which has been approved by the building authorities since 2008. Straight and curved bars are available, offering flexibility in terms of component geometries – as in the case of The CUBE Dresden.
Photo: Schöck Bauteile GmbH

[Schoeck_The-Cube-Dresden_10]

Schöck Isolink Type C is the façade fastener made of glass fibre composite material and the energy-efficient alternative to conventional stainless steel solutions for connecting the concrete shells of core-insulated sandwich and element walls.
Photo: Schöck Bauteile GmbH

About Schöck:

Schöck Bauteile GmbH is a subsidiary of the multinational Schöck Group with 14 international sales offices and approximately 1,000 employees. The company’s success story started in 1962 in Baden-Baden at the edge of the Black Forest. The company’s founder Eberhard Schöck applied his knowledge and construction site experience to develop products that streamline construction and solve complex problems in building engineering. This mission has formed the foundation of the company's philosophy to this day. It has made Schöck into one of the leading providers of reliable and innovative solutions to reduce thermal bridges and impact sounds and to create thermally insulating and secure facade fasteners and reinforcement technology. Schöck products make smart construction methods possible and ensure consistent construction quality. Addressing building engineering and energy efficiency are the company’s top priorities. To meet the construction needs of tomorrow, Schöck is driving the adoption of digital technologies in all areas, from workflows and planning to the construction site.