BIM

Building Information Modelling (BIM) will bring a paradigm shift in the construction industry

Glass fibre-reinforced polymers (GFRP) play an important role in the building industry, competing with traditional building materials. Carbon fibre-reinforced polymers (CFRP) are particularly interesting for highly-stressed parts in construction.

The big potential of carbon in lightweight construction is due to the fact that the individual fibres are aligned with the direction of forces. The material in itself responds to the stress factors, making it well suited for a variety of applications.
However, the price factor is still an impediment. Carbon fibres are much more expensive than glass fibres. They are used in CFRP blades, reinforcement fabrics for concrete, ropes or membranes.
The major advantage is that they do not corrode and they are lighter than aluminium or steel. Research is trying to optimize the series production of composite parts to make them more cost-efficient.
Glass fibre-reinforced plastics are by far the largest material group in composites. More than 10 million tons are produced worldwide, including around 2.8 million tons in Europe.
The worldwide demand for carbon fibre-reinforced plastics was estimated at 112,000 tons in 2017, including around 38,000 tons for Europe (Carbon Composites e.V. Market report 2017).
Their low weight is not the only advantage of composites compared to other construction materials.

First carbon concrete bridge of its kind worldwide in Albstadt-Ebingen – (copyright photo: solidian GmbH)

They offer a variety of additional features like excellent corrosion properties, high dimension stability, low maintenance, high durability, load-bearing capability and a high level of design freedom.

interview

Dipl.-Ing. Boris Peter,
Managing Partner Knippers Helbig Advanced Engineering
Dr.-Ing. Matthias Oppe,
Director, Knippers Helbig Advanced Engineering

JEC Composites Magazine: Could you outline Knippers Helbig's experience with composite materials in construction and how you envisage the future?

Boris Peter : When talking about fibre-reinforced ceramics, fibre reinforced plastics, carbon or glass fibre, we are always facing the same problem: they are non-standard components, which need an authorisation on a case-by-case basis.

Let me explain this showcasing our project for the acoustical reconstruction of the Staatsoper Berlin opera house.

The design for the reconstruction of the state opera house by HG Merz architects included improving the acoustics of the concert hall and optimizing the reverberation time.

For this purpose, the top floor ceiling had to be lifted by 4 m, thus creating a reverberation gallery comprising reflective and sound-absorbing components.

The requirements related to the load-carrying capacity and fire safety were decisive to determine the choice of the appropriate material.

Glass fibre-reinforced plastics did not comply with the fire safety standards and had to be replaced by fibre-reinforced phosphate-ceramics, which were used for the first time ever in a building structure.

Where do you see new challenges and opportunities coming from digital transformation?

B. P.: We have always been relying on digital methods, particularly for free-form shell structures.
The most striking advantage I see is that we are able to reduce the error rate.

Knippers Helbig uses process-oriented computation methods linking all the design components to database-driven engineering tools such as Building Information Modelling (BIM).

BIM planning methods mean a paradigm shift in planning processes, with enhanced transparency and increased cost stability. At the same time, this requires a high level of teamwork. All the partners are obliged to work together to achieve the project's objective, adopting the mindset of a master builder without regards to individual company profiles.

BIM also offers the opportunity to redefine the interface between planning and execution, and focus on close cooperation and partnership.

Robot-manufactured reverberation gallery made from fibre reinforced phosphate-ceramics at Staatsoper unter den Linden, Berlin, Germany - (©Marcus Ebener)

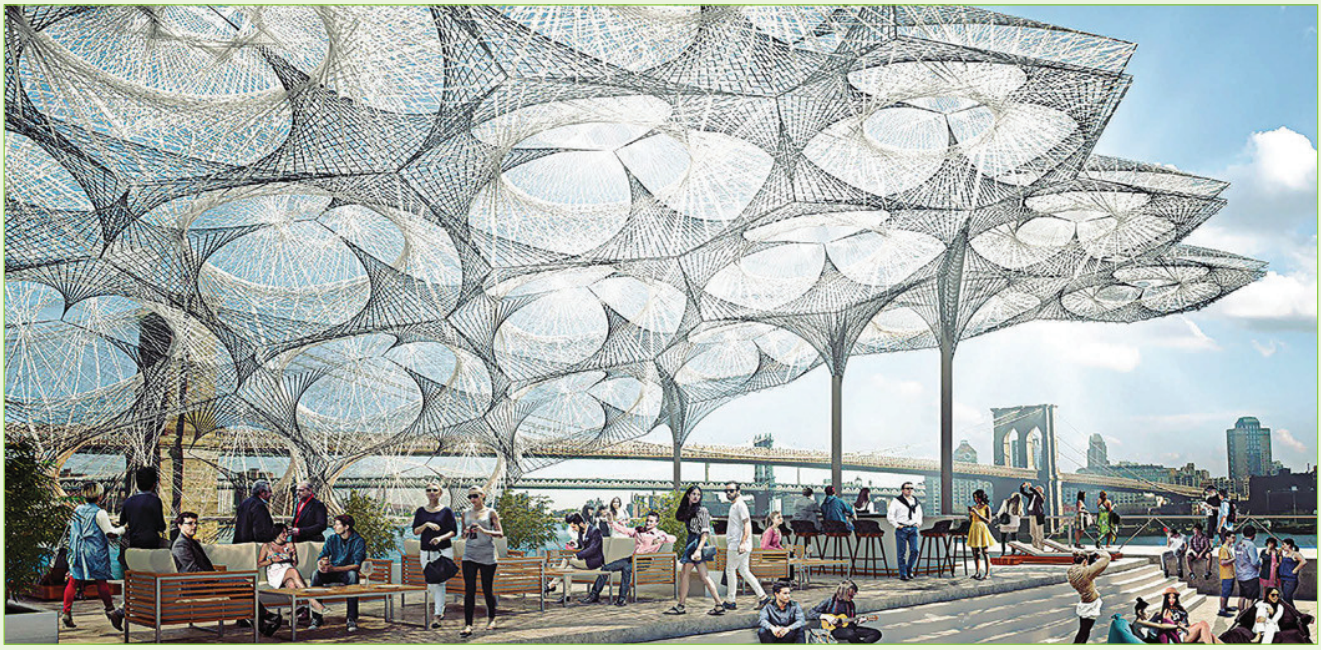
How important is artificial intelligence in these planning processes?

Matthias Oppe: We frequently apply artificial manufacturing methods in our work. Take highly stable and ultra-light building envelopes for example. This is lightweight construction carried to extremes. Our founding partner, Thorsten Helbig, is currently working on a portable temporary lightweight stage roofing for Pier 17 in New York City, designed by Menges Scheffler Architects.

The eye-catching unique canopy is composed of 77 hexagonal robotically-woven interlocking glass and carbon fibre cells.

> Coordination of approval process is a somehow usual business for us.
> Dr.-Ing. Matthias Oppe

In a foreseeable future, BIM will find widespread adoption and lead to a disruption in the building industry.
Apart from enhancing teamwork, the entire value chain may be improved.



Portable temporary lightweight stage roofing at Pier 17, New York City designed by Menges Scheffler Architects – (copyright photo: Howard Hughes Corp. via The Tribeca Trib)

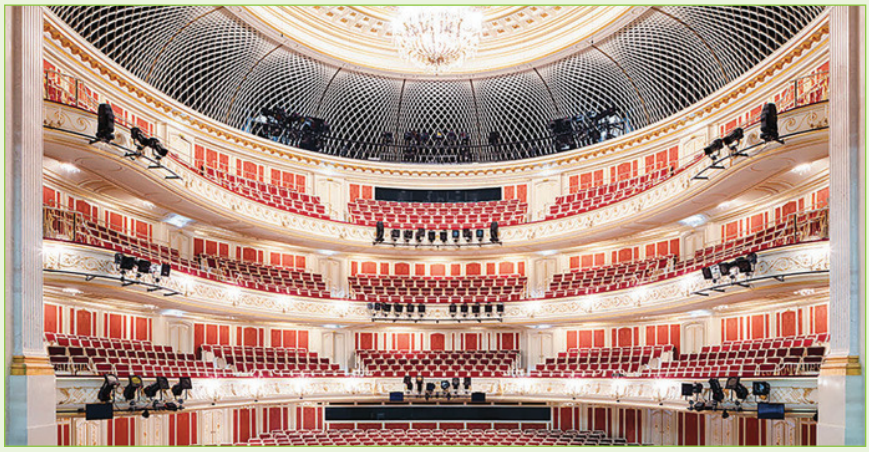
As planners, we have to take hold of the reins of digitization ourselves.
It is time for a paradigm shift in the construction industry. I would add that coordination of approval process is a somehow usual business for us.

Where do you see notable challenges in the value chain in terms of research, planning and construction?

B. P.: We are always facing the same topic when it comes to load-bearing structures and this is fire protection. In our current textile concrete projects, we experience a reluctance from the executing companies to apply current research in their construction work.
The transition of an application from research into practice is lagging behind. Nobody wants to take the risk of using innovative solutions. Furthermore, conventional procurement procedures do not open the way for constructive cooperation between the different partners in the value chain.
As a planning office, we try to close that gap.

> **We conceive innovation as kind of a subversive act to stand up for the freedom of design.**
> Dipl.-Ing. Boris Peter

We consider it our responsibility to translate between research and executive construction.
This is our strength. We often skip the executing companies to create and use new material combinations.
We conceive innovation as a kind of a subversive act to stand up for the freedom of design.



Restructuring the Staatsoper Unter den Linden, opera house in Berlin, the engineers have broken new ground using the latest manufacturing techniques and innovative materials. Copyright photo ©Marcus Ebener

However, traditional construction methods are still predominant. Most of the producers of prefabricated parts we met are not motivated to do something apart from off-the-peg products.
We always attempt to explore the boundaries, since we believe in progress and innovation.
Our sector must not confuse method with innovation.

What are the main barriers to the widespread use of composite structures despite their outstanding advantages?

M. O.: Authorisation and approval procedures are nowhere else as burdensome as in Germany, except France perhaps.

Take again the example of our Pier 17 project in the US, a fabric construction with carbon fibres. If the scientific tests are positive, we can go ahead.

Or take the example of bridge construction. In the Netherlands or other European countries, the number of bridges made from glass fibre-reinforced plastics is extremely high due to the positive properties of these materials like being non-corrosive, durable and lightweight.
In the Netherlands, you will find thousands of flap bridges, in Germany only a few.

The same with carbon concrete as a new material that is not yet approved for construction.
For the world's first and only carbon fibre-reinforced concrete bridge in Albstadt-Ebingen, we had to obtain approval for that individual case (ZiE – Zustimmung im Einzelfall). □

More information:
www.knippershelbig.com

More information

Knippers Helbig Advanced Engineering is an internationally-operating consulting engineering practice with a multidisciplinary team of civil and structural engineers, architects and façade engineers (around 70 staff members). Knippers Helbig was founded in 2001 by Prof. Dr.-Ing. Jan Knippers and Dipl.-Ing. Thorsten Helbig, who is now running the company together with Dipl.-Ing. Boris Peter. In addition to the headquarters in Stuttgart, the company has subsidiaries in New York City and Berlin.

The company's project portfolio encompasses a broad spectrum of very diverse buildings for various purposes, such as schools, museums, airports, office buildings, shopping malls, art installations or bridges.

It has outstanding expertise in the use of a wide variety of materials and experience in creating innovative, integrated and sustainable engineering solutions, particularly with new materials such as membranes, glass fibre-reinforced plastics and ultra-high-strength concretes.

testimony

A new generation of ancient shades of architecture

An era of new-age composites technology, blending the oldest architectural styles with 21st century materials and aesthetics, is now beginning.

Indian architecture stands as one of the most ancient forms of architecture. It has evolved over time and space with shades from a variety of art and architectural forms that have configured the Indian history. As the new generation of architects grows the industry, there has been an increasing urge to experiment with something different. Architects are gradually embracing composites to bring their imagination alive. Here are interviews with some of them, as well as manufacturers of architectural composites in India.

Our team visited Agni Fiber Boards Pvt. Ltd. to pen down their view on architectural composites and the company's current success. A 100% FRP gate with a metallic finish slid open to usher us inside the campus. The vestibule of the company's building was innovative with a long FRP pole surrounded by FRP barricades painted in lovely pastel colours. The wooden-looking FRP park bench was difficult to miss. The work floor was thronged with 36 pultrusion lines capable of producing up to 800 MT of FRP every month. In the conference room, we started a small chat with young entrepreneur Mr. Paresh Patel. ◻

interview

Paresh Patel,
Marketing Head
Agni Fiber Boards Pvt. Ltd.

JEC Composites Magazine: What is the signature product of Agni Fibers?

Paresh Patel: FRP barricades circumscribing transformers are our main product. In a huge country like India, upkeeping transformer stations is definitely a challenge, especially, when the midst of a city area starts looking ugly as the metal of transformer station towers corrodes. With the introduction of the Clean India Mission (Swachh Bharat), Agni Fibers can provide FRP barricades that offer a number of benefits such as light weight, an aesthetically appealing finish, corrosion resistance, prevention of domestic animals dying or being injured due to metal barricades and prevention of impact injuries in case of a vehicle collision.

The authorities were quick to question the comparative costs, and it took some time and a number of samples to convince them that the lifecycle cost of installing FRP barricades, together with their aesthetic value, would definitely be beneficial. We already supplied FRP barricades for 86 transformer stations.

What are your major architectural composite products?

P. P.: When the imagination of architects blends with the manufacturing ease of FRP, the sky is the only limit for product variety. The list can be endless. Agni Fiber has by now been able to supply front facades for modern buildings, louvers (for both factories and residences), pergolas, electric poles, gates and stylized entrances, pipeline covers and fins. We are preparing to provide FRPs for chemical environments and highly humid areas.

Each product for architecture is unique. Combining the creativity of architects and mass production is a challenge. Agni Fiber specializes in identifying and maintaining many similar basic profiles across a wide variety of architectural products. This enables us to use similar dies.

However, the variation in the finish, aesthetics and assembly of these profiles in different patterns offers enormous possibilities to architects. Despite standardized variations, some products need to be revised at the very beginning of the manufacturing line. The challenge for Agni Fiber is to produce different products for architects and end-users.

What are the manufacturing challenges that Agni Fiber faces?

P. P.: Manufacturing quality products in large volumes is our forte. Aesthetics and variations are the two key pillars of success for architectural composites.

To cater to variations in the desired output,