COMPOSITE REBAR
NEXT GENERATION.

Abstract
Composite rebar is a more durable, high performance lightweight solution for concrete. It is a successful proven reinforcing alternative to the heavy corrosive steel, offering longer service life, especially in highly corrosive environments. No corrosion crackings in the concrete structures caused by the steel reinforcements, save the high maintenance and repair costs in the construction industry. In addition, the composite products are easier for handling or transport, free from magnetism and not thermally conductive. Currently, there are several solutions for composite rebar available but they are still expensive and some also have corrosion problems. Now, after four years of research, development and testing, KraussMaffei is ready to enter the market with a high-end pulwinding machine, providing an economic, turnkey solution for production of GFRP rebars using fast curing epoxy resin.

Motivation
The market for composite rebar is growing firmly with double digit rate in the past 10 years. Standards and vast number of pilot projects opened the industry after decades of testing and development of engineering guidelines. Today, the prognosis for the next decade looks identically optimistic. From the technology point of view, the FRP global composite rebar market appears to be diverse, without unified material specifications. This has led to different products worldwide, with diverse physio-mechanical properties and geometries. The present situation motivated KraussMaffei for evaluating the existing technologies, seeking for innovate solution as well in the area of chemistry as in the manufacturing process.

The sustainable solution
In composite concrete reinforcement, the rovings take on the mechanical load and the matrix protects them from the effects of the external environment. The high pH-value of almost 13.9 in high alkaline concrete attacks every medium and acts as a real challenge in the long-term corrosion resistance. Extensive research work has shown that polyester resin does not have the necessary long term resistance to the corrosive chloride chemicals present in ocean site concrete structures or in wintertime with deicing salts. Further on, anhydrid epoxy resin decomposes in an alkaline medium and thus also doesn’t have the desired long-term stability. Some vinyl ester rebars have about 50 years of service life. However, a real breakthrough in the lifespan of composite rebars can be realized using an epoxy amin system. This fast reacting resin withstands up to 100 years in harsh alkaline environment and is applied as extra coating to some rebars. The industry prefers it in long-term projects, adding real economic value and preventing from the chief cause of failure in concrete structures.

Another milestone in the reinforcement is the compounding force of the rebar with the concrete structure. Evaluating different technologies of surface texture, as different sand coatings, helical grooved or helical wraps and measuring the force strength level, KraussMaffei developed own helical rib solution, benchmarking leading companies and corresponding with settled global construction standards. This solution led to the economic viable glass fiber rebar, pultruded in KraussMaffei’s novel technology approach – the iBox. The company was crowned with an innovation award in 2017 by FSK for reaching pultrusion speed of 2,9m/min with polyurethane, innovating the iBox techolgy. Now, the currently smallest diameter of 8mm rebar is being produced with the speed of 10m/min in two lines, with a total output of about 2.700km per year.
Applications in construction sector

The applications for composite rebars in construction projects are quite versatile - from bridges, underground structures (also for soft eyes), marine constructions, roads, parking decks, industrial plants, research facilities or magnetic resonance imaging rooms to energy efficient buildings, airports, Formula 1 tracks, balcony facades, foundations, water treatment facilities or as another example hydro dams.

The composite rebar is a perfect reinforcing element for smelters, transformer buildings, airports runways or towers, eliminating any electricity losses or radio signal corruption. The application in a seawall, strengthening the iconic 7-star Burj Al Arab hotel in Dubai reveals the technology competitiveness in premium construction projects under harsh environment.

Road and bridge infrastructure of FRP rebars

The largest GFRP fully-reinforced project in the world was started 2019 in the Jizan Economic City (JEC), Saudi Arabia. The 23km long, 40m wide unique structure serves as flood mitigation channel for one of the biggest Saudi Aramco’s refinery built in an area of high flood risk between the mountains and the sea coast. Saudi Aramco mandated GFRP rebar to be included to internal construction standards for corrosion-risk areas.

GFRP rebar mesh with epoxy amin resin

GFRP amin rebar ultimate advantages

- Longer service live properties
- Absolute corrosion & alkaline resistance
- Superior tensile strength & lightweight
- Excellent fatigue resistance
- Non-magnetic & non-conductive
- Very-high chemical resistance
- Low thermal conductivity
- Easier machinability
- Lighter for transport & installation
- Cost effective

Only in the USA, there are more than 620K road bridges. According to different analyses roughly 11% of them are structurally deficient, which generates economy expenses of over 8 billion $/year. The real costs are estimated to be even 10 times higher due to lost of productivity in the economy because of maintenance work and extensive traffic delays. In addition to this consideration, the railway bridges could be taken in the economic expenses account. It is a simple estimation revealing the importance of having competitive, sustainable infrastructure nowadays.
Standard pulwinding machine for composite rebar production by KraussMaffei and Pultrex

A turnkey iPUL rebar pulwinding line

- Metering machines for fast curing epoxy resin
- Pulwinding line of two composite rebars
- Low pressure mixing head
- Injection box with a die for different rebar sizes
- High performance winder for greater speeds
- Different heating and cooling zones
- Specially designed caterpillar
- Flying cut off saw for desired batch lengths
- Take-off table or rebar coiler

The technology is proven and available to scale up production, provided by KraussMaffei.

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High-lights of the hidden revolution

Often about 100mm of concrete is added as a barrier for moisture ingress, to protect the metal bar of corrosion, preventing rapid degradation of the reinforced structure. Using non-corrosive rebar makes this additional thickness obsolete. Furthermore, the tensile strength is typically 2 times higher than from steel rebars. Moreover, a composite rebar is one-quarter of the weight of comparably performing steel, inducing lightweight structure design. The excellent fatigue resistance of composites makes them suitable for cyclic loading applications.

Executive summary

Corrosion is one of the largest governmental asset expenses in the developed global economies. Simultaneously, the demand for sustainable infrastructure and at whole-of-life cycle savings increase. Market driven, KraussMaffei developed a high speed machine for innovative corrosion-free rebars. Removing the risk of corrosion crackings in concrete structures means lower carbon footprint and reduced environmental impact in the sector. We cooperate and build up the future in the construction industry with you together!