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GFRP rebar for durable pre-cast concrete tunnel lining

Tunnel Boring Machines (TBM) are a marvel of today's civil engineering. Pre-cast steel reinforced segments, traditionally used for lining tunnels excavated with a TBM, are being replaced with GFRP rebar alternatives.

A TBM consists of a cutter-head, a shield which holds the equipment to erect the tunnels' lining, and behind on a flatbed rail, trailing gear which houses the machine's control unit, and allows excavation of debris and the delivery of the tunnels' pre-cast segmental linings and other equipment.

"Soft-Eyes" saves time and money

TBMs begin, and end work, in a reinforced concrete launch or end station shaft excavated to the tunnels' level. Retaining walls could be several meters thick. TBMs are not designed to cut through steel reinforcement, which requires costly manual intervention before tunneling begins. Due to its anisotropic characteristics, GFRP rebar is used in sections - called "Soft-Eyes" - for example in front of the TBM, allowing it to easily cut through and start boring immediately.

High tensile strength, lightweight, and corrosion-free

ATP srl, based in Angri (SA), Italy, a leading manufacturer of GFRP solutions for underground civil engineering projects, is a pioneer in the use of GFRP rebar in pre-cast concrete linings and "Soft-Eyes". They are being used in the new Milan Metro Rapid Transit Line, due for completion in 2022.

"GFRP rebar, which is extremely resistant in the fiber direction but easily cut in the orthogonal direction, also offers advantages when sections of the tunnel are cut into creating cross passages between parallel tunnels, emergency evacuation exits and safety niches," says Aniello A. Giamundo, General Manager at ATP srl. Principal advantages are high tensile strength, lightweight, and corrosion-free properties when compared with steel. Pre-cast lining rings are prepared (above ground), usually in 6 sections including a trapezoidal 'keystone' segment, and delivered to the underground excavation site via the trailing gear. The TBM advances several meters and stops to allow hydraulic and vacuum equipment to install the lining sections, which are bolted together, meeting the exact diameter of the tunnel. The process is then repeated to advance tunnel boring and lining.

Image and data source: Courtesy of ATP srl, Italy.

Contact: composites@owenscorning.com

OWENS CORNING COMPOSITE MATERIALS, LLC
ONE OWENS CORNING PARKWAY
TOLEDO, OHIO, USA 43659

1-800-GET-PINK™
w.owenscorning.com/composites

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