Critical track settlement criteria met by Tensar stabilised trackbed design

Rail
№ 474

Belfast Transport Hub Track Foundation

Belfast, Ireland

CONSTRUCTED IN 2023

Benefits

5 year zero-maintenance design to meet contractor's obligations

15mm maximum settlement target after 5-years incorporated into the design and confirmed by the FEM design approach

No deep soil stabilisation or removal of weak subgrade needed, reducing overall construction time

Track foundation design to meet a zero-maintenance target

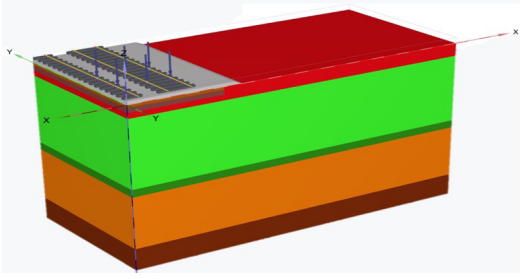
State of the art track foundation design was employed to ensure full service-life performance, plus a 5 year zero-maintenance requirement. The trackbed was analysed with PLAXIS FEA software, using the Tensar Stabilised Soil Model plug-in to model the mechanically stabilised layer incorporating Tensar geogrids.

CLIENT'S CHALLENGE

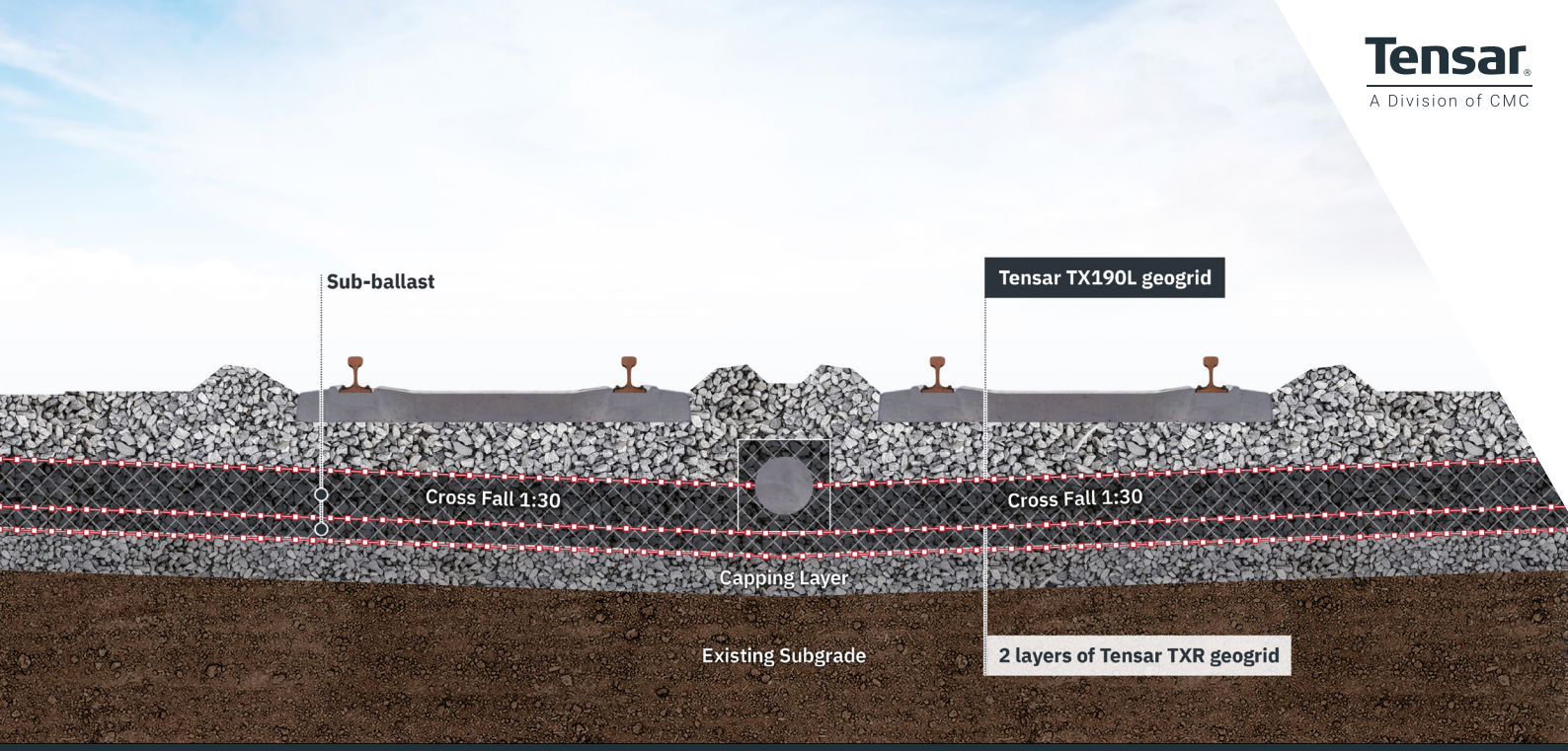
The track crosses two zones with distinct subgrade types, a stiff glacial deposit, and soft alluvium with loose made ground. A design based on a target formation modulus (Ev2) would not adequately consider the depth of influence of the rail loading and the associated settlement. In addition to this, the contractor needed a zero-maintenance design to meet a 5-year contractual obligation.

TENSAR SOLUTION

Tensar introduced their elasto-plastic mechanistic empirical design approach for trackbed foundations that can limit subgrade deformations. In addition, the Tensar Stabilised Soil Model plug-in to FEA software enabled design of a mechanically stabilised trackbed to limit settlement. The strain-based design enabled maximum settlements to be assessed with confidence.



3D Plaxis Model of Tensar Mechanically Stabilised trackbed over soft alluvium and made-up ground



Trackbed stabilisation of approach line works

PROJECT BACKGROUND

The Belfast Transport Hub is a flagship project that will become the largest integrated transport facility on the island of Ireland. As part of the development, eight railway platforms are being constructed with associated rail line works on approach to the station.

The site has two distinct zones of foundation soils. Zone 1 - An area underlain by stiff Glacial Deposits, and Zone 2 - underlain by Alluvial Deposits with varying thickness' of loose made ground.

HBPW was appointed to undertake detailed design of the track formation through the station area, while Byrne Looby were responsible for design of the approaching track works. For consistency they needed to agree on a common track design across the interface.

Arup, the clients design representative had indicated that a traditional target Ev2 static formation modulus design approach (using Network Rail NR/LT/TRK/2102 Table 3) would not adequately consider the depth of influence from rail loading and the effect on settlement and serviceability.

Tensar was first approached by HBPW, but any solution needed to satisfy both HBPW and Byrne Looby. Tensar introduced the design teams to an advanced elasto-plastic mechanistic-empirical design approach for trackbed foundations (Lees & Kelly, 2023). Importantly, this strain-based design method, which has been fully validated and peer reviewed, can limit subgrade deformations.

Tensar also proposed use of a mechanically stabilised trackbed incorporating Tensar TXR and TX190L geogrids (both having Certificates of Acceptance from Network Rail).

The trackbed was modelled in PLAXIS FEA software using an advanced hardening plasticity constitutive model for the subgrade to predict permanent deformation under a single loading, before using an empirical relationship to predict permanent deformation accumulation under successive loadings (Li-Selig method). The Tensar Stabilised Soil Model plug-in to PLAXIS was used to correctly model the mechanically stabilised layer in the design.

The final design for the approach line trackbed comprised a stabilised sub-ballast layer incorporating two layers of Tensar TXR geogrid, with a single layer of Tensar TX190L for ballast stabilisation in some sections.

References.

- Lees A.S., Kelly R.B., Railway formation design by elasto-plastic FEM mechanistic-empirical approach. Transportation Geotechnics 39 (2023) 100955.
- Li D., Selig E.T., Method for railroad track foundation design I: Development. J Geotech Geoenviron Eng 1998;124(4):316–22.
- Li D., Selig E.T., Method for railroad track foundation design II: Applications. J Geotech Geoenviron Eng 1998;124(4):323–9.

Client
Translink

Consultant
Byrne Looby
(approach line works)

HBPW
(platform works)

Contractor
Farrans

"It was satisfying to collaborate with parties working on adjacent contracts on this key infrastructure project, and the eventual adoption of the Tensar solution for by both design consultants"

Peter Matthias
Rail Lead
Tensar

