Improved Trackbed Performance Over Low Strength Formation Soils Using Mechanically Stabilised Layers

Jonathan Cook - Manager of Products and Technology - Tensar International Limited, UK
Mike Horton – Application Technology Manager – Tensar International Limited, UK
Tony Roe – International Sales Manager – Tensar International Limited, UK
Dr Leos Hornicek – Czech Technical University in Prague, Czech Republic

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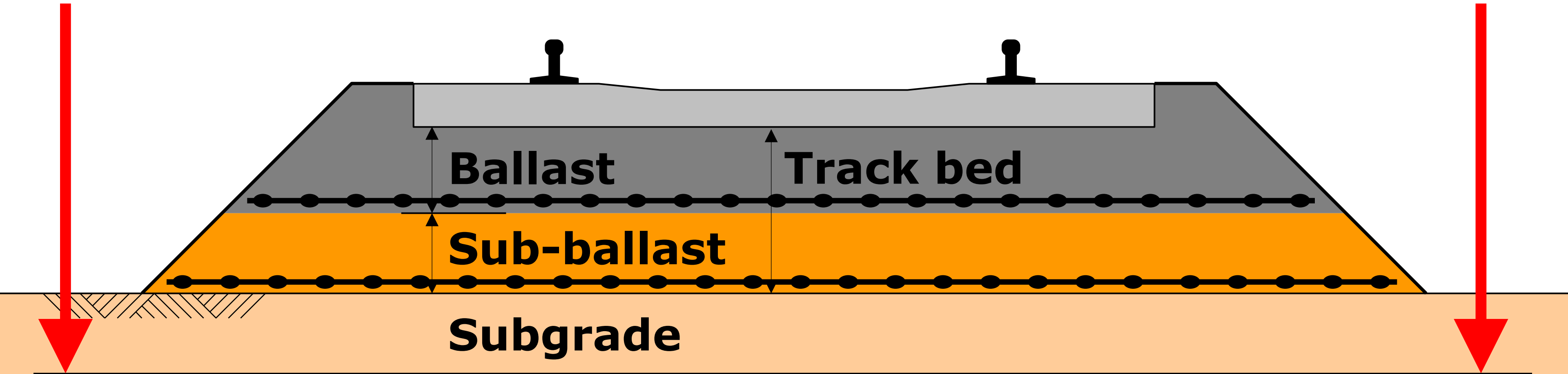
Mechanical stabilisation
Two areas of application

Sub-ballast stabilisation:
Principal function is increased bearing capacity

Ballast stabilisation:
Principal function is lateral confinement of ballast



Common aim: to preserve the alignment of the rail, (vertically and horizontally) and reduce the track maintenance

Introduction

Maintaining track geometry is important for:

- Timely operation of services
- Reduction in expensive and disruptive track maintenance operations

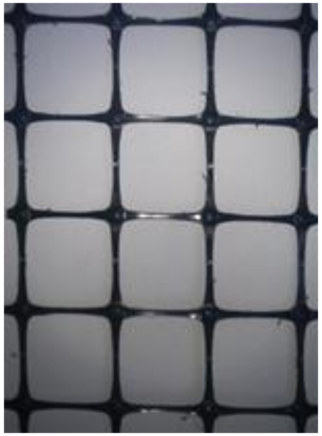
The use of geogrids in such applications driven by extensive full scale research:

- Laboratory
- “Live line” sites

Early research with biaxial geogrids (square grid structure) later research with multiaxial hexagonal geogrids with triangular apertures

Introduction

Biaxial



Multiaxial
(TriAx)

Introduction

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Research programmes have examined the effect of geogrids in ballast on:

- Settlement rates (reduced)
- Reduced traffic-induced ballast degradation
- Extended ballast maintenance cycles

Performance of geogrids also examined to assist engineers constructing track over low bearing capacity sub-grade soils as an alternative to:

- Chemical stabilisation of sub-grade OR
- Excavation and replacement with granular sub-ballast

Research Background

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The effect of geogrid in sub-ballast and ballast applications is difficult to quantify theoretically – results for one type may not be reflected in the result for another type of geogrid

Full-scale performance assessment gives confidence to manufacturers and designers to apply geogrid technology to benefit projects in terms of performance

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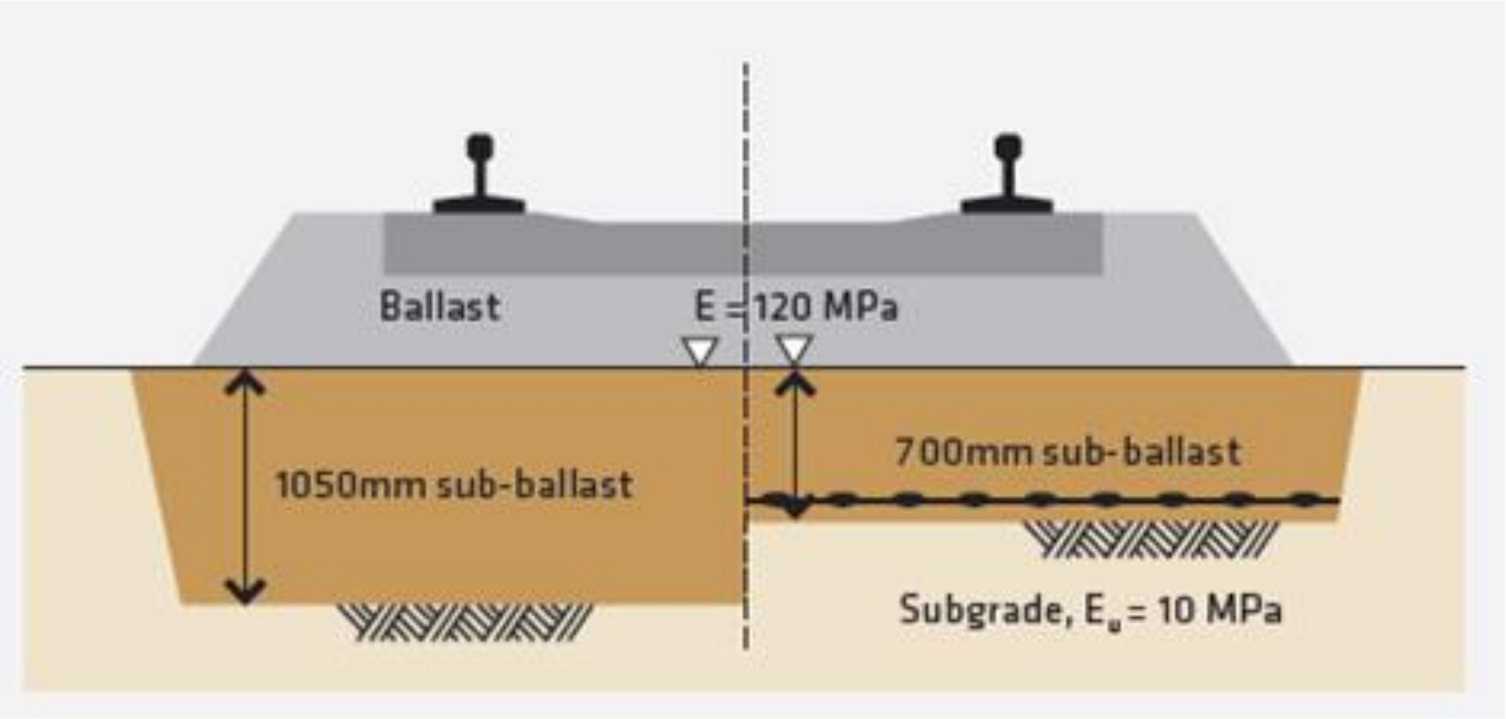
Deutsche Bahn, Cologne, Germany 2003 – Monitored Project



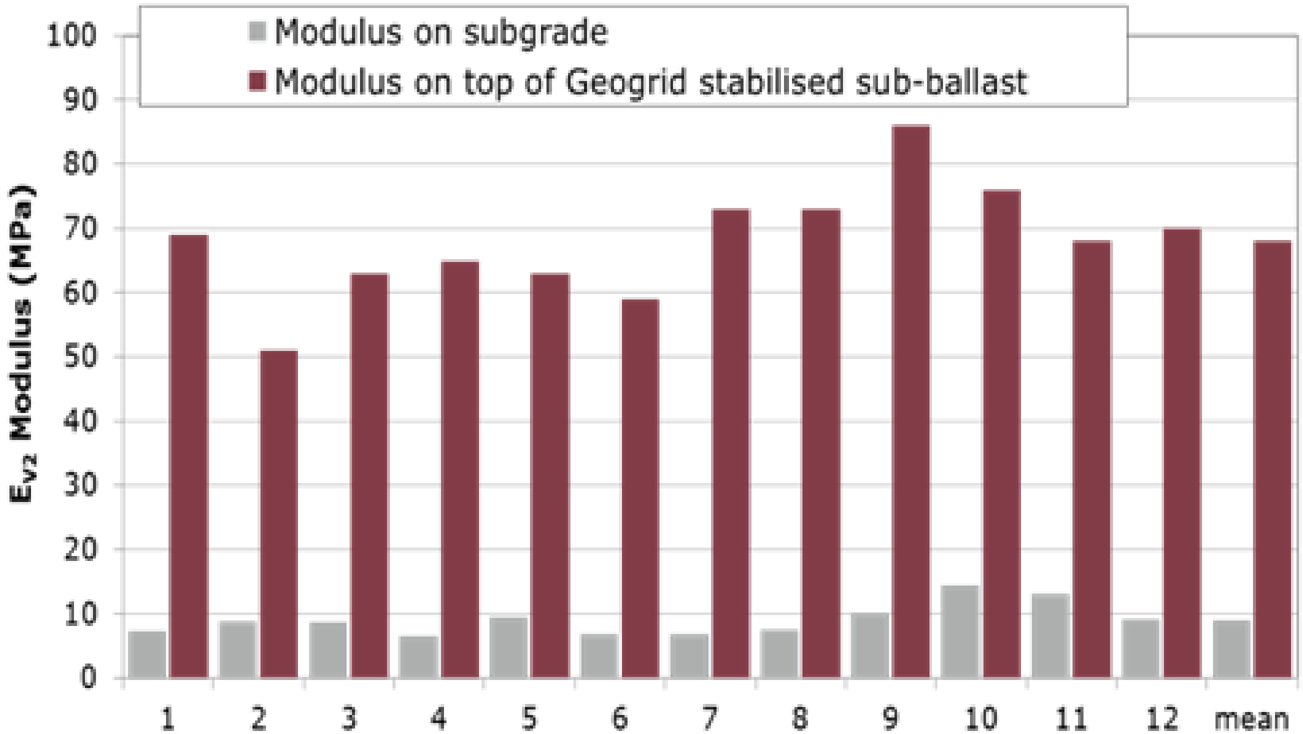
- Reduced thickness of sub-ballast
- Lowered cost – reduced importation, excavation and construction times

Bratislava-Trnava line, Slovakia,1999 – Monitored Project

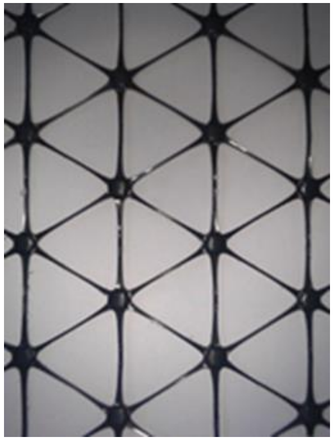
- 160km/h line speed
- >50MPa EV_2 for ballast layer
- Existing subgrade <10MPa - variable ground conditions

Bratislava-Trnava line, Slovakia,1999

- Design carried out to determine appropriate sub-ballast thickness
- Plate load test conducted to examine validity of design



Multi-axial hexagonal geogrids - TriAx



- Distinct from the ‘reinforcement function’ of other geogrids
- Geogrids operating as stabilisation geogrids are used to “….minimize deformations under trafficking, to improve bearing capacity and increase the design life of the granular layer in or under construction in roads, railway and other trafficked areas….”.

Geogrid parameters associated with the stabilisation function are:

- Radial stiffness at 0.5% strain;
- Radial stiffness ratio;
- Junction efficiency; and
- Hexagon pitch (aperture size)

Note that Tensile strength (associated with the reinforcement function) has been shown to be a poor indicator of performance under trafficking – extended into research that follows

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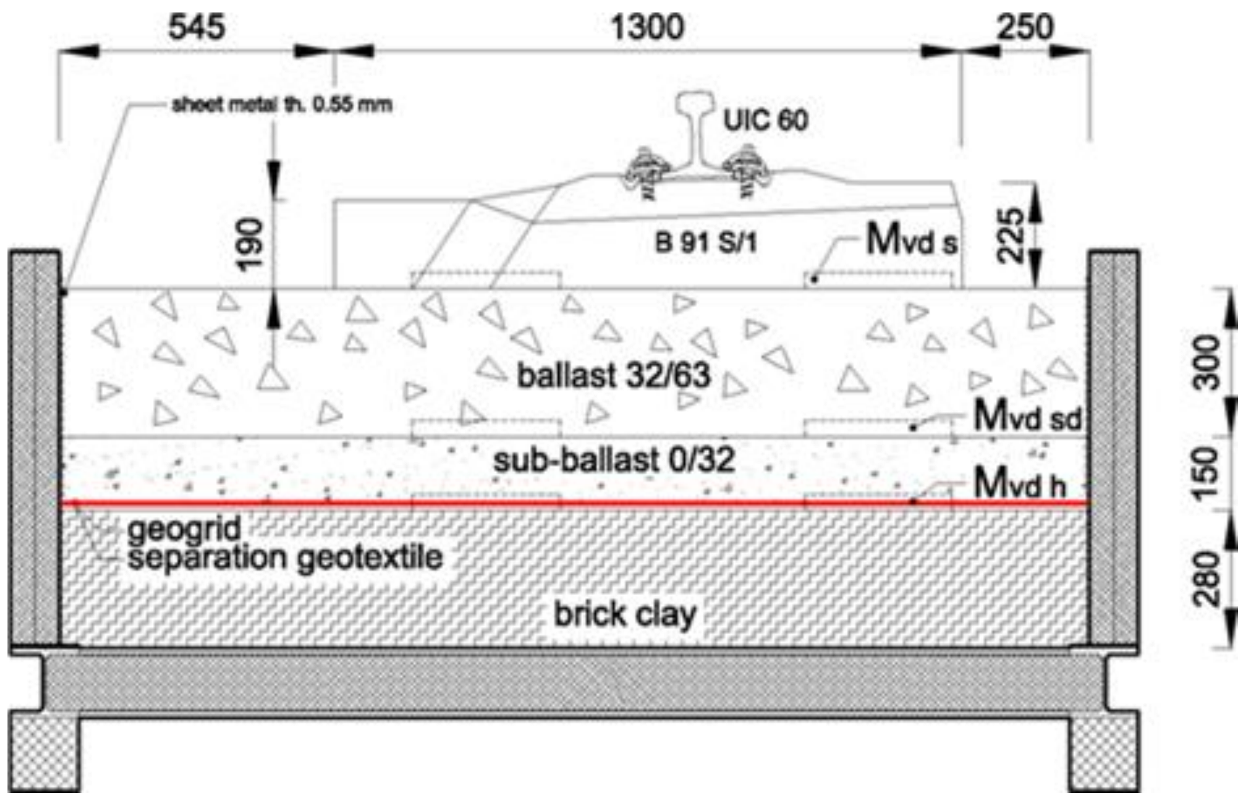
Test Set-up



Comparative performance of geogrids within sub-ballast under cyclic loading

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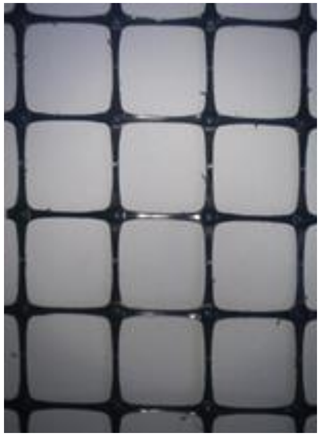
Geogrids Tested



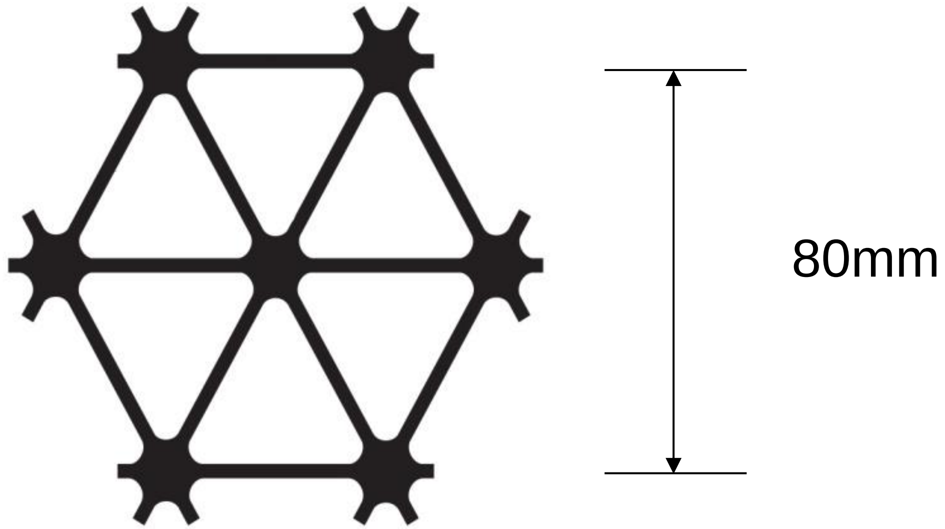
Biaxial SS30

30kN/m geogrid
Aperture 39mm x 39mm

Multiaxial (TriAx) TX160

Stabilisation geogrid
Hexagon pitch 80mm.

Hexagon Pitch

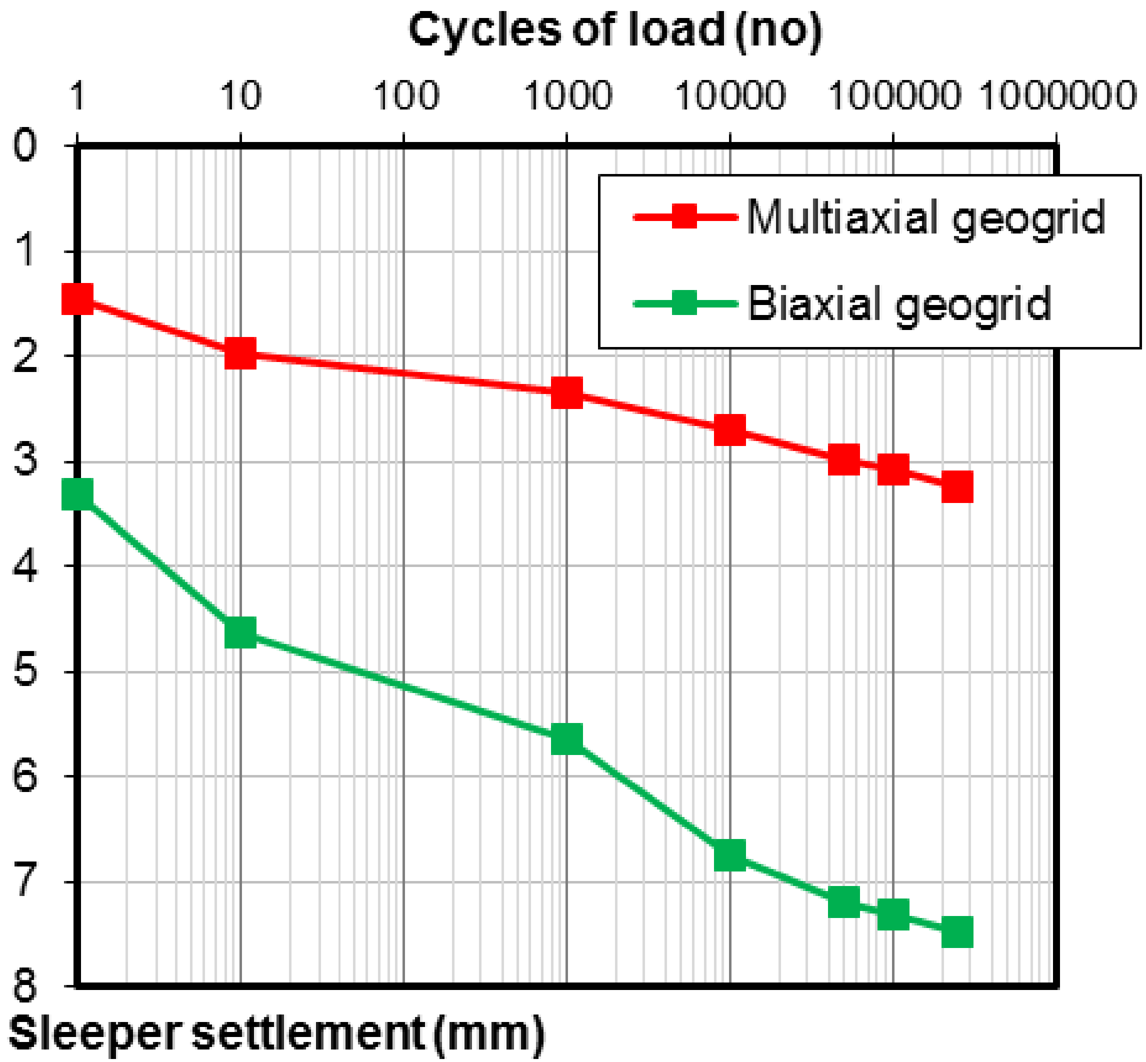


Load Application

Load cycled at 3Hz to 42kN

Settlement monitored at top of sleeper section

Measured Sleeper Settlement over 250,000 cycles



Static Deformation Modulus after 250,000 cycles

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Test section	Biaxial geogrid SS30	Hexagonal geogrid TX160	Variance
Static deformation modulus on ballast surface after cyclic loading (MPa)	110.2	116.9	+6.1%
Static deformation modulus on sub-ballast surface after cyclic loading (MPa)	48.2	55.6	+15.3%

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Biaxial/Hexagonal geogrid – Wilsonville, Alabama, USA

- Biaxial and Hexagonal geogrids included in different sections of track plus control on compacted subgrade, 200mm sub-ballast and 250mm ballast
- Pressure cell and track settlement monitoring over 7 month period

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Biaxial/Hexagonal geogrid – Wilsonville, Alabama, USA

- Geogrid stabilised sections showed lower sub-grade pressures
- Pressures lower in hexagonal geogrid-stabilised section

Hexagonal geogrid – Railway reconstruction, Bratislava, Slovakia

- Complete reconstruction – increased operational speeds
- Weak formation soils with track deterioration
- Reduced excavation due to reduced sub-ballast thickness allowed by use of hexagonal geogrid
- Large aperture geogrid used to permit use of recycled ballast

Hexagonal geogrid – Turnout reconstruction, Kaapmuiden, South Africa – Transnet

- Standard reconstruction methodology - 400mm imported sub-ballast layer
- Short possession times – incorporation of hexagonal geogrid permitted halving of sub-ballast
- Reduced excavation - reduced construction times and reduced risk to shallow underground services

Conclusions

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- Using geogrids to improve trackbed stiffness established with extensive research and geogrid development
- Potential benefits of different types of geogrid only realistically based on full-scale assessment
- Comparative assessments shows that assessing a product based on index properties alone will not provide an accurate prediction of performance of the trackbed structure
- Innovative geogrids (hexagonal) have been shown to out-perform older biaxial geogrids – allows railway engineers more opportunity to build-in value

Thanks

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Dr Leos Hornicek and his team at the Czech Technical University in Prague and **Dr Zikmund Rakowski** for their work in planning, preparing and conducting these trials at the Faculty of Civil Engineering – Department of Railway Structures

THANK YOU