Project Name: Cross Lane, Hoylandswaine, Barnsley

Customer: Paragon Highways

Contact: Leigh Ogden

Tensar Ref: P-34393

Date: 1st September 2016

Tensar contact: Craig Andrews

Tensar Engagement Stage

Concept	**Feasibility**	Detailed Design	Product Supply Only

Objective: To form a Tensar Mechanically Stabilised Layer(s), to initially provide construction access over existing weak ground and to reduce the whole pavement thickness, maintain pavement performance and mitigate potential differential settlement



This document contains an Application Suggestion, which has been prepared by Tensar International Limited on a confidential basis to enable the application of **Tensar geogrids** to be evaluated. The Application Suggestion is illustrative and is not a detailed design. It is specific to the unique characteristics of the **Tensar geogrids** referenced within the calculations.

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Summary of Tensar Proposals

Leigh Ogden of **Paragon Highways** requested **Tensar International** to provide an Application Suggestion demonstrating the benefits of Tensar TriAx geogrids.

This application suggestion proposes Tensar Mechanically Stabilised Layers, to initially provide construction access over weak ground; Tensar has also provided a more economical construction option by rationalising the whole pavement thickness, maintain pavement life and mitigate potential differential settlement, at Cross Lane Hoylandswaine project.

Information contained within this document gives details of how the unique performance of Tensar TriAx geogrids have been applied to achieve savings in pavement construction, applying performance criteria based on the site conditions and the direct trafficking of the pavement layers.

Tensar Proposal Limitations

It should be noted that Tensar cannot act as Geotechnical Engineers on this or any other project; our PI cover does not permit us to act in such a capacity and therefore any geotechnical parameters that may appear in this application suggestion will need to be confirmed by either the client or a 3rd party with appropriate qualifications and experience, prior to final design. You should note that this condition will apply whether or not we may have preliminary assessed any geotechnical data provided and incorporated them into this Application Suggestion; we cannot take responsibility for these parameters and they will need to be confirmed as outlined above.

Any assessment of ground parameters (including CBR) that Tensar undertake in an Application Suggestion is purely to allow concept or feasibility assessment and to allow the likely suitability of our solutions to be assessed. In order to provide a final and professionally identified design, if required, Tensar will need all geotechnical parameters confirmed and verified by either the client or a 3rd party.

Basis for Assessment

In the absence of a full design brief being supplied to Tensar, the following parameters have been assumed to form the basis of our assessment. The responsibility of verifying parameters lies with the Customer.

Assumed Area: Advised being as 678m^2
(Ref: "Tensar Ground Stabilisation Form" received via Paragon Highways' email dated 26th August 2016)

Ground Conditions: CBR value of 1% has been adopted for this assessment, as agreed by Paragon Highways via phone conversation dated 26th August 2016. It was assumed that any soft ground must be identified and treated and achieve a minimum CBR of 1%.

Please note: customer is responsible for verifying the actual site conditions and inform Tensar if different parameters should be adopted.

Proposed Pavement Layers: According to the "975 102 Section 38" received via Paragon Highways' email dated 26 August 2016, it was understood that the following pavement has been proposed. For the purpose of this assessment, Tensar has assumed material equivalent moduli and CBR value for the purpose of this assessment, all the values must be verified by customer):

Surface Course: 80mm thick paving block with an equivalent modulus of 1,410MPa
Binder Course: 30mm thick sand with an equivalent modulus of 1,410MPa
Base Course: 50mm thick AC32 base with an equivalent modulus of 2,500MPa
Sub-base Material: Type 1, well-graded granular fill with a maximum particle size of 75mm, with an equivalent CBR of 30%, to achieve the necessary performance, compaction requirements and mechanical interlock associated with this proposal.

Target Pavement Traffic Load: 1msa has been adopted for the purpose of this assessment, as advised by Paragon Highways via phone conversation dated 26th August 2016.

Groundwater Conditions: Assumed to be at depth, to be confirmed by customer.

Appropriate drainage needs to be provided (designed by others) to ensure that the platform remain adequately drained, to avoid water ponding and so that the MSL and the formation also remain reasonably dry. The drainage ditch and measures should not cause any global stability issues for the constructed MSL and should be positioned at a suitable distance from the access road to ensure that this remains the case. The global stability should be assessed by others.

Assessment Method

For the purpose of this illustration we have produced a proposal using our in-house TensarPave 7.00.07 AASHTO design software to generate a Tensar TriAx geogrid stabilised pavement.

The whole pavement has been modelled and assessed using the American Association of State Highways and Transportation Officials 1993 (AASHTO 93) approach. This method, used in the USA and other parts of the world recognises the benefits of geogrids in pavement construction in terms of increase life and/or pavement thickness reduction. Extensive research on the behaviour of Tensar TriAx geogrids in whole pavements allows us to carry out a check to make sure the reductions available with the Tensar MSL have no detrimental effect on the pavement life.

General Notes:

This Application Suggestion is not intended to be a final and complete detailing of the proposed stabilisation construction. There are a number of other considerations that have to be made in the production of a complete design, (e.g. drainage provisions, detailing at structures and boundaries etc). This Application Suggestion will need to be adapted before being incorporated in a final design and unless otherwise shown or discussed, such features are not covered by this Application Suggestion.

This document has been prepared by Tensar International Limited on a confidential basis to enable the application of Tensar TriAx geogrids to be evaluated. The Application Suggestion is illustrative and is not a detailed design. It is specific to the unique characteristics of Tensar TriAx geogrids referenced within the calculations.

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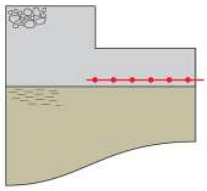
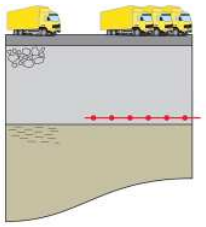
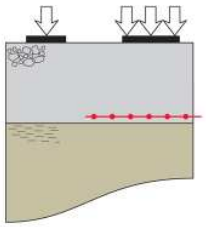
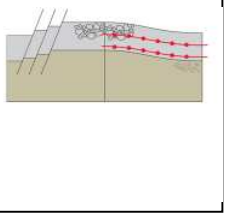
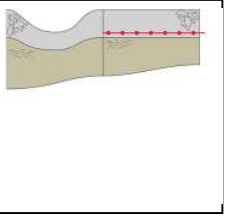
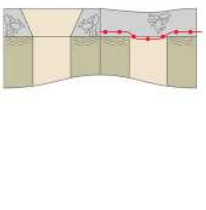
The geogrid(s) to be referenced on the contract drawings, shall be incorporated as a component in a composite construction of geogrid(s), unbound aggregates to form a mechanically stabilised layer(s) and asphalt surfacing. The thickness of the stabilised layer has been determined to meet or exceed project specific performance targets and is based on the predicted performance of the stabilised layer incorporating the referenced geogrid. Pavement layer thicknesses, performance values and the project specific performance target(s) shall be stated on the contract drawings.

The geogrid(s) referenced in this proposal has been evaluated to provide the specific 'stabilisation function' as defined in the European Organisation for Technical Assessment (EOTA®) Technical Report TR 41. Any proposal for use of an alternative to the referenced geogrid shall include the following, to be submitted as part of the tender bid:

- Evidence that the geogrid carries a CE Mark based on European Technical Approval (ETA) certification for the stabilisation function' as defined in EOTA® Technical Report TR 41.
- Evidence of the trafficking performance characteristics of a composite layer incorporating the alternative geogrid within an unbound aggregate layer, forming part of a flexible pavement structure.
- Analysis by software which includes the geogrid benefit expressed as a 'stabilisation factor' derived from multiple programmes of full scale accelerated pavement testing.
- Independent third party validation of the derivation from test data of the stabilisation factor adopted.

Scope

The six common uses of Tensar geogrids in stabilisation are shown here and comments relevant to this Application Suggestion are provided.

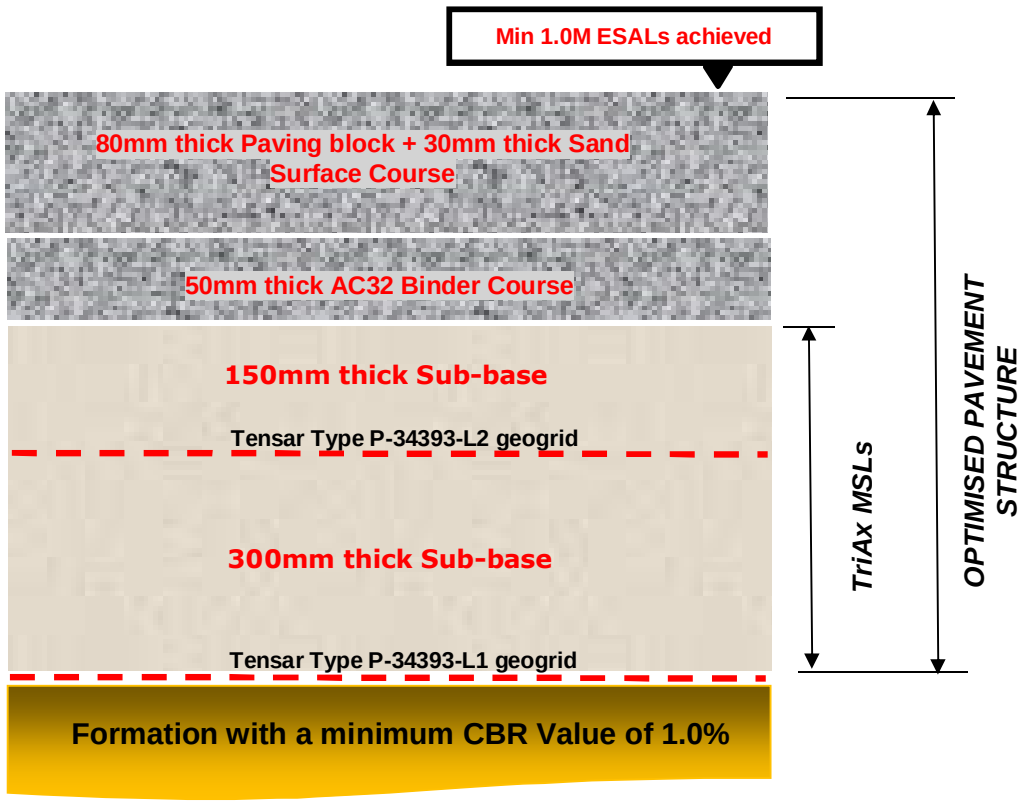
	**Reducing layer thickness** More than 30 years of installation and intensive testing has demonstrated that the installation of Tensar stabilisation geogrids allows for a reduction in aggregate thickness without loss of performance.
	**Increasing life** The use of Tensar TriAx geogrids in pavement layers can extend the service life of the pavement structure and therefore the use of Tensar Technology makes significant savings in maintenance budgets.
	**Increasing bearing capacity** **Not directly assessed in this document**
	**Controlling differential settlement** The use of two layers of Tensar TriAx geogrids in pavement layers can mitigate against the effects of differential settlement associated with weak and variable ground conditions. A supplementary geogrid carries the additional benefit of further increasing the life of the pavement structure.
	**Capping weak deposits** **Not directly assessed in this document**
	**Spanning voids** **Not directly assessed in this document**

Proposal

The AASHTO 93 method input values are summarised below and are based on typical values associated with the unbound and bound layers.

AASHTO 1993 input values	Value	Units
Reliability	80.00	%
Serviceability Indexes (Initial / Term.)	4.20 / 2.00	
Overall Standard Deviation	0.490	So
Subgrade Condition	**1.0**	% CBR

AASHTO 1993 pavement parameters	Value	Units
Paving block + Sand Binder Course	1,410	MPa
AC32 Base Course	2,500	MPa
Agg. Sub-base Layer(s)	30	% CBR
Granular Layer Drainage coefficient	1.0	



Key Benefits

- Efficient analysis of pavement section and use of TriAx
- Initial pavement construction costs further reduced.
- Accelerated construction programme and reduced overheads.
- Enhanced initial stiffness in the granular layers
- Retarding the rate of stiffness decay in the granular layers
- Improved service life and management of pavement fatigue.
- Life of the pavement increased; reduced maintenance.
- Whole life costs and carbon emissions reduced.
- Reduced construction waste, resources and health and safety risks.
- Reduced dust, noise and visual impact on surrounding environment.
- Mitigation of potential differential settlement

Specification

MS_ETA_TriAx_MSL

Appendix

CS_TriAxUK

Case Study

Ref.330 – Yr.2013, Birch Road, Tadley, Hampshire

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Q 05288
BS EN ISO 9001:2000

EMS 86463
BS EN ISO 14001:1996

ROADS AND PLATFORMS

Tensar TriAx® Stabilisation Geogrid

Model Specification – Tensar Mechanically Stabilised Layer (MSL)

This model specification is intended for use where the specifier wishes to specify a mechanically stabilised layer (MSL), incorporating a specific Tensar geogrid (to be referenced on the project drawings) within an unbound aggregate layer as part of a conforming performance based design.

1. The geogrid(s) referenced on the contract drawings, shall be incorporated as a component in a composite construction of geogrid(s) and unbound aggregate to form a mechanically stabilised layer. The thickness of the stabilised layer has been determined to meet or exceed project specific performance targets and is based on the predicted performance of the stabilised layer incorporating the referenced geogrid. Both the thickness and the project specific performance target(s) are stated on the contract drawings.

2. The geogrid(s) referenced on the contract drawings has been evaluated to provide the specific 'stabilisation function' as defined in the European Organisation for Technical Assessment (EOTA®) Technical Report TR 41.

3. Any proposal for use of an alternative to the referenced geogrid shall include the following, to be submitted as part of the tender bid:

4. Evidence that the geogrid carries a CE Mark based on European Technical Approval (ETA) certification for the stabilisation function' as defined in EOTA® Technical Report TR 41.

5. Evidence of the trafficking performance characteristics of a composite layer incorporating the alternative geogrid within an unbound aggregate layer.

6. Analysis by software which includes the geogrid benefit expressed as a 'stabilisation factor' derived from programmes of full scale accelerated pavement testing.

7. Independent third party validation of the derivation from test data of the stabilisation factor adopted.

8. The Contractor shall provide a technical submission including all of the above to demonstrate the equivalence of the alternative composite construction along with the supporting test data, at least three weeks prior to the required product approval date.

9. It should be noted that index properties or performance characteristics for the geogrid in isolation, such as tensile properties measured in air, or quality control data, will not be accepted as an adequate demonstration of equivalent performance.

Tensar

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Q 05288 ISO 9001:2008

EMS 86463 ISO 14001:2004

CE 0799-CPD-110
ETA 12/0530
ETA 12/0531
13

Installation guideline for Tensar TriAx geogrids for the mechanical stabilisation of unbound granular fill over poor subgrades

This installation guideline applies to Tensar TriAx geogrids supplied by Tensar International or any of its appointed distributors. It provides a guideline for specifiers in their compilation of specification clauses particular to their own projects and also a guideline to installers. It applies to both the permanent and temporary mechanical stabilisation of areas over which vehicular access is to be provided.

Specifications for the geogrids are available on request from Tensar International or a local Tensar Distributor.

Subgrade Preparation

For a subgrade over which construction plant cannot safely traverse:

> **Tensar geogrids** shall be laid directly on the site, having removed major protrusions such as rocks and tree and bush stumps and also having filled local hollows and depressions with the approved fill but otherwise retaining the vegetation and topsoil covering the site.

or where site conditions permit:

> The subgrade shall be levelled in accordance with Highway Agency, Manual of Contract Documents for Highway Works,Specification for Highway Works, Clause 616.

Placing Tensar Geogrids

Heavy duty gloves should be worn when handling TriAx.

Tensar geogrids may be placed on the subgrade either parallel to the road centre line or in the transverse direction. If a geotextile separator has also been specified with the geogrid, then the geogrid should be placed above the geotextile (so that the placed fill can interlock with the apertures of the geogrid).

Overlaps

The width of overlap between adjacent rolls is dependent upon the grading and thickness of sub-base and the stiffness of the subgrade. The minimum overlap shall be 300mm and the maximum normally required shall be 600mm or as directed within the contract documents.
Overlaps must be secured and maintained during the filling operation. This is generally achieved by placing small heaps of granular fill locally over the overlaps ahead of the main filling operation.

Granular Fill

A graded aggregate sub-base is suitable for the unbound granular fill. Type 1 or 2 sub-base is recommended, as described in clauses 803 and 804 respectively in DoT Specification for Highway Works. Type 6F granular capping to clause 613 in HA Specification for Highway Works may also be used if appropriate to the design.
Specifiers are requested to contact Tensar International or a local Tensar Distributor for specific advice when fill other than the above is to be used.

Placing Granular Fill

Lorry loads of granular fill material shall be tipped into stockpiles on placed fill and not tipped directly onto the geogrids. The fill stockpiles shall be spread by mechanical plant which causes the aggregate to cascade onto the geogrids, such as an excavator bucket or dozer with an opening bucket.
Fill shall be spread in layers of not less than 150mm thickness. The initial layer thickness to be placed on the geogrid shall be specified in the contract documents along with the maximum layer thickness.
In the stabilisation of wide and broad areas, fill shall be spread such that the first layer advances across roll widths rather than along roll lengths.

Care shall be taken to avoid damage to the geogrids. No traffic or site plant shall be permitted to travel on the geogrids prior to covering them with a layer of granular fill.

Compaction

Compaction of granular sub-base shall normally be carried out in accordance with HA Specification for Highway Works Clause 802. Compaction of other fills shall be carried out in accordance with DoT Specification for Highway Works Clause 612

Over exceptionally soft subgrade the degree of compaction applied to the lowest layer of fill may have to be reduced from the above DoT Clauses. Details shall be specified within the contract documents.

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Q 05288
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CASE STUDY : Ref 330

Residential Route, Birch Road Tadley, Hampshire, UK 2013

Whole pavement thickness optimisation over weak and variable subgrade conditions



Exposing the weak subgrade and installing the Tensar Pavement Optimisation System between existing kerbs.

BENEFITS TO CLIENT

The Tensar proposal was able to optimise the whole pavement structure achieving an overall thickness reduction of 39%. Pavement costs were also reduced through the reduction of earthworks activities. As well as doubling the predicted pavement life, Tensar gave the client flexibility to use locally sourced recycled aggregates within the mechanically stabilised layers (MSLs).

THE PROBLEM

The existing carriageway comprised concrete slabs with asphalt overlay. Disruption due to historical excavation and installation of utility trenches in combination with a weak subgrade had caused the pavement to fracture. Such conditions would traditionally require reconstruction using an excessive pavement thickness which can be costly and also create prolonged construction programmes. It was important to limit excavation within the existing kerb arrangement to avoid incurring additional costs beyond the carriageway.

THE SOLUTION

Tensar Technology was exploited to provide a proven, practical solution to the customer's site-specific requirements. The whole pavement structure was optimised by installing two Tensar mechanically stabilised layers incorporating TriAx® geogrids to stabilise the subgrade, reduce total pavement thickness and control differential settlement. The solution reduced excavation, made best use of recycled materials and retained existing kerbs to avoid disturbance of adjacent footpaths, verges and parking spaces.

PROJECT DESCRIPTION


Installation of lower MSL

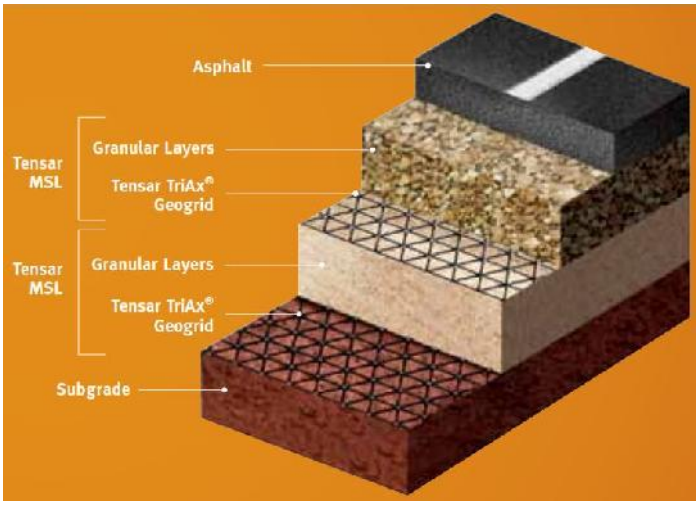
Birch Road is a residential route in the small town of Tadley which lies in the north west of Hampshire.

Upon exposing the existing subgrade, the wet, weak and variable conditions were confirmed, with CBRs across the site as low as 1%. An immediate design solution was required to avoid construction delays and careful consideration was given to the underlying poor drainage conditions due to the moisture susceptible clay subgrade.

Weak subgrades will have a variable quality of support and pavement layers are prone to differential settlement. Installation of Tensar TriAx® geogrid creates a flexible but stiff pavement foundation. Through the use of Tensar Technology the effects of inconsistent subgrade conditions and the associated level of support can be smoothed out.

Feedback from the client confirmed that their conventional rehabilitation method would have involved full depth reconstruction by excavating in the region of 1 m thickness of the carriageway and subgrade, prior to rebuilding with well-graded granular material.

Tensar's proposal provided the client with an innovative way of reducing the whole pavement thickness, as well as the opportunity to use locally sourced recycled aggregates. The Tensar solution using 2 layers of TriAx® geogrid allowed for the prevailing site conditions whilst still increasing the predicted life of the whole pavement structure.



The combined effect of thickness reduction, increased life and the use of recycled aggregates provided the client with a significant reduction in construction carbon emissions.

Comment from Colin Norris, Hants CC "At this particular site, the Tensar solution helped us reduce constructional costs associated with the initial earthworks and delivery, placement and compaction of the aggregate layers. As a consequence, the programme on site was also reduced."

CONTRACT DETAILS

Client: Hampshire County Council
Consultant: Hampshire County Council
Contractor: Amey
Sub-Contractor: Morgan Ashurst

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