Sending for reinforcement

Reinforcement of Pavements with Steel Meshes and Geosynthetics by Guy Watts TRL and Howard Cooke MIAT. MIHT. Asphalt Reinforcement Services

THROUGHOUT Europe, the usage of reinforcements to improve the performance of road pavements is increasing. Reinforcement may be used to overcome problems where a standard un-reinforced solution cannot be adopted because of other constraints such as available construction depth, adjacent structures, existing road furniture etc. Reinforcements are also often used on some schemes with a tight maintenance budget; e.g. asphalt reinforcement may provide a timely investment and prolong the pavement lifecycle, reduce maintenance costs and keep the asset viable.

In general, the reinforcement of pavements offers certain advantages - primarily, economic, environmental and safety. This method is presumed to allow thinner road structures and longer life cycles, which lead to a saving in natural resources and prolonged service intervals, providing a cost effective solution for rehabilitation and reduced maintenance cost.

Engineers have a great variety of different reinforcement materials to choose, from glass grids, steel grids, plastic grids and meshes to woven and non-woven textiles.

Design engineers, maintenance engineers and contractors are recognising the value of incorporating reinforcement into pavement construction. However, improved guidelines for design and assessment methods for the properties of the construction materials are essential to extend confidence and expansion in this area.

Background

The cracking of a new overlay surface is due to the inability of the overlay to withstand shear and tensile stresses created by movements of the underlying pavement. This movement may be caused by either traffic loading (tyre pressure) or by thermal loading (expansion and contraction). In some cases this *reflective cracking* is accompanied by *surface cracking*. Under specific conditions cracks can be initiated at the pavement surface and grow downwards, as evidenced by frost heave experienced in Nordic countries. Choosing a solution to these problems provides the engineer with a dilemma because the effectiveness of an anti-reflective cracking solution is strongly dependent on the in-situ conditions.

Pioneer development work for reinforcement of pavements and structures has mainly been driven by the Geosynthetics' industry. Work in the utilisation of steel grids to prevent damage due to frost action has been done to some extent in the Nordic countries with the co-operation of the steel industry and local road authorities. In the EC-framework of BRITE/EURAM 111 a research project REFLEX-Reinforcement of flexible road structures with steel fabrics to prolong service life was started in 1999.

In other European countries, laboratory studies as well as field trials were carried out on reinforcement products and interface products in order to study their efficiency in preventing reflective cracks in asphalt overlays. Here in the United Kingdom, Nottingham University led a comprehensive study to understand reinforcing and test methods.

Problem

At present general guidelines for structural design and execution of reinforced pavements and road sub-bases does not exist, nor is there a consensus on the optimum methods for determining relevant material parameters, essential for analysing or predicting the behaviour of the reinforced pavements.

Solution

The European COST Action 348 was formed to forward and enhance the process of material assessment and design, as well as to develop appropriate structural design methods and measurement techniques in order to reach the status of a generally accepted alternative in road construction. The COST Action has successfully generated international co-operation between road authorities, research institutes and industry. The construction, and maintenance of pave-

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ments is a substantial market within the EU, and COST 348 has focused on the potential to enhance European technology to assist the development of improvement in infrastructure, which is essential for economic growth, road safety and environmental measures.

Over 20 European countries participate in COST 348 and many others are international observers. The following countries are represented; Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, The Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

COST 348's technical programme was divided between five Working Groups (WGs), each with a leader and separate specific tasks, operating under the auspices of a Management Committee.

WG1 Assessment of benefits and goals for different reinforcement applications

Working Group 1 assembled information from all the member countries, and beyond, regarding the use of geosynthetics and steel meshes in the reinforcement of pavements. In addition a number of processes were involved to ensure that the terminology for the pavement layers and the reinforcement functions were universally understood. A questionnaire was developed to help gather information relevant to this and the other Working Groups.

The work of WG1 was careful to differentiate between reinforcements installed within the *bound layers* and *unbound layers* within the pavement. The various reinforcements were categorised according to their location and their primary design function, which included one or more of the following factors:

- Increase pavement fatigue life
- Minimize differential and total settlement
- Reduce rutting - surface and subgrade
- Prohibit or limit reflective cracking
- Increase resistance to cracking due to frost heave
- Reduce natural material usage o Reduce maintenance costs
- Increase of bearing capacity
- Bridging over voids
- Construction platform

It was noted that the reinforcement of the *bound layers* utilises a wider range of materials and is used to address more problems. Reinforcements include polymer geotextiles, polymer grids, steel fabrics, and glass grids and address the problems of rutting, increase of bearing capacity, reflective cracking, differential settlement, subgrade deformation and frost heave cracking.

WG2 Inventory

Working Group 2 was tasked with compiling details of existing guidelines and documentation. These included:

- design principles and installation procedures relevant to different materials;
- review of the existing structural design methods for reinforced road structures, depending on loading and climatic conditions;
- an inventory of existing laboratory testing procedures producing material parameters for design purposes,
- identification of models used to predict the in-service performance of a pavement, based on the results of a suite of laboratory and field tests.

As part of this work it was noted that there is experience of recycling pavements incorporating reinforcement within asphalt mixtures. In the case of geosynthetic grids and nonwoven, as well as glass grids, it is preferred to mill as deep as possible through the reinforcement plane before the asphalt mix is reused; note that sieving might be required.

WG3 Development and testing work

Working Group 3 investigated the range of laboratory testing procedures best describing the in-situ behaviour of relevant reinforcing materials, by evaluating actual cases. In addition special consideration was given to the management of discontinuities of in-situ reinforcements caused by restrictions in the geometrical dimensions and to the behaviour of joints.

A wide range of material property tests exist for steel and geosynthetic reinforcements. However, the study revealed the lack of a direct link between results of the tests to assess the properties of the raw materials and the data input to a design procedure. The tender specification investigation showed that they are used in very few countries and the main gap appears to be the link between reinforcement material properties and generally accepted design methods.

WG4 Selection of design, models and design procedures

Working Group 4 reviewed available models and procedures for the structural design of roads with reinforcement products, depending on the type of damage and the loading conditions. The design procedures cover reinforcement applications for pavement coating (SAMI), pavements, base and sub-base layers and road widening. From the work carried out, it can be concluded that:

- Only a small number of methods/procedures exist for the design of pavements with steel meshes/geosynthetics in the unbound granular base layers or in the asphalt layers.
- No generally accepted design method/procedure is available, which is accessible for everyone; this is also true for so-called reference pavement structures (without steel mesh/geosynthetic).
- No universal design method/procedure exists (or has been validated) that covers all loading conditions, or can do predict pavement performance for all ground conditions that can occur in the field

It was recommended that effort should be directed into creating more user-friendly generic design tools. It was also recommended that the collecting of long-term field data should be encouraged such that data is available for the calibration and validation of new design procedures. Further, much useful information could be generated by incorporating both trial and control sections into new-build or maintenance re-construction.

WG5 Dissemination

The work, conclusions and recommendations of COST Action 348 will be published, and disseminated at a Symposium to be held at the Savill Court Hotel, Egham, Surrey on 16 March 2006.

The Symposium will be of direct interest to all concerned with the road construction industry; e.g national and local road authorities, standardisation bodies and research establishments, manufacturers of reinforcements etc. For details of the Cost Action 348 Dissemination event on 16 March, please email conferences@trl.co.uk or visit the TRL web site www.trl.co.uk ●

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