

Developing a Jute Geotextile-based Paving Fabric For Control Of Top-Down Cracking

By

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Introduction

Flexible pavements usually suffer two kinds of fatigue failure. In the first type the distress in the shape of cracks are initiated from the base of the bituminous layer while in the second the distress starts from the wearing course itself. The cause of the first kind is the repetitive flexure of the bituminous layer, resulting in cracks that propagate from bottom upward, also known as bottom-up cracking (BUC). The cause of the second type of cracks is high surface stress/strain induced by heavy dynamic imposed load. This type of cracks has come to be known as top-down cracking (TDC). TDC is not common. Recently there have been cases where TDC-failures have been reported necessitating the need for developing a suitable wearing course that can resist such cracks. Mastic asphalt could be a solution in respect of TDC. But its comparatively high cost prompts a search for a new paving fabric that is low-priced and effective.

A project has recently been taken in hand at the initiative of Jute Manufactures Development Council, Kolkata, a national body under the Ministry of Textiles for developing a Jute Geotextile-based paving fabric that can withstand high surface stress/strain imposed by dynamic load. This paper indicates different options that can be experimented for the purpose. The project incidentally has been entrusted to Institute of Jute Technology, Kolkata which will collaborate with Central Road Research Institute (CRRI) for laboratory simulation trials. The project is being funded under Jute Technology Mission launched by the Government of India.

The Phenomenon of TDC

Manifestation of TDC is usually longitudinal cracks just outside the wheel paths that are joined by short transverse cracks. Such cracks are usually confined within the wearing course and may not extend further down and are caused by the dual effects of thermal and load-induced stresses with the thermal stress initiating the distress followed by their extension under extraneous loads. The upper layer of the wearing course is affected first presumably due to the prevailing higher surface temperature that reduces its stiffness modulus. High tyre-edge stresses are also a factor to reckon with. Surface cracks due to such causes are sometimes self-healing under congenial stiffness modulus of the bituminous surface and kneading action of tyres. In a study conducted in Japan (Matsuno & Nishizawa 1992) it was observed that TDC on the wearing course did not depend on the thickness of the wearing course.

The issue of criticality of high axle loads and tyre-pressures has also been investigated in a recent study (Satya Kumar et al 2008). It has been observed that high magnitudes of transverse tensile strains develop at the outer edge of the contact loading area and reach the maximum value at a depth of 10 mm of top bituminous wearing course. Despite certain limitations of this study, it is a pointer to the fact that there is need for reinforcing the bituminous wearing course to prevent TDC. Bitumen is a visco-elastic material that loses its stiffness with the rise in temperature. Understandably the temperature and the bituminous mix along with the extent and the nature of the imposed loads influence the extent of the thermal stress on the bituminous wearing course.

Mastic Asphalt—Its Properties

Mastic asphalt is a blend of asphalt cement, mineral fillers and other additives that form a homogeneous mass that is impermeable. The mix can be spread under a suitable ambient

temperature. The filler is cement, lime or sulphur. The additives are polymeric materials that act as modifying agents.

Mastic asphalt has a long durability spanning over a decade or so. It is capable of resisting permanent deformation because of its elasticity, but at the same time possesses low temperature fracture toughness and adequate stiffness to restrict permeation of water. There have been experiments with its composition and testing methods. Unquestionably mastic asphalt provides a resilient and durable wearing course on a pavement. Indian Roads Congress in its “Specifications for Bridge & Road Works- 1997” under clause 515 has detailed the ingredients of mastic asphalt and their requisite physical properties. It mentions lime stone powder as filler. It recommends use of both fine and coarse aggregates along with the filler. The specification is silent about use of additives or modifying agents.

Any way it is now established that mastic asphalt provides a durable and effective wearing course that can prevent TDC. No report on the distress of a pavement with mastic asphalt on top resulting out of TDC is available on date in India.

Use of Jute Geotextile-based Paving Fabric as Wearing Course

Jute Geotextiles (JGT) can be used as a reinforcing material in the wearing course. Jute and hot bitumen has excellent thermal compatibility. A combination of woven and non-woven jute fabrics could provide the requisite strength to the course. Non-woven JGT is a very good receptor of bitumen and can provide the desired bondage. It is to be seen if the mineral fillers can be eliminated. If not, the volume of fillers can certainly be reduced. Jute-bitumen combination popularly known as “tar felt” has worked effectively as a water-resistant course on roof-tops. The period of guarantee offered by the manufactures is usually eight years.

Prima facie it is felt that the coarse aggregates can be eliminated from the proposed paving fabric. This will reduce the cost. The following combinations of JGT may be tried to ensure the desired abrasion resistance.

--woven JGT with a strength of 20 / 25 /30 kN/m tensile strength stitched over non-woven JGT of 500 gsm

or, --non-woven JGT of 500 gsm sandwiched between two woven JGT. The top woven fabric should be of higher strength than the bottom woven fabric to check TDC.

Similarly experiments may be made with different types and grades of bitumen to decide on the right grade of bitumen. IRC specifies use of straight-run bitumen satisfying the requirements of IS:73 or industrial bitumen conforming to IS:702. In this case suitability of bitumen has to be decided in terms of its workability and overall features of the paving fabric. It requires to be ensured that the hardness number of the end-product should be at least 20 or near about at 25⁰ C. The content of bitumen binder will depend on the the amount of bitumen absorbed by the non-woven fabric.

Arrangements for hot bitumen impregnation in JGT with width up to 2 meters exist at Kolkata at a couple of places. The selected combination may be dipped in a hot bath of bitumen and squeezed between rollers to remove excess bitumen.

In fact the experiments as envisaged should lead to production of the most suitable paving fabric not only in terms of the quality but also in respect of economy. One aspect requires attention. This is about fixity of the paving fabric with the BM or the top of the base course of a pavement. The moving loads may generate shear force that needs be effectively resisted.

Closure

It is admitted that the durability of the paving fabric under development will be less than the mastic asphalt. But considering the aspects of economy, JGT-based paving fabric

should be acceptable to the highway engineers in preference to mastic asphalt at least in SHs. JGT-based paving fabric will score over mastic asphalt in terms of ease of its installation. Ready-to-use paving fabrics can be transported to the site on trucks and directly laid on the BM with minor arrangements for its in-situ fixity. It is also easily replaceable.

Reinforcement provided as a result of insertion of JGT-combination in the paving fabric under development will be able to put TDC on check effectively. PW (Roads) department should consider offering sites for the field trial. We are eagerly looking forward to the success of the experiment.