CONTROL OF REFLECTIVE CRACKING

Scott C. Matthews
Regional Manager, Victoria
Cement & Concrete Association of Australia

1 INTRODUCTION

A crack in a stabilised layer will result in a Stress distribution which can affect the mechanical behaviour of the overlying layer. This layer may in turn crack and 'reflect' through the surfacing, in particular bituminous surfacings.

The crack in the layer may have resulted from two distinct mechanisms: fatigue cracking and shrinkage cracking.

With the two different cracking mechanisms there are two design approaches that can be adopted:

(a) Avoidance of surface cracks. This is the standard practice in Australia for the majority of projects.

(b) Acceptance of cracking with, in wet climatic zones, adequate maintenance (crack sealing). Alternatively special surfacings are being trialed for use on extensively cracked bases. For example a 'geoseal' has been used on the Pacific Highway, NSW

2 FATIGUE CRACKING

The first is 'fatigue' cracking of the layer. This type of cracking is the result of the application of loads on the pavement and is controlled by appropriate thickness design which 'ill not be discussed in detail here. Thickness design includes not only the design strength and thickness of the stabilised, but other design elements such as delaying reflection cracking, or limiting stresses in the stabilised layer, by adopting a minimum thickness of overlying material. This may include an unbound layer utilising the 'upside down' pavement approach. The actual thickness required of the overlying material varies but for example PIARC (Ref.1) recently reported when the thickness of coated materials exceeds 20 cm the emergence of shrinkage cracks at the surface is generally uncommon; when it is 15 cm thick, the cracks emerge at the surface, but do not shorten the life of the surface course, especially if they are sealed. This experience has been gained 'with legal axle loads of 130 kN, considerably greater than the Australian legal axle load.

3 SHRINKAGE CRACKING

The second type of cracking is shrinkage cracking. Cement stabilised materials will shrink due to a combination of excess moisture drying Out of the layer and secondly that the hydration process of the cement reacting with the water causes heat and that the material will shrink on cooling. When the stabilised layer is restrained by friction, by the under-lying layer, the layer cracks as the layer is subject to stresses trying to move it but it is prevented from doing so and its tensile strength is insufficient for the stresses developed.

By appropriate mix design to limit the tensile strength of the layer a network of fine cracks can be developed which do not reflect through bituminous surfacings, rather than a few wide cracks which can, depending on the thickness of the overlying material.

This approach is normally adopted when base layers are stabilised, particularly when pavements are recycling insitu.

Stabilisation of base courses was 'widely used in Victoria in the 60's and early 70's. After a year or two of service many of these pavement exhibited unsightly reflective cracking in the asphalt or sealed wearing surfaces. The cracking was associated 'with high cement contents (5% - 10%) in granular materials. The high cement contents gave a relatively high tensile strength to the pavement material, and this meant that cracks associated with drying shrinkage were relatively widely spaced and therefore that these cracks were then relatively wide. Excessive quantities of water were also regularly added in the belief that this would aid the hydration of the cement. This is not so as at near optimum moisture contents there is ample water to fully hydrate the cement. The higher water contents did however increase the amount of drying shrinkage and hence reflective cracking. This scenario produced cracks which easily reflected through thin wearing courses, particularly thin asphalt. It should be noted however, that while cracked, these pavements have performed well. Since then it has become the practice to place a Strict upper limit on the tensile strength of a stabilised base course unless some special form of surfacing is to be applied such as a seal 'with a geosynthetic membrane.

A low tensile strength in the pavement ensures that shrinkage cracks will be closely spaced, and narrow, and tend not to reflect through the wearing course. This approach has been used successfully throughout Australia and in particular in the western suburbs of Sydney, at Blacktown and particularly at Bankstown, where over 500,000 m^2 of cement stabilised base course have been completed. Unconfined Compressive Strength (UCS) while not a direct design input is used as an indirect measure of tensile strength. It is necessary to limit the maximum UCS at 7 days to 2 MPa which has been found to work well in practice.

The other important factor influencing the development shrinkage cracking is the proportion of clay minerals. In recycling lightly trafficked roads the subgrade is often incorporated into the new pavement. If excessive shrinkage cracking results the proportion of clay in the pavement should be minimised.

It is good practice to use only the minimum cement content necessary to achieve the required properties of the base course layer (e.g. 100-120%). With a granular pavement material, these properties are often achievable with cement contents of three percent or less. Other methods of controlling cracking are to use the correct plant so that uniform mixing and adequate pulverisation is achieved, to exercise good supervision and quality control, to ensure that the moisture content does not rise above optimum, and to apply adequate curing to the pavement.

There are a number of examples of cement stabilised base courses, with both asphalt and bitumen seal wearing course, which have shown an adequate service life without deterioration, and particularly without the appearance of reflective cracking these examples can be seen in, amongst others, Shire of Buln Buln, Shire of Lilydale, Shire of Hastings and the City of Ballarat.

4 REFERENCE

1. Semi-Rigid Pavements, 1991, Permanent International Association of Road Congresses (PIARC).