AustStab
Pavement Recycling and Stabilisation Association

AustStab Technical Note

No. 8 August 2014

Structural Design of Granular Pavements incorporating Stabilised Natural Subgrades & Formations

1 Introduction

In the design and/or construction of pavements the designer may consider stabilisation of the subgrade or prepared formation to take advantage of:

- A stronger subgrade stiffness being achieved with lime and cementitious binders
- A stable subgrade resisting shrink swell characteristics in expansive clays being achieved with lime binders

In addition subgrade stabilisation may be chosen to enhance construction processes by

- Use of Lime in drying out wet material for trafficability and compactibility
- Use of Lime or cementitious binders to produce a construction platform facilitating construction in all weather conditions
- Producing sound platform against which satisfactory compaction of overlying layers can be achieved.

Financially the cost of stabilisation is often offset by

- A stronger subgrade requiring a thinner pavement
- A stronger subgrade enabling specified compaction levels of overlying pavement layers to be achieved
- A stable subgrade enhancing pavement rideability and reduced maintenance
- A more trafficable subgrade expediting construction progress

.

2 Design Background

In 2013 Austroads has clarified the design methodology on the procedure of designing granular pavements on stabilised subgrades. The method is quick and simple and uses Figure 8.4 Austroads 2013.The method is not applicable to alternate pavement configurations incorporating bound layers or thick asphalt layers where mechanistic design methods are required

The design CBR of a subgrade has considerable influence on the required pavement thickness. This is because of the need of the pavement to "protect" the subgrade from deformation under traffic loading, so the weaker the subgrade the thicker the pavement required.

To demonstrate the process, below is an example of the use of Fig 8.4 showing for the same design traffic (4×10^6 ESA) for subgrade CBR of 3% the pavement thickness is 590mm, whilst for CBR 10% the pavement required is only 290mm (see Fig 1)

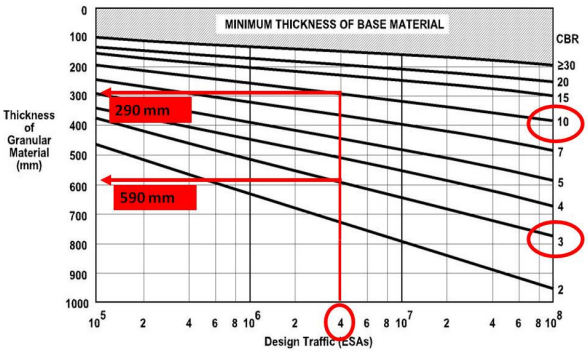

Fig 1 - determine total thickness of cover of granular material for different CBR

However if the designer wishes to take advantage of a thinner pavement through stabilisation of the subgrade, the depth of stabilisation required needs to be determined.

This method clarifies the determination of depth of stabilisation required based upon the use of the Austroads design chart Fig 8.4 (Austroads 2013)

3 Design Methodology: Austroads three-step process

This procedure is only for granular pavements with spray seal or asphalt less than 40mm thick.

Step 1 Calculate the required pavement thickness above the insitu subgrade.

Step 2 Determine the cover to the subgrade must always be maintained.

Step 3 Calculate the cover required on the improved CBR stabilised layer.

This method now uses the stabilised layer as a subbase making up part of the required pavement thickness (see Fig 2).

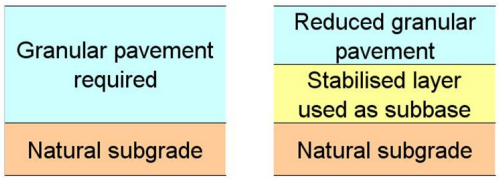

Fig 2 - Pavement cross section before and after stabilisation

There are three requirements in using this method

(a) A formal mix design to determine the type of binder and amount required must be undertaken in accordance with the procedures detailed in Austroads (2006)

(b) If lime is the only binder to be used, a lime demand test should be carried out to derive the minimum lime content of the stabilised layer. The reaction of lime with the clay is permanent as long as there is sufficient lime to achieve an alkaline environment of pH 12.4. The lime reacts with the clay silicates and aluminates to form a cement-like structure that as well as converting deleterious clay particles it adds considerable strength to the material. The permeability of the stabilised layer is also substantially improved.

(c) Check local allowable maximum design CBR. Many State Road Agencies require a maximum allowable design CBR of 15 or 20 %; and

(d) The stabilised layer shall not use a design CBR greater than the original CBR multiplied by 2 raised to power of layer thickness (mm) divided by 150. As an example if the original CBR was 4% and the stabilised layer 300mm then the maximum allowed design CBR is

$$\text{Max CBR} = 4\% \times 2^{300/150} = 16\%$$

Subgrades can be stabilised using various binders the most common being lime, slag and lime or lime and cement. The choice of binder depends on the characteristics of the insitu material with clays usually more suited to lime and sandier materials requiring a cement or slag. Local geotechnical consultants or contractors can normally advise on the most suitable binder.

The best way to understand the process is to follow a worked example

4 Worked Example

Objective: Design a granular pavement with a stabilised layer

Parameters:

- Wearing surface a sprayed bitumen seal or thin layer of asphalt
- Natural subgrade CBR 3%
- Stabilised Subgrade CBR (from mix design) 10%
- Design traffic 6 x 10^6ESA's

Step 1 Determine using Fig 8.4 the depth of pavement required on subgrade of CBR 3%. = 620mm (Fig 3)

Step 2 Adopting the CBR of the stabilised material from the mix design determine the pavement thickness required for the improved subgrade stiffness = 310mm (Fig 4)

Step 3 The difference between the depths determined (Fig 3 – Fig 4) represents the depth of subgrade required to be stabilised to achieve a CBR 10% ie 310mm (Fig 5)

.

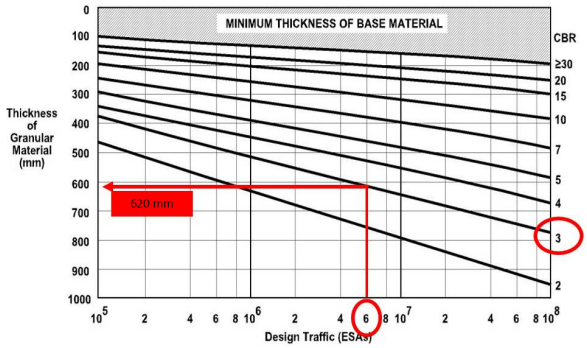

Fig 3 determine total thickness of cover of granular material

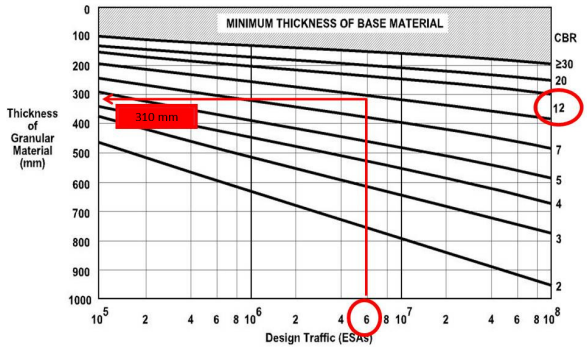

Fig 4 – determine total thickness of cover on stabilised subgrade

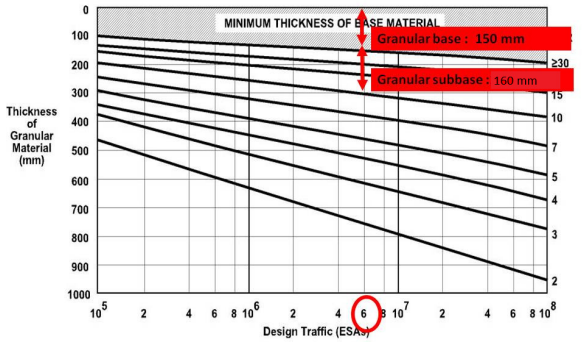

Fig 5 – Select granular material qualities & thicknesses

5 Summary

This design procedure is simple and gives a far more economical pavement than the typical alternative of boxing out to the full depth and replacing with granular material.

Reference

Austroads 2013 Guide to Pavement Technology Part 2 "Pavement Structural Design"AGPT02-12. ISBN 978-1-921991-11-0- Austroads (2006) Guide to Pavement Technology Part 4D "Stabilised Materials" AGPT04D/06 ISBN 1-921139 38 2