AustStab Technical Note

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Stabilisation using insoluble dry powdered polymers

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1 Introduction

There are various types of chemical binders available in Australia and this *Technical Notes* only discusses the use of insoluble dry powder polymer binders for road stabilisation. Further information on other chemical binders may be sought from Austroads (2006).

2 How do dry powdered polymers work?

Many road gravels have adequate strength to resist traffic stresses when they are dry but lose this strength with an increase in moisture content during and after periods of wet weather. When the gravel becomes wet, the clay fines within the gravel become 'greasy' and lubricate the larger stones. This allows them to slide relative to each other to produce rutting under wheel loadings. Strength loss is often very pronounced for gravels that have smooth, rounded stones and highly plastic fines.

Polymers act to preserve the dry strength of water-susceptible gravels. This involves creating a hydrophobic[1] soil matrix between the stones, which reduces permeability and so limits water ingress. Also, because the polymer is so strongly attracted to clay, silt and soil particles, it competes successfully with water to coat them. Thus the softening and lubricating effect of any moisture that does enter the pavement is much reduced, referred to as 'internal' waterproofing of fine-grained particles.

For dry powdered polymers to perform over the design life the polymer must be water insoluble.

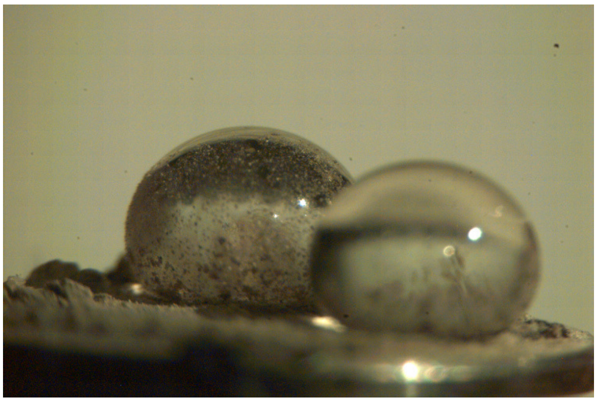

Figure 1 *A view of a water droplet failing to penetrate the surface of a DPP stabilised material.*

3 Where it may be used

Dry powdered polymers (DPPs) have been successfully used on roads and industrial sites. Typically, road stabilisation with DPP binders is being used for roads:

- ❑ in flood prone areas,
- ❑ where the subgrades have a high PI,
- ❑ in irrigated areas (including levee banks), and
- ❑ where there is a scarcity of local gravels and the existing road is a thin layer of base course.

[1] Tending not to dissolve in, mix with, or be wetted by water.

Figure 2 DPP being used in urban and rural sites using conventional insitu stabilisation equipment.

4 Testing for suitability

It is recommended that normal basic soil parameters, such as MDD, OMC, grading and PI, are determined on the parent pavement material.

Figure 3 shows the selection and application rate (by mass) of Polyroad binders under specific pavement conditions. This pavement material selection diagram may not be applicable to all DPPs and contact the supplier for their recommendations based on laboratory data and performance data.

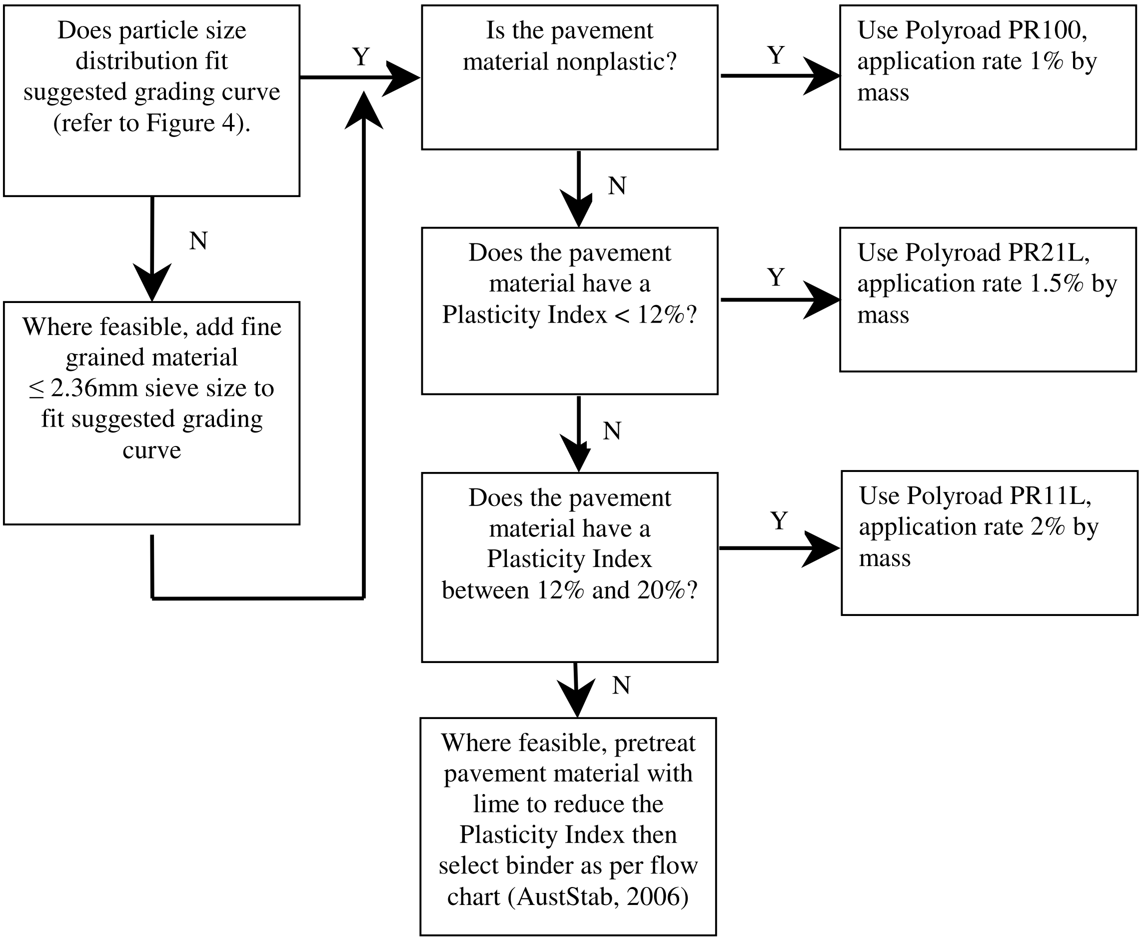

Figure 3 Determination of Polyroad binders for granular pavement materials.

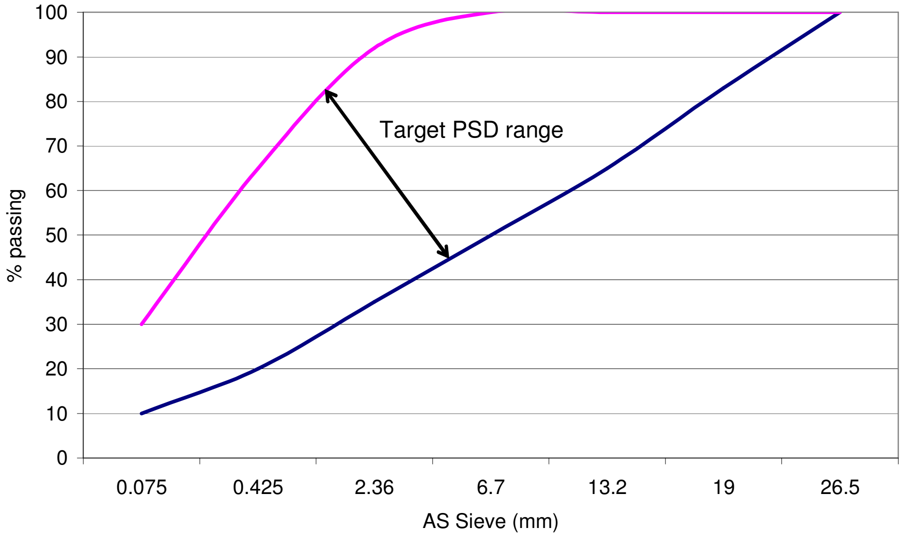

Figure 4 *Suggested particle distribution range for Polyroad binders.*

Another test to evaluate the stabilised material treated with DPPs is the capillary rise and swell test (AS 1141.53). It is useful to mould an untreated sample for comparison should swelling arise in the stabilised sample (see Figure 5).

Figure 5 *A view of a pavement material sample unstabilised (left) and stabilised with DPP (right) subject to soaking in water for 24 hours.*

Testing for strength may consist of CBR testing for subgrade materials and moderate to poor quality pavement materials, and repeated load triaxial (RLT) tests for all pavement materials. Whilst granular materials for road construction are typically defined by grading and PI and wet/dry strength variation, RLT testing gives a greater indication of the strength and stiffness of the material under both dry and wet state conditions. There is also an increasing trend to carry out RLT tests on all supplies of granular pavement materials to avoid poor materials (even though they may have a low PI and reasonable grading) being supplied to road projects.

5 Design considerations

Stabilisation of pavement materials with DPP reduces the potential for rutting after periods of wet conditions. DPP also reduces the plastic deformation of the stabilised basecourse itself.

Reducing moisture ingress into the subgrade and minimising the wetting of the base course increases pavement life. For example, where road distress is not primarily due to traffic but involves environmental cracking of the surface caused by movements in a reactive clay subgrade, stiffening of the basecourse may not be the most important criteria. In this case the stabilised basecourse can function as an impermeable, non-cracking protection to the subgrade to improve its volume stability. Especially in areas of poor drainage, the stabilised basecourse should be a barrier rather than a path to water reaching the subgrade from periodically flooded shoulders.

Stabilisation with a DPP binder acts to preserve the dry strength of plastic gravels by a process of internal waterproofing of fine-grained particles. The stabilised basecourse has reduced deformability and also functions as a flexible, low permeability protective barrier to the subgrade.

The current layer thickness design approach is to establish the modulus from a RLT test and use this in a layered elastic analysis or refer to design charts for various subgrade CBR values and pavement material stiffness.

6 Construction procedures

Construction is carried out using conventional road stabilisation equipment. The DPP is delivered in bulk pneumatic tankers and pumped into conventional spreaders or injection equipment in the same way as cementitious binders. Care should be taken in spreading the product during windy conditions, as DPP's are lighter (typically 700 kg/m^3) than cementitious binders.

The DPP should be incorporated with purpose built stabilisation equipment [AustStab, 2000]. Typically most application rates are in the range of 1 to 2% by mass of the parent material and it is essential that the DPP binder is properly mixed within the parent material to the full design depth. In most cases two passes of the stabiliser is recommended.

While the stabilised material may be remixed and recompacted at any time, it is good practice to compact as close as practical behind the mixer.

For 'weak' aggregates, multiple passes of the reclaimer may change the particle size distribution (ie more fines) leading to poorer compaction and stiffness.

It is recommended that construction personnel consult the Material Data Safety Sheet before using the binder.

7 Examples of DPP's

One of the most common DPP's in Australia is Polyroad. The stabilising binder consists of a polymer thermally bound to an inert fine carrier, typically fly ash, which is then mixed with hydrated lime. The lime is not coated with the polymer (see Figure 6), rather its function is to flocculate and prepare clay particles for adhesion to the polymer.

Figure 6 *A view of Polyroad under the electron microscope.*

As can be seen under an electron microscope and demonstrated by attempting to stir the powder into water, the fly ash is effectively encapsulated by the polymer. Therefore, it is misleading to compare the product with stabilising binders that contain fly ash/lime mixtures. The latter acts differently and cementitious bonds formed by the pozzolanic reactions produce modified or bound pavements depending on application rate.

8 References and bibliography

Austroads (2003) *Dry powdered polymer stabilising binder* APRG Technical Note 14, Sydney.

Austroads (2006) *Guide to Pavement Technology Part 4(d): Stabilised Materials* Austroads Project No: TP1089, Sydney, NSW.

AustStab (2000) *Profilers versus stabiliser* AustStab Construction Tip No.1, Australian Stabilisation Industry Association, Chatswood, NSW.

AustStab (2006) *Lime Stabilisation Practice* AustStab Technical Guideline, Australian Stabilisation Industry Association, Chatswood, NSW.

GeoPave (2003) *Stabilisation of pavement materials using dry powder polymer stabiliser* Report No. GR02700, VicRoads, Burwood East.

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Rodway, B (2001) *Polymer Stabilisation of Clayey Gravels* Proc. 20th ARRB Conf. Melbourne.

Wilmot, T (1994) *Selection of additives for stabilisation and recycling of road pavements* Proc. 17th ARRB Conf. Gold Coast.

Web Sites

http://www.auststab.com.au
http://www.polyroad.com.au [details and project reviews of the use of Polyroad]

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