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An overview of road stabilisation in Tasmania

Pavement Stabilisation

Andrew Walter Constructions – Handout notes

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Introduction

Objective

- To review road pavement stabilisation activities within Tasmania.

  The objective of the presentation is to improve awareness of stabilisation as an option for road pavement rehabilitation and construction in Tasmania.

Stabilisation

- Stabilisation is a construction procedure where natural or manufactured binders are used to improve the properties of pavement materials. Improvements from these binders can be mechanical, from the addition of fines to a course material to improve grading, or chemical where the reaction from cement, limes, etc either binds or improves the engineering properties of the material.

  Stabilisation is commonly carried out using modern stabilisers, which uniformly pulverizes and blends insitu pavement to a predetermined depth.

  The four basic properties of soils that affect their suitability and performance as a construction material are:

  - strength
  - volume stability
  - durability
  - permeability

A stabilisation process is aimed at one or more of these criteria and will affect the others simultaneously to differing degrees. It can be regarded both as a corrective measure to improve otherwise substandard materials and as preventive measure or insurance against adverse conditions developing during the course of construction or while the pavement is in service.

History

Pavement recycling has been around for many years. Records indicate that cement stabilisation was carried out in Queensland, NSW, Victoria and South Australia in the 1960's and that there was a major increase in its use in the early 1970's in NSW in particular. Other states progressed at a less rapid pace but with evidence that the technique was successful and improved technology, recycling is now generally accepted and widely used as a viable and cost effective means for pavement rehabilitation.

Tasmania's history of use of stabilisation goes back over thirty years. Unfortunately, application has been intermittent and we lag behind other states predominantly because we have depended on interstate stabiliser units for substantial projects. This has undoubtedly hindered more widespread acceptance of stabilisation within Tasmania. However, over time there has been much pavement recycling conducted for both local and state government with greater or lesser degrees of success. The main problems identified have been the accuracy of stabilising agent-spread rates, variable moisture contents and non-uniform mixing.

AWC became active in stabilising in April 1996 when we purchased a Caterpillar RR250B reclaimer/stabiliser and flocon spreader truck. Since that time we have gradually developed a degree of acceptance for stabilising methods among a range of clients and while the level of work has not always been high a steady amount of work has allowed us to maintain and develop our skills and equipment. In May 2007 AWC upgraded to a more powerful Caterpillar RM300 machine.

Advantages

There are two key benefits derived from stabilisation.

- **Cost**

The main benefit of stabilisation is that it costs less than traditional full reconstruction methods. Savings are obtained from reuse of existing pavement, eliminating transport costs for new pavement materials and reducing overall construction time. Using a stabilising agent also reduces the overall depth of pavement required.

- **Time**

Overall construction time is far less than for full construction methods. Disruption to road users and the community is dramatically reduced, and the risk associated with adverse weather is reduced.

Other benefits include

- Resistance to moisture, reducing pot holing and rutting.
- Improved durability and lower maintenance cost.
- Improving the characteristics of low quality pavement materials.
- Minimal disruption to levels and services.

- **Environment**

Today, the decision to recycle roads encompasses many environmental issues, such as:

- Communities expectations that government has an obligation to be a leader,
- Conservation of quarry products
- Speed of construction to reduce traffic delays
- Reduction in local road construction traffic
- Less construction tip sites and increasing tip fees and
- Fuel savings on trucks.

In addition, insitu stabilisation construction reduces local-road construction traffic and traffic noise, and the proliferation of dirt and dust on local roads.

Applications

Stabilising of existing base for reuse as base course

Existing base may be improved and recycled for use as base course. If the base is particularly thin it may be mixed with imported gravel.

Stabilising of existing base for reuse as sub-base

Existing base may be improved and recycled for use as subbase course and an overlay placed. Austroads does not recommend this type of “upside down” pavement but has been used successfully in the past with sufficient overlay.

Recovering existing base for reuse elsewhere (e.g. as sub-base)

For example when working between kerbs with a thin base over a poor sub-grade the existing base may be removed the sub-grade replaced or stabilised and the reclaimed base placed as a sub-base or as a base (possibly stabilised depending on quality).

Reclamation of gravel on existing unsealed roads

Andrew Walter Constructions have had particular success in reclaiming the existing gravel instead of resheeting gravel roads.

Stabilisation of subgrades

Stabilisation of poor sub-grades instead of replacing them can be particularly cost effective.

The ranges of materials that may be effectively stabilised include unstable sands through gravel to plastic clays.

Others

Capping layers for tip sites, reducing permeability of landfill linings etc.

Materials

Binders

When Andrew Walter Constructions started working in this area binders used for road stabilisation could be categorized into two groups, either lime or cement. Now the range is much broader and includes:

- General Purpose cement readily available but issues such as low working times (typically less than 2 hours), potential for shrinkage cracking and higher cost compared to alternative have led to increased use of blends or combinations with other binders such as bitumen.
- Lime (either quicklime or hydrated lime), commonly used, particularly on clay subgrades and improvement of plastic base course gravels. Readily available through Unimin (at Mole Creek), BCSC, ICL.
- Cementitious blends, including various combinations of flyash, ground blast furnace slag, lime & GP cement and including triple and quaternary blends. AWC is installing a blending plant to produce cement/lime blends locally while products such as fly ash and GBFS need to be imported.
- Emulsion treated bases (ETB). Usually used in conjunction with cement (or lime) to provide high early strengths, this treatment is to blend bitumen emulsion (usually less than 2.5%) to improve compactability and compacted density, by reducing internal friction of the granular material. It also reduces water susceptibility, allows the layer to be trafficked sooner and usually eliminates the need for priming. This technique is successfully used in South Africa for low to high volumes of traffic and has been used in Tasmania at a test strip at Cleveland.
- Foam bitumen. May also include cement/lime, this technique foams bitumen in the presence of air and steam to temporarily increase its volume greatly and improve its ability to disperse and coat the pavement material. Bitumen stabilisation is usually intended to introduce cohesion into non-plastic materials and/or reduce sensitivity to moisture. This method has been used in the Southern Tasmania Maintenance contract for rehab work and on the Dove Lake tourist road at Cradle Mountain.
- Mechanical. That is, granular materials such as sands, quarry products, clays etc to improve gradings and/or plastic properties of materials.
- Polymers. Polymeric stabilisers are available in a powder form and commonly consist of a mixture of polymers thermally bound to a carrier such as fly ash. They act to

waterproof the pavement and increase soaked CBR values e.g. Polyroad DPP by Polymix Industries Pty Ltd.

- Other chemical binders such as Soilbond by Huntsman Chemicals. Soilbond is a water-based organic emulsion used as a chemical binder in road stabilisation and dust control and is under trial in several areas.
  Also resins, lignin and lignosulphides, bentonite, calcium salts and sodium chlorides have been used for soil stabilisation with varying degrees of success.

The most suitable binder and quantity will depend on the properties of the pavement material to be stabilised and the environment in which the pavement must operate.

Plant and Equipment

Technology of stabilising has vastly improved over the years and largest stabilisers are now capable of recycling depths in excess of 400mm and productivity of up to 6000m2 per day. Binder spread rates and moisture controls have also improved with better computer controls.

υ Equipment

The following are key plant and equipment used in stabilising operations:

- υ Reclaimer/Stabiliser
- υ Spreader truck
- υ Other Construction equipment

Traditional trimming and compaction equipment is used. Locally we have been using a variety of compaction equipment including a Cat 815 earthworks compactor for cohesive soils and/or deep lift stabilising. Another recent innovation is the use of an on-site silo for powdered binders to minimise delays to delivery tankers and ensure product is on site when required.

Reclaimer/Stabiliser – e.g. Caterpillar RM300

υ Features

υ Reclaiming/Stabilising rotor

- Dedicated machines are suitable for reclamation and stabilisation applications. Machines not purpose designed for this work such as graders, rotary hoes etc are not suitable for stabilising applications.
- Appropriate geometry to keep the rotor steady in the cut for uniform depth control.
- Depth control to manage change in depth and correct rotor level to maintain predetermined depth.
- A range of rotor speeds for maximum performance in a variety of materials and cutting depths.

- Adequate cutting depth e.g. RM300 to 450mm (18”).

- **Moisture control**
  Microprocessor controlled Liquid Additive System (emulsion or water) to meter liquid delivery. Liquid delivery rates are linked to the machine speed to keep a constant application rate (i.e. constant litres per square metre). In some machines bitumen emulsion can be sprayed accurately into the mixing chamber to provide versatility in what design options are available for stabilising pavements.
- **Production rates**
  Modern rclaimer/stabilisers are high performance units and impressive production rates are possible, minimising disruption to road users and the community.
- **Maneuverablity**
  Front and rear wheel steering

Spreader Truck

Key to ensuring accurate application of fine-grained binders for stabilising the road pavement.

- Features
  This unit incorporates a lime and cement vane spreader with self-aligning conveyor system. A rubber belt conveyor was selected to minimise leakage.
- **Accuracy**
  The vane spreader accurately controls the discharge rate for spreading lime or cement to 20kg per m2. The unit uses adjustable hydraulic vane speed control. The speed of the belt can also be precisely controlled.
- **Flexibility**
  All controls can be operated from the cabin or from the rear of the truck. Spreading width is variable up to 2.4m. The unit can be operated as a normal Flocon truck and has four independent adjustable rear doors.

- **Modifications**
  Modifications to traditional Flocon truck include the vane spreader and a sealed top. All attachments are easily removed or added. Other features include:

- Automatic vane overfill protection.
- Automatic tailboard control.
- Ability to fill the truck with binder direct from on site silo, pneumatic tankers or concrete plants.

Specifications and work practices

There are a variety of specifications used for work carried out in Tasmania. These would include:

- DIER specification R42 – “Insitu Stabilisation with Cementitious Materials” March 1995 – badly out of date and is to be revised.
- Other State Road Authorities, e.g. VicRoads
- Auststab Model Specifications (can be viewed at http://www.auststab.com.au/) – Tailored for Stabilising works and for different methods e.g.;
  - Insitu Stabilisation of Local Government Roads with Cementitious Binders including Lime (Version D - Minor changes)
  - Insitu Stabilisation of Local Government Roads with Bituminous Binders (Version C - Minor changes)
  - Insitu Stabilisation of Main Roads with Bituminous Binders (Version B)
  - Model Specification 4 - Plant-mix Stabilisation of Main Roads with Bituminous Binders (Version A)
  - Insitu Stabilisation of subgrades and pavement materials using lime for Local Government Roads (Version B)
  - Insitu stabilisation of subgrade materials using lime for main roads (Version A)
  - Insitu Granular Stabilisation of Local Government Roads (Version A) To be released soon.
  - Model Specification for Supply of Limestone for Acid Sulphate Sites (Version A)
- Specifications issued by manufacturers – if applicable should be called up in relevant contract.
- Specifications issued by consulting engineers etc - usually directly referring to one of the above or heavily based on those documents.
- AUSTROADS publications e.g. AP-G75/03 : “Guide to Best Practice for the Construction of Insitu Stabilised Pavements” 2003
- AustStab publication “Pavement Recycling and Stabilisation Guide” 2011.

Investigation, design and preparation

The following are key requirements for success in any stabilising operations:

- Investigation

  The initial step in the stabilisation process is to carry out test pitting and simple laboratory tests on the material to be stabilised. These tests are aimed at determining available insitu pavement depth, sub-grade CBR, the suitability of the pavement for stabilisation, the required binder content to achieve the desired properties and the amount of water to be added during stabilisation to gain the maximum compaction.

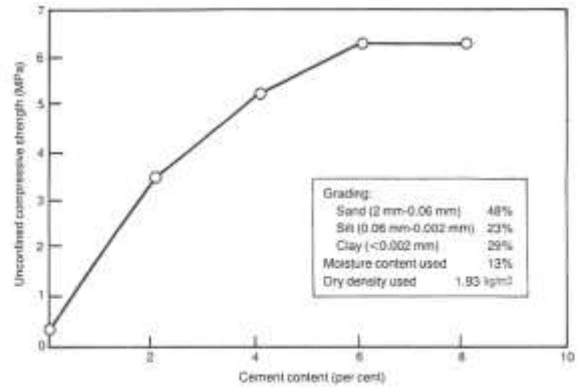
Any or all of these may be carried out as part of a pavement investigation:

1. Pavement condition survey
2. Benkleman Beam
3. Test pitting – pavement depth, sub-grade CBR
4. Testing of samples – Grading, plasticity, strength tests at various binder contents

υ Design

Elements the design process include:

Design traffic over required life
Locality (moisture regime etc)
Subgrade strength
Selection of binder type and content
Selection of layer thickness
Determination of properties of stabilised material over time



Determination of layer depths by:

- Empirical rule of thumb - it worked before!
- Semi empirical methods - e.g. AASHTO structural numbers, layer equivalence (30% rule)
- Design charts produced from mechanistic procedures – e.g. Austroads publication
Guide to Pavement Technology Part 2: Pavement Structural Design
- Mechanistic procedures - e.g. Circly, Strand 6 FEM

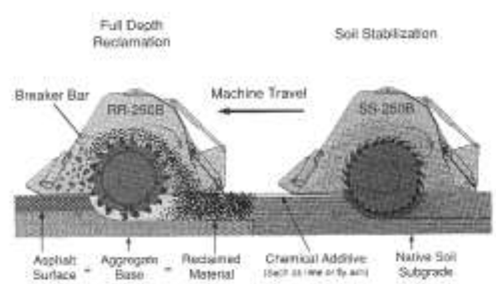
Note: Binder contents as expressed as percentage contents by mass.
Lime contents generally refer to hydrated lime unless otherwise stated and an adjustment can be made if quick lime is used. Lime is not a “pure” agent and different sources contain varying proportions of the active component calcium hydroxide. Some specifications refer to applying a percentage (or spread rate) of calcium hydroxide and an adjustment made for the available calcium hydroxide for the selected suppliers lime. Refer http://www.auststab.com.au/technotes/TNote01.pdf

υ Preparation

Table drains are cleaned, any other remedial action identified during the investigation addressed (e.g. concrete patches removed), services lowered (if required), manhole covers and valve-boxes temporarily lowered and the material to be stabilised is reshaped (if major reshaping is to take place).

υ Mixing

The required quantity of binder and water for compaction is incorporated into the material and mixed thoroughly through the layer depth. During the mixing process the material is pulverised to its natural grading. The uniformity and thoroughness of mixing is critical and is one reason graders and agricultural hoes and not successful. In order to reduce the risk of reflective cracking through the seal moisture should be kept below optimum (say 1% below).



υ Compaction

As with other types of pavement, the strength of the pavement is dependent on the extent of compaction achieved. No special compaction equipment is necessary, however the time available for compaction may be reduced for some binders e.g. only two hours is available for compaction on material stabilised with GP cement.

- Curing

  Curing is the final step in the process to prevent rapid evaporation of moisture from the surface and to allow the binder to harden fully. Options include frequent watering with a watercart, overlaying the material with the next layer of material if one is to be placed or a light coat of bituminous material.

Case Studies:

Andrew Walter Constructions have undertaken projects for a variety of Clients or the years. Below we have listed a cross section of some projects to highlight the possible options and methodology that could be adopted.

Brooker Highway - Howard Road, Department of Transport
Reclaim existing asphalt and base and remove to reuse as subbase in other works, new base course layer placed

Dorans Road (Client: Clarence City Council, design by AWC/CCC, construction by AWC/Clarence CC)
Investigation revealed 200-220 mm of good quality FCR overlaying a thin variable depth decomposed dolerite subbase and a highly plastic clay subgrade. The road was lightly trafficked. Available widths prohibited further overlays. As the existing base was of very good quality it was decided to reclaim one half longitudinally, grade this material onto the other half (and level to provide a trafficable surface) and lime stabilize the subbase/subgrade. The base was than cut back into place and the process repeated for the other side. A nominal 30-50 mm of additional base was then mixed with the existing base to provide material for shape correction and make good losses of material.

Department of Transport, Bridport Main Road
Cement stabilise existing base to use as subbase layer 250 mm deep. Overlay with 200 mm of base course gravel.
Although this method of construction appears to have been very successful in this case this “upside down” method of construction is not recommended in the current Austroads guide.

Various clients – Lime stabilisation of clay subgrades.
Often carried out on new pavements in subdivision work a variety of depths have been used (150 mm to 350 mm) using 3-4% lime based on consulting engineer or AWC recommendations. A very cost effective solution to extensive subgrade replacement or much thicker pavements. Also facilitates easier construction access.

Midland Highway – Cleveland overtaking (slow) lane (Principal DIER, client: Works Tasmania, design: Pitt & Sherry/DIER)
Bitumen emulsion stabilisation of ironstone gravel, 200 mm deep, using 2% (residual) bitumen emulsion and 1.5% GP cement. Work progressed well with some settlement at the

construction joint (corrected with asphalt) and slight seal flushing some years later. Most of these issues could be reduced through improved compaction equipment such as the Cat 815 compactor.

Cape Tourville Access Road (Client: Parks & Wildlife)
Stabilisation of access road 200 mm deep using 2% triple blend cement (60/25/15 GP/Slag/fly ash). The existing unsealed pavement was basically sound and over good subgrade but the fine decomposed granite gravel was prone to unraveling due to its rounded stone shape and was also prone to rutting. The nominal binder content provided sufficient strength gains for the gravel to be sealed, no signs of cracking are evident.

Various Councils – Rural Road rehabilitation
Many local government rural road pavements have a substantial depth of gravel but the base is generally of low quality being excessively plastic and of low strength. This is particularly true of decomposed dolerite or basalt pavement. Modification of the base with nominally 2% lime either 150 mm or 200 mm deep has proven an effective rehabilitation measure.

Launceston Southern Outlet (Principal: DIER, client: Civil Construction Corporation, design: Pitt & Sherry, construction by Civil Construction Corp/AWC)
Design called for 5% of "alkali activated slag" binder, 300 mm deep to be mixed into the pavement. Two lanes of traffic had to be open during peak hours. Concerns were expressed pre-tender about the high binder content. The pavement is being monitored but two main issues are:
Roughness – the requirement for two lanes of traffic meant that the traffic was placed on the stabilised gravel before it had dried back and set-up sufficiently to carry the traffic loading. The pavement rutted overnight and had to be recut the following day with attendant damage.
Pavement lamination - The traffic also caused severe potholing during intense rain that required repair. Unfortunately this was not carried out full depth and created a lower strength “laminated” pavement in those areas that subsequently required further repair.
Monitoring will reveal the validity of the high modulus design however the project would have benefited by not trafficking the freshly stabilized material until dried back. This could have been easily achieved in the low traffic post Christmas period.

Conclusion

υ Deployment options

Options for project delivery may include:

υ Hire

Hire on a daily/hourly basis or schedule of rates.

υ Full construction

Delivery of full construction services by the contractor.

υ Design & construct

External design and construction by specialist contractors.