On the Highway: a Comparison of In-situ Stabilisation Techniques

Matthew Brown of Milburn Cement takes a look at pavement recycling techniques in New Zealand and Australia.

Stabilisation, broadly defined as the addition of binders to improve the load-bearing capacity and/or stability of materials within any layer of pavement, is not a new technique. Increasing demand, however, for improved quality and safety standards in roading infrastructure has highlighted its value. During a recent trip to Queensland, Australia, I was fortunate to have the opportunity to observe and compare differences and similarities in the area of road construction and logistical systems using in-situ stabilisation (or pavement recycling) techniques.

In many cases, demand for improved quality and safety standards in our roading infrastructure can realistically only be addressed by appropriate maintenance methodology and rehabilitation techniques. Both New Zealand and Australia face problems associated with growing heavy traffic volumes, tighter budget constraints, increasingly scarce raw materials, environmental concerns, and limitations on construction times.

Logistics: Queensland vs New Zealand

The obvious difference between Queensland and New Zealand is size, of both the land mass and the roading network. Australia has over 900,000 kilometres of roads, of which approximately 33% are sealed. The state of Queensland alone measures 1.7 million square kilometres, equal in area to France, Spain, Germany and Italy together. It is not unusual for binder suppliers, usually the cement companies (Queensland Cement Ltd and Sunstate Cement), to transport material up to 1300 kilometres.

In comparison, New Zealand's roading network is 92,075 kilometres, with approximately 80% sealed roads.

The size of the Australian roading network means maintenance and rehabilitation of pavements are logistically difficult. The geology of Australia also means some areas are devoid of suitable roading aggregate; stabilisation is an alternative to transporting large volumes from elsewhere.

Binders

The type and quantity of binder used in stabilisation vary, and include cementitious powder, lime, bituminous, granular addition, and certain chemicals.

Until the late 1980s cement and lime were predominantly used for stabilisation in Australia, where ambient temperature limits working time to approximately two hours. In the Queensland summer heat, shrinkage cracks were a common occurrence in cement-stabilised pavements, and because of this roading authorities took a very cautious view of the "shrinkage cracking syndrome". While this shrinkage cracking syndrome is also a concern in New Zealand, this type of pavement failure has been significantly reduced over the years thanks to moderate temperatures and climate, and continued awareness of the cracking behaviour of cement-bound pavements. ARRB (the Australian Road Research Board) transport research has indicated that allowing traffic over the final trimmed, stabilised pavement as soon as possible helps to induce micro-cracking that does not compromise the pavement's stability.

Urban and local authorities in Australia have recognised the benefits of in-situ pavement recycling in terms of cost, time and environmental considerations over many decades. This approach is now increasingly used by state roading authorities too. A provision of this, which Australia has recognised and fully embraced, is the use of supplementary cementitious binders blended with cement or lime. Characteristically these binders have slower setting times, which allows more time in shaping the final surface, as well as a slower rate of strength gain, which helps to control shrinkage cracking.

The use of blended binders in the state of Queensland increased throughout the 80s and 90s, with the most commonly specified blend being cement/fly ash, with a fly ash content ranging from 25% to 30%. Tables 2.1 and 2.2 show the various specified types of blended binder on the Queensland market.

New Zealand does not have access to these industrial pozzolanic and semi-hydraulic materials as readily as Australia, and as a result blended binders are nearly non-existent in the New Zealand market. Hiway Stabilizers, however, uses a semi-hydraulic product called KOBM (Kontinous Oxygen Blast Maxite). KOBM is a by-product of the steel-making process at the BHP Glenbrook steel mill. A class C fly ash is available in New Zealand from Huntly.

These Photos show the machinery at work in Australia.

A Wirtgen 2500k construction on a deep lift pavement, with a lime binder. Note the binder tanker in front allowing the direct injection of binder into the ground without dust emissions.

A Wirtgen stabiliser/reclaimer 2500k stabilising using the conventional spread and mix construction technique.

Construction Techniques

Construction techniques in both Australia and New Zealand are very similar, with the Australian stabilisation industry guided by AustStab.

In-situ stabilisation requires two pieces of specialised equipment: a binder spreader and a stabiliser mixer and/or reclaimer stabiliser. The spreader unit spreads the binder uniformly over the pavement prior to the stabiliser mixer, with the addition rate determined by prior testing. The acceptable spreading tolerance is within +10% of the target. The conventional-sized reclaimer/stabiliser thoroughly mixes the binder and pavement material to a depth of 400 millimetres.

Water content is a critical factor. Water added to the mix either is sprayed on by a water truck prior to the milling of the road or is by direct injection, which allows accuracy and control of the soil's optimum moisture content. Good quality water content (free of organic material and low in sulphates) is crucial for stabilisation, not only for the hydration process but to gain the specified density of the pavement through compaction effort. With the use of GP cement, hydration will begin immediately and proceed rapidly. Therefore it's essential that adequate compaction takes place immediately after the mixing process. Any delay in this process can compromise the strength and performance of the constructed pavement. The blended binders will also react immediately, but their rate of strength gain is slower because secondary reactions of components in the blends allow extended working time.

Quality control throughout construction is not an option in stabilisation - it is a necessity. Competent and close supervision is the key to getting it right. Quality factors include the binder spread, moisture content, stabilisation depth, compaction, trimming, curing (critical), and finally sealing of the pavement.

In Australia the 1990s saw the introduction of the reclaimer stabiliser, a machine that can both reclaim and stabilise with the same rotor – without using rippers to loosen the pavement. The rotor is designed to mix and pulverise the pavement, and the large machines can reclaim material up to 500 millimetres in depth.

Dustless stabilisation, a technique that has been particularly successful in urban areas of Australia, has resulted from this technology. This technique, a recent development, spreads the binder directly in front of the reclaimer stabiliser via a specially designed tanker connected to the stabiliser, which simultaneously feeds it with binder and water.

This article provides an overview of the differences and similarities of in-situ pavement recycling with the use of cementitious binders in New Zealand and Australia. While New Zealand has been highly innovative in the design and construction of stabilised pavements, Australia does have the edge in terms of machinery technology and the use of blended binders. A smaller roading network, smaller population and limited resources in supplementary cementitious materials are all contributors to this current situation for New Zealand.

Recommended Reading

***Guide to Stabilisation in Roadworks,* Austroads, 1998.**

AustStab www.auststab.com.au

Binder Selection Guide

	More than 25% Passing 75µm			Less than 25% Passing 75µm		
Plasticity Index	P1c10	10cP1c20	P1c20	P1c6 Pix% passing 75µm = 60	P1c10	P1>10
Form of Stabilisation						
Cement and Cementitious Blends	Usually suitable	Doubtful	Usually not suitable	Usually suitable	Usually suitable	Usually suitable
Lime	Doubtful	Usually suitable	Usually suitable	Usually not suitable	Doubtful	Usually suitable
Bitumen	Doubtful	Doubtful	Usually not suitable	Usually suitable	Usually suitable	Doubtful
Bitumen/Cement Blends	Usually suitable	Doubtful	Usually not suitable	Usually suitable	Usually suitable	Doubtful
Granular	Usually suitable	Usually not suitable	Usually not suitable	Usually suitable	Usually suitable	Doubtful
Miscellaneous Chemicals*	Usually not suitable	Usually suitable	Usually suitable	Usually not suitable	Doubtful	Usually suitable

*Should be taken as a broad guideline only. Refer to trade literature for further information.

Key: Usually suitable / Doubtful / Usually not suitable

Note: The above forms of stabilisation may be used in combination, eg. lime stabilisation to dry out materials and reduce their plasticity, making them suitable for other methods of stabilisation.

Table 2.1 Commonly specified binders

Binder	Proportion %
GP Cement : Fly Ash	75 : 25
GP Cement : Fly Ash	70 : 30
GP Cement : Slag	40 : 60
Fly Ash : Hydrated Lime	60 : 40
Quicklime	100
Hydrated Lime	100

Table 2.2 Alternative specified binders

Binder	Proportion %
GP Cement : Slag	70 : 30
Hydrated Lime : Slag	30 : 70
GP Cement : Fly Ash : Hydrated Lime	30 : 40 : 30
GP Cement : Fly Ash : Slag	50 : 25 : 25

A Guide to the Structural Design of Road Pavements

Over the past 50 years New Zealand has established many stabilisation design and construction methods. Across the Tasman in 1992, Austroads (the Association of State, Territory and Federal Road and Traffic Authorities in Australia), of which Transit New Zealand is an active member, published a pavement design manual, *A Guide to the Structural Design of Road Pavements,* which placed some emphasis on the design of stabilised pavements.

The manual assists those who plan and design new pavements, and those who rehabilitate existing examples. It is well suited for both New Zealand and Australian requirements, and takes advantage of knowledge and experience from both countries. Transit New Zealand has adopted its design procedures, with variations as detailed in the New Zealand supplement. Austroads, in association with AustStab (the Australian Stabilisation Industry Association) and the Australian Asphalt Pavement Association (AAPA), has also produced a *Guide to Stabilisation in Roadworks.*

This provides excellent direction for designers and contractors in the methodology of stabilisation construction techniques, as well as materials and quality management. A Transit New Zealand representative was part of the steering committee involved in this publication.