FOREST ROADING - THE NEW WAY

FOREST ROADING SERVICES (FRS) LTD

INTRODUCTION

Forest Roading Services (FRS) Ltd, the vision is simple

" World Leaders in Forestry Management"

Key Supplier engineering has real understanding of forest engineering

The successful bid for CHHF Key Supplier Engineering Contract has been achieved through a real understanding of forest engineering, what has been done in the past? and what needs to be done in the future?

Key supplier aims are to

- Improve Health and Safety
- Improve Environmental Standards
- Improve Quality
- Reduce Costs

FRS has been formed with a focus to achieve these aims.

METHODOLOGY

Vision realised by team of dedicated individuals

The FRS vision is being successfully realised by a team of dedicated individuals.

A personal commitment and "ownership" philosophy is achieving real results.

- Health and Safety improvements are being made.
- Environmental responsibility is improving
- Quality is up
- Costs are down

Meet or exceed client requirements

The priority of the team is to focus on the clients expectations and requirements, particularly in regard to the above, and to meet or exceed these.

ENGINEERING ALTERNATIVES

Methodologies are based on existing knowledge

The team recognises the importance of the existing knowledge that has been gained through many years of forest roading and engineering. This knowledge whether it may be from the "bulldozer driver" or the engineering consultant makes for the basis of each proposed construction and maintenance methodology.

Multi skilled team develops most cost effective viable solution

This experience based knowledge is then additionally complemented by a team with skills ranging from practical contracting experience through to laboratory, consulting and a range of full technical support which develops the most cost effective, viable methodology to achieve the required results.

Construction and maintenance strategies, with alternative methods and a continual desire to "Challenge Tradition" means the FRS and the key supplier philosophies will be achieved.

Resources of aggregates being depleted at increasing rate

For a long period, most of New Zealand's roads including forest roads have been constructed from aggregate (premium and marginal) which, over the years, has seen the resources of these aggregates being depleted at an increasing rate.
There is now more than ever a responsibility to preserve these and other resource supplies and optimise the use of materials in the most appropriate situations.

Need to source alternative materials

With the onset of the resource deletion, there is now a need to source alternative materials, and to stabilise or modify them to meet the strength and durability requirements of the pavement.

Design the pavement to suit conditions and utilise local materials

The "pavement designer", has a much greater need to design the pavement to suit the site conditions, design traffic loadings, and to utilise local materials imported and insitu in the most cost effective manner.

Material properties need to be identified and addressed.

This requires the "designer to have a knowledge of:

- The end use load conditions and the material properties needed to meet these conditions,
- The properties of the available materials they are dealing with,
- In what way the properties don't meet the pavement requirements
- How those properties may be altered by stabilisation with the appropriate binders and specified / constructed in an appropriate manner, to meet the pavement requirement.

STABILISATION

DEFINITION

Stabilisation can be defined as the treatment of materials to improve and maintain the engineering properties of soils.

Stabilisation can provide major recognised benefits for roading projects of all sizes and significantly offers an acceptable cost effective environmental alternative to conventional designs that rapidly diminish resources of premium products. The properties that are usually altered by stabilisation include:

Strength
Strength increases with increasing lime or cement content.

Stiffness
Bitumen will retain flexibility in materials while achieving long term strengths.

Volume Stability
Even small amounts of lime or cement can greatly reduce moisture-induced swelling and shrinkage.

Sensitivity to changes in Moisture Content
Lime reduces plasticity by increasing the plastic limit and decreasing the liquid limit all of which improve the engineering properties.

Durability
The chemical reactivates are not reversed by the presence of water.

Permeability
Decreased permeability thus giving more protection to subgrade.

TREATMENTS

Identify properties that require altering and the effect of stabilising on the properties

Most stabilisation treatments include Lime, KOBM, Cement or bitumen emulsion or a combination of these. Correct use of stabilisation, with the appropriate binders, requires the identification of the properties that require altering and the effect the stabilising process will be on these properties.

Soils and aggregates have a wide range of properties. Consequently the reaction of a specific material with any particular stabiliser cannot be determined by simple observations, or by defining the soil type.

Targeted testing results in most appropriate option

Adequate targeted testing needs to be undertaken to result in the most appropriate stabilisation option. A tool available is the CBR quick test which will give an indication of reactivity, and effectiveness of the stabilisation option, within a very short time allowing quick on site assessment of options.

FORESTRY CONSIDERATIONS

Ideal forestry pavement fails on last load of logs

A pavement built with the lowest total cost and that completely fails as the last load of logs exist would be ideal. This demanding and unique situation requires some serious considerations.

Some examples of forestry road stabilising follow and demonstrate the effectiveness of stabilisation as a cost effective solution:

INSITU MATERIAL	**Heavy Clay Subgrades**
PROJECT:	Subgrade Stabilisation
LOCATION	Mahurangi Forest – Redwoods Road
BINDER	Lime Oxide

THE CHALLENGE

Insitu clay low bearing strength and high plasticity

The insitu clay material on this project typically had a low bearing strength, high plasticity and suffers from large shrink / swell problems. It is extremely moisture sensitive and, predominately due to its moisture contents, the clays' strength is variable across a site.

Traditional methods of dealing with these insitu clays, under an unbound pavement design, involve excavation of a nominal depth of the material and have resulted in greatly increased depths of aggregate. The aggregate sources are often some distance from the site and equated to an increased cost for the pavement.

Less aggregate compaction possible over soft clay

The insitu materials result in softer bases on which to undertake compaction of the following pavement layers, with less resistance to compaction effort. This decreased the density and strength of the layers, when compared to compaction of aggregates on stronger stabilised subgrades and provided much less realisation of the aggregates full strength potential

THE SOLUTION

Replaces aggregate at 30 % cost savings

The developed design methodology was to stabilise the material with lime oxide which demonstrated the effectiveness of a stabilised subgrade within the pavement, and replaced an equivalent volume of new aggregate, at a lower cost and reduced construction time.

Lime reacts with clay to reduce plasticity and increase strength

The developed solution presented a cost saving of 30 % over a conventional unbound aggregate pavement.
Lime reacts with clay soils in a chemical process known as pozzolanic reaction which reduces soil plasticity and provides a significant increase in strength that can continue indefinitely.

The slaking process converts the Calcium Oxide to Calcium Hydroxide, which is the chemical that undergoes an exchange between the Sodium or Hydrogen clay cations and Calcium lime cations, reducing the plasticity.

Spray nozzles ensure effective slaking

Granulated lime oxide @ 3 % was slaked by the use of spray nozzles from a side shift boom over a few applications (Fig 1). This reduced trafficking of the slaked binder and ensured an evenly controlled application of water to prevent drowning of the lime and adequate slaking.

Fig 1 Lime slaked from side shift boom

Particle sizing ensures compaction

A Spade Tip Stabiliser was used to mix the lime through the clay as a primary hoe followed by a secondary hoe called a Particle Sizer which worked together to achieve an appropriate clay particle size to ensure uniformity of chemical modification and enable compaction with a vibrating padfoot roller.

Targeted testing results in most appropriate option

The essential component to the success of subgrade stabilisation, being the identification of the appropriate binders and application rates, was achieved through targeted lab testing.

Cement is used in association with lime where the material had a silt component or a higher end strength was desired.

Correct level tolerances essential prior to stabilising

It was essential to achieve level tolerance and ensure that the correct quantity of material is in position, at the right cross section and longitudinal profiles prior to the additive spread. Any shape correction works that are performed after stabilisation simply removes a layer of the strengthened material decreasing the end result.

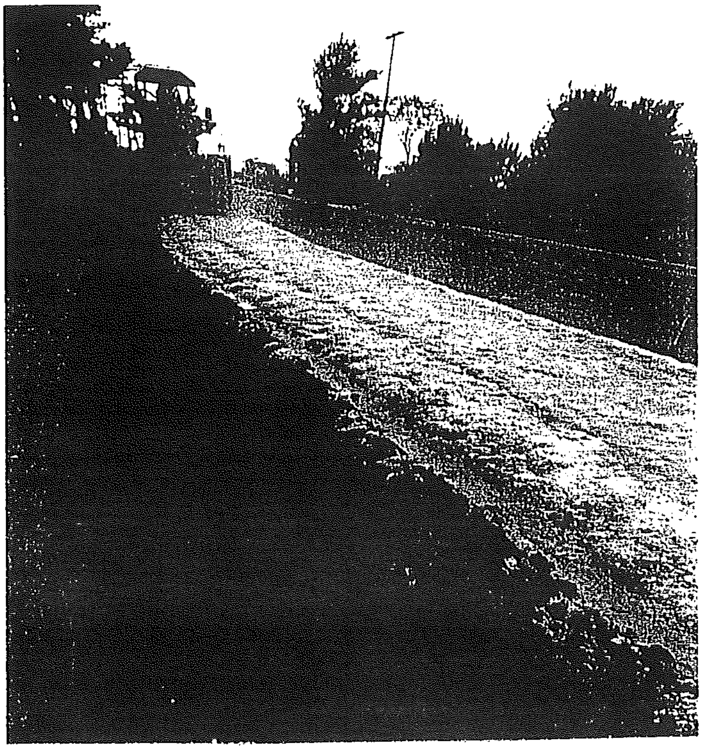

Fig 2 Stabilising Clay Subgrade

INSITU MATERIAL: **Single size sand / poor aggregate**
PROJECT: Aggregate Modification
LOCATION: Woodhill Forest – Inland Road
BINDER: KOBM and Cement

THE CHALLENGE:

Very weathered insitu aggregate

The existing pavement consisted of a single sized sand ver weathered subgrade, a clayey sand capping with approximately 200mm depth marginal and very weathered aggregate. It had low strength and high plastic fines content.

Additionally the length of road was through an area where no road line clearing was able to be completed hence the pavement remained continually shaded.

The section of road is the main arterial through Woodhill forest.

THE SOLUTION:

Two alternative upgrade options were considered

1.) Conventional unbound overlay

2.) Stabilise the existing pavement

Stabilised option realises 25% savings

The stabilised option was chosen due to a 25% cost savings in construction costs and the significant reduction in maintenance grading requirements (bound material vrs. Unbound).

Design testing was completed by Scala pentrometer, Insitu test pits and Target laboratory CBR testing.

KOBM and cement are effective binders

A KOBM and Cement blend was used as the stabilising binders. This blend was chosen as the most effective solution and would successfully modify a variety of marginal materials to meet the pavement requirements.

MODIFIED MARGINAL AGGREGATE

GAP 65 marginal due to plastic fines content

One of the principal reasons the insitu material was classed as a marginal aggregate was due to the plastic clay fines within its structure due to the breakdown of the aggregate. These are modified by the addition of KOBM @ 25kg/m^2 and cement @ 6kg/m^2.

KOBM is produced at the Glenbrook Steel mill as a by-product from the steel making process. Lime is added to the smelt to remove impurities in the process and lime is retained in the resulting slag some of which has active lime. The resulting material is a consistent product that meets the requirements for an effective stabilising binder.

KOBM enables high particle to particle contact with minerals

One of the main advantages of KOBM in the modification of plastic fines in an aggregate is the volume of stabiliser added is higher than other products resulting in a much greater particle to particle contact with the minerals to be destroyed.

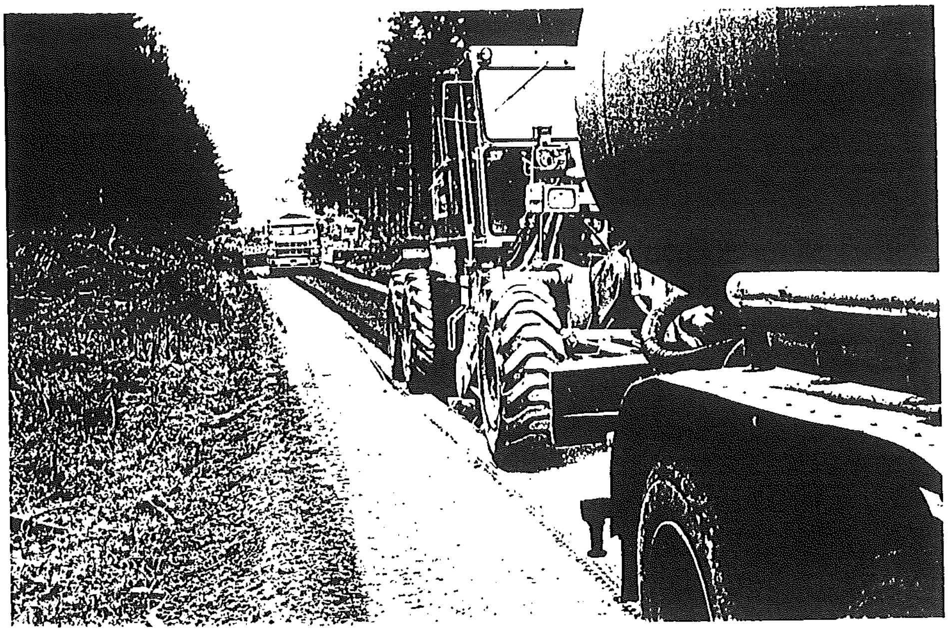

Fig 3 KOBM and cement spread in the foreground with stabiliser producing a modified - aggregate while the road is open to logging traffic

KOBM coverts plastic fines into stable hydration products

The addition of KOBM reacts with the plastic fines present in the material and converts them into stable hydration products that increase the material strength. The cement provides a catalytic effect on the KOBM increasing the reaction product while also providing good early strength gain to the pavement enabling rapid construction.

Only enough water to assist compaction was added

The KOBM requires much less water than lime to become reactive and as it has the ability to carry its own weight of water into the material, it is commonly spread first, watered and followed by the cement application.

Project successfully completed in cold and wet winter

The project was completed in winter months – conditions that were both wet and cold. Additional cement needed to be added where subgrade conditions required. These areas were identified on site by "heaving" coming up through the base aggregate materials. The need for a quick strength increase was required due to the fact the pavement remained open for traffic whilst construction work proceeded.

Critical to have appropriate compaction and trimming plant

Compaction with a vibrating steel drum roller immediately followed the stabilising so it was critical to restrict any transporting of the material horizontally as the chemical reaction commenced once watered. This was achieved by ensuring an accurate grade and reasonable density was achieved prior to hoeing and having appropriate compaction and trimming plant after hoeing. Primary compaction needed to be complete 2 hours after the addition of cement and final compaction within 6 hours.

Topcourse was spread to provide surface protection from vehicles on the live road and retain moisture in the stabilised layer to assist curing.

Health & Safety Improvements – Reduced Dust !!!

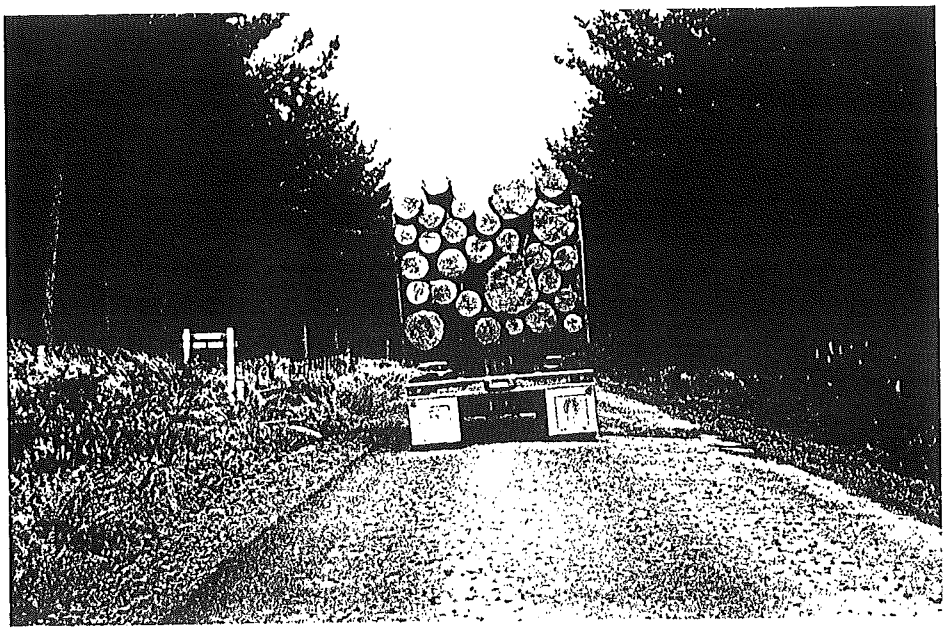

Fig 4 Completed modified aggregate pavement meeting traffic demands with greatly reduced dust.

INSITU MATERIAL	**Sand**
LOCATION	Woodhill Forest – High North road
PROJECT	Secondary Road Upgrade
BINDERS	Lime and Cement

THE CHALLENGE

No nearby supply of aggregates

A forestry block required a secondary road upgrade at the top of South Head in the predominantly sand topography where the nearest supply of aggregates was a considerable distance from the site. The future traffic loading was calculated from harvest planing information and a design based on this information was developed as the pavement material requirements were less demanding than a premium quality pavement and allowed a wider choice of materials to be considered.

Insitu sand low strength and poor water retention

The insitu sand material had a low bearing strength and a poor ability to retain moisture making compaction difficult. The rounded particles had little cohesion resulting in shallow shear failures with the material, at times, unable to carry light vehicles let alone heavy loadings

Initial trials determined that an excessive amount of cement would be required to effectively stabilise the sand with cement only and provide sufficient strength to act as the basecourse layer.

THE SOLUTION

Due to the remoteness of the site location, the design required lateral thought to achieve an economic solution that met the pavement requirements yet was still able to be constructed.

In depth practical experience supported by Circly designs

The experience of the design team was utilised and a design methodology derived that utilised the insitu materials to the fullest as the use of these results in the most cost effective solution. This application of in depth practical knowledge was supported by designs that confirmed the "field based design" was suitable to enable the subgrade and pavement materials to support the vehicle loadings

Methodology of insitu friable clayey sand lime and cement effective

As the anticipated traffic loadings were not expected to be excessive a pavement design of insitu friable clayey sand, 2% lime and 1.5% cement was utilised. This innovative methodology resulted in cost savings of 40 % over conventional unbound pavements

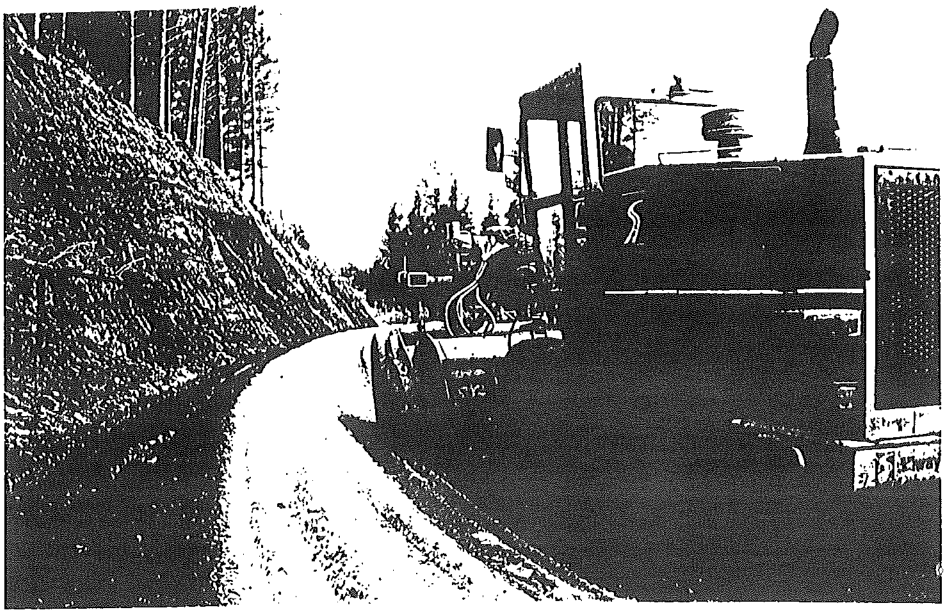

Fig 5 Stabilizer mixing slaked Lime Oxide – one pass, full depth operation.

Inert sand was overlayed by clay for lime reaction

The insitu sand material was inert so clay was introduced which conglomerated the material and assisted in retaining sufficient water in the pavement for compaction. The clay presence also provided suitable material for the lime reaction to generate gel formations leading to the increased strength.

Following trimming of the insitu sand subgrade to grade, the clay material sourced nearby was spread and trimmed and compacted to shape. The Lime Oxide was spread, slaked and hoed to the full 250mm depth.

24 hours curing of lime to allow reaction

A curing period of 24 hours was maintained to allow the lime to react and conglomerate the pavement materials and the following day the pavement was lightly watered and the cement spread.

Water introduced to the material during hoeing via direct hood injection

As the stabilizer mixed the materials, water was injected directly to the rotor head via a controlled feed from the preceding watercart. This ensured sufficient water was introduced to the pavement to achieve compaction while undertaking the hoeing

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