LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

REPORT

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STRENGTHENING LOGGING ROADS

Figure 1. Rock Topcourse: The Normal Road Strengthening Material

ACKNOWLEDGEMENTS

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INTRODUCTION

In some logging operations in New Zealand, road construction and maintenance cause greater problems than harvesting itself. The difficulties are associated particularly with clay soils which are common throughout New Zealand. LIRA has collected information currently available and summarised it in this report. The use of trade names is for the convenience of readers and does not imply that LIRA endorses specific products.

THE PROBLEM

Major problems in forest roading can arise when roads must be sited on soils which have a poor load bearing capacity, such as wet clay or organic soils. When a loaded wheel

passes over these soils the surface deflects, squeezing soil out from under the wheel to bulge at the road surface. On a very weak road, one or two passes of a loaded wheel may be sufficient to cause complete road failure and result in a vehicle bogged in mud.

Thus the strength design of a road is essentially a problem of ensuring that each part of the road structure has sufficient strength to prevent significant deformation taking place under the design wheel loads.

METHODS FOR STRENGTHENING ROADS

If the subgrade or base material on which a road is built is not strong enough to carry the design wheel loads, then there are two courses open to strengthen the road:

(a) Subgrade treatment. This is done by drainage, compaction, the introduction of some additive to the soil, or by a combination of these methods.

(b) Application of a stronger material (i.e. pavement) over the subgrade. This is usually done with material such as brush, corduroy, quarry rock or river gravel, bitumen, or concrete.

TRADITIONAL METHODS AND THEIR LIMITATIONS

Drainage and compaction are probably the most effective and cheapest means of strengthening soils. Compaction increases soil density and therefore load bearing capacity, but it can only take place over an optimum range of moisture content. In clay soils mositure content is usually high and drainage too slow to allow adequate compaction immediately after road formation. Up to 12 months may be required for soil drying prior to effective compaction.

Corduroy and brush have been used successfully on clay soils. The availability of suitable material at a reasonable cost limits the value of these materials in plantation roading operations.

Bitumen and cement are not suitable for strengthening clay soils on logging roads.

Lime can be used to increase subgrade strength by binding clay soil particles together. In this it has an advantage over simple compaction of reducing the depth of gravel required, with potential cost savings. The operational limitations are that soil moisture content must be resonably low (so that road formation must be carried out early) and specialised equipment is needed to apply the lime.

Rock may be used to build up a strong pavement. Almost any road subgrade can be strengthened with a sufficient thickness of quarry rock or river gravel. The major limitation is the availability and cost, against which other materials are compared.

RECENTLY DEVELOPED METHODS

Fabrics are the modern equivalent of corduroy and brush. They function by preventing movement of the fine subgrade particles into the rock course, where the presence of clay and silt will cause substantial loss of bearing capacity and failure of the road. Fabrics fall into two classes; woven and nonwoven.

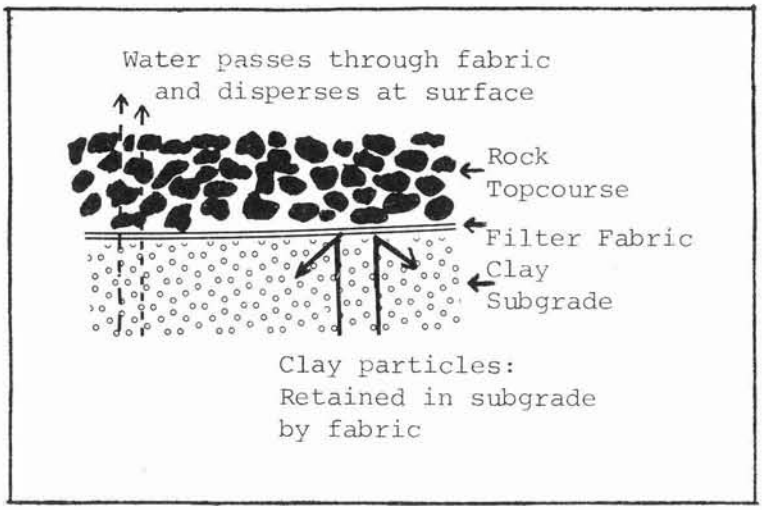

Figure 2. Action of Nonwoven Fabric

Woven fabrics, such as Polywave R, have a fairly open structure suited to use over coarse soils and sand or gravel subgrades. The fabric prevents the pavement from sinking into the subgrade but allows moisture to rise through the pavement and dissipate.

Nonwoven fabrics, such as Feltex Profel, are designed for use in conjunction with unstable subgrades, especially where high clay or silt contents are a problem. The nonwoven construction produces a fabric with a much finer pore structure than can be achieved in woven fabrics. This allows free passage of water, but retains the fine soil particles below the fabric.

Liquid soil densifiers may be used to strengthen wet clay soils. These materials allow the water to be removed from the subgrade soil during compaction with consequent improvement in soil density and strength. Materials of this kind, e.g. Reynolds 2-3-5 soil densifier, have been used in New Zealand on forest roads. The material is applied diluted with water from a standard water tanker. The process takes several weeks and frequent compaction is required.

NEW ZEALAND EXPERIENCE

While the results of a number of overseas trials of road strengthening are available, very few New Zealand trials have been documented. One New Zealand trial at Glen Dhu in Southland, compared a number of road strengthening methods. It was a co-operative trial involving the N.Z. Forest Service and the National Roads Board, and compared Reynolds Road Packer, hydrated lime, a liquid densifier called Arquad 2Ht, and standard rock. The trial strips were compared some 18 months after construction by the Benkleman Beam method, which tests the deflection and rebound of the road surface during and after passage of a loaded wheel.

The tests showed that no specific treatment was better than any other. However, subsequent to the final testing heavy winter rains and daily traffic caused all the sections which did not have the rock base course to cut up severely with the clay turning to a slurry and mixing with the top course rock. This well documented trial therefore showed inconclusive results.

Fabrics, both woven and nonwoven, have been used successfully on logging roads in New Zealand (e.g. by the N.Z. Forest Service in Nelson and Fletcher Forests Ltd. at Tairua). However, no documented trials or testing have been found. They do not require special equipment for laying and can be used on small sections of roadway where special problems exist. The nonwoven fabric finds more use than the woven fabric, as most of the problem areas are on fine particle clay soils.

Suppliers and costs of some materials mentioned:

1. Fabric: Corrugated Steel Products,
Fletchers Private Bag,
Auckland.

Sarlon Polyweave R (woven) Rolls, 3.86m x 250m: $0.65 per m^2
PRO-FEL (nonwoven) Rolls 4m x 50m or 100m
140 gram per m^2 grade (light duty): $1.70 per m^2
200 gram per m^2 grade: $2.10 per m^2

2. Liquid Soil Densifier: Chemical Imports Ltd.,
P.O. Box 100,
Mosgiel.

Reynolds 2-3-5 soil densifier (Reynolds Road Packer)
Containers 20 and 200 litres, $5.32 per litre
Chemical cost $0.28 per m^2

CONCLUDING COMMENTS

1. The cheapest and perhaps the most effective method of producing a strong roadway on a wet clay soil, is to prepare the roadway well in advance of use and to allow it to dry out naturally. Provided road profile and drainage are adequate, a relatively thin layer of pavement should provide an all-weather, high-bearing capacity road. If gravel is expensive and lime is available, then lime strengthening should be considered.

2. In some instances logging roads must be formed and used immediately. An example of this is where access to wind-thrown timber must be obtained. In these cases the alternatives appear to be:

   (a) Apply a very deep layer of pavement material such as quarry rock or river gravel. The depth required depends on the nature of the subgrade.

   (b) Apply a soil densifier or lay a fabric on the subgrade. Then apply a layer of rock or gravel for the pavement. The depth of the pavement should be much less than that required with alternative (a).

3. The decision to use a liquid or fabric instead of deep rock or gravel depends on the relative prices of the materials and the time available. A simple calculation will show whether the reduced cost of less gravel compensates for the cost of the liquid or fabric which must be applied. The more expensive the gravel, the more likely is a liquid or fabric to be applied.

4. The liquid soil densifier is relatively cheap and can be applied successfully to longer stretches of road. It is, however, more complex to apply than is the fabric, and requires a longer time to strengthen the roadway. Fabrics, while more expensive, can be applied in an emergency to make a road immediately useable. Of the fabrics, the woven variety is cheaper than the nonwoven variety. The woven variety is best used on organic soils such as old pastures and other coarse soils, while the nonwoven fabric should be used where the roadway subgrade is clay or has a high silt content.

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