SOIL STABILISER FOR PLANTATION ROADS

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Plantation roads provide the means of transporting fresh fruit bunches (FFB) to the mill and, bringing and sending fertilizer to the site as well as other field activities. Any slack in preparing or building the roads will affect the delivery time of farm products as well as the bringing in the farm needs. Plantation roads are soil roads. Soil roads can be relatively cheap to build when compared with other alternative materials. Without regular maintenance and resurfacing, these roads have a limited useful life. Weather conditions make them impassable and poor road surface creates damage to vehicle. There are instances where farm and plantation produce is not delivered to market due to poor roads.

Improving the load-bearing characteristic of the road, by hardening the road surface increases its utility and life. The hardening and stabilising of the road surface by chemical and physical methods were carried out at PORIM's Paka Research Station. An organic soil stabiliser (*TerraZyme*) was applied to a stretch of 23km of soil roads. These roads were not passable during the monsoon season. After the treatment, the roads have become all-weather roads. This improvement enabled harvested FFB to be transported to the mill on schedule. Hence, good road surface will enhance mechanisation.

MATERIAL AND METHOD

Concept of stabiliser. The stabiliser used in this trial has a trade name, *TerraZyme*. It is a natural non-toxic biodegradable liquid that easily suspends in water. It is produced based on fermentation technology. The chemical is an imported product sold through their Far East agent based in Singapore. A local engineering company, Syarikat Warasjaya Sdn Bhd, developed the technology of using this chemical for plantation road surface.

This chemical acts to reduce the voids between soil particles and to minimise absorbed water in the soil for maximum compaction. This decreases the swelling capacity of the soil particles and it also reduces permeability. The reduction in void between soil particles enhances weather resistance and increase load bearing capacity of the road. These features are evident in fine grain soils such as clay in which the formulation affects the swelling and shrinking behavior. This formulation has the ability to change the matrix of the soil so that after compaction, the soil loses its ability to reabsorb water. This change means that the mechanical benefits of compaction are not lost even after water is reapplied to the compacted soil.

The manufacturer claimed that most soil types are appropriate for treatment with this stabiliser. The only exceptions being pure sandy and sterile soils containing less than 15% colloids, as well as all peat and marshy soils with humus only. Extreme heavy clay soils needs different formulation of the stabiliser.

Soil analysis is critical in qualifying those soils that are likely to achieve maximum stabilisation after treatment with enzyme stabiliser. The type of soil and the particle size, distribution granular analysis, or percentage of particles that pass through size sieves, are important factors influencing the stability of soils.

Optimum soil moisture is necessary for compaction. Water lubricates the soil, helping the water particles

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to move in a more dense position during compaction. Water also gives cohesive soils their attracting and sticking qualities. For every soil mix, there is an amount of water (Optimum Moisture Content), at which it is possible to obtain a maximum density under standard compaction (Bio-Cide Asia-Pacific) using this soil stabiliser.

The trial site. A total of 23km of PORIM's oil palm estate roads in Paka Terengganu was applied with this soil stabiliser. These roads were prone to damage during monsoon seasons (*Plate 1*).

Method of application. The application rate for the enzyme stabiliser used in this trial was one litre of the formulation to 3 to 3.5 m^3 of soil. The dilution of water ranged from 1:500 to 1:1000, depending on soil dryness and type.

The equipments required to effectively apply the soil stabiliser were:

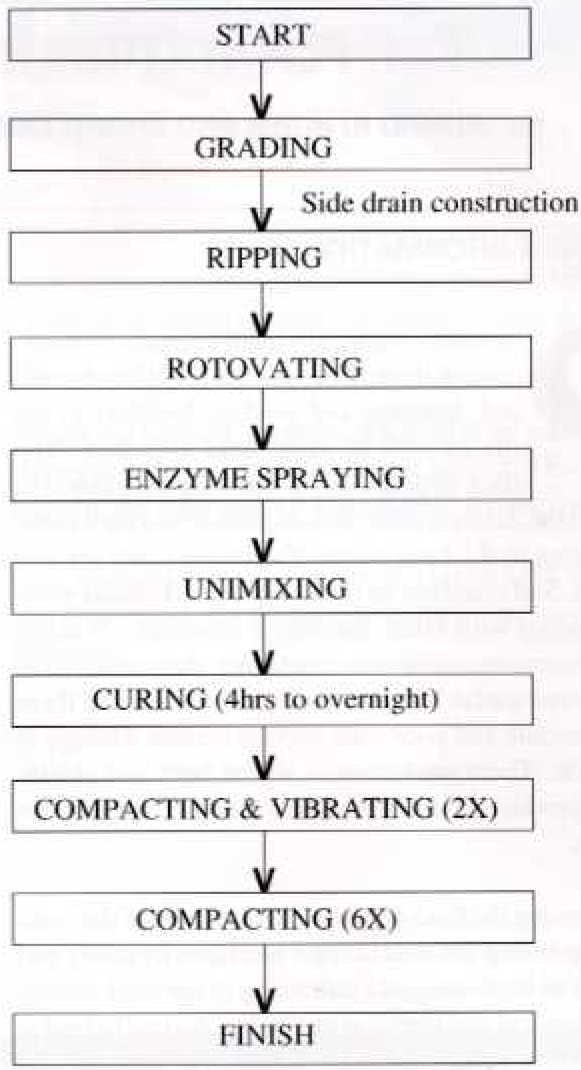
- Grader with ripping teeth for breaking the road surface.
- A rotary tiller for pulverising the soil and mixing the formulation.
- Water tanker (12 000 to 20 000 litres) with wetting nozzles.
- Flat steel drum compaction vibrator-roller (1.5 to 2 metres wide).

The activities (*Figure 1*) undertaken for resurfacing the roads were:

1. Grading and side drain construction
2. Ripping the road surface
3. Pulverising the broken soils
4. Formulation spraying
5. Rotovating
6. Compacting

Proper gutters, ditches and culverts reduce ponding and softening of the road sub-base. Thus, these were addressed first prior to the resurfacing activities of the road. The grading and side drain construction were undertaken at the same time (*Plate 2*). The ditches (V or rounded) must be deep, wide and slope enough to transport surface water. At the same time, extended, slope, crown and camber on the road surface were formed. When these were done, the road was then scarified to 20 to 25cm deep (*Plate 3*). When the soil became loose, it was pulverised to the depth of 15 to 20cm (*Plate 4*).

Figure 1. Process of resurfacing plantation roads using soil stabiliser.



A known quantity of the enzyme formulation to the volume of water necessary was then prepared to suit the soil condition. Water served as a vehicle to distribute the enzyme formulation. The formulation was then sprayed on the pulverised soil (*Plate 5*). The sprayed soil was again pulverised to properly mix the formulation. Some time was required to cure the mixture. During this time the moisture of the soil mixtures were checked whether they were ready for compaction.

When the materials were ready for compaction, a vibratory roller was used for the first and second passes (*Plate 6*). However further compaction should be done without vibrator to avoid cracking. Sufficient compaction effort must be applied to obtain maximum density. A total of six passes were carried out on these roads. This completed the road.

Light traffic was allowed to pass after compaction and normal traffic was allowed after 72 hours of completion under normal warm conditions (*Plate 7*).

RESULTS

PORIM road with stabiliser has undergone three monsoon seasons. Some of the road sections were under water from one to ten days from 2cm to 2m deep. The roads were still in very good condition in spite of such exposure (*Plate 8*). From the three years monitoring it was found that:

1. The roads surface are still in good condition even after three monsoon seasons.
2. No road repairs have been made during the three years after enzyme application compared to non treated roads which costs RM2.50/m

Plate 1. Initial condition of road surface

Plate 2. Surface leveling and side drain construction

Plate 3. Scarifying

Plate 4. Pulverising

Plate 5. Enzyme application

Plate 6. Rolling

Plate 7. Completed road

Plate 8. A stretch of road condition, 3 years after application

3. Side drain maintenance has been carried out at an average cost of RM0.88/m.
4. The road with stabiliser is an all-weather road that is passable both in hot and wet seasons.
5. There has been less vehicle damage on enzyme road compared to non-treated road.
6. There is a significant reduction of dust.

CONCLUSIONS

The use of soil stabiliser on plantation roads is capable of making the road surface more durable. As the original soil of the road can be used, there is no need to bring soil from outside. This can save costs in road resurfacing.

During pulverising, quarry stone need to be added on slopes as these stones gave a coarse surface. This was to make the road surface less slippery during rain.

Less favourable results could be experienced when manufacturer's procedures for application were not followed.

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