XIII ICSMFE, 1994, New Delhi, India / XIII CIMSTF, 1994, New Delhi, Inde

TRANSPORTATION IN ROADLESS LAND
TRANSPORT A TERRE SANS CHEMINS

Per Lennart Svensson

Senior Consultant, SUAB, Stockholm, Sweden

SYNOPSIS

Temporary access roads in building and forestry work sites on soft ground cause high transportation costs and environmental damadges in sensitive areas. Today transportation vehicles cause deep rut depth in the road and often damage it badly before improving it with brushwood or logs in forestry and gravel or macadam in construction.
There are two ways to improve economy and minimize environmental damages:
1: Improving ground.
2: Improving trafficability of the vehicle.
In this project there is a study of both these effects.
A test road has been made, where geotextiles under a thin aggregate layer have been tested.
Ten test areas with Tensar Geogrid, coir mat and forming fabric under macadam, wood chips and bedding of brushwood will be tested by driving trials with a special constructed forwarder. This forwarder has 800 mm wide tyres and there is a compressor with which you can change inflation pressure when driving the forwarder depending of the ground conditions.
The result shows that the tested matherials and equipment are useful and will give experiance of choosing the best combination of soil improvement and type of vehicle.

INTRODUCTION

In Sweden there are built a great number of temporary access roads both in construction and forestry. Many of them are constructed over soft soil with risks for ground damages and bad trafficability. Within the forestry attention has been payed to environmental problems with the ground damages recently.
Infrastructural construction works are increasing during coming years. Therefore access roads will be both economically and environmentallly important.
Problems will occur mainly within areas with soft soil and high ground water level.
There is not the same demands on temporary access roads as on permanent roads. Rut depth up to 15-30 cm will often occur but will not be accepted in the future. At greater rut depth ground damages will increase and the trafficability get worse.
There are two ways to improve economy and minimize environmental damages:
* Improving ground

* Improving traficcability of the vehicle

Within the construction industry they have mainly worked with a sub-base of gravel. The sub-base is often to thin with ground damages and they have to increase the sub-grade afterwards.

Within the forestry they have mainly worked with developing the vehicles and have improved ground with existing material as brushwood and logs.

This project intends to:

* Studying problems mentioned above and for that purpurse construct a test road with different improving methods on soft soil and then perform driving trials with a special constructed forwarder with which one can change inflation pressure and use tyres with different widths.

* Testing recycling materials; coir mats and wood chips beside more common as Tensar Geogrid and makadam. A new soil reinforcement matherial; Forming Fabric, a rest product from the pulp industry, is tested as well.

The aim of the project is:

* Compare the behavior of different matherials on soft soil during load testing.

* Give some example of design of temporary access roads.

* Give useful advices concerning construction.

TEST ROAD

A suitable test road was planned in an area for logging at Korsnäs AB in Gimo, about 140 km north of Stockholm. A soil investigation was made showing that under a vegetation turf and treeroots there was 0,5-2,5 m of peat with high water content (about 500 %) and very soft (about 10 kPa). Clay and till were underbedding the peat.
Ten test areas after each other was made. Each area was 20 x 4 m.
Here is a describtion of the test areas:

* Test area 1
Macadam, 0,15 m
New forming fabric

* Test area 2
Macadam, 0,15 m
Tensar Geogrid SS 2

* Test area 3
Wood chips 0,15 m
Geogrid SS 2

* Test area 4
Wood chips 0,15 m
coir mat

* Test area 5
Wood chip 0,15 m
Used forming fabric
* Test area 6
Brush wood
Geogrid SS 2

Fig. 1. Construction of the test road. Geotextiles have been layed out. In front Geogrid and in the background Coir mat and Former fabric.

* Test area 7
Brush wood
Coir mat

* Test area 8
Brush wood
Forming fabric

* Test area 9
Brushwood

* Test area 10
Reference area

The design of test road was made so it would be destroyed during the driving trials. It would not been used afterwards.

The test road was constructed in June 1992. The weather was sunny and warm and the ground dry.
With a special harvester mounted on excavator the trees was cut down. Some stumps were excavated and some were left. At test area 1 and 2 the vegetation turf, roots and stumps were removed.

The geotextiles come to the site in rolls 4 m wide. They were layed out on the ground easily by one person.
The brushwood from the cut down trees was spread out on the road by the harvester excavator.
Woodchip was made at site from brushwood and transported to the beginning of the road with a lorry.
Makadam was transported from outside the area to the beginning of the road. The excavator spread out the makadam over test area 1 and 2 without problems.

Then the wood chips had to be transported to test area 3 over area 1 and 2 by the lorry. Due to deep rut depth it must be interrupted after one passage. Ruts were filled with makadam and then the wood chips were transported over area 1 and 2 with a minidumper without problems.
Then the excavater spread out the wood cips over area 3-5.

DRIVING TRIALS

Within The Forest Operation Institute there has been developed a forwarder FMG 250 special equipped with wide tyres from Trelleborg-Tyre AB. During driving one can change inflation pressure with a compressor depending of the ground conditions.
The developement work has been carried out of Mr Ulf Hallonborg and Mr Björn Löfgren at the Institute.
As a link in this research driving trials was made at the test road.
We also wanted to study if this method could be useful for lorries in the construction industry.
The driving trials was carried out in the beginning of July 1992.
Weather was so dry and sunny,that there was a forest fire in the area at the same time and the special FMG 250 had to be rescued from the flames in the last minute.
The driving trials were carried out in three phases; from lower ground pressure to higher.
Phase 1: Tyres, 800 mm wide and low inflation pressure, 10 passages
Phase 2: Tyres, 800 mm wide and high inflation pressure, 3 passages
Phase 3: Tyres, 600 mm wide and high inflation pressure, 3
During phase 3 the teste road was destroyed.
During the driving test a new method for measuring rut depth was applied. The x-, y- and z-cordinates for a prism fixed at FMG 250 were surveyed from a Geodimeter at certain intervals during driving. The prism was fixed nearby the rear axle. So it was not exactly the rut depth measured, but sinking of the wheeles. A small amount of the sinking was elastic.

Fig. 2. Driving trials with the forwarder FMG 250 and Trelleborg tyre, width 800 mm.

TEST RESULTS

Test area 1:
Rut depth = 7-16 cm after 16 passages.
Comments: Makadam thickness up to 0,3 m in tracks due to crossing of the dumper. Peat thickness only about 0,5 m.

Test area 2 :
Rut depth = 4-16 cm after16 passages.
Comments: Makadam thickness up to 0,35 m in tracks due to crossing of the lorry. Peat thickness only about 0,5 m. Geogrid was broken sometimes, when the rut depth was large.

Test area 3:
Rut depth = 8-26 cm after 16 passages.
Comments: Rut depth are strongly depending of stumps and breaking down of the root mat or if stubbs and root mat are excavated. Peat thickness = 0,5-1, 0 m.

Test area 4:
Rut depth = 20-26 cm after 16 passages.
Comments: The same as test area 3, but peat thickness = about 1,0 m.

Test area 5:
Rut depth = 20-24 cm after 16 passages.
Comments: The same as area 3, peat thickness 0.5-1,0 m. Nearby a stone the forming fabric was uncovered.

Test area 6:
Rut depth = 18-24 cm after 12 passages.
Comments: The same as area 3, peat thickness 1,0-1,5 m. Geogrid was uncovered in some spots , broken in one spot and disappeard in one spot.

Test area 7:
Rut depth = 20-26 cm after 11 passages. In one sektion the road was repaired with logs after 7 passages.
Comments: The same as area 3. Peat thickness 1,5-2,0 m. In one spot the coir mat was deep in the rut.

Test area 8:
Rut depth = 20-32 cm.In one sektion the road was repaired with logs after 7 passages.
Comments: The same as area 3. Peat thickness 1.5-2,0 m. In one spot the former fabric was uncovered and in one it was deep in the rut.

Test area 9:
Rut depth = 14-22 cm after 11 passages.
Comments: The same as area 3. Peat thickness 2,0-2,5 m.

Test area 10:
Rut depth = 13-24 cm.
Comments: In this area there was a thick root system. Peat thickness about 2.5 m.

The driving trials destroyed the test road. Now, in December 1992, is the analyses of the driving trials not yet finished.

CONCLUSIONS

We can at this stage make the following conclusions for this soft sub-grade:

* It is very important not to damage or remove stumps, roots or vegetation turf. In spots where theese were removed deeper rut depth occured very soon.Trees has to be cut very close to the ground so stumps will be very short.

* All three soil reinforcement material were easy to hadle and had good function, when the rut depth was less than 15 cm. Where the vegetation turf was thin or excavated, it had not been possible to do any passage without soil reinforcement.

* Wood chips have almost as good function as macadam. They are lighter than macadam and cause therefore less settlements.

* If we as in test area 1 and 2 first make ruts and then fill the ruts with sub-base matherial, the function will be much better .

* Recycling materials are useful in the construction of access roads.

* In a regular access road we must have a thicker sub-base.

After further analyses we intend to give dimension rules and introduce recycling matherials for temporary access roads.
Input parameters for designing thickness of sub-base are:
ground pressure from the vehicle, shear strength and ground water level down to 60 cm depth in the sub-grade, type of soil reinforcement and sub-base and number of passages.
We will also give advices concerning construction.

Fig. 3. Test road after finishing driving trials.

ACKNOWLEDGMENT

This project is done in cooperation between Skanska AB, Korsnäs AB, The Forest Operations Institute , Geoprojektering AB, SUAB, Trelleborg Tyre AB, Norvest AB och Mark & Park Import HB with support from The Developement Fund of the Swedish Construction Industry.
We in the working team; Ulf Hallonborg, Björn Löfgren, Göran Jonsson and Torbjörn Lundbom express our gratitude for good cooperation.

REFERENCES

(1987), *French Committee of Geotextiles andGeomembranes* Geotextile manual, Chapter 2, Temporary access roads,low volume roads and improved subgrades.

Giroud, J.P, et al, (1981), Geotextile-Reinforced Unpaved Road Design, *ASCE-Proc. Vol. 107.*

Jonsson, G, et al. (1989), Mossetransport, Finnmossen, *Statens Energinämnd, Sweden*

Rankilor, P.R., (1992), UTF Geosynthetic Manual, *UCO Technical Fabrics NV, Belgium.*