The Importance of Choosing the Pavement Materials on Forest Roads

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Abstract:

Forest roads are main facilities which provide access to forest lands for extraction, regeneration, protection, and recreation activities. In our country, is located in the forest areas of the mountainous regions often. Therefore, the construction of forest roads is very difficult and expensive. Besides, road construction activities remove the forest vegetation and disturb soil structure, which may lead to number of environmental damages in forest ecosystem. Pavement is very important to use forest roads for a long time. Therefore, the selection of the pavement materials becomes important. In this study, materials and techniques used for pavement on forest roads examined. Identified errors in the selection of material on forest roads and the results of errors have been introduced. Besides, equipment used in the pavement study was investigated. Identified mistakes made in planning and the solutions for these were manufactured.

Key Terms: Forest road, pavement, maintenance, gravel

Introduction:

If only high price trees are harvested forest productivity, health and diversity will decrease in natural forest management. A selection cutting system in a natural forest will not be successful without forest road network (Potocnik et al. 2005). There are Type A and Type B forest roads in Turkey to provide access into the forested areas (GDF, 1984). These forest roads are constructed by considering road types and sizes, intended usage, and land conditions. After the construction, the forest roads should be maintained and repaired at certain periods to preserve structural integrity and travel quality of the forest roads (Akay, 2006). If the maintenance and repair activities are not performed, deformations formed on road surface may block the usage of the road. The pavement construction activities on approximately 17% of the forest roads have been completed in Turkey (Acar and Eker, 2001).

Wheel load and nominal ground pressure results in temporary deformations on both pavement and substructure along the roadway (Bayoğlu, 1997). Due to the pressure of the wheels on the ground, the substructure moves to the sideward, causing the breakdowns. Additionally, after a certain period, the access of the road can be completely closed due to the excessive amount of moisture, breakdowns, and ruins caused by heavy load and lack of road maintenance (Figure 1).

According to FAO (1998), local factors such as the surfacing material, climate and traffic mix, gradient, and vehicle speed influence the rate of surface deterioration. For example, re-grading is suggested after 20000 vehicle passes as a typical interval.

Surface maintenance can be also computed depending on the timber volume transported over the road such as 2.5 cm rock displacement for every 4500 m³ timber haul (Akay and Sessions, 2003). Kramer (2001) stated that maintenance, road drainage, pavement, and ditch improvement activities must be periodically scheduled in every year.
The type of surfacing material should be chosen by considering traffic load, frequency of usage, grade of road, soil type in natural roadbed, available materials, cost, and aesthetics. To ensure a good bond between the soil and surfacing material and to provide early protection against soil erosion, crushed rocks or gravel surfacing materials should be placed on the surface instantly after road construction (Anonymous, 2005). Road maintenance is also very important for water quality, considering drainage control and streamside management (Turton et al., 2005). After periodic forest operations have been completed and major storm events has passed, forest roads must be maintained during active use to ensure that the drainage structures are functioning properly. In spreading pavement materials on the road surface, graders should be used (Skorseth and Selim, 2000).

Heavy rainstorms may cause cut slope failures that blocks ditches, directs water flows to the road surface, and erodes the surface and fill slope. Proper road surface is usually desirable and, in many cases, necessary to add subgrade structural support by improving the roadbed of native soil surface with materials such as gravel, coarse rocky soil, crushed aggregate, cobblestone, concrete block, or some type of bituminous seal coat or asphalt pavement (Bayoğlu, 1969). Gravel materials are mostly used to ensure stable pavement on forest surface.

The periodic maintenance of the roads should be completed before forest transportation starts in spring or after the forest transportation ends in autumn. Besides, a pavement should be constructed on the forest roads where daily and annual vehicle traffic volume is very high and that should be kept open during the year.

In this study, materials and techniques used for pavement on forest roads were examined. Identified errors in the selection of material on forest roads and the results of errors have been introduced. Besides, equipment used in the pavement study was investigated. Identified mistakes made in planning and the solutions for these were manufactured.

Forest Road Cross Section: Pavement constructed on a forest road limits the movement of the ground to sideways and therefore it prevents a vertical deformation (GDF, 1984). Pavement of a forest road is divided into two layers including surface course and base course (Figure 2).

**Materials at Road Pavement:**

Materials used in pavement construction activities are:

- Natural stone materials (ingenious rock, sedimentary rock, metamorphic rocks)
- Natural aggregates (gravel, sand)
- Artificial aggregates (cement)
- Asphalt (Umar and Agar, 1985).
In the forest roads of Turkey, gravel and crushed rocks are generally used for pavement materials. Asphalt is used for the forest roads located in national parks, recreational areas, and some forest village roads. In last few years, industrial wastes such as lime mud have been also used in pavement construction activities (Eroğlu, 2003; Machado et.al., 2004). The objective of this study is to examine the pavement construction activities in a sample forest road section, especially with heavy traffic loads.

**Pavement Thickness:**

Strew thickness of the surface materials is generally determined by “Group Index (GI)” method, which was developed by Steele (1945). There are five categories in this method and these categories are determined according to average daily traffic. The pavement is calculated according to ground compaction, which is measured based on Group Index. Ground compaction varies with the following factors:

- Moisture proportion of ground
- Dry density of ground
- Configuration of ground

Since the first and the second factors can be controlled by a good drainage and compression of subgrade, ground compaction shall only be reflected by the third factor, which refers to the structure of ground. Group Index method was developed based on this assumption.

Group Index of a ground can be calculated by the following equation (Umar and Agar, 1985):

$$GI = 0.2 \times (a) + 0.005 \times (a \times c) + 0.01 \times (b \times d)$$

where

- $a =$ The amount of the ground sifted with the sieve no. 200 that is greater than 35% and less than 75% (it is expressed as a cardinal number between 0 – 40)
- $b =$ The amount of the ground sifted with the sieve no. 200 that is greater than 15% and less than 55% (it is expressed as a cardinal number between 0 – 40)
- $c =$ The part of numerical liquidity limit of the ground that is greater than 40 and less than 60 (it is expressed as a cardinal number between 0 – 20)
- $d =$ The part of numerical plasticity indices of the ground that is greater than 10 and less than 30 (it is expressed as a cardinal number between 0 – 20)

After all these values are obtained, the thickness of the pavement material can be found. An abacus was developed to determine the pavement thickness required for the forest road (Umar and Agar, 1985; Aykut, 1978).

**Problems and Solutions for Pavement on Forest Roads:**

The biggest problem with the pavement operations on forest roads are in the selection of material occurs. Also, the mix of pavement materials has been determined as a good rate (Dust, sand, stone etc.). Laying and compaction of large-size material is very hard on the road. Large-sized materials reduce vehicle ride comfort. Furthermore, the safety of vehicles reduces in the formation of high-banquet. Second, machine selection at pavements operations is very important. These operations must be a grader and a cylinder. These studies use a loader is able to provide very inaccurate results. Grader may dispense as more uniform material on the road and the thickness of the material is the same along the way.
During pavement work, the recommended spreading width of the material should be complied. The material that spread wider than it was necessary flows to ditches or downwards from the fill slope and lost. As a result, the material thickness will be lower and more material will be wasted. The materials should be spread on the road by a grader. Grader can distribute the material on the road homogeneously and can better adjust the thickness of the spread material.

One of the most important matters that should be noted is that the pavement material that flows to ditches or road sides should not be taken from the area that exists and should not be re-used as mixed with soil. Pavement material mixed with forest soil can reduce the resistance of road surface. The other important task in a pavement activity of a forest road is opening the ditches and performing the maintenance of the ditches. Lacking or closing of the ditches along the road sides enables the rain water frequently moves on the road that damages the road and the pavement material. Besides, bevel should be banked on both sides of road axis on flat places, and the material should be spread in pavement activity by considering these bevels.

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