Subgrade Recovery of Aggregate Roads in Oregon

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In the coastal regions of the western United States, logging is a year-round business as the precipitation falls predominately as rain and does not prevent access to the resources. In-forest hauling primarily occurs on private roads surfaced with aggregate until the trucks reach the public roads that are paved. The aggregate performs two functions; one is to provide additional traction during wet weather. The others is to distribute the stress from the vehicle load to a level that is below the bearing capacity of the subgrade. If the stress at the subgrade level exceed the soil's bearing strength either ruts or pot-holes can occur. Depending on the depth of the rut, they can result in accelerated sediment deliver and result in an additional hazard as it restricts the vehicle movement on the road.

Many organizations in the western United States have established regulations to limit hauling during wet-weather events. For example, some organization will restrict hauling when the subgrade becomes saturated. Another one is Jackson State Forest managed by the California's state forestry agency, Calfire, restricts hauling when more than 0.25 inches (6.3 mm) of rainfall occurs during a 24 hour period. These regulations are designed to reduce the sediment production from forest roads often by allowing the subgrade to dry before hauling resumes.

There are potential costs of these types of restrictions. They can hinder the efficient flow of material from the forests. Log-yard inventories will need to be increased to hedge against a shortage of supply during the rainy seasons. Additionally, the inability to remove logs from the landings can result in the either larger landings to hold the additional logs or logging operations my cease as there is no room to store logs due the lack of trucks being able to haul material. The result can be a reductions in machine utilization that can increase logging costs that hinders the areas ability to compete in world markets. Thus, there is a need to determine if the potential effectiveness of these rules and protecting subgrades.

This project has two goals; one is to observe the subgrade strength recovery for an existing aggregate road during the spring and summer. The second goal is to determine if the road was properly compacted, would the 48-hour drying result in a significant improvement in subgrade strength measured with changes in California Bearing Ratio, (CBR).

The field portion of the research selected an aggregate road that was constructed, but no hauling has occurred to further compact the subgrade. It was an "as-built" condition commonly found in the Oregon coastal mountains. The road had been exposed to rain throughout winter including April. The subject road width is 12 feet (3.65 m) wide out-sloped road, no ditch. The subgrade soil are classified as a MH or ML, silt soils, using the Unified Soil Classification System. The longitudinal road grades varied for two to 12 percent with side slopes between 30 and 60 percent. The field measurement were taken fortnightly and included moisture content, field CBR and Clegg impact value. There were seven repeated measures completed between late spring and midsummer (April through August 2007).

Subgrade moisture content remained nearly constant varied from 45 to 40% during the spring and summer drying period. There was no observable recovery for both strength values during the same observation period. Subgrade strength showed a similar lack of recovery with an average CBR values that ranged between 9 and 5 CBR and data show no upward trend of recovery during the dry summer.

A similar pattern was found for the Clegg impact value (CIVs) hat ranged between 4 and 6 CIVs with no upward trend during drying.

In the laboratory, the effect of deliberate drying was further explored. Soils were compacted to 85% of standard proctor level in the 6-inch (15 cm) standard CBR mold and immersed in a water bath for 96 hours. One set of replicates were exposed to 48 hours of drying at 1-bar suction prior to determining the CBR value; the second was tested after the standard 15 minutes between the sample being removed and testing. The 1-bar was an attempt simulation of the drainage due to gravity alone.

The results showed that percent saturation was marginally lower for those exposed to drying with a reduction from an average percent saturation from 93% to 91% for the samples exposed to 48 hours drying. There was very little change in the CBR values as the standard method had an average value of 16 CBR values while after 48 hours of drying had marginally higher value of 17 CBR values. Thus, there was little improvement in the road when exposed to 1-bar drainage for 48 hours.

Further exploration was made to determine at what matrix suction the soils would drain. The air entry value, the matric suction where air moves into the larger pore space in the soil, was used to determine this value. The air entry value for these silt soils was approximately 6 kPa indicating the high tension which the water is held by the soils. Thus, there will be a long time frame required for the drainage.

The conclusion is limited to the fine silt soils used in this study have small pore sizes that are able to hold a significant amount of water beyond 48 hours. Since drainage is the only mechanism for drying these soils, the moisture content remains high after rain events. Thus, there is no real improvement in subgrade strength. If the purpose of these rules is restore subgrade strength, then the emphasis should be placed on creating the desired subgrade strength during construction through proper compaction control techniques to improve subgrade performance during wet weather hauling. Relying on drainage from a 48-hour hauling restriction may be ineffective.