Prolonging Haul Over Frozen Roads

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A 5-cm-deep blanket of sawdust was used successfully on a timber haul road in the Kootenai National Forest in northwestern Montana to extend the period of timber hauling from mid-February to the end of March. The annual cost for applying, maintaining, and removing the sawdust from the road was far less than that of rebuilding the road after failure or reconstructing it for all-season haul.

The Kootenai National Forest in northwest Montana has been considering ways to extend timber haul during the spring breakup period from mid-February through March. As the hauling period becomes shorter because of considerations under the Threatened and Endangered Species Act, extending the haul period has become essential to the timely removal of forest products. The USDA Forest Service has used an age-old technique for insulating roads while at the same time has begun to perform some state of the art nondestructive testing to analyze how it may modify or lift road use restrictions.

The project road is located in northwest Montana near the Canada-U.S. border, with a rise of approximately 850 m in about 14 km. Much of the timber haul is limited to the 4-month period between December and March because of restrictions placed for the protection of grizzly bears. This haul season is further shortened because of spring breakup, thawing of the road bed. One lumber company suggested that hauling might be extended beyond the normal spring breakup time by applying sawdust to the snow-covered road surface, thereby insulating the road prism.

The Kootenai National Forest gave approval for field-testing of the sawdust/insulation proposal in January 1993. The mill provided and placed sawdust on the lower-elevation segment of the road and was able to extend the period of frozen road haul into late March.

Description of Road

The project road, Kootenai Road Number 92, is located about 15 km south of the Canada-U.S. international border and 50 km east of the Idaho-Montana state border (see Figure 1). By road, the city of Eureka, Montana, lies approximately 30 km east of the beginning of the project.

Forest Service Road Number 92 was completed in 1984 with approximately 7.5 cm of asphalt cement pavement and 15 cm of crushed aggregate base over the subgrade. The subgrade is a glacial till that has a high silt content and is therefore very susceptible to frost action. The high spring groundwater and relatively slow-draining silt keep the subgrade saturated until late in the spring. The road does not regain most of its strength for about 10 weeks.

The mountainous project road starts at an elevation of about 875 m at the junction of a Lincoln County road and twists and turns as it climbs on an average of over 6 percent for 13.8 km to the pass, where the elevation is 1715 m.

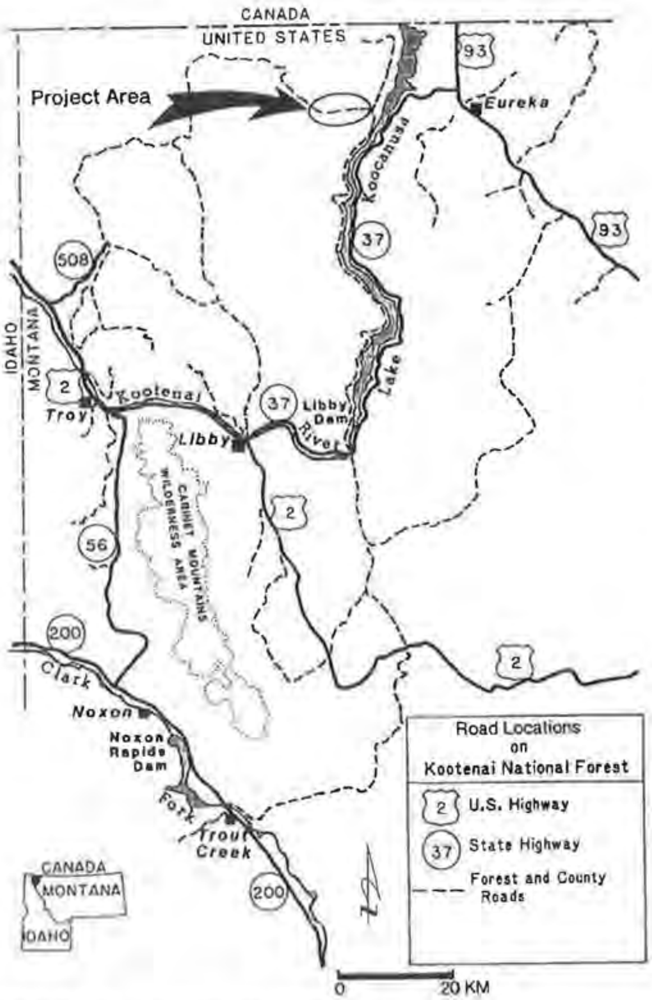

FIGURE 1 Location of project area.

Road Management

The Forest Service is in a unique position to manage its road system. Since technically it is not a public road agency, it can easily restrict size, weight, speed, and type of vehicle. With the ability to close roads or severely restrict their use, the Forest Service very seldom designs roads to support traffic loads for all-season use because of the additional cost of providing for the few weeks of worst subgrade conditions. The same economics affect most low-volume roads elsewhere in the world; they also are not built to provide all-season full traffic load support.

The Kootenai National Forest uses data collected from thermistor strings (*1*) installed in many of its roads to restrict road use during spring breakup. The thermistor string consists of a multistrand electrical cable with several thermistor sensors, small semiconductors whose electrical resistance varies with temperature fluctuations that are attached and sealed at specified intervals. Data from these thermistor strings show that there can be a 2- to 3- month delay from the time the road goes into spring breakup at the lower elevation until it reaches breakup conditions at the summit.

Dynamics of Breakup

Frost penetration on this road often reaches a depth of 1.5 m. Latent internal heat prevents the frost from much greater penetration. It also thaws the lower frost depths when surface temperatures rise. The rate of thaw from below is much slower than the rate caused by rising surface temperatures caused by the sum on the asphalt pavement.

The sun does not reach the pavement until the ice-and-snow cap, up to 30 cm thick, has melted. There is a general requirement not to bare road surfaces during plowing operations.

Because of the twisting-turning orientation of the road and the various shading conditions, the ice-and-snow cap melts at various rates within the same general elevation zone. Some sections will melt a month sooner than others, which means that some sections of the road will be completely frost-free before thawing begins on other sections.

Problem

When the road was built, logging activities were allowed during most of the year, except during the spring breakup when the roads lost their strength and the ground became too saturated for yarding activities. Since then a grizzly bear recovery plan has been implemented, which affects much of the logging activity in the Kootenai National Forest.

The restrictions have been placed to improve habitat conditions for the grizzly bear, an endangered species. In many areas of the forest, timber harvest is now allowed only when the bears are hibernating in their dens, from late November to late March. Much of the timber harvesting is contractually restricted to a 4-month period: December, January, February, and March.

General timber truck haul does not occur until sufficient quantities of timber have been cut and brought to landings beside local roads. Once trucking is started, the operators want sufficient logs beside the roads so that haul can continue uninterrupted. It takes 2 or 3 weeks to ensure that there is sufficient timber beside the roads. This operation takes place during the first 2 to 3 weeks in December, before the general shutdown for Christmas and New Year.

Timber haul normally starts shortly after the first of the new year. Spring breakup usually occurs around mid-February at the lower elevations, and the Forest Service imposes load limit road restrictions. The hauler who used to be able to operate trucks for 5 months or more is now limited to the 6 weeks between January 1 and mid-February.

Solutions

The timber purchaser and the Forest Service started looking for means to extend the haul season through March. The obvious solution was to build an all-season haul road, but an estimated cost of \$150,000 to \$250,000 per kilometer dampened enthusiasm.

It was then decided that the entire road would not have to be rebuilt, since only the first 3 or 4 km at the lower elevation actually went into spring breakup before the end of March. Even the cost for rebuilding only 3 to 4 km seemed staggering: \$500,000 to \$1,000,000.

Another solution considered was to allow haul on the road during spring breakup; that solution was rejected because it would have caused the pavement to be destroyed every 2 to 3 years. Replacement costs are estimated at \$50,000/km. Again, a cost of \$50,000 to \$75,000 per year to replace the lower 3 km seemed too high.

One of the company owners suggested that sawdust be placed on the road in late winter. The sawdust would act as an insulation and prevent the thaw of the ice-and-snow cap on the road surface, therefore delaying the thawing of the road structure.

There is good historical evidence of the insulating value of sawdust. It was used extensively to protect ice in ice-houses until modern refrigeration replaced the use of ice for food preservation. Sawdust can still be found within some old building walls. It was used before the advent of modern insulation.

The company requested permission to apply 10 cm of sawdust to the road in January 1993. The Forest Service agreed to the proposal, but continued to make arrangements for nondestructive testing.

Field Trial and Results of Sawdust Application

In February 1993 the purchaser hauled 560 m^3 of sawdust and spread it on those sections at the lower elevations that were the most exposed to the sun. The hauling vehicle, a truck-tractor with an 80-m^3 self-unloading trailer, made the primary laydown and was followed by a grader that completed the spread.

Sawdust was placed on road segments for a total of a little less than 1 km. The sawdust was laid down approximately 6 m wide and 10 cm deep.

Initially the logging trucks had trouble climbing the grade with 10 cm of loose sawdust on the ice-and-snow pack. Five cm of sawdust was bladed off the road after the second day of timber haul. Thereafter, when the sawdust was incorporated into the ice-and-snow layer, the truckers reported better traction.

Trucks continued to haul timber over the road until the end of March. At that time areas above the segments receiving sawdust were starting to develop exposed pavement and were going into spring breakup. The surface was bladed once during the haul period to remove ruts that had developed in the ice-and-snow and sawdust. Late in April the sawdust was bladed off the road onto the shoulders and fills in an attempt to suppress weed growth. The remnants left on the road after blading were allowed to blow off by the winds generated by traffic.

The field trial proved to be so successful that spot applications of sawdust 5 cm deep were placed on the road again in February 1994.

Costs

The 1993 costs were less than \$3,000, which included the sawdust, hauling, spreading, maintaining, and removing. The sawdust was valued at \$1.40/m^3. This is the approximate price that the mill can receive for the sawdust when it is used as fuel.

In 1994 the total cost is expected to be about \$1,500 even though the sawdust will be picked up and hauled to storage. The cost will be lower because less sawdust will be used—5 cm instead of 10—and haul to the project will be reduced from about 30 km to about 12, as sawdust is coming from a closer mill.

Environmental Concerns

The sawdust alters the immediate roadside environment. The effects of blading the sawdust to the side of the road were both positive and negative: it reduced noxious weeds on the shoulder and upper part of the fills, but at the same time it also killed desired grass species. The total amount of biomass that was introduced to the landscape is no greater than that found naturally on much of the forest floor on either side of the road.

The biggest concern is the potential fire hazard. Normally the roadsides have much less fuel on the shoulders and cut-and-fill slopes. It is feared that the careless presence of travelers on the road could lead to a potential fire in the sawdust along the road shoulder, which could spread to the surrounding forest.

There is little concern about the impact of the sawdust on the natural view, since most of the traffic is related to timber harvest. The people involved in timber harvest see the sawdust as a solution and not a deterrent.

Forest insects and diseases are not a major concern since the sawdust is being developed from locally harvested timber. Concern would be much higher if the sawdust were coming from milled timber that was not from the immediate area. Two other factors in normal milling activities reduce the potential of spreading diseases and insects. Most mills debark the logs before sawing. A large percentage of insects live just under the bark in the cambium and are destroyed or removed with the bark.

In addition, the sawdust used on this project had been placed in large piles, which through natural decomposition develop high internal heat that would kill most forest diseases.

There are no large bodies of surface water crossing or adjacent to the road. Most surface flow is caused by snow melt. Almost all the sawdust moved by snow melt or heavy rains would be trapped in the natural vegetation and debris on the forest floor below the road. Insignificant amounts might find their way into a channel.

Future operations will remove most of the sawdust from the road and place it in easily accessible stockpiles so it can be used repeatedly in future years. The small amount left on the road will be dispersed into the surrounding forests by mechanical brooming or by the traffic-generated wind.

Past Uses

Shortly after the first trial in 1993, a retired woodsworker came forward with the information that the same process had been used on some gravel surface roads in the early 1940s to extend timber haul in the spring. It was equally successful.

Applications for Sawdust Use by Others

Sawdust might be used by other agencies or industries to extend the period of haul in the spring when the following conditions exist:

1. Frost depths under roads reach or exceed 1 m,
2. Ten to Fifteen cm of compacted snow or ice can be tolerated on the road surface,
3. Traffic speeds are generally less than 40 km/hr, and
4. Traffic volumes do not support the cost of providing an all-weather road.

Sawdust was the material of choice on this project because of its availability and relative inexpensiveness. Another material with good insulating qualities and durability could easily be substituted. What was done on this project for the short term is not different from what has been accomplished for the long-term insulation on roads built in permafrost.

Summary

Sawdust has been successfully used in northwestern Montana to insulate a road in spring. The insulating effect delayed thawing of the road structure thus allowing timber haul to be extended by weeks. The annual cost for applying, maintaining, and removing the sawdust from the road is far less than that for rebuilding the road after failure or reconstructing it for all-season haul.

REFERENCE

1. McBane, J., and G. Hanek. Determination of Critical Thaw-Weakened Periods in Asphalt Pavement Structures. In *Transportation Research Record 1089*, TRB, National Research Council, Washington, D.C., 1986, pp. 138–146.