VARIABLE TIRE PRESSURE TECHNOLOGY

REDUCING TRANSPORTATION COSTS AND PROTECTING FOREST ECOSYSTEMS

THOMAS L. MOORE AND RICHARD SOWA

The U.S. Department of Agriculture's Forest Service is responsible for operating and maintaining a network of more than 580 000 kilometers (362,500 miles) of unsurfaced and lightly surfaced roads, including the primary roads by which logging, cattle, equipment transport, and other heavy-haul vehicles reach forest resources. During rainy and freeze-thaw periods, load-related deformation of subgrades and damage to road surfaces can result.

PROBLEM

Vehicles operating on the Forest Service roads with tires set at standard highway pressures of 620 to 830 kilopascals (90 to 120 pounds per square inch) can cause rutting, accelerate wear of surfaces, and erode the surface layer, thus increasing the amount of sediment in streams where fish spawn. These undesirable effects could be mitigated by increasing the strength of the road pavement, reducing the vehicle load on tires, using an improved vehicle-suspension system, reducing repetitions of tire loading on roads, and changing the dimension of the tire footprint. The Forest Service's objective was to determine which of these solutions would be operationally feasible and economical.

SOLUTION

After analyzing all available data on the various options, the Forest Service concluded that an economical approach would be to change the dimension of the tire footprint. A technology known as Variable Tire Pressure (VTP) has been used by the U.S. military since World War II to do just that, thereby improving the mobility of vehicles in mud and sand.

Many controlled tests and field demonstrations conducted by the Forest Service and other organizations have confirmed the benefits of using VTP technology. In one demonstration by the U.S. Army Corps of Engineers Waterways Experiment Station, two identical logging trucks, one with low tire pressure and the other with standard high pressure, traversed various thicknesses of asphalt and gravel surfaces. The demonstration revealed that reduced tire pressure tripled the life of thin asphalt surfaces and reduced blade maintenance on gravel surfaces by 80 percent. The Forest Service also found that a 25 percent reduction in the required thickness of gravel surfaces is feasible with low-tire-pressure traffic.

In Oregon the Forest Service simulated rainfall for a study of the effect on 12 percent grade gravel-surfaced logging roads of trucks with tire pressures of 620, 344, and 480 kilopascals (90, 50, and 70 pounds per square inch). The demonstration revealed that roads traversed by trucks with tire pressures of 344 kilopascals had 85 percent less surface erosion than those traversed by trucks with standard highway tire pressures of 620 kilopascals. Roads on which trucks with moderate tire pressures (480 kilopascals) were driven had 44 percent less surface erosion. These studies showed that reducing tire pressures in light- and heavy-haul vehicles by 40 to 60 percent (340 to 420 kilopascals) of standard highway pressures dramatically reduces rutting and erosion of gravel- and native-surfaced roads. However, trucks with minimum tire pressures are required to be driven at a lower maximum speed than those with standard highway tire pressures.

APPLICATION

The Central Tire Inflation (CTI) system was developed to make VTP technology operationally feasible. The Forest Service has 75 transport vehicles, dump trucks, fire engines, and water tenders equipped with the system, which consists of onboard components that allow tire pressures to be adjusted while a vehicle is in motion.

The cost of retrofitting the CTI system on a standard 18-wheel, western-style log truck is approximately $15,000. When purchased as an optional feature on a new vehicle, the system costs

$13,000. These figures are expected to decrease as the technology improves and its use increases.

BENEFITS

By significantly reducing rutting of roads, use of low-pressure tires can decrease road maintenance costs and provide other benefits. The Forest Service calculated the potential for savings in road maintenance on the basis of the following assumptions: the use of heavy-haul vehicles with low tire pressures on approximately 120 000 kilometers (74,500 miles) of native- and gravel-surfaced roads and a minimum of 3 bladings per year at an average cost of $90 per kilometer for each blading. Because studies of VTP technology have shown that blade-maintenance costs can be reduced as much as 80 percent when the tire pressures of all vehicles on a road are reduced, blading costs could decrease from slightly more than $32 million per year to less than $6.5 million.

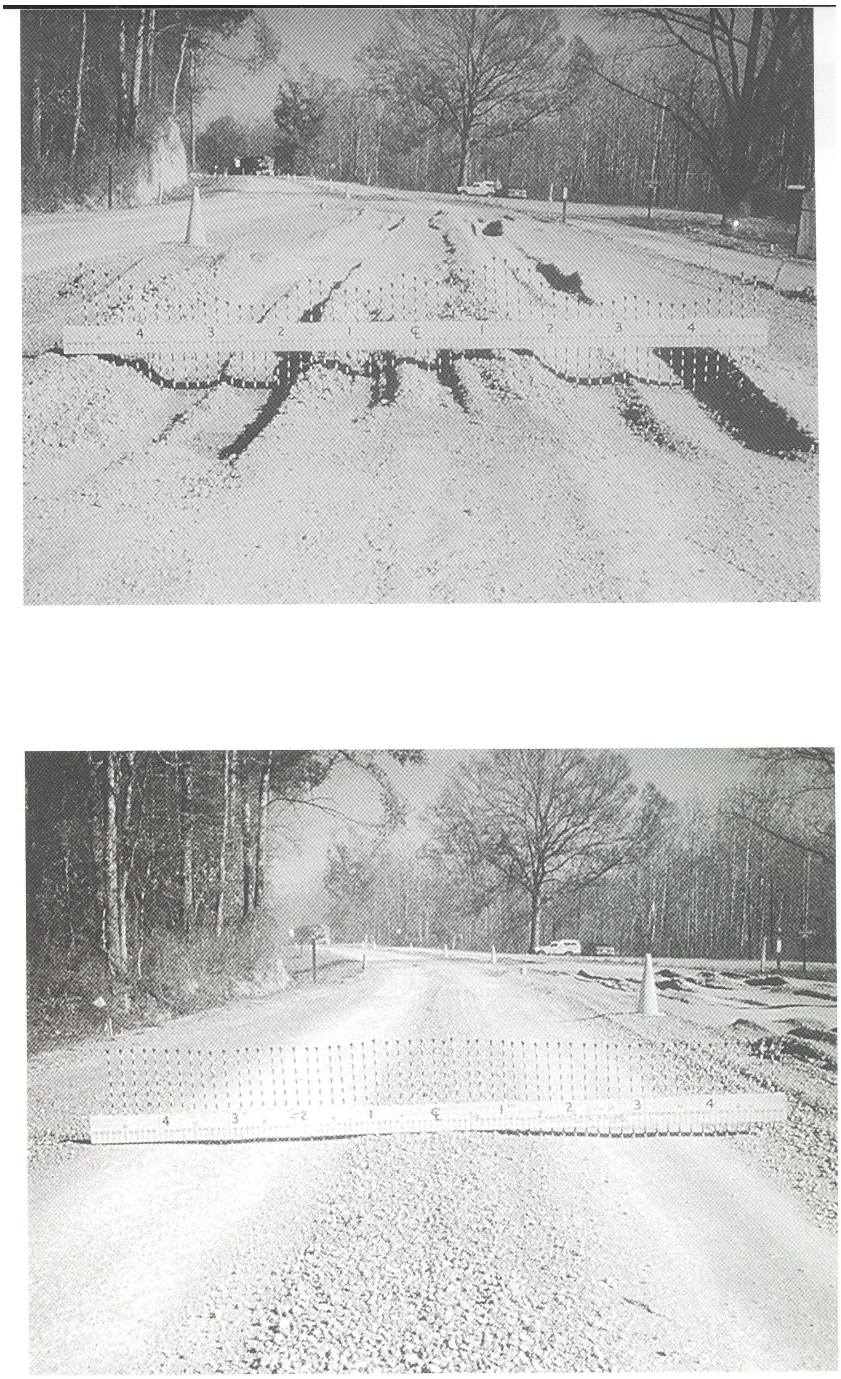
Each year approximately 1500 kilometers (932 miles) of Forest Service gravel roads require resurfacing at an average cost of $9,000 per kilometer for gravel replacement. With VTP technology, wearing action on these roads could be reduced by 10 to 25 percent. Therefore at least $1.3 million could be saved if all vehicles operating on Forest Service roads used this technology.

In addition to reducing blade-maintenance and road-resurfacing costs, VTP technology allows heavy vehicles to operate year round with minimal damage to roads. The technology has the potential for application worldwide to low-traffic-volume roads, such as roads between farms and markets, which are generally unsurfaced or lightly surfaced.

For further information, contact Richard Sowa, USDA Forest Service, Washington Office of Engineering, Auditors Building, 201 14th Street, S.W., Washington, D.C. 20250 (telephone 202-205-1437, fax 202-205-0861) or Thomas L. Moore, USDA Forest Service, San Dimas Technology and Development Center, 444 Bonita Avenue, San Dimas, CA 91773 (telephone 909-599-1267 ext. 229, fax 909-592-2309).

EDITOR'S NOTE: Special appreciation is expressed to Frank N. Lisle and G. P. Jayaprakash, Transportation Research Board, for their efforts in developing this article.

Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 (telephone 202-334-2952; e-mail gjayapra@nas.edu).



Top: After 600 passes, 80,000-pound, western-style log truck with tires set at standard highway pressure of 90 pounds per square inch causes deep rutting. *Bottom:* Adjacent section of same road shows no rutting after 900 passes of equivalently loaded truck with tires set at pressure of 50 pounds per square inch.