# Tire Shreds Save Money for Maine

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Obtaining adequate slope stability of highway embankments constructed on weak foundation soils is a challenging design problem. To address this problem, highway engineers often consider using lightweight fill, such as expanded polystyrene, shale, wood chips, or tire shreds made from used rubber tires.

Nationwide an estimated 800 million tires lie in abandoned stockpiles. In addition, 64 million tires with no productive end use are generated annually. Since approximately 100 tires are required for one cubic meter of compacted tire shred fill, there is a great potential for the use of rubber tire shreds on highway projects.

## Problem

The designers of a new interchange for the Maine Turnpike, intended to provide more direct access to the Portland Jetport and surrounding city streets, were faced with weak foundation soils. The site for the 9.8-m-high bridge approach embankments on each side of the turnpike was underlain by up to 12 m of weak marine clay, offering unacceptably low safety factors for slope stability.

Several alternatives for strengthening the foundation soils and stabilizing berms were examined, including ground improvement techniques such as stone columns and deep soil mixing. However, these options were discarded because of their

Bulldozer spreading 300-mm-thick lift of tire shreds.

Completed approach embankment for Portland Jetport Interchange.

impact on adjacent wetlands and their relatively high cost. For a cost-effective solution, geotechnical designers turned to the results of research conducted since 1990 at the University of Maine on use of tire shreds as lightweight fill. For the Jetport project, information from five projects funded by the Maine Department of Transportation (MDOT) and three projects funded by the New England Transportation Consortium (NETC) was used.

## Solution

The studies funded by MDOT and NETC provided information on the engineering and environmental characteristics of tire shreds as lightweight fill for highway embankments and retaining-wall backfill. The study results show that tire shreds have an in-place density of 0.70 to 0.95 Mg/m$^3$ as compared with a typical soil density of 2.0 Mg/m$^3$. It was also found that tire shred layers will be compressed by the weight of any overlying soil, making it necessary to overbuild the initial thickness of tire shred layers. In addition, field research indicated that tire shreds should be covered by at least 0.8 m of soil to provide proper support for an overlying flexible pavement.

A field study has been addressing concerns related to the effect of tire shreds on groundwater quality. The site for this study is on Route 231 in North Yarmouth, Maine. At two locations beneath the shoulder of the road, 3-m$^2$ geomembrane-lined basins are being used to collect water that has infiltrated through 0.6 m of tire shreds covered by about 1 m of granular soil. A third basin, used as a control, is overlain only by granular soil.

Water quality at the site has been monitored for more than 5 years. Results show that the tire shreds have increased the levels of manganese and iron, but these metals are not a health concern. Concentrations of other metals have been similar to those found in water samples taken from the control section, and all have been well below the primary drinking water standard levels. In addition, samples were taken for volatile and semivolatile organics on two dates, with no detectable levels found.

In 1995 and 1996, three tire shred fills built elsewhere underwent self-heating reactions. Subsequently, the University of Maine, in conjunction with the Federal Highway Administration and the scrap tire industry, conducted a study on how to limit heating of thick tire shred fills. This study resulted in guidelines now embodied in ASTM D6270-98, Standard Practice for Use of Scrap Tires in Civil Engineering Applications.

## Application

For the Portland Jetport Interchange, the designers elected to take a conservative approach, and used 1.8 m of soil between the top of the tire shred layer and the bottom of the flexible pavement. Results of laboratory compressibility tests indicated that the tire shred layers should be overbuilt by about 10 percent of their final thickness. Information from the North Yarmouth study was used to obtain environmental approval for the project.

The Portland Jetport Interchange was the first project to fully implement the newly developed guidelines for limiting the heating of thick tire shred fills. To comply with those guidelines, the designers of the interchange used 300-mm maximum-size tire shreds, less than 1 percent of which were smaller than 4.75 mm. The shreds were placed in two layers, each with a maximum thickness of 3 m, separated by 0.9 m of fine-grained soil. The outsides of the tire shred layers were also covered with fine-grained soil. Temperature measurements taken in the tire shred layers during and after construction showed no evidence of self-heating.

## Benefits

Of all the lightweight materials considered for providing slope stability, tire shreds were found to be the cheapest. An agreement among the project designer, the Maine Turnpike Authority (MTA), and the Maine Department of Environmental Protection (MDEP) specified that the source of the tires be an abandoned stockpile about 50 km from the project site. Under this agreement, MTA paid the normal "low-bid" price to purchase the tires, and MDEP paid the cost of shredding the tires in the specified stockpile. By using tire shreds from this source, MTA saved $300,000 over the next-cheapest alternative. Since it would have cost MDEP $300,000 more to have these same tires processed for tire-derived fuel, use of tire shreds as lightweight fill on this project saved the state of Maine a total of $600,000.

Altogether, this project used 1.2 million tires, and MDOT has used 1.1 million tires on other projects. Cumulative savings from these projects have more than returned the money invested in the University of Maine's tire shred research.

In addition, use of tire shreds on the Jetport project did not impact the adjacent wetlands, as would have been the case with the other methods considered. As a final benefit, the results from the University of Maine research and the self-heating reaction study were used to develop an ASTM standard.

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