TIRE CHIPS IN THE BASE COURSE OF A LOCAL ROAD

REPORT 94-2

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MATERIALS AND RESEARCH DIVISION

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16. Abstract

The construction of a tire chip base has provided an improved driving surface on the 2500 lineal feet of treated roadway. The chips from 65,000 tires have enhanced the gravel road by cutting off the capillary rise of subsurface water and by reducing the moisture content of the gravel through proper drainage.

The utilization of the waste tires at a cost of $1.00 per cubic yard reduced the need for additional gravel which would have cost $3.85 per cubic yard.

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Table of Contents

Acknowledgment

The cooperation of the town of Georgia and, specifically, that of Mr. Clarence Bocash, Town Road Foreman, who initiated the concept of utilizing a tire chip base and managed its construction, is appreciated. Without his cooperation, all the necessary testing and monitoring required to complete this report would not have occurred.

TIRE CHIPS IN THE BASE COURSE OF A LOCAL ROAD

INTRODUCTION

Pressures are mounting on the transportation community to develop procedures which will accommodate the use of waste scrap tires in highway applications. Mandates include specific requirements for tire rubber use in bituminous mix or asphalt chip seals and stress absorbing interlayers. The disadvantages of utilizing rubber in asphalt include the high cost of such treatments and the low rubber consumption rates. Other more practical and less costly uses are needed to effectively use up the waste tire stockpiles and the additional tires being added to the waste stream annually.

This report describes a promising alternative use which can consume a high volume of tires with the potential for cost savings for the user.

TREATMENT

The alternative use of tire chips as a base course layer began in 1990 in the town of Georgia, Vermont, with the construction of a 330 foot test section on Town Highway (TH) No. 4. The shredded tires were designed to serve as both a drainage layer and a barrier to prevent contamination between a wet silty sand subgrade and the gravel base. The initial success of the treatment, described in Vermont Report U91-06, led to the construction of additional segments in the following three years.

LOCATION AND MATERIALS

The tire chip base was constructed on Town Highway 4, known as the Oakland Station Road, in the town of Georgia, Vermont. This Class II highway begins at the intersection with Route 7 at MM 2.50, one mile north of the junction with Interstate 89 at Exit 18 and continues north 3.36 miles to an intersection with TH 1, approximately 0.35 miles west of the intersection of VT Route 104. The test section starts approximately 1.3 miles north of the junction with Route 7 and extends northerly for 2500 lineal feet.

The original roadway consisted of approximately two feet of gravel on a silty sand subgrade. Gradation tests on samples of the subgrade material revealed from 24% to 43% passing the number 200 sieve. A high water table commonly resulted in the area becoming impassible for two-wheel drive vehicles during the spring mud season. The pumping action of the traffic had resulted in contamination of the gravel with fine materials. The traffic is in the range of several hundred vehicles per day, with much of it consisting of early morning and late afternoon commuters, plus some heavy vehicles such as milk trucks.

CONSTRUCTION PROCEDURE

The construction process included removal of the existing gravel with a backhoe, removal and disposal of approximately six inches of silty subgrade material, and backfilling with tire chips. The chips were placed with dump trucks and leveled in a 9 to 12 inch course with the backhoe. Replacement of most of the original gravel and the addition of several inches of new gravel completed the process.

The initial construction in 1990 included 50 cubic yards of large tire shreds (nominal size 4" x 4") which had passed through the chipper a single time, and 150 cubic yards of small shreds (nominal size 2" x 2") which had been chipped two or three times. The chips were transported with town trucks and stockpiled near the construction site. In subsequent years, only two inch chips were utilized and the material was hauled directly from the chipping site in 12 cubic yard dump trucks with sideboards which increased the capacity to 16 cubic yards.

In the Fall of 1992, a chip seal was placed over the initial section of roadway treated in 1990. The process included the placement of a layer of pea stone, a one gallon per square yard application of asphalt emulsion, and a mixed 1/4 inch and 3/8 inch stone surface topping.

COST INFORMATION

The tire chips were purchased from Palmer Shredding, Inc., U.S. Route 7, Box 905, North Ferrisburg, Vermont 05473 (phone number (802) 425-4031), at a cost of $1.00 per cubic yard. Purchases included 200 c.y. in 1990, 288 c.y. in 1991, 426 c.y. in 1992 and 576 c.y. in 1993. Replacement gravel was purchased at a cost of $3.85 per cubic yard.

TESTING AND OBSERVATIONS

An inspection of the initial test section on August 30, 1990 revealed the existence of some fine longitudinal cracks in the surface of the gravel roadway. The cracks were noted at eight locations, totaling approximately 63 lineal feet. A few short transverse cracks were also noted extending off the longer logitudinal cracks. There was no detectable rutting in the wheel path areas.

The test section and adjacent roadway were free of any additional distress when observed on November 20, 1990. At that time, two inch diameter, slotted, PVC well monitoring pipe was installed at two locations along the easterly toe of the roadway. The water table was found to average 17 1/2 inches below the ground surface, or 11 1/2 inches below the bottom of the tire chips.

On April 3, 1991, the roadway was inspected, photos were taken, and the water table elevation was measured. The roadway surface within the test section was visibly dry and free of any rutting. A few fine longitudinal and transverse cracks were visible on the northerly half of the test section, with most noted in the southbound lane. The water table averaged 12 inches below the ground surface or 6 inches below the estimated bottom of the tire chips. The water table elevation was 5 1/2 inches higher than that recorded the previous November.

In comparison, the untreated roadway north and south of the tire chip section was in poor condition. The surfaces were visibly wet and revealed numerous ruts, cracks, and boils. The poor areas were soft to walk on and water could be drawn to the surface with a tamping action. In general, TH No. 4 was in better overall shape than in other years, due to a milder winter with below-average snowfall and a dry spring season.

On July 25, 1991, construction of another segment was observed and photographs were taken. At that time, the backhoe was utilized to place two additional monitoring pipes and to dig a test pit in the one year old tire chip section. The soil at the well sites began as a sandy silt which approached saturation approximately four feet below the road surface elevation, changed to a mixed brown and grey silty clay at the five foot depth and became a pure gray clay at the six foot depth.

The 2 x 6 foot test pit was dug in the left wheelpath of the southbound lane, 25 feet north of the southerly well point placed in 1990. The pit revealed 21 inches of gravel over 8 to 9 inches of tightly compacted tire chips. The top six inches of gravel contained 8% minus no. 200 sieve material, while the remainder averaged 15% minus no. 200 material. A trace of moisture was noted on the top side of the chips while the bottom side was dry. The silty sand beneath the chips contained enough moisture to ball together when squeezed. No attempt was made to locate the water table elevation.

Falling weight deflectometer (FWD) tests were taken on the two month old chip seal surface in November, 1992. The test values indicated a significant deflection of the test surface. This would suggest the tire chip layer will allow too much deflection under heavy loads for any future bituminous pavement to survive without additional subbase cover thickness.

On August 12, 1993, construction of another tire chip base segment was observed and the eleven month old chip seal was inspected. The nearly full width transverse crack and a few random longitudinal cracks were visible in the northbound lane, and a nearly continuous longitudinal crack extended for one-half the length of the treatment in the southbound lane. All of the cracks were very fine, and stone loss was minimal. Several bituminous patches had been placed along the centerline where there had been some loss of the seal at the construction joint.

SUMMARY AND CONCLUSIONS

The construction of a tire chip base by the town of Georgia, Vt., and its performance to date, can be summarized as follows:

Approximately 65,000 tires chipped to a two inch size have been placed on 2500 lineal feet of TH No. 4 in Georgia, Vermont.

The tire chips have provided a tightly compacted layer averaging nine inches in thickness beneath 21 inches of poor quality gravel which contained an average of 15% minus no. 200 sieve material.

The tire chip layer has enhanced the poor quality gravel by cutting off the capillary rise of subsurface water and by reducing the moisture content of the gravel through proper drainage.

The muddy road conditions prevalent in past spring seasons have not recurred following the placement of the tire chip layer.

The use of tire chips at a cost of $1.00 per cubic yard has reduced the need for additional gravel which would cost $3.85 per cubic yard.

An asphalt emulsion chip seal placed on the initial test section revealed only minor distress through its first year of service.

Falling weight deflectometer test values suggest the tire chip layer will allow too much deflection under heavy wheel loads for a bituminous pavement to resist cracking without additional subbase thickness over the tire chips.

RECOMMENDATIONS:

The Agency of Transportation should encourage cities and towns to utilize tire chip layers in town highway bases, with an emphasis on areas where moisture conditions are a problem and future paving is unlikely. If the cost of hauling tire chips makes some potential locations unsuitable, consideration should be given to the concept of collecting tires at regional solid waste sites and subsequent shredding with portable equipment.

Additional deflection testing is warranted, with emphasis on the comparison of values for similar gravel segments with and without the tire chip layer.

FOLLOWUP:

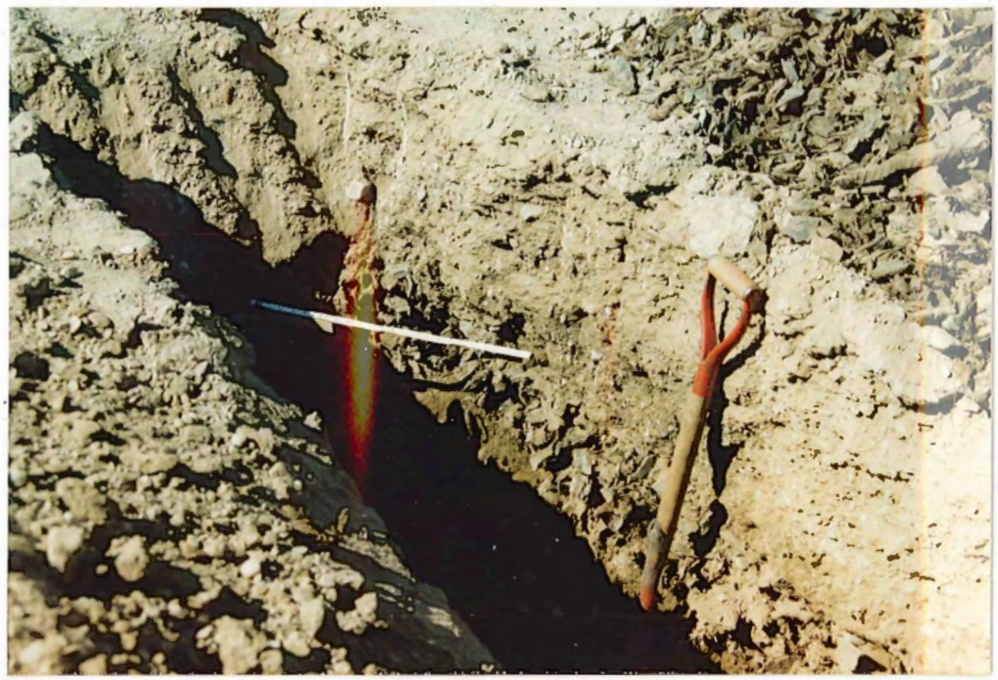
Monitoring will continue on the tire chip base and additional reports will be prepared when significant information is obtained.

Backfilling the 24" to 30" excavation with a 16 c.y. load of tire chips.

Leveling the tire chips with a backhoe to obtain a 9" to 12" layer.

Backfilling the trench with the original gravel.

Excavating a test pit in the 1990 construction project.

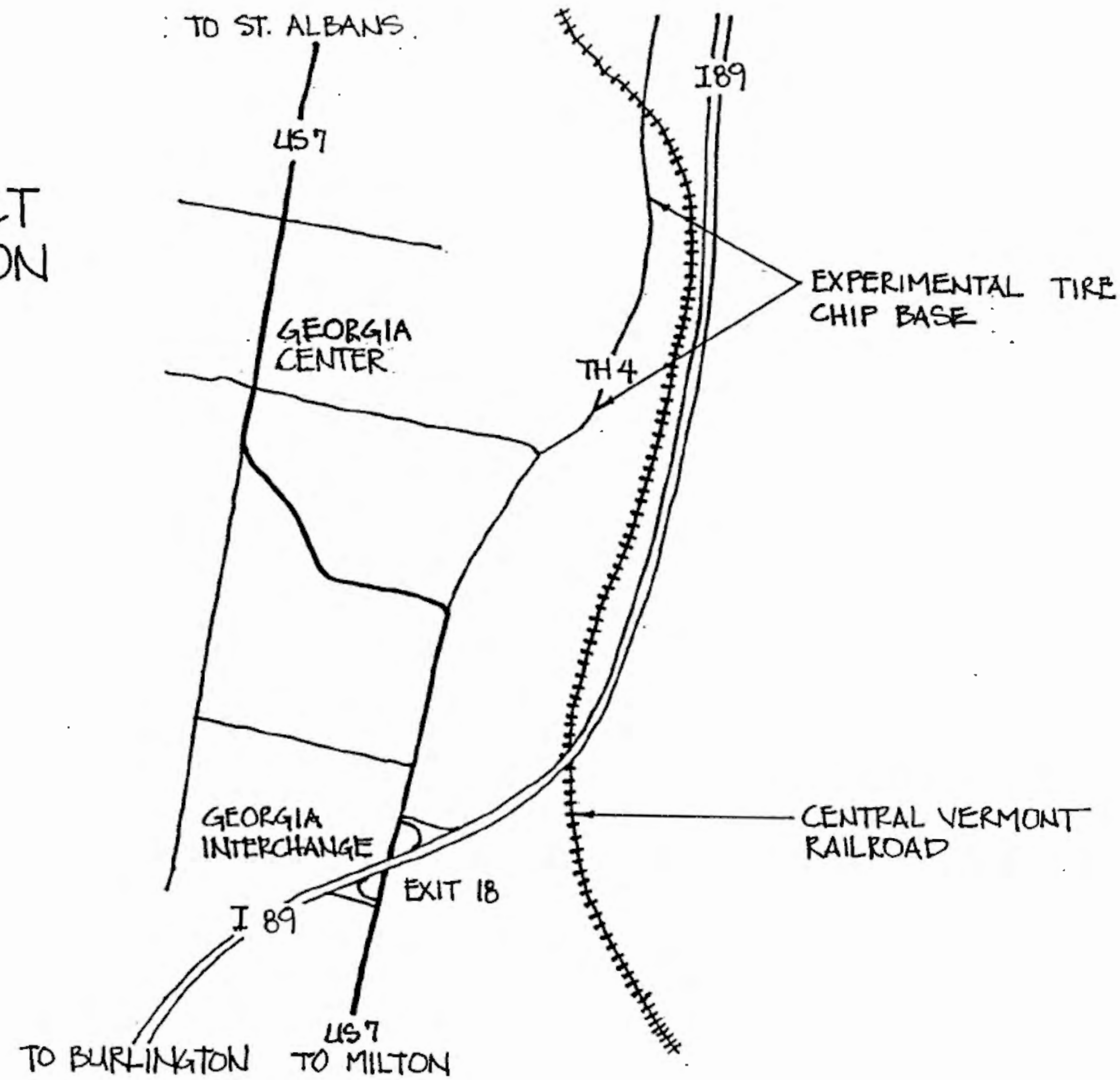


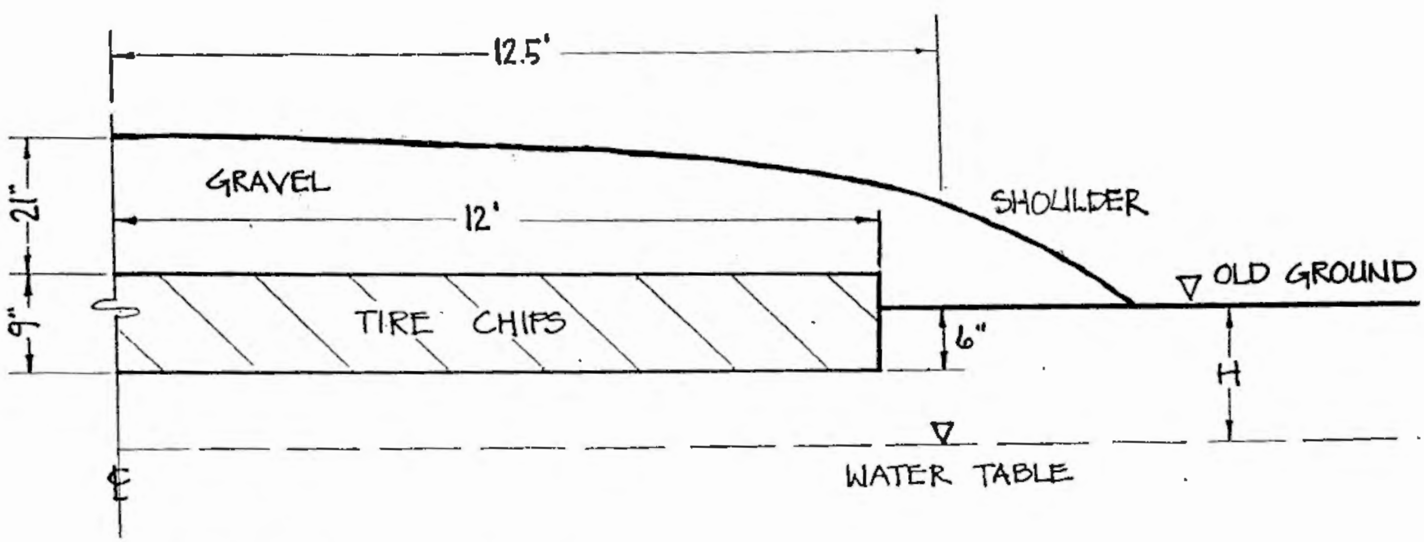
The base consisted of 21" of dirty gravel over 9" $\pm$ of compacted tire chips. The gravel was dry, while the silty sand subgrade contained enough moisture to hold the material together when squeezed.

Overview of the tire chip section on April 3, 1991.

Note surface moisture on the adjacent untreated sections.

PROJECT LOCATION





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