Demonstration Projects Program
Technology Transfer
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DEMONSTRATION PROJECT NO. 37

DISCARDED TIRES IN HIGHWAY CONSTRUCTION

SIOUX FALLS, SOUTH DAKOTA

Prepared for
and
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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 15
DEMONSTRATION PROJECTS DIVISION
1000 NORTH GLEBE ROAD
ARLINGTON, VIRGINIA 22201
Use of Granulated Rubber from Discarded Tires in Seal Coat Construction

Final Report
July, 1979

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
RESEARCH & SPECIAL ASSIGNMENTS PROGRAM
Introduction:

The modification of bituminous materials with various kinds of rubber for use in seal coat construction has been used in South Dakota as long ago as the mid 1950's. The use of ground rubber from discarded tires in relatively large percentages is an innovation which had not been tried previously in the state. The purpose of the study discussed in this report is to demonstrate the construction procedures involved and to evaluate the performance of the resulting chip seal. The construction phase was accomplished in August 1976.

Project Information:

The roadway selected for this project is a 7.730 mile long section of South Dakota 11 commonly called Shindler Road. It is located in Minnehaha and Lincoln Counties and extends from the junction of South Dakota 38 south to Harrisburg Road. The elevation of the area is about 1400 feet above sea level. The soil is a loess situated on gently undulating terrain and has a liquid limit in the 40-50 range and CBR values from 4 to 6.

In 1963 the Average ADT was 283, 16.6% of which were trucks. The daily equivalent 18-kip single axle loads were 14. In 1976 the traffic had increased to ADT of 1071, 5.4% trucks, and a daily equivalent 18-kip single axle loading of 38.

Grading was done in 1962 with a 40 foot wide subgrade with a 1/4 inch crown slope, 4 to 1 inslopes, a 14 foot wide ditch bottom and 3:1 to 5:1 backslopes. In 1963 a 9 to 12 inch subbase was placed and a 5 inch cement treated base course and a 2 inch bituminous surfacing. Reflected cracking from the cement treated base was a problem which started early in the life of the pavement. Continuing maintenance consisted of crack filling, patching small holes, spot sealing and flushing to re-
tard spalling of crack edges. A slurry seal was placed in 1968 and alleviated surface maintenance for a short time only.

Climate:

It is estimated that there are about 12 freeze-thaw cycles per year and frost penetration may reach 60 inches. Precipitation and temperature extremes for the five years prior to constructing the chip seal coat are shown in table I.

<table>
<thead>
<tr>
<th>Year</th>
<th>Precipitation</th>
<th>Temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>1971</td>
<td>23.64</td>
<td>-27</td>
</tr>
<tr>
<td>1972</td>
<td>26.43</td>
<td>-32</td>
</tr>
<tr>
<td>1973</td>
<td>28.19</td>
<td>-26</td>
</tr>
<tr>
<td>1974</td>
<td>17.03</td>
<td>-32</td>
</tr>
<tr>
<td>1975</td>
<td>26.10</td>
<td>-19</td>
</tr>
</tbody>
</table>

Condition Prior to Construction:

Just before application of the chip seal 20 randomly selected evaluation sections were located and marked along the project. Crack surveys and photographs were taken at each of these 20 locations. In general the surface was badly cracked due to reflected cracks from the cement treated base. Many areas were also extensively patched from previous maintenance activities and from the application of an intermittent leveling course prior to construction of the seal. Although the road surface was rather unsightly due to cracking, patching, crack filling, spot sealing etc. it still presented a relatively smooth driving surface. Skid resistance was good with an average skid number of 53 and the deflection was low as indicated with an average Dynaflect reading 0.80.

The excellent structural strength exhibited by the pavement indicated a sound roadway which did not require substantial added thickness. The extreme and persistent cracking problem had not been more than briefly alleviated by normal maintenance materials and procedures. For these reasons this section of road appeared to be an excellent and perhaps somewhat severe test of the ability of asphalt
modified with reclaimed tire rubber to seal or bridge over rather large and varied crack types.

**Plan for Demonstration and Evaluation:**

The plans for the project called for a tack coat to be applied to the old surface prior to placing the rubberized asphalt for the seal coat. Either a SS-1h emulsified asphalt or a RC-70 could be used and applied at the rate of 0.05 gallons per square yard. The seal coat was applied in three variations discussed separately below:

**Station 4+20 to Station 357+96**

Rubber modified asphalt - This material was to be placed at the rate of 0.60 gallons per square yard or about 34.3 tons per mile. The mixture was to consist of about 75% 120-150 penetration asphalt cement and 25% ground vulcanized tire rubber.

Cover aggregate - The cover aggregate was to be crushed and graded Sioux Falls Quartzite. The aggregate was to be preheated to between 290° and 350° and precoated with 0.5 percent of asphalt cement. The rate of application was specified at 38 pounds per square yard.

**Station 357+96 to Station 405+96.5**

The rubber asphalt was the same for this section as the previous sections. The aggregate however was not to be precoated and was to be preheated to a minimum temperature of 250° F. Application rates etc. were the same as for the previous section.

**Station 405+96.5 to Station 410+96.5**

This area was designated as a control area and was constructed to standard chip seal specifications. The asphalt for this area was RC-800 and was to be applied at the rate of 0.35 gallons per square yard. The same cover aggregate was used as in the previous sections except that it was not to be preheated nor precoated and was to be applied at the rate of 30 pounds per square yard.
Materials:

Mobil Oil Corporation of Sioux Falls, South Dakota furnished all RC-800, RC-70 and 120-150 penetration paving asphalt. Two samples of the RC-800, 3 samples of the RC-70 and 10 samples of the 120-150 penetration asphalt were tested in the laboratory. No deviations from specifications were found in any of the samples tested. The penetration of the 120-150 penetration grade asphalt average about 140.

Sweetman Construction Company of Sioux Falls furnished the Sioux Falls Quartzite Aggregate which exhibited the following characteristics:

Gradation

<table>
<thead>
<tr>
<th>% Passing</th>
<th>Specs.</th>
<th>Avg. 6 Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch sieve</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/8 inch sieve</td>
<td>70-100</td>
<td>80</td>
</tr>
<tr>
<td>#4 sieve</td>
<td>0-10</td>
<td>5.3</td>
</tr>
<tr>
<td>#8 sieve</td>
<td>0-5</td>
<td>2.5</td>
</tr>
<tr>
<td>#200 sieve</td>
<td>0-2</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Abrasion

-40  23

Sodium Sulfate Soundness Loss

-12  1.6

Particles with at least 2 crushed faces +75%

100%

Tack Oil: AASHTO M-81

Granulated Rubber:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>One Test- % Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>100%</td>
</tr>
<tr>
<td>16</td>
<td>97</td>
</tr>
<tr>
<td>20</td>
<td>47</td>
</tr>
<tr>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>80</td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Construction:

Construction started on August 16, 1976 with the following equipment:
1 tack coat oil distributor
2 rubberized asphalt distributor.
1 chip spreader
4 rubber tired rollers
7 dump trucks
1 self-propelled broom
1 "Follow me" truck
several pickups for fuel, mechanics and supervisory personnel
1 rubber elevator
1 sand spreader truck

The construction sequence consisted of applying the tack oil with the tack distributor and following this with the rubberized asphalt. Two distributors were used for the rubberized asphalt. Because of the time required to fill, heat and mix the rubber with the asphalt one distributor was being filled while the other was applying the rubber asphalt mixture. Immediately behind the asphalt rubber distributor was the chip spreader and the chip trucks which were followed by the rollers. A very light application of blotting sand was applied before or during the rolling operation. Usually the excess chips were not broomed until the following day. One way traffic was controlled with a flagman at each end of the construction area and a "follow me" truck leading traffic through the construction. Traffic was not allowed on the fresh seal for at least 2 hours after application.

Problems during construction were relatively minor and resulted in no serious imperfections in the final product. The only real imperfection in the appearance of the finished seal was a streaked look in some areas. The tack coat had a streaked appearance when it was placed and some thought the tack might be responsible for the final appearance. It was decided that the asphalt-rubber mix was diluted with from 5 1/2% to 7 1/2% by volume of kerosene and after mixing some loads had to wait for the chip trucks causing an evaporation of the diluent. This resulted in a thicker
liquid being sprayed on the surface which did not flow as readily as a thinner liquid and resulted in a "roping" or "ridging" of the asphalt-rubber mixture. This phenomenon did not develop over the entire job and where it did occur it is apparent to the eye but seems to have no effect on rideability or steering. This condition can be avoided with better coordination between mixing time and chip delivery. More chip trucks would have made possible a steady supply of chips to the job site and few delays in the application of the asphalt-rubber material.

The chip rate application overran by about 4 pounds per square yard. Variation in the unit weight of the chips was partially responsible for this however, the application rate of the coated chips was apparently difficult to control through the spreader. Construction was completed August 20, 1976.

Observation and Evaluation:

From on-site inspections and photos taken before and semiannually after construction, there are some indications that, even though there was more cracking of the old surface in the control section than in other areas prior to construction, the asphalt-rubber seal appears at this point to be somewhat more effective than the standard seal in filling and bridging over old cracks and irregularities. Cold weather reflection cracks seem to be a little less prone to open up and those that do are somewhat narrower than those in the control section.

Chip retention and skid resistance is good throughout the project with no significant difference between sections being noticeable at this time. Friction numbers average 53, about the same as before construction.

One 600 foot long section in the vicinity of station 48+00 between mile posts 71 and 72 has been overlayed for the full widths of the pavement. This section apparently developed structural distress which is in no way attributable to the chip seal coat. A few other localized areas have been patched due to local distressed areas.
On this project the cost of the rubberized asphalt sections was approximately 4 times the cost of the control sections. While the rubberized sections appear to be somewhat superior to the control sections the cost factor will probably limit usage to unique problem areas rather than general use.

Black and white photographs and colored slides of the project are available at the Research and Special Assignments Program office.

Reference