USE OF HIGH FLOAT EMULSION ASPHALT IN ALASKA

FINAL REPORT

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June, 1987

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in cooperation with

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

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FHWA-AK-RD-87-03

2. Government Accession No. 

3. Recipient's Catalog No. 

4. Title and Subtitle 
Use of High Float Emulsion Asphalt in Alaska

5. Report Date 
June, 1987

6. Performing Organization Code 

7. Author(s) 
Billy Connor

F27132

9. Performing Organization Name and Address 
Same as 12

10. Work Unit No. (TRAIS) 

11. Contract or Grant No. 

12. Sponsoring Agency Name and Address 
State of Alaska
Department of Transportation & Public Facilities
2301 Peger Rd.
Fairbanks, AK 99709

13. Type of Report and Period Covered 
Final


15. Supplementary Notes 
Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. Abstract 
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17. Key Words 
High float emulsion
Surface treatments
Pavement performance

18. Distribution Statement 
Unrestricted

19. Security Classif. (of this report) 
Unclassified

20. Security Classif. (of this page) 
Unclassified

21. No. of Pages 
12

22. Price 
n/a
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ABSTRACT

In response to a resolution passed by the Thirteenth Alaska Legislature, three test surfaces were placed to investigate the merits of a high float emulsion asphalt surface treatment currently used in the Yukon Territory, Canada. The experience gained from these test sections indicates that for low volume roads and for roadways which will undergo significant differential settlement, this type of surface may well be competitive with the more conventional bituminous surface treatments (BST). However, essentially all the guidelines which apply to BST's apply to the Canadian process as well. See previous page.
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INTRODUCTION:

A resolution passed by the Thirteenth Alaska Legislature requested the Department of Transportation and Public Facilities (DOT&PF) to investigate the merits of a high float emulsion asphalt surface treatment currently used in the Yukon Territory, Canada. To fulfill this request, three sections were constructed during the summer of 1984 at the following locations:

- Persinger Road - Fairbanks, Alaska
- Freeman Road - Fairbanks, Alaska
- Mud Bay Road - Haines, Alaska

These sections have been closely observed over the past two years to determine the merits of this technique under the Alaskan environment.

This type of surface treatment is not new. The Canadian Government has about 12 years of experience. A review of the literature shows that the concept of using high float emulsion with a dense graded aggregate has been used for about 17 years. However, it should be emphasized that the political and economic environments in Canada are significantly different than in Alaska, which may impact their choice of surface. For example, the Yukon tends to place the high float surfacing with maintenance forces while Alaska prefers to place most surfaces under contract.

BACKGROUND:

The term "high float emulsion" refers to a specific type of asphalt-water emulsion and not to the construction method which is more accurately described as a surface treatment. Like conventional bituminous surface treatments, the primary purpose is to provide a dust free surface that seals the pavement structure from moisture and prevents the loss of aggregate. Since surface treatments do not add strength to the roadway, the roadway embankment may need strengthening when it is converted from a gravel surface
to a paved surface. Therefore, no cost savings can be expected in construction of the embankment when surface treatments are used.

High float emulsion is an anionic emulsified asphalt which has the specific quality, imparted by the emulsifying agents, that permits a thicker film coating without danger of runoff. This property tends to make high float emulsions more compatible with fine aggregate. The HF350S specifications used by the Yukon Territory are presented in Table 1.

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>Min.</th>
<th>MAX.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residue by distillation, % by mass</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Oil portion of distillate, % by volume</td>
<td>1.5</td>
<td>6</td>
</tr>
<tr>
<td>Viscosity at 59°C</td>
<td>75</td>
<td>400</td>
</tr>
<tr>
<td>% by mass retained on No. 1000 sieve</td>
<td>-</td>
<td>0.1</td>
</tr>
<tr>
<td>Storage stability test, 24 hr. % by mass</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Penetration at 25°C 100 g. and 5 s.</td>
<td>350</td>
<td>700</td>
</tr>
<tr>
<td>Float test at 60°C</td>
<td>1200</td>
<td>-</td>
</tr>
</tbody>
</table>

The primary difference in the Canadian technique and the conventional surface treatment is the aggregate gradation as contrasted in Table 2. High float emulsion is considered critical to their technique because of its ability to coat dusty particles and the "wicking" action it provides.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>C&quot; Chips</th>
<th>Alaska D-1</th>
<th>Canadian Cover Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>100</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>70-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>100</td>
<td>50-80</td>
<td>15-50</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>90-100</td>
<td>35-65</td>
<td>15-50</td>
</tr>
<tr>
<td>#4</td>
<td>10-30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#8</td>
<td>0-8</td>
<td>20-50</td>
<td></td>
</tr>
<tr>
<td>#40</td>
<td>8-30</td>
<td>5-15</td>
<td></td>
</tr>
<tr>
<td>#200</td>
<td>0-2</td>
<td>0-6</td>
<td>0-5</td>
</tr>
</tbody>
</table>

-3-
Discussions with Canadian officials in the Yukon Territory indicate that they feel that the high float surface treatment is cost effective when compared with the costs of maintaining a gravel surface. The Canadian officials stated that the available budget does not allow the use of hot mixed asphalt. Finally, low traffic volumes which seldom exceed 500 vehicles per day do not warrant extensive hot asphalt paving.

Norway has used an aggregate grading similar to that used by the Canadians with a medium cure cutback asphalt for about 17 years for a surfacing they call "Otta-surfacing." (1) Some cationic asphalt emulsions (CMS2) have been successfully used in the Otta-surfacing method which Norway finds cost effective when compared with the maintenance of gravel roads. They do not feel it is competitive with higher performance pavements under higher traffic loadings.

DEFINITIONS:

Since this report will be comparing three types of bituminous surface treatments (BST) a naming convention must be established to minimize confusion. While not technically correct, the Canadian practice of using high float emulsion will be referred to as simply "high float" or "HF." Whenever the Canadian process is used with CMS-2 instead of high float emulsion, it will be referenced as the "CMS-2 sections." Finally the more conventional bituminous surface treatments using one sized chips will be referred to as "BST's" or "conventional BST's."

ALASKAN EXPERIENCE: Mud Bay Road

The first section to be constructed in Alaska was on Mud Bay Road in Haines. Several problems were encountered in the construction process, most of which were due to the lack of experienced personnel and inadequate equipment. Changes in specifications were recommended after this trial.

Both high float emulsion (HS350S) and CMS-2 emulsions were used on the project. The D-1 base course aggregate used is similar to the Canadian specifications. The resident engineer felt the high float emulsion provided
coating superior to that provided by the CMS-2 emulsion, which is consistent with the Canadian experience.

Shortly after completion of the project, complaints of potholing and severe surface deterioration were received. As expected, the excess gravel became loose and caused a surface similar to a gravel road. At the suggestion of Mr. Ray Magneson of Yukon Highways, the excess gravel was removed using a grader equipped with a rubber blade. Additional brooming left a hard surface similar to a conventional surface treatment. However, as expected, the surface treatment did not provide the smooth surface of a hot asphalt pavement. This fact caused considerable public criticism because the public had wanted a hot mix pavement surface.

An on-site inspection of the roadway surface in August 1985 showed potholing and ravelling in many areas as shown in Figure 1. From the streaking on the surface, it was apparent that the application of asphalt had been uneven. The potholes are occurring in areas where there was a noted lack of asphalt. Most of the problems on this project appear to be directly related to construction and drainage problems. The performance of the HF350S appears to be superior to the CMS-2 as noted by a 74% failure of the CMS-2 as compared to the 13% failure of the HF350S sections. However, as will be discussed, this is in sharp contrast to the experience in Fairbanks.

The following generalizations can be made from experience gained on this project:

1) Only asphalt distributors capable of delivering a uniform application rate of 0.70 gallons of asphalt/square yard should be allowed.

2) In times of high rainfall, the technique may be ill-advised because of high aggregate moisture content. While damp aggregate is desirable, wet aggregate is unacceptable. Covering of the aggregate stockpile may alleviate this problem.

3) Loose gravel must be removed prior to paint striping.
4) Use of this type of surface treatment should be avoided on steep grades. Runoff problems with the high application rates were encountered on this project when grades exceeded 6%.

5) The ride quality of hot asphalt pavement should not be expected from this type of surface whether CMS-2 or HF350S emulsion is used.

6) It is difficult to draw firm conclusions concerning the performance of the CMS-2 sections due to the noted construction deficiencies.

Figure 1.
Typical Performance on Mud Bay Road
PERSINGER DRIVE:

A second test section was constructed near Fairbanks on Persinger Road/Keeling Drive. Again, both HS350S and CMS-2 emulsion asphalts were used on adjacent lanes in order to directly compare the performance. Placement of the surface went very smoothly except for a delay in the arrival of the high float emulsion from Watson Lake, Yukon Territory, Canada. Traffic caused potholing of the unsurfaced lane adjacent to the surfaced lane which proved difficult to repair.

The project engineer had the following comments (3):

1) Chip spreader equipment is designed for a tightly banded graded material and does not work well with a wider band of graded material such as D-1. Also the chip spreader is not designed to spread at this higher application rate (70 lbs./s.y.).

2) The high float asphalt (HF350S) appeared to wick into the cover coat material better than the CMS-2. However, high float asphalt produced an erratic pattern where it wicks through the cover coat material surface producing spots the size of a quarter or larger in erratic patterns. The rollers picked this up leaving "potholes" and deposited pancakes elsewhere on the mat.

3) Brooming the surplus cover coat material off after three days or longer requires a considerable effort before striping can be done.

A photographic record of six representative 100 ft. sections was kept from the date of completion until August, 1986. Photographs similar to Figure 2 were taken of the sections which were marked into 10 ft. x 10 ft. grids with white paint at the beginning and end of each summer. All potholes and surface defects were marked and recorded on a monthly interval during the spring and summer months. During this period, very few potholes developed. There is no noticeable difference in performance between the high float sections and the CMS-2 sections. To date, both emulsions are performing as well as the more conventional surface treatments. It is not clear that the performance of the high float sections is better than the CMS-2 sections.
It is impossible to differentiate between the two sections at this time.

FREEMAN ROAD:

A third section was constructed near Fairbanks on Freeman Road. The results were essentially identical to those on Persinger Road.

Figure 2.
Monitored Section on Persinger Road
COST COMPARISON:

In order to compare the cost effectiveness of any process, its costs must be compared to some standard. Two types of surfacing are commonly used in Alaska; hot asphalt concrete and bituminous surface treatments (BST). Table 3 provides a comparison of cost data using the cost data on Persinger Drive and the most current construction bid data. These costs assume only the cost of producing and placing the surface.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>CONVENTIONAL BST</td>
<td>$2.85</td>
<td>$2.73</td>
</tr>
<tr>
<td>HIGH FLOAT</td>
<td>$2.68*</td>
<td>$2.19</td>
</tr>
<tr>
<td>CMS-2</td>
<td>$2.34</td>
<td></td>
</tr>
<tr>
<td>2&quot; HOT ASPHALT</td>
<td></td>
<td>$4.68</td>
</tr>
</tbody>
</table>

* Persinger Drive bid data

While the Canadians have had considerable experience with this type of surface treatment, it is still too early to assess the life cycle cost of the surface treatment in Alaska. Canadian literature shows that their surface treatment is cost effective when used on low volume roads where dust control is the primary concern. The surface life claimed compares favorably with the more conventional BST. However, there is not enough data in Alaska concerning maintenance, expected life and the public acceptance of the method to provide a detailed cost analysis. Further, since the requirements of each project varies, any cost analysis should be considered valid only for the project in question. The lack of experience precludes any generalizations. The data here only indicates the first cost of placing various pavement surfaces and should be used only as a basis for project specific analysis.
SUMMARY:

Three roadway test sections have been built in Alaska using a surfacing method commonly used in the Yukon Territory and Norway. The method and surface consist of a dense graded aggregate and high float emulsion (HF350S). Placement is very similar to that used in conventional bituminous surface treatments. Canadian experience has been quite favorable and has caused the widespread use of high float throughout Canada on roadways with less than 500 ADT.

The following conclusions can be drawn from experience on these three projects:

1) Placement is a little more difficult than conventional surface treatments. Because of the high volumes of asphalt (0.70 gal./s.y.) and aggregate (70 lbs./s.y.) being spread, care must be taken to ensure the distributor and the chip spreader are adequate to provide a uniform product at these high spread rates. This may require minor modifications of the equipment.

2) All of the specifications concerning the construction of conventional surface treatments apply to this technique. The only difference is the type of aggregate and emulsion being used. It would be ill advised to consider the high float technique where a conventional BST would not be appropriate.

3) At this point, it is unclear whether using the higher cost HF350S is warranted. While the performance of the high float section is superior to the CMS-2 section on the Mud Bay Road, there is no perceptible difference in the performance in Fairbanks. Norwegian experience has indicated that the CMS-2 performance is adequate. It is, therefore, recommended that further comparisons be made to determine if CMS-2 can be used instead of the more expensive HF350s. However, note that the primary reason for the higher cost of high float emulsion is the lack of use. Higher use may well make it competitive with CMS-2.
4) Considerable brooming is required before application of traffic paint striping.

5) Canadian experience has shown maintenance costs to be higher for the high float surface treatments than for hot asphalt concrete pavement. All potholes must be repaired quickly to prevent rapid deterioration of the surface.

6) On low volume roads constructed over stable terrain, hot asphalt concrete appears to be more effective than surface treatments. However, it is recommended that a life-cycle cost analysis be performed on each project to determine which is most cost effective. However, on roadway sections built on thermally sensitive ground where the type of surface does not influence the life of the roadway, surface treatments appear much more attractive. It is still unclear whether the high float emulsion surface treatment will be more cost effective than the conventional BST over the long term. However, it is clear that the method does have merit and should be considered. It is also apparent that the first costs of using the D-1 gradation with either high float or CMS-2 emulsions are somewhat lower than the more conventional BST.

IMPLEMENTATION STATEMENT:

In general, it is recommended that this technique be considered whenever the design calls for a pavement surface with a relatively short life or on low volume roads where dust control is the primary reason for surfacing. It is also recommended that additional projects be built with CMS-2 emulsion and D-1 aggregate to determine if this less expensive asphalt will perform adequately. However, since the construction cost of this technique is still unclear, it is recommended that it be bid as an alternate until the costs become clear.
REFERENCES


2) Memorandum from Larry Geise to Dale Miller, July 2, 1986