Memorandum

TO: Gene Rehfield
Coordinator, Experimental Features
DOT&PF, Headquarters

THRU: Paul W. Misterek, P.E.
Technical Services Engineer

FROM: Robert L. McHattie, P.E.
Geotechnical Engineer
Northern Region

DATE: January 31, 1994
FILE No.: 244N
PHONE: 451-2236

SUBJECT: Final Evaluation of
Experimental Features
Projects AK8701A and
AK8701B

Research Project No. AK8701A, Construction Project No. F-065-
1(6), Elliott Highway Dust Control and Stabilization with EMC²:
- AND -
Research Project No. AK8701B, Construction Project No. F-065-
1(6), Elliott Highway Dust Control and Stabilization with
Montmorillonite:

Introduction & Previous Work

This is the second and final report concerning the performance of experimental
dust palliatives used on the Elliott Highway. The Elliott Highway extends about
70 miles north from Fox, Alaska (15 miles north of Fairbanks) to Livengood,
Alaska. The project area is located at the southern end of the unpaved portion
of the Elliott Highway.

These experimental features were constructed to evaluate the dust palliative
capabilities of two products, one a proprietary liquid (EMC²), the other a
commercially packaged clay (montmorillonite). The performance of the test
sections was compared to an adjacent road segment, treated normally with CaCl₂
(calcium chloride). Use of the special surfacing additives was aimed primarily
at limiting dust generation. It was further expected that one or both products
would promote binding of the surface course materials to form a tight waterproof
surface. It was necessary to determine the length of time required for the
condition of the specially treated sections to become worse than the calcium
chloride control section. Knowing the period of acceptable performance, cost
comparisons were possible using a standard, present worth analysis. The
objective was to find a functionally and/or economically superior alternative to
the presently used calcium chloride.

Both the EMC² liquid and the montmorillonite clay were supplied by Soil
Stabilization Products, Inc., of Merced, California. Just prior to construction,
EMC² was substituted for another material known as BIO CAT 300-1, originally
intended for use on this project. The BIO CAT was also a product of Soil
Construction plans called for rehabilitating a section of the Elliott Highway between milepost 28 and milepost 73. The experimental sections are located at the southern end of the project, beginning at mile 28 and extend 5.3 miles. Except for the experimental sections, gravel surfacing materials used on the remainder of the project were treated with calcium chloride. A 2.7-mile section of the calcium chloride-treated roadway, abutting the northern end of the experimental sections, was selected as a control section.

The experimental surface treatments were placed within the following roadway segments:

<table>
<thead>
<tr>
<th>Project Stationing</th>
<th>Milepost Interval</th>
<th>Treatment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1579+22 - 1645+22</td>
<td>28.00 - 29.25</td>
<td>EMC² (Pugmill Mixed)</td>
</tr>
<tr>
<td>1645+22 - 1712+80</td>
<td>29.25 - 30.63</td>
<td>EMC² (Road Mixed)</td>
</tr>
<tr>
<td>1712+80 - 1736+00</td>
<td>30.63 - 31.12</td>
<td>Montmorillonite (36’ wide)</td>
</tr>
<tr>
<td>1736+00 - 1830+00</td>
<td>31.12 - 32.99</td>
<td>Montmorillonite (38’ wide)</td>
</tr>
<tr>
<td>1830+00 - 1846+08</td>
<td>32.99 - 33.30</td>
<td>Montmorillonite (36’ wide)</td>
</tr>
<tr>
<td>1846+08 - 1988+64</td>
<td>33.30 - 36.00</td>
<td>Calcium Chloride (control)</td>
</tr>
</tbody>
</table>

The EMC² and montmorillonite sections received only a single, initial treatment of dust control agent. Application rates for these materials were: EMC² @ 1 gallon/324 ft³ of surface course aggregate and montmorillonite @ 2% by dry weight of surface course. After construction no additional dust palliative materials were added to the EMC² or montmorillonite sections until the summer of 1993, although occasional maintenance blading was done. During construction the control section was treated with 8 tons/mile of calcium chloride. The control section also received normal maintenance blading plus an additional 5 ton/mile application of calcium chloride during the summer of 1992 and again in 1993.

Construction reports, written by Bruce Herning, Resident Engineer, described the construction of the EMC² and montmorillonite sections. These reports were included as attachments to the first Experimental Features evaluation.

A field visitation, soon after construction in 1991, found the gravel road surface on both experimental sections to be "cemented" into a material which appeared resistant to excessive ravelling and dust production when exposed to normal truck traffic. The calcium chloride-treated control section appeared to be in similar condition at that time.

During 1992, a driving inspection was done, photos were taken and dust samples were collected. The condition of the experimental sections appeared good during the inspections performed during July and August of 1992. Photos taken at the time confirmed that the experimental sections appeared to produce no more dust, in response to vehicle traffic, than the control section. The dust samples were intended to help quantify the relative benefits of the surface treatments although the results were inconclusive. The maintenance foreman responsible for the test area expressed only positive opinions concerning the performance of the experimental sections through the end of summer 1992.
Details concerning specifications and construction methods used for this experimental section were presented in an Experimental Feature construction report for this project issued February 18, 1993.

**Final Assessment**

The previous report cited acceptable performance of the EMC\(^2\) and montmorillonite treatments one year after the original application. The experimental work plan called for a single application of the special dust palliatives followed by performance monitoring until additional dust palliative was needed. This summer (1993) it became necessary to treat the experimental sections with another dose of palliative — according to the requirements of the work plan, this ends the experiment.

For a period of about one year, there was no significant difference between the performance of the EMC\(^2\) and the montmorillonite materials, nor was there a noticeable performance difference between the experimental sections and the calcium chloride-treated control section. By the spring of 1993 the dust control effectiveness of both products had diminished to the point where it was necessary to apply more palliative. Calcium chloride finally was added to both of the experimental sections as well as to the control section at the rate of 5 tons/mile.

In conclusion, it appears that both experimental treatments worked similarly well for a period of more than one year but perhaps less than two full years. From testing so far, the acceptable performance life of the EMC\(^2\) and montmorillonite treatments is probably about 1.5 years — on a per-treatment basis (without considering relative material costs), both experimental palliatives seem to provide a slight performance edge over calcium chloride.

Cost considerations change the picture of relative benefit significantly. The following table presents the results of a present worth analysis of the dust palliatives monitored in this project.

<table>
<thead>
<tr>
<th>Dust Palliative Type</th>
<th>First Cost for Material Applied Every Year for 10 Years(^a) (per yd(^2), per mile)</th>
<th>First Cost of Material Applied Every 2(^{nd}) Year for 10 Years(^b) (per yd(^2), per mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC(^2)</td>
<td>$0.81, $15,000</td>
<td>$0.78, $14,500</td>
</tr>
<tr>
<td>Montmorillonite</td>
<td>$4.07, $76,500</td>
<td>$3.92, $73,500</td>
</tr>
<tr>
<td>Calcium Chloride</td>
<td>$1.00, $19,000</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* The analysis period is 10 years with an assumed interest rate of 10%. For yearly applications, the amount of EMC\(^2\) and montmorillonite used after the first year, i.e., after
construction, would be half that used for the first year’s application. Initial application rates for both of the experimental palliatives were stated previously in this report. Calcium chloride would be applied at 8 tons/mile initially and at 5 tons/mile in succeeding years. Costs listed above consider only the approximate purchase price of materials, FOB Fairbanks, Alaska. The total ten-year labor costs assuming yearly applications should actually be less than double those for bi-yearly applications since less material must be handled during each application.

The EMC² is an attractive alternative in terms of materials present worth. Additional field testing is needed to conclusively determine whether the time between reapplications of the EMC² can actually be extended to a full two years. Verification of a two-year reapplication cycle would clearly favor use of EMC² or a similar product.

Supplemental Testing

Independent laboratory testing on the EMC² additive was commissioned and paid for by Soil Stabilization Products Company (the supplier of EMC²) as part of their own monitoring of DOT&PF’s research work. Testing was done by Arctic Alaska Testing Laboratories (AATL) to examine certain ease-of-compaction and compacted strength characteristics of surface course materials stockpiled during construction. The test results are of interest and are included as a supplement to the DOT&PF field study.

A sample of stockpiled surface course was collected by AATL from a DOT&PF stockpile located at Mile 47.5 on the Elliott Highway. The sample was divided into two portions, one of which was treated with EMC²; the other portion was left untreated. Both were similarly tested. Attached is an AATL test report describing significant improvements in compactability and compressive strength (compression tests run on compacted and cured samples) as compared to aggregate samples containing none of the additive.

Cost for This Reporting

A total of about 48 hours of my time was required for report preparation. The FY 1994 expenditure is approximately $2,700 to date, charged against Ledger Code 30869442.

Attachments: as stated

RLM/rm
November 2, 1993

Soil Stabilization Products Company, Inc.
P.O. Box 2779
Merced, California 95344

Attn: Mr. Bob Randolph

RE: MATERIAL PROPERTY TEST ON AGGREGATE STABILIZED WITH EMC SQUARED (EMC²)

Per your request, an aggregate sample was collected on September 22, 1993 from the State of Alaska DOT&PF stockpile at 47.5 mile on the Elliott Highway by Randall K. Fletcher, of our firm. The sample aggregate was a well graded ¾” (19 mm) maximum aggregate (GC) used by DOT&PF for aggregate surfacing on the Elliott Highway. The sample material was allowed to air dry to less than Optimum Moisture Content. Water was then added to bring the sample material to Optimum Moisture Content of 6.5%. A sample was prepared with the EMC SQUARED stabilizing agent added at the application rate recommended in the "EMC SQUARED General Information" guideline literature. The second sample was moisturized with water only. The moisturized aggregate materials were allowed to stand overnight in covered containers and then compacted into 6" x 12" (152.4 cm x 304.8 cm) steel cylinders. Samples were compacted using ASTM D 1557 Modified Proctor Compactive Effort (see Section 2 below). Both samples were allowed to cure in their molds for 24 hours, then removed and allowed to cure at room temperature until tested in compression at 14 days of age. The results of those tests are printed below:

<table>
<thead>
<tr>
<th>Cylinder</th>
<th>Treatment</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>EMC SQUARED</td>
<td>421 psi (2,900 kPa)</td>
</tr>
<tr>
<td>#2</td>
<td>Untreated</td>
<td>269 psi (1,853 kPa)</td>
</tr>
</tbody>
</table>

Additional tests were conducted which demonstrated the effectiveness of the EMC SQUARED stabilizer in facilitating compaction, in increasing compacted density, and in translating increased compactive effort into increased strength.

> FACILITATION OF COMPACTION (Reduction of Required Compactive Effort)

Prepared mixture divided into two portions, Sample A brought to Optimum Moisture Content without use of additive and B brought to Optimum Moisture Content with use of EMC SQUARED additive. After compacting Sample A to a target density, Sample
B was compacted to the same target density with approximately 15% less compactive effort required.

**INCREASED DENSITY**

The treated and untreated samples subjected to unconfined compressive strength testing, as reported above, were compacted in 6" x 12" (152.4 cm x 304.8 cm) steel cylinders (conventionally used for testing concrete) using ASTM D 1447 Modified Proctor Compactive Effort. Compaction was applied by placing the material in 5 layers with 122 blows of a 10-lbf (44.5 N) rammer with an 18" (457 mm) drop applied to each layer producing a compactive effort of 56,000 ft-lbf/ft³ (2,700 kN-m/m³). The untreated aggregate specimen reached a unit weight of 137.84 pounds per cubic foot (2,203.50 kg/m³), when compacted to 100% ASTM D 1557. The aggregate specimen treated with KMC SQUARED reached a unit weight of 141 pounds per cubic foot (2,254.01 kg/m³), or 102.29% compaction.

**EFFECTS OF INCREASING COMPACTION**

Two aggregate samples from the Elliott Highway aggregate source were treated with the same quantity of stabilizer, cured under similar conditions and tested in compression seven days after compaction. One specimen was compacted with full Modified Proctor effort while the second specimen was given only fifty-seven percent of that compactive effort, 31,920 ft-lbf/ft³ (511,294.6 kg/cubic meter). The sample which was compacted with reduced effort achieved only 60% of the compressive strength of the sample that was compacted to 100% ASTM D 1557 Modified Proctor effort. It is interesting to note that for this treated aggregate there was a very direct relationship between increased compactive effort and increased strength.

Sincerely,

**ARCTIC ALASKA TESTING LABORATORIES**

a division of SHANNON & WILSON, INC.

By [Signature]

Randall K. Fletcher
Laboratory Supervisor

RKF/laf

RPT/149.11/2/93/id/1af

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