**RESEARCH REPORT DOCUMENTATION PAGE**

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| ND 92-01 | January 1999 | N/A | UNH-1-810(012)002 |

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| Evaluation of Ralumac as a Rut Filler and Its Rut Resistant Capabilities | Work Plan ☐<br>Construction ☐<br>Evaluation ☐<br>Final ☒ | U-1-981(033)042<br>8. Project No.<br>9. Project No.<br>10. Project No. |

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14. Supplementary Notes

15. Abstract


**Purpose and Need**

Due to the heavy traffic and commercial development in the area of the project and the relatively low cost of the Ralumac, the chip seal coat was eliminated and replaced with a full width Ralumac overlay to reduce the project time.

**Objective**

The objective of this rehabilitation project was to eliminate excessive rutting on a portion of the Bismarck Expressway. The usual method of dealing with wheel ruts is to mill and apply a full-width overlay. The rehabilitation was to use a polymer-modified slurry seal, also known as a micro-surfacing slurry seal, to fill wheel ruts. This method was selected because it was an estimated 35% to 50% savings over mill and overlay, had same day traffic utilization, it proposed to correct major rutting problems, it has a uniform texture and seal, and it had a minor construction time.

**Scope**

The entire project had 2.163 net miles. This included part of the Bismarck Expressway (project number UNH-1-810(012)002) from a point 1,500 feet west of Washington Street, east to Airport Road and some of Washington Street (project number U-1-981(033)042) from a point 600 feet south of Arbor Avenue, south to Denver Avenue in Bismarck, North Dakota. The North Dakota Department of Transportation (NDDOT) decided to use a micro-surfacing slurry seal to fill the ruts. The items being monitored are distresses, overall surface condition, performance, maintenance costs, actual construction costs, ride, and skid resistance. These items will be evaluated annually for six years.

**Summary**

The Bismarck Expressway was rehabilitated due to excessive rutting on portions of the project. Ralumac, a Micro-surfacing product, was selected to rehabilitate this project. Ralumac was a cost effective solution to the rehabilitation problems on the Bismarck Expressway. Minor problems were encountered with its use, which primarily is brittleness and some color appearance. Ralumac is outstanding as far as ease of construction and overall project time.

Ralumac has performed well with few negative aspects. The Ralumac has prevented the return of the severe rutting on the project except at stop bars at some intersections. The Ralumac is brittle and tends to spall at the transverse cracks. It is hard to route and acts like concrete, according to city work crews.

The Ralumac received a ride rating in 1998, which borders the poor to fair rating. The project was given a good rut rating with the worst rutting found at stop bars. Ralumac still has a rather rough surface texture except in the wheelpaths where it is worn. No skid resistance tests were conducted after 1993, but skid numbers were estimated to be satisfactory. A skid number of 35 is generally considered the minimum desirable skid resistance. In 1993 the Ralumac received an average skid number of 36 and had been in service for a year. Surrounding asphalt sections received an average skid number of 30. It is assumed that Ralumac sections will have higher skid values than near-by asphalt sections.

Although the pavement marking tape is not an experimental product, problems did exist between the Ralumac and pavement marking. A 35% to 50% savings has been experienced by using Ralumac over a mill and overlay procedure. Performance of the Ralumac has been satisfactory.

**Recommendation**

Ralumac should be considered to rehabilitate projects that are excessively rutted based on past performance. The underlying support structure should be in good condition for best performance from the Ralumac. With benefits like ease of construction, overall project time, and a 35% to 50% savings over conventional rehabilitation, its use would be very beneficial.


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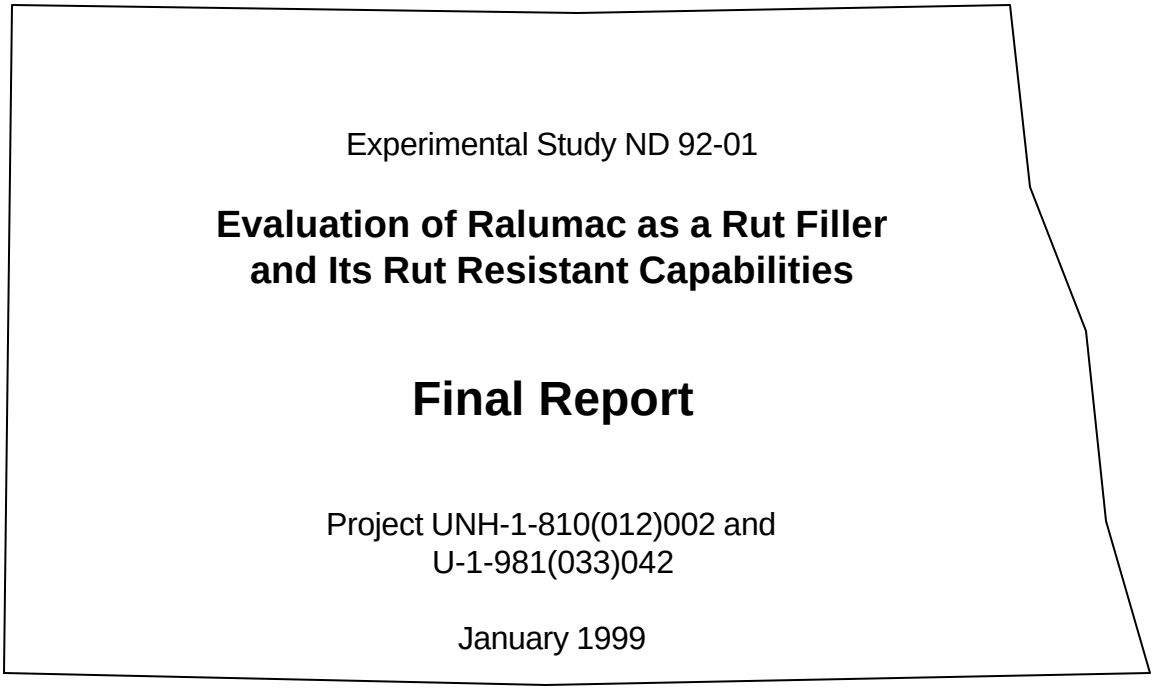
**NORTH DAKOTA**
**DEPARTMENT OF TRANSPORTATION**

# MATERIALS AND RESEARCH DIVISION



Experimental Study ND 92-01

## Evaluation of Ralumac as a Rut Filler and Its Rut Resistant Capabilities

## Final Report

Project UNH-1-810(012)002 and
U-1-981(033)042

January 1999


**Prepared by**

**NORTH DAKOTA DEPARTMENT OF TRANSPORTATION**
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**Ron Horner**

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

# EXPERIMENTAL PROJECT REPORT

**EXPERIMENTAL PROJECT**

EXPERIMENTAL PROJECT NO.

| | STATE | YEAR | | NUMBER | SURF |
|---|---|---|---|---|---|
| 1 | ND | 92 | - | 01 | |

CONSTRUCTION PROJ NO
8 UNH-1-810(012)002
U-1-982(033)042

LOCATION
Bismarck, ND
28

EVALUATION FUNDING
1 X HP&R
2 CONSTRUCTION
3 DEMONSTRATION
4 IMPLEMENTATION
48

NEEP NO.
49

PROPRIETARY FEATURE?
X Yes
51 No

**SHORT TITLE**

TITLE
52 Micro-Surfacing - A Rut Resisting Material Used As An Asphalt Rut Filler

**THIS FORM**

DATE
140 0 1 - 9 9

REPORTING
1 INITIAL 2 ANNUAL 3 X FINAL

**KEY WORDS**

KEY WORD 1
145 PAVEMENTASPHALT

KEY WORD 2
167 OVERLAYS

KEY WORD 3
189 Micro-Surfacing

KEY WORD 4
211 Slurry-Seal

UNIQUE WORD
233

PROPRIETARY FEATURE NAME
255 Ralumac

**CHRONOLOGY**

| Date Work Plan Approved | Date Feature Constructed: | Evaluation Scheduled Until: | Evaluation Extended Until: | Date Evaluation Terminated: |
|---|---|---|---|---|
| 01-92 | 08-92 | 07-97 | | 01-99 |
| 277 | 281 | 285 | 289 | 293 |

**QUANTITY AND COST**

QUANTITY OF UNITS
1646
297

UNITS
1 X LIN. FT
2 SY
3 SY-IN
4 CY
5 X TON
6 LBS
7 EACH
8 LUMP SUM
305

UNIT COST (*Dollars, Cents*)
155491.00
306

**AVAILABLE EVALUATION REPORTS**

X CONSTRUCTION
315

X PERFORMANCE

X FINAL

**EVALUATION**

CONSTRUCTION PROBLEMS
1 X NONE
2 SLIGHT
3 MODERATE
4 SIGNIFICANT
318 5 SEVERE

PERFORMANCE
1 EXCELLENT
2 GOOD
3 X SATISFACTORY
4 MARGINAL
319 5 UNSATISFACTORY

**APPLICATION**

1 ADOPTED AS PRIMARY STD.
2 X PERMITTED ALTERNATIVE
320 3 ADOPTED CONDITIONALLY
4 PENDING
5 REJECTED
6 NOT CONSTRUCTED

*(Explain in remarks if 3, 4, 5, or 6 is checked)*

**REMARKS**

321 Ralumac has successfully prevented severe rutting from returning. Some rutting has returned at intersection stop bars. Ralumac is brittle and some spalling results at transverse cracks and around manholes. Ralumac can provide a cost savings of 35% to 50% over a conventional mill and overlay.

700

Form FHWA 1461

Experimental Study ND 92-01

# Evaluation of Ralumac as a Rut Filler and its Rut Resistant Capabilities

## FINAL REPORT

Project UNH-1-810(012)002 and
U-1-981(033)042

January 1999

Written by
Mike J. Marquart

## Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

# TABLE OF CONTENTS

# Evaluation of Ralumac as a Rut Filler and its Rut Resistant Capabilities

## Project UNH-1-810(012)002 and U-1-981(033)042

### NDEP 92-01

## Objective

This project consisted of partially rehabilitating a portion of the Bismarck Expressway which had an existing section consisting of 10 inches of Hot Bituminous Pavement. The objective of this rehabilitation project was to eliminate excessive rutting on a portion of the Bismarck Expressway. The usual method of dealing with wheel ruts is to mill and apply a full-width overlay. The rehabilitation was to use a polymer-modified slurry seal, also known as a micro-surfacing slurry seal, to fill wheel ruts. This method was selected because it was an estimated 35% to 50% savings over mill and overlay, had same day traffic utilization, it proposed to correct major rutting problems, it has a uniform texture and seal, and it had a minor construction time.

## Scope

The North Dakota Department of Transportation (NDDOT) decided to use a micro-surfacing slurry seal to fill the ruts. Besides the micro-surfacing slurry fill and surfacing, traffic marking and other incidentals were included in this project. Ralumac is the brand name of the micro-surfacing slurry seal chosen for this project. Due to the heavy traffic and commercial development in the area of the project and the relatively low cost of the Ralumac, the chip seal coat was eliminated and replaced with a full width Ralumac overlay to reduce the project time. The project work consists of placing Ralumac, a slurry seal micro-surfacing mixture, on an existing rutted pavement.

## Location

The entire project had 2.163 net miles. This included part of the Bismarck Expressway (project number UNH-1-810(012)002) from a point 1,500 feet west of Washington Street, east to Airport Road and some of Washington Street (project number U-1-981(033)042) from a

point 600 feet south of Arbor Avenue, south to Denver Avenue in Bismarck, North Dakota, see Appendix A.

Project UNH-1-810(012)002 included the roadway from Station 32+20 to 123+33. This project repaired the east bound lanes from Station 32+20 to 43+20. Full width repair extended from Station 43+20 to 123+33.

Project U-1-981(033)042 included the roadway from Station 13+75 to 38+00. This project repaired the full width of the roadway from Station 13+75 to 26+75. The east curb lane was repaired from Station 26+75 to 38+00.

## Project History

### Construction

This project was constructed in the early 80's. The typical section was four 2.5 inch lifts of class 25 Hot Bituminous Pavement (HBP) for a total of 10 inches. The subgrade was scarified to a depth of 6 inches and recompacted.

### Traffic

The Bismarck Expressway is functionally classified as a major arterial. The traffic and design data for this project was taken from the plans and is shown in Table 1.

| Traffic | Average Daily | | | | ESAL Flex. |
|---|---|---|---|---|---|
| | Passenger | Trucks | Total | Est. 30th Max. Hour | |
| Current (1991) | 19300 | 1000 | 20300 | 2030 | 500 |
| Design Speed 35 MPH | | | | | |
| Traffic Classification "M" | | | | | |
| Minimum Sight Distance (Stopping) 240 feet | | | | | |

**Table 1**

Traffic data on this project has been broken into three segments and is shown in tables 1a, 1b and 1c.

| Year | Pass | Trucks | Total | Flex ESALs |
|---|---|---|---|---|
| 1992 | 19,200 | 775 | 19,775 | 350 |
| 1998 | 22,800 | 575 | 23,375 | 360 |
| Expressway ---- Between Washington and 7th Street | | | | |

**Table 1a**

| Year | Pass | Trucks | Total | Flex ESALs |
|---|---|---|---|---|
| 1992 | 20,000 | 490 | 20,490 | 300 |
| 1998 | 21,225 | 490 | 21,715 | 310 |
| Expressway ---- Between 7th Street and 9th Street | | | | |

**Table 1b**

| Year | Pass | Trucks | Total | Flex ESALs |
|---|---|---|---|---|
| 1992 | 15,700 | 480 | 16,180 | 290 |
| 1998 | 17,275 | 480 | 17,755 | 360 |
| Expressway ---- Between 9th Street and 12th Street | | | | |

**Table 1c**

## Design

When pavements have developed deep wheel ruts, corrective measures usually include a design to mill and apply a full width overlay. Ralumac was selected because it was an estimated 35% to 50% savings over mill and overlay. It also had same day traffic utilization, provided a uniform texture and seal, and had a minor construction time.

Ralumac micro-surfacing is a tough and durable thin overlay material. It is a combination of emulsified asphalt, mineral aggregate, mineral filler, and water. The emulsified asphalt is a cationic emulsion modified with natural latex rubber. The mineral aggregate is usually a hard, high polished, slow-wearing aggregate such as crushed granite, slag, limestone, chat, or crushed sand stone. Non-air entrained portland cement, hydrated lime, or any other approved mineral filler that is lump free can be used as the mineral filler in the mixture. The water must be potable and free from harmful soluble salts.

Cationic emulsions are in micro-surfacing slurry seals. They have a great proclivity for a variety of damp aggregates whether they are basic or acidic. Cationic emulsions release water faster than anionic emulsions which results in a faster break and a rapid cure. Cationic emulsions also possess good anti-stripping properties.

## Construction

The main problem with this roadway was the excessive rutting in the wheel paths. A study was conducted and showed that the rutting did not extend into the subgrade. Further, the study showed that most of the rutting occurred in the upper two lifts of the existing bituminous pavement.

The area to be surfaced was thoroughly cleaned by sweeping prior to application of the Ralumac. The material was mixed with a self-propelled Micro-surfacing machine. The machine was a continuous flow mixing unit that was able to deliver and proportion the aggregate, emulsified asphalt, mineral filler, field control additive and water to its revolving multi-blade twin shafted mixer. The machine is shown in photo 1. Photo 2 shows the spreader box and what Ralumac looks like. Photo 3 shows that Ralumac is a brown slurry which later turns black. A finished look of the project from 18th street westbound is shown in photo 4.

**Photo 1. Micro-Surfacing Machine**

**Photo 2. Continuous flow of the Ralumac slurry into the spreader box**

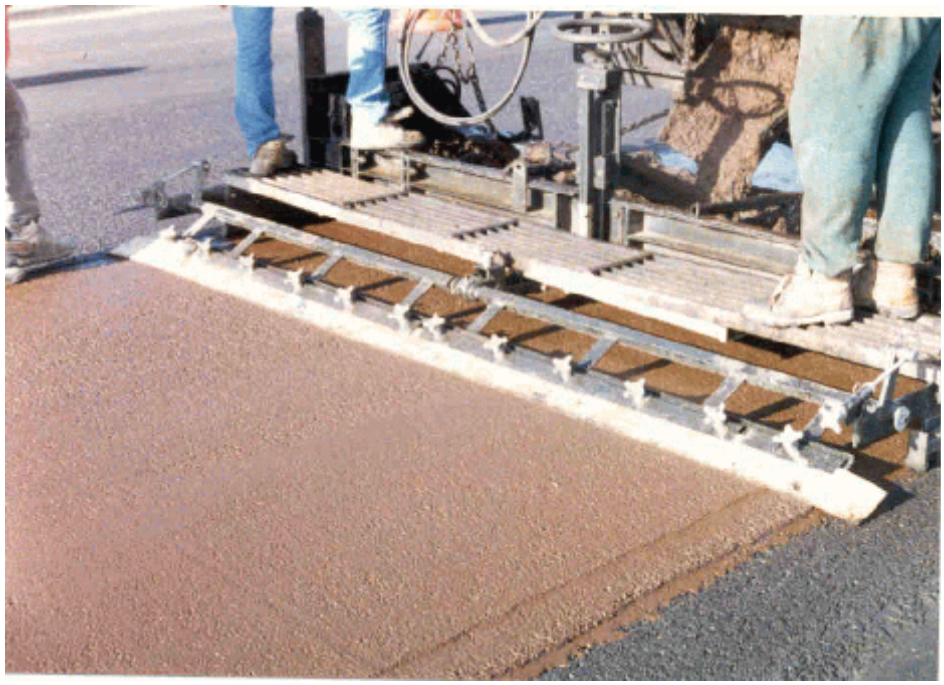


**Photo 3. Ralumac slurry is brown and within a few minutes it turns black**


**Photo 4. Finished project looking west from 18th street on Expressway**

Although the initial appearance of the Ralumac was a bit unusual, the appearance of the final product was satisfactory. The Ralumac was easy to place and resulted in a short construction period. Special Provision - 207 controlled all work related to the Ralumac project. A copy of the Special Provision is found in Appendix B.

## Final Evaluation

Overall the Ralumac project is in good condition. Problems with the Ralumac were encountered during the first winter season. Ralumac surrounding the manhole rings was breaking away. The reason this happened was that Ralumac is brittle and broke away when snowplows contacted the manhole rings. Another problem that developed on this project was with the pavement marking tape. The tape would come loose and lift the Ralumac beneath the tape along with it and create a small pothole. It was suggested that the adhesive strength of the tape was stronger than the tensile strength of the Ralumac. These areas were repaired with an all weather paving and patching compound.

The Ralumac has prevented the severe rutting from returning, thus achieving its intended purpose. In 1994 the project received an average distress score of 88.5. This is a good rating. The ride and rutting were also in the good category. During the fourth and fifth year of service, the Ralumac still was not rutting much, except at some stop-bars as shown in photo 5.

**Photo 5. Bismarck Expressway --rutting at stop-bars at 9th St.---W.B.**

**Photo 6. Typical transverse crack ---patched**

Stresses imposed on the pavement from vehicles stopping and accelerating are causing the rutting. The wearing surface of the Ralumac looks good. The wheelpaths have been worn and have a shiny appearance. Other than the transverse cracks, the ride on this project is considered to be good. Transverse cracks are open and many are spalling. Bismarck city crews have been patching the spalled areas and small potholes. A typical transverse crack is shown in photo 6. An area were Ralumac material was lost due to spalling is shown in photo 7.

**Photo 7. Spalling has resulted in the lost of Ralumac material**

This spalling usually takes place in the wheelpaths where they cross a transverse crack. The Bismarck Expressway is heavily traveled. The Bismarck maintenance crews have been sealing transverse cracks and have stated the difficulty they had in sawing or routing the cracks. The crew said that when routing was performed, the edges of the crack would break off. They claim that the Ralumac is brittle and compare it to concrete. This Ralumac is hard on their cutting edges. The maintenance crew for the city of Bismarck hope that this project would be the last using Ralumac. The city Engineering Department likes the performance they have received from Ralumac.

The west end of the project seems to be in the better condition. The east end has more crack spalling and stop bar rutting from Kirkwood Mall area to 12th street. Photo 8 shows a closer look at the present condition of the Ralumac.

**Photo 8. Present texture of Ralumac -- wheelpath and between**

This photo was taken in the westbound lane at 2nd street. Notice the wear in the wheelpaths. The rougher texture is in between the wheelpaths or to the outside of the lane.

A sewer line problem developed from 19th street westward on Bismarck Expressway. This area was subcut and rebuilt in July of 1996. The repair section was topped with a Hot Bituminous Pavement. It was approximately 370 feet in length and covered both roadways from 19th street westward. Photo 9 shows the repair section. Photo 10 shows where the Ralumac meets the repair section. The repair section is performing satisfactory so far and has no cracking.

**Photo 9. Subgrade repair section -- measuring Ralumac thickness**

**Photo 10. Line indicates where subgrade repair begins+ 370 feet**

Photo 11 is a view of Bismarck Expressway looking west from near 18th street. This photo was taken on April 7, 1998. Compare it to photo 4 of this report which was taken soon after construction in 1992. To compare Ralumac to an asphalt pavement, a photo was taken east of airport road. Photo 12 is taken on Expressway from 22nd Street looking east. This asphalt pavement has tighter transverse cracks and no spalling compared to the Ralumac section. This section is on high ground and may consist of different soil types. The subgrade in the Ralumac and asphalt sections are similar and were constructed in 1985.

**Photo 11. Looking west from near 18 th street–April 7, 1998**


**Photo 12. Asphalt east of airport road -- looking east from 22 nd street**

At one time Ralumac extended from Bismarck Expressway north on Washington Street. The north side of that intersection was redesigned and replaced with asphalt. New businesses were located on the northeast corner and this caused the redesign of the intersection. It did not have anything to do with Ralumac failing.

Data obtained from the Pathway Road Profiler was evaluated and is shown in the following tables. The rut and ride ratings that were used are also shown.

## Bismarck Expressway Ride Data

**From Washington Street to Airport Road**

| | Eastbound | | | | | | Westbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Laser Ride Index percent (post 1996)** | | | **Ultrasonic Roughness Index percent (pre 1997)** | | | **Laser Ride Index percent (post 1996)** | | | **Ultrasonic Roughness Index percent (pre 1997)** | | |
| **Y** | **Poor** | **Fair** | **Good** | **Poor** | **Fair** | **Good** | **Poor** | **Fair** | **Good** | **Poor** | **Fair** | **G** |
| **1** | N/A | N/A | N/A | 65 | 24 | 11 | N/A | N/A | N/A | 64 | 19 | 1 |
| **1** | 44 | 17 | 39 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N |
| **1** | 49 | 32 | 19 | N/A | N/A | N/A | 55 | 30 | 15 | N/A | N/A | N |

Since the arrival of the new Pathway Road Profiler in 1997, the 1997 Ride Index and IRI may show an improved roadway. The 1996 data cannot be compared with the 1997 or 1998 data.

(Different methods were used to compute the IRI).

**Table 2**

Ride score readings were averaged every 100 feet and totaled about 80 points. The percentages found in table 2 are based on how many points fell in each ride rating. For example, in the eastbound lane for 1996, 65% of the points received a poor rating. In 1997 the eastbound lane improved for a rating of 44%. This improvement is due to a new ride rating system and road profiler. The ride on the Ralumac is not as bad as the table indicates. The total Ride Index is influenced by each transverse crack. Most of the roughness is at the cracks and patches.

| | Rut Rating (In.) | Ride Rating |
|---|---|---|
| **Excellent** | 0.004 - 0.10 | > 4.00 |
| **Good** | 0.10 - 0.25 | 3.25 - 4.00 |
| **Fair** | 0.25 - 0.50 | 2.50 - 3.24 |
| **Poor** | < 0.50 | < 2.50 |

Many ride scores have improved in 1997. This is due to new equipment that was purchased. The new Pathway Road Profiler replaced the PaveTech van. The readings from the old ultrasonic sensors on the PaveTech van were impacted by wind, noise, water, and texture of the road surface. The Pathway Road Profiler uses laser sensors in combination with the ulrasonic sensors. Many of these influencing factors have been eliminated or minimized. Beginning in 1997 the heading "Roughness Index" has been changed to "Ride Index".

Rut depths ranged from 0.03" to 0.74". The deepest rutting is taking place at the stop bars at 12th street, 9th street, 7th street, and 3rd street. The same 100 foot sections, for 80 points, were averaged and applied to the rut rating. The eastbound lane had four areas in 1996 where ruts were greater than 0.25" deep. In 1997 there were 6 areas that had ruts greater than 0.25" and 10 areas in 1998. The westbound lane had only three areas with ruts deeper than 0.25" in 1996 and 9 areas in 1998. These are rut depths collected by either the PaveTech van or the Pathway Road Profiler. The rut depths at the stop bars by the traffic control lights are not included in the rut depths mentioned earlier. Rut depths at the stop bars at 9th street westbound, range from 0.25 to 1 inch. Refer back to photo 5. For the most part, the Ralumac has prevented rutting from returning.

Skid testing was conducted on the Ralumac in 1993. A skid number of 35 is generally considered the minimum desirable skid resistance value. The Ralumac received an average number of 36 and had been in service for a year. Surrounding asphalt sections had an average skid number of 30. Skid testing was not accomplished after 1993. It is assumed that Ralumac will have higher skid values than near-by asphalt.

## Cost

The rutting on the Bismarck Expressway was anticipated to be in the upper 4 1/2 inches of the pavement. The usual rehabilitation would be to mill and overlay. To mill 4 1/2 inches of pavement and overlay with Class 33 HBP would cost the following.

| Operation | Estimated Cost |
|---|---|
| Milling | $90,500.00 |
| Class 33 HBP | $271,500.00 |
| Asphalt Cement | $130,320.00 |
| Seal Coat | $66,818.28 |
| General Contract | $267,165.23 |
| **Total** | **$826,303.51** |

**Table 3**

There were three rehabilitation options that incorporated the use of Ralumac during the project concept stages. They were; Ralumac rut filling only, Ralumac rut filling with a Ralumac overlay, and Ralumac rut filling with a standard seal coat. The Ralumac rut filling with a standard seal coat selected for this project. Due to the high cost of subcontracting the seal coat, it was decided to issue a change order for the Ralumac overlay. This option was estimated to increase the total cost of the project by $9,500.00.

| Ralumac Rut Fill Only | | Ralumac Rut Fill & Overlay | | Ralumac Rut Fill & Seal Coat | |
|---|---|---|---|---|---|
| Operation | Estimated Cost | Operation | Estimated Cost | Operation | Estimated Cost |
| Rut Filling | $155,491 | Rut Filling | $155,491 | Rut Filling | $155,491 |
| General Contract | $267,165 | Ralumac Overlay | $91,070 | Seal Coat | $66,818 |
| Temp. Pavement Marking | $14,908 | Temp. Pavement Marking | $14,908 | Utility Adjustment | $7,500 |
| | | General Contract | $267,165 | General Contract | $267,165 |
| | | Utility Adjustment | $7,500 | | |
| **Total** | **$407,747** | **Total** | **$506,300** | **Total** | **$497,000** |

As can be seen in the above numbers, the selected Ralumac rut filling and overlay was approximately 62% of the milling and overlay. The Ralumac rut filling was 49% of the milling and overlay and the Ralumac rut filling with seal coat was 60% of the milling and overlay. Thus, a Ralumac rehabilitation procedure can be expected to save 35% to 50% of the cost of conventional rehabilitation procedures. This is a substantial savings.

## Summary

The Bismarck Expressway was rehabilitated due to excessive rutting on portions of the project. Ralumac, a Micro-surfacing product, was selected to rehabilitate this project. Ralumac was a cost effective solution to the rehabilitation problems on the Bismarck Expressway. Minor problems were encountered with its use, which primarily is brittleness and some color appearance. Ralumac is outstanding as far as ease of construction and overall project time.

Ralumac has performed well with few negative aspects. The Ralumac has prevented the return of the severe rutting on the project except at stop bars at some intersections. The Ralumac is brittle and tends to spall at the transverse cracks. It is hard to route and acts like concrete, according to city work crews.

The Ralumac received a ride rating in 1998 which borders the poor to fair rating. The project was given a good rut rating with the worst rutting found at stop bars. Ralumac still has a rather rough surface texture except in the wheelpaths where it is worn. No skid resistance tests were conducted after 1993, but skid numbers were estimated to be satisfactory. A skid number of 35 is generally considered the minimum desirable skid resistance. In 1993 the Ralumac received an average skid number of 36 and had been in service for a year. Surrounding asphalt sections received an average skid number of 30. It is assumed that Ralumac sections will have higher skid values than near-by asphalt sections.

Although the pavement marking tape is not an experimental product, problems did exist between the Ralumac and pavement marking. A 35% to 50% savings has been experienced by using Ralumac over a mill and overlay procedure. Performance of the Ralumac has been satisfactory.

## Recommendations

Ralumac should be considered to rehabilitate projects that are excessively rutted based on past performance. The underlying support structure should be in good condition for best performance from the Ralumac. With benefits like ease of construction, overall project time, and a 35% to 50% savings over conventional rehabilitation, its use would be very beneficial.

# APPENDIX A

JOB# 8

| ITMA REGION | STATE | PROJECT | SHEET NO. |
|---|---|---|---|
| 8 | N.D. | UNH-1-810(012)002<br>U-1-981(033)042 | 1 |

## DESIGN DATA

| Traffic | Average Daily | | | Est. 30th Max. Hr. |
|---|---|---|---|---|
| Current (1991) 19300 | Pass. 1000 | Trucks 20300 | Total | 2030 |
| Forecast (2011) 32600 | Pass. 1300 | Trucks 33800 | Total | 3380 |
| Design Speed | MPH 35 | | | |

Traffic Classification "M"
Minimum Sight Distance (Stopping) 240'

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

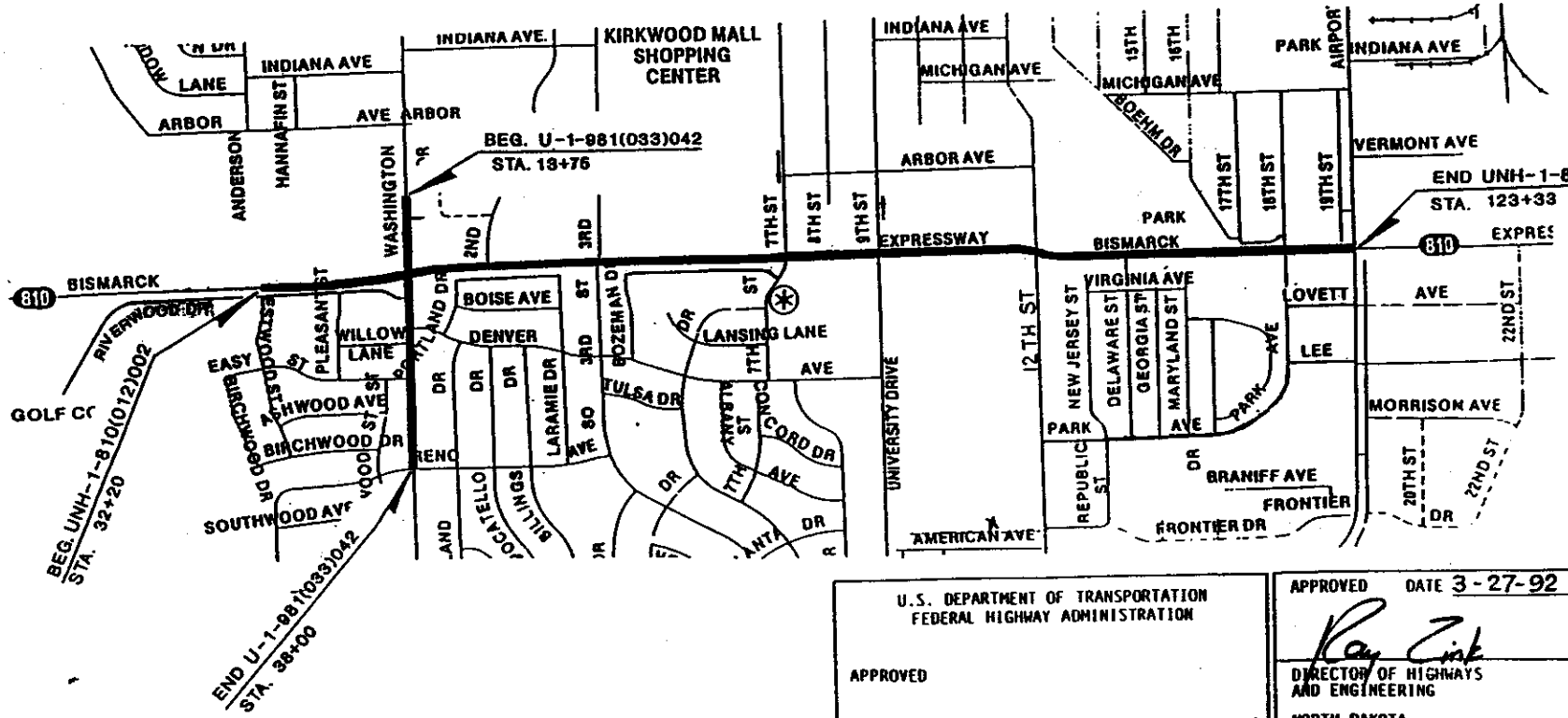
# BURLEIGH COUNTY
## UNH-1-810(012)002 & U-1-981(033)042
## RALUMAC MICRO SURFACING of WHEEL RUTS
## SEAL COAT, MARKING & INCIDENTALS

GOVERNING SPECIFICATIONS:

Standard Specifications for Road and Bridge Construction, adopted by the North Dakota State Highway Department, November 1986, shall apply to all North Dakota Department of Transportation contracts, standard drawings currently in effect, and other contract provisions submitted herein.

LENGTH OF PROJECT

| Project | Miles-Gross | Miles-Net |
|---|---|---|
| F-1-810(012)002 | 1.726 | 1.726 |
| M-1-981(033)042 | 0.466 | 0.437 |




U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED

DIVISION ADMINISTRATOR DATE

APPROVED DATE 3-27-92

DIRECTOR OF HIGHWAYS AND ENGINEERING
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

RAY ZINK REGISTERED PROFESSIONAL ENGINEER

A-1

# APPENDIX B

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

RALUMAC MICRO-SURFACING

PROJECTS UNH-1-810(012)002 AND U-1-981(033)042

JUNE 19, 1992

## DESCRIPTION

This work consists of placing Ralumac, a slurry seal micro-surfacing, on an existing rutted pavement. The micro-surfacing shall be a mixture of modified cationic asphalt emulsion, mineral aggregate, mineral filler, field control additive, and water properly proportioned, mixed, and spread on the paved surface.

## MATERIAL

### A. General

Materials will be accepted according to Section 105.06 of the Standard Specifications. Sampling and testing will be performed by the Engineer during the course of the work and any material found to be defective may be rejected.

### B. Emulsified Asphalt

The modified emulsified asphalt used to produce the Ralumac is a product of:

Koch Materials Company
901 Burlington Road
Saginaw, Texas 76179
Contact Person: Bill Wilkins
Telephone Number: 817-232-4441

Emulsified asphalt shall be modified with natural rubber latex, co-milled into the base asphalt at the plant, and meet the following requirements:

## Specification for Modified Emulsified Asphalt

| Test on Modified Emulsified Asphalt | Min | Max |
|---|---|---|
| Viscosity, Saybolt Furol, 25°C (77°F), Sec. AASHTO T59 | 20 | 100 |
| Particle charge test, AASHTO T59 | Positive | |
| Sieve test, percent, AASHTO T59- | - | 0.1 |
| Storage Stability test, one day, % AASHTO T59 | - | 1 |
| Settlement, 5 day, %, AASHTO T59 | - | 5.0 |
| Distillation: | | |
| Oil distillate, by volume of emulsion, % AASHTO T59 | - | 0.5 |
| Residue, %, AASHTO T59 | 62 * | |
| **Test on Residue from Distillation: **** | | |
| Penetration, 77°F, 100 g, 5 sec, AASHTO T59 | 40 | 80 |
| Ductility, 77°F, 5 cm/min, cm, AASHTO T59 | 50 | - |
| Solubility in trichloroethylene, %, AASHTO T59 | 97 | - |
| Softening Point, R & B, °F, AASHTO T53 | 135 | - |
| Viscosity, absolute 60°C (140°F), poise, D2171 | 8000 | - |
| Ash in Bituminous Materials, %, AASHTO T59 | - | 2.5 |

* Residue by distillation (Aluminum Alloy Still per AASHTO T59), 350°F maximum temperature 20 minutes commonly referred to as "Texas Modified Distillation."

** Residue by evaporation (California Method 331) may be used and will be the referee test in the event of properties non-compliance on residue obtained from the distillation procedure.

The modified emulsified asphalt shall be so formulated that when the paving mixture is applied at a thickness of one inch the material will cure sufficiently so that rolling traffic can be allowed in one hour with no damage to the surface, provided the temperature is above minimum specification and the humidity is not above 50%.

C. Aggregate

The mineral aggregate used shall be 100% crushed material and shall be crushed from 3/4" plus rock. The aggregate source shall be approved by Koch Materials Company and shall meet the following requirements:

## Aggregate for Micro-Surfacing

Gradation, Washed AASHTO T11, T27

| Sieve Size | Percent Passing |
|---|---|
| 3/8" | 100 |
| No. 4 | 70-90 |
| No. 8 | 45-70 |
| No. 16 | 28-50 |
| No. 30 | 19-34 |
| No. 50 | 12-25 |
| No. 100 | 7-18 |
| No. 200 | 5-15 |

| | Min | Max |
|---|---|---|
| Sand Equivalent, ASTM 2419, % | 65* | |
| Methylene Blue | | 15* ** |
| Soundness: AASHTO T104 | | |
| Sodium Sulfate 4 Cycle, % | | 18 |
| Magnesium Sulfate 4 Cycle, % | | 25 |
| Hardness, AASHTO T96, % (Parent Aggregate) | | 35 |

* Used as a general guideline. May be waived if past satisfactory performance dictates.

** Test procedure provided by Koch Materials Company

D. Water

The water shall be potable and shall be free of harmful soluble salts.

E. Mineral Filler

A recognized brand of non-air-entrained portland cement shall be introduced into the aggregate as a mineral filler. The amount of mineral filler needed shall be determined by the laboratory mix design and will be considered as part of the material gradation requirement. Any changes or substitutions shall be approved by the designing laboratory.

F. Micro-Surfacing Mix Stability and Field Mix Control Additive

The micro-surfacing mixture shall be homogeneous during and following mixing and spreading. The micro-surfacing mix shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. To maintain mixture stability, a liquid field control additive approved by the emulsion producer may be introduced to provide effective control of the required quick-set properties. (PERAL 417 is the only additive currently approved for use on the project.)

## MIX DESIGN

Before work commences, the Contractor shall submit to the NDOT Materials and Research Division a signed mix design covering the proportions of emulsified asphalt, aggregate, and mineral filler to be used on the project. This design shall be performed by a qualified laboratory and be approved by the Materials and Research Engineer. Compatibility of the aggregate, mineral filler and emulsified asphalt shall be verified by the mix design. All component materials used in the mix design shall be representative of the material proposed by the Contractor for use on the project. Once the materials are approved, no substitution will be permitted unless first tested and approved by the laboratory preparing the mix design.

The laboratory performing the mix design shall also provide test results and certify that the modified emulsified asphalt and the aggregate meet the specified requirements.

## EQUIPMENT

### A. General

Equipment shall be specifically designed for micro-surfacing work.

### B. Mixing Equipment

The material shall be mixed by a self-propelled micro-surfacing mixing machine which shall be a continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, field control additive, and water to a revolving multi-blade twin shafted mixer and discharge the mixed product on a continuous flow basis. In addition, the machine shall:

1. have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, field control additive, and water to maintain an adequate supply to the proportioning controls between supply vehicle exchange,

2. be equipped with loading devices which provide for the loading of materials while continuing to apply micro-surfacing,

3. be equipped with opposite side driving stations to optimize longitudinal alignment, and

4. be equipped to allow the operator to have full control of the forward and reverse speed during application of the micro-surfacing material.

The self-loading devices, opposite side driving stations and forward and reverse speed controls shall be original equipment manufacturer design.

Each mixing unit shall be calibrated in the presence of the Engineer before being used on the project. Previous calibration documentation

covering the exact materials to be used may be acceptable provided they were made during that calendar year. Documentation shall include the individual calibration of aggregate, mineral filler, and emulsified asphalt at various settings, which can be related to the machine proportioning devices to verify the application rate and mix design compliance.

C. Proportioning Device

Individual volume or weight controls for proportioning each raw material to be added to the mix shall be provided and properly marked. These proportioning devices can be revolution counters or similar devices to be used in material calibration, determining the mix design dial and gate settings, and calculating the materials output at any time.

D. Spreading Equipment

The micro-surfacing mixture shall be spread uniformly by means of a mechanical spreader box attached to the paver, equipped with rotating paddle or spiral auger shafts to agitate and spread the material throughout the box. A front seal shall be provided to ensure no loss of the mixture at the road contact point. The rear seal shall act as the final strike off and shall be adjustable. The mixture shall be spread to fill cracks and minor surface irregularities and leave a uniform friction resistant application of material on the surface. The spreader box and rear strike off shall be so designed and operated that a free flow of material to the rear strike off is achieved.

The longitudinal joint where two passes join shall be lapped a maximum of two inches or butted to provide a uniform joint. The spreader box shall have suitable means provided to side shift the box to compensate for any change in longitudinal alignment.

E. Scale

The scale shall meet the requirements of Section 151.07 of the Standard Specifications.

CONSTRUCTION REQUIREMENTS

A. Stockpile

Precautions shall be taken to insure that stockpiles do not become segregated or contaminated. The mineral aggregate shall be tested according to AASHTO T-27 after being delivered from St. Cloud.

B. Surface Preparation

The area to be surfaced shall be thoroughly cleaned by sweeping or with compressed air. Manholes, valve boxes and other service entrances shall be protected from the micro-surfacing mix.

C. Application

1. General

The surface should be pre-wetted by fogging, with water, ahead of the spreader box. The rate of application of the fog spray shall be adjusted during the day to suit temperatures, surface texture, humidity, and dryness of the pavement.

The micro-surfacing mixture shall be of the desired consistency upon exiting the mixer and no additional materials shall be added. A sufficient amount of material shall be carried in all parts of the spreader box at all times so that complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumps, balls or unmixed aggregate shall be permitted. The material shall not be segregated.

Streaks, such as those caused by oversize aggregate, will not be allowed in the finished surface. If excessive streaking or drag develops, the construction operation shall cease until the Contractor proves to the Engineer that the situation has been corrected. Ruts greater than 1 1/2 inch in depth shall be filled by two passes of the paver. Ruts deeper than one inch and areas where hard, sharp turning and braking occur may require additional cure time.

2. Weather Limitations

Material shall be spread only when the road surface and atmospheric temperatures are at least 50°F and rising and the weather is not foggy or rainy and temperatures are not expected to drop below 32°F within 48 hours from the time of placement.

3. Joints

No excessive buildup, uncovered areas, or unsightly appearances shall be permitted on longitudinal or transverse joints. The contractor shall provide spreading equipment wide enough to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. If half passes are used, they shall not be the last pass of any paved area.

4. Hand Work

Areas which cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide completed and uniform coverage. Handwork shall be completed before or at the time of the machine application. The area to be handworked shall be lightly dampened with water prior to mix placement. The same type of finish as applied by the spreader box shall be required. Care shall be exercised to minimize unsightly appearance from handwork.

5. Lines

Care shall be taken to insure straight lines along curbs and shoulders. Runoff onto the curbs and shoulders will not be permitted. Lines at intersections shall be kept straight to provide good appearance.

6. Curing

Adequate means shall be provided to protect the micro-surfacing from traffic until the new surface will support the traffic without damage. Any damage done by traffic to the micro-surfacing shall be repaired by the contractor. All excess material shall be removed from the job site before restoring traffic to the surfaced area.

METHOD OF MEASUREMENT

A. Ralumac Micro-Surfacing

Ralumac Micro-Surfacing will be measured by the Ton of micro- surfacing mixture used. The weight of the micro-surfacing material shall be determined by the total weight of aggregate and mineral filler used on the project. The moisture content of the aggregate will not be measured and no deduction will be made for moisture content in the aggregate. The liquid field control additive used to maintain mix stability will not be measured for payment, but will be incidental to the price bid for Ralumac Micro-Surfacing.

B. Latex Modified Emulsified Asphalt

Latex Modified Emulsified Asphalt will be measured by the Gallon.

BASIS OF PAYMENT

The accepted quantities measured as provided above will be paid for at the Contract Unit Price for the following:

| Pay Item | Pay Unit |
|---|---|
| Ralumac Micro-Surfacing | Ton |
| Latex Modified Emulsified Asphalt | Gallon |

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.