RESULTS OF THE QUESTIONNAIRE:

"USE OF CHIP SEAL EMULSIONS CONTAINING POLYMER MODIFIED ASPHALTS".

by

Lewis G. Scholl
Research Coordinator

and

Bo Miller
Research Specialist

Research Unit
Materials and Research Section
Highway Division
Oregon Department of Transportation

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AUTHOR

Lewis G. Scholl and Bo Miller

PERFORMING ORGANIZATION (NAME AND ADDRESS)

Oregon Department of Transportation
Highway Division, Research Unit
800 Airport Rd., SE Salem, OR

SPONSORING AGENCY (NAME AND ADDRESS)

Same as above

ABSTRACT

A guestionnaire was distributed to materials engineers in all 50 states and 3 FHWA Direct Federal Divisions. The report summarizes the responses from 47 states and 2 Direct Federal Districts concerning their use of polymerized asphalt emulsions for chip seals.

KEY WORDS	LOCATION
Asphalt emulsions Polymers Chip seal	Materials Library
TYPE	CATEGORY

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1.0 INTRODUCTION

In 1987 the Oregon State Highway Division constructed a series of chip seal test sections using seven different polymer modified emulsions and two types of conventional emulsions. It was intended that the study of this project would help to guide future policy.

Although this study has provided some preliminary results (1), it was decided that further information was needed to make policy decisions. A questionnaire on emulsion use, it was hoped, would provide further data to supplement information provided by the test sections. It was desired that test data could be collected to either confirm or deny conclusions of the test section study.

The questionnaire was sent to the materials engineers of all 50 states and the three Direct Federal Divisions of the Federal Highway Administration. Forty-seven states and two Direct Federal Divisions responded. The four non-respondents were: Alaska, Nevada, Tennessee, and the Western Direct Federal Division of the Federal Highway Administration. Nevada was contacted by telephone and indicated that they recently constructed 18 miles of test sections.

Note:

(1) A report on these test sections on Oregon Route 22 will be published in early 1989.

2.0 SUMMARY

2.1 Significant Findings

Although no firm conclusions about relative product performance can be made from this survey, the following information was derived.

1.) Although most respondents having experience with polymers agree that they have some benefits, few users were willing to commit beyond experimental use. 90% of all chip seal users have used polymers at least experimentally, while less than 25% have gone beyond experimental use.

2.) All respondents reporting test sections with more than one polymer were still evaluating the performance reports and there were no clear conclusions recommending any particular product over another. These states might have good information in the future: Virginia, South Carolina, Delaware, Nevada, and Oregon.

3.) Respondents reporting one polymer compared against a control showed mixed results concerning cost-effectiveness. These states were: Florida, Minnesota, Vermont, Connecticut, Iowa, Illinois, and Montana.

4.) Improved chip retention, both short and long term, was the most common reason for using polymer modified emulsions. About two-thirds of the chip seal users cited chip retention as the reason for polymer use.

5.) Those who did not use polymerized emulsions generally felt that they are not cost-effective or were satisfied with standard emulsions.

6.) Those who did use polymerized emulsions cite the following reasons for use.

   a) Greater initial aggregate retention can reduce the costs and public inconvenience of vehicle damage such as broken windshields.

   b) Greater initial aggregate retention can allow traffic on the freshly placed chip seals sooner with a reduction in traffic control costs and driver inconvenience.

   c) Greater initial aggregate retention can cut the costs of choking, brooming, and other remedial maintenance.

   d) Greater long term aggregate retention can extend the life of chip seals and provide better resistance to snow plow damage.

e) Better seals placed in colder and wetter weather could allow a relaxation of the specifications for moisture and temperature requirement during placement. This could allow a longer chip sealing season and possibly a drop in the contractor's bid prices.

f) The use of polymers may allow the use of dustier and dirtier aggregate and result in a drop in the average unit price of rock.

g) Improved crack sealing and resistance to bleeding may extend the range of pavement distress that can be properly chip sealed, and consequently, reduce the need for expensive overlays.

2.2 Data Summary

Organizations Responding - 49 respondents

Of the 49 responding organizations, including Oregon:

- **86%** use chip seals,
- **18%** require polymers in chip seal emulsions,
- **20%** allow polymers in chip seal emulsions as an option, and,
- **53%** have used or are using polymer modified chip seal emulsions experimentally.

Seven respondents do not use chip seals, and fifteen respondents use chip seals but do not use polymerized chip seals.

Organizations Using Polymerized Chip Seals - 38 respondents

Thirty-eight organizations have used or are using polymer modified chip seals on some basis, either as a requirement, an option, or as an experiment.

Reasons for Polymer Use - Short Term

- **13%:** cold weather placement,
- **13%:** wet weather placement,
- **68%:** initial chip retention,and,
- **29%:** dusty or dirty aggregate.

Reasons for Polymer Use - Long Term

- **61%:** chip retention,
- **39%:** reduced bleeding, and,
- **26%:** improved crack sealing.

Number of Users by Product

Product	Number of Users Having Experience with Product
Elf-Aquitane Asphalt "Styrelf" Process	17
Goodyear "Ultrapave"	15
BASF Chemical (formerly Polysar) SBR	10
DuPont "Neoprene"	8
DuPont "Elvax"	6
Styrene Based Co-Polymer (Ductilad D1002)	6
Latexes- no brand name specified	3
Ground Tire Rubber- no brand name specified	3
Dow Chemical polyethylene	2
Styrene-Butadiene Rubber (SBR)- no brand name specified	2
Asphalt Supply and Service	2
BASF Chemical (formerly Polysar) EPDM	2
Dow "Downright"	2
Shell "Kraton" (SBS)	2
Exxon "EX042"	2
Styrene-Butadiene-Styrene (SBS)- no brand name specified	1
Polyisoprene (Vulcanized Natural or Synthetic Rubber)- no brand name specified	1
"Atlos" Rubber	1
Exxon "Polybilt 103"	1
Goodyear "Pliopave L-170"	1
Koch Asphalt Company's CRS-KP and HF-KP	1

Notes:

1) If the user described experience with products from a particular polymer type instead of a brand name, the polymer type is noted.

2) The number of users is not a good gage of product performance. The product sales organization, the geographical availability of the polymer, and the length of time that the product has been available can all affect the number of users.

3.0 RESULTS OF THE QUESTIONNAIRE:

"Use of Chip Seal Emulsions Containing Polymer Modified Asphalts"

3.1 Extent of Polymerized Chip Seal Emulsion Use

In this section, Questions 1 and 2 of the questionnaire are stated and followed by a summary of the results. For Question 2, the results are followed by an abstract of comments provided by the respondents.

Question No. 1: "Do you use chip seals?" yes_____ no_____

-Of the 49 respondents:

- **86%** use chip seals, including Oregon.

Question No. 2: "Do you use polymer modified asphalts in your chip seal emulsions:

- as a requirement?"	yes_____	no_____
- as an option?"	yes_____	no_____
- experimentally?"	yes_____	no_____

-Of the 49 respondents:

- **18%** require polymers in chip seal emulsions,
- **20%** allow polymers in chip seal emulsions as an option, and,
- **53%** have used or are using polymer modified chip seal emulsions experimentally.

-Of the respondents using polymer modified emulsions as a requirement:

The following agencies require polymer modified emulsions in all or some of their chip seals:

Alabama	Michigan	New Mexico
California	Mississippi	Texas
Colorado	Missouri	Utah

An abstract of the comments:

Mississippi - Polymers are specified in chip seals on high traffic volume roads.

Missouri - Requires polymers in chip seal emulsions. Chip seals are used mainly on shoulders and bridge decks.

Texas – Requires polymers in certain chip seal emulsions. About 30% of the chip seal placed this construction season either required or allowed the use of polymers.

-Of the respondents using polymer modified chip seals as an option:

The following agencies use polymer modified asphalt as an option:

Alabama	Louisiana	Texas
Arkansas	Minnesota	Wisconsin
Georgia	Nebraska	
Idaho	Oregon	

An abstract of the comments:

Arkansas – Polymer modified chip seals are used as an option by the individual districts. Some districts use polymer modified emulsions exclusively, and some do not use any.

Georgia – Chip seals using polymers on a "Qualified Products List" are used as an option.

Louisiana – Chip seals using polymers on a "Qualified Products List" can be used, and only on roadways with a maximum ADT per lane of 750.

Minnesota – Most chip sealing is done either under local maintenance contracts or by counties and cities. Polymer modified chip seals are an option.

Texas – See Texas' comments in the "Required Chip Seal Use Section".

-Of the respondents who use or have used polymer modified chip seals experimentally:

The following agencies use or have used polymer modified emulsions experimentally:

Arizona	Louisiana	Oregon
Arkansas	Maine	Pennsylvania
Connecticut	Minnesota	South Corolina
Delaware	Mississippi	Vermont
Florida	Montana	Virginia
Illinois	New Hampshire	Washington
Indiana	North Carolina	West Virginia
Iowa	North Dakota	Wisconsin
Kansas	Oklahoma	

An abstract of the comments:

Arizona	-	Four projects to date.
Arkansas	-	Experience and experimentation with polymer modified emulsions for the last nine years has resulted in a generic specification.
Connecticut	-	Polymer modified asphalt emulsion test sections were constructed in 1986 and are being evaluated.
Florida	-	Two experimental polymer modified chip seals were built in the early 1970's.
Illinois	-	Experiments are underway with polymer modified emulsions and dirty aggregate. Other experimental test sections were built and are performing well after six years.
Iowa	-	A portion of a test project is being evaluated.
Kansas	-	Two experimental polymer modified chip seals were constructed in 1983 and 1988.
Louisiana	-	Polymer modified asphalts must perform well on an experimental basis through both a cold and hot season, for a minimum of 6 months, in order to be put on a "Qualified Products List". In addition, polymer modified emulsions are used experimentally on roadways with an ADT per lane greater than 750.
Maine	-	Some experiments were conducted using natural rubber (melted tires) in chip seals.
Minnesota	-	Polymer modified chip seals have been used experimentally in the last two years on trunk highways in western Minnesota.
Mississippi	-	Two brands of polymer modified emulsions are being evaluated.
Montana	-	One polymer modified chip seal test section is in place.
New Hampshire	-	Some districts have used and are using polymer modified chip seals. Polymer modified emulsions have been tried experimentally.
North Dakota	-	Experiments were conducted with polymers in both standard and high-float emulsions.

Oklahoma	-	One division out of eight used only polymer modified chip seals this season. Polymer asphalt emulsions are occasionally used by maintenance.
Oregon	-	One set of test sections is in place and is being evaluated.
Pennsylvania	-	Polymer modified asphalt chip seals have been in place for two construction seasons.
South Carolina	-	Currently, stone retention is being compared between chip seals constructed with standard and polymer modified asphalts.
Vermont	-	Limited experiments were conducted in 1984 and 1987. However, this season each of nine maintenance districts was directed to use one additional application of polymer modified emulsion.
Virginia	-	A demonstration project using nine polymer modified seals is being constructed. Polymer modified chip seals placed in 1986 and 1987 are being evaluated.
Washington	-	Polymer modified test sections are being evaluated.
West Virginia	-	Polymer modified test sections built in August 1988 are under evaluation.
Wisconsin	-	Polymer modified chip seals were constructed and tested.

3.2 Reasons for Using Polymerized Emulsions

In this section, Questions 3 and 4 of the questionnaire are stated and followed by a summary of the results. For both questions, the results are followed by an abstract of the respondent's comments.

Question No. 3: "If you do not use chip seals or polymer modified asphalts, please state your reasons and return this form."

Of the seven organizations that do not use chip seals as a surface treatment; most either discontinued chip seal use after previous bad experiences, or have pavement maintenance programs using plant mix seals.

Fifteen organizations use chip seals but expressed reservations about polymer modified emulsions. Almost all of these users were either satisfied with their standard emulsions or did not feel that polymer modified emulsions were cost-effective.

-Of the seven respondents who do not use chip seals:

An abstract of the comments:

Hawaii	-	Does not use chip seals due to past failures. The state may consider chip seals in the future, as new types and products are available.
Maine	-	Has a statewide mulching (plant mix seal) program.
Massachusetts	-	Uses an open graded friction course seal. This treatment has been "less subject to the vagaries of climatic conditions, dirty aggregate, bleeding, etc".
New Hampshire	-	This state does not use chip seals. It feels that this treatment is susceptible to snow plow damage and they have a good plant mix seal program.
New Jersey	-	Does not use chip seals due to past failures.
Ohio	-	Does not use chip seals due to past failures.
Rhode Island	-	Does not have money available for chip sealing.

-Of the fifteen respondents who have reservations about polymerized emulsions:

An abstract of the comments:

FHWA Central Direct Federal Division- The division has not yet placed a chip seal in any area where they feel that they could benefit from a polymer.

FHWA Eastern Direct Federal Division- The division has not experienced problems with standard emulsions.

Connecticut - Presently polymer modified emulsions are not considered cost-effective.

Illinois - Polymer modified and non-modified chip seal test sections are performing well after six years. The state feel that in a well constructed chip seal, no benefits from polymers can be seen.

Indiana - Feels that a standard emulsion placed with proper attention to details can give good results. Also feels that polymers provide a greater margin for error but they do not compensate for poor workmanship. The department does not believe the additional cost of polymers to be justified.

Iowa - Unsure if the added cost of polymers in emulsions is justified. Intends to experiment more before establishing a polymer use policy.

Kansas - The department is satisfied with the performance of their standard emulsions. The standard seals have lasted until the roadway becomes rough due to reflective transverse cracking. Seals are used on roadways with an ADT less than 1000.

Kentucky - Chip seals are used as a surface treatment only on shoulders and low traffic volume roads. Does not use polymers in chip seals because of added cost.

Maryland - The D.O.T. is satisfied with their standard emulsions and feels that polymer modified emulsions are not cost-effective.

New York - Occasionally chip seals shoulders, with very little chip sealing overall. This D.O.T. is looking at the polymer modified chip seal experiences of other states. Does not feel that the addition of a polymer is cost effective.

North Carolina - "Cost is probably the main reason for the limited use of this material."

North Dakota - Experiments with polymer modified emulsions produced "no demonstrated benefit".

South Dakota - The department is satisfied with their non-modified high float emulsions.

West Virginia - Polymer modified emulsions tended to remain "sticky" and track in the same manner as the departments non-modified asphalt emulsions. The use of modified emulsions was discontinued.

Wisconsin - The D.O.T. finds polymer modified chip seals effective on a short term basis only. They do not consider polymer modified emulsions cost effective.

Question No. 4: "What are you reasons for using polymer modified rather than non-modified emulsions:

a) Short Term Performance

- cold weather placement?" yes_____ no____
- wet weather placement?" yes_____ no____
- initial chip retention?" yes_____ no____
- dusty or dirty aggregate?"yes_____ no____
- other? Explain." yes_____ no____

Thirty-eight organizations have used or are using polymer modified chip seals on some basis, either as a requirement, an option, or as an experiment. Of these respondents, the following percentages indicated their reasons for using the polymer modified product based on short term performance:

- **13%:** cold weather placement,
- **13%:** wet weather placement,
- **68%:** initial chip retention,and,
- **29%:** dusty or dirty aggregate.

Comments on **"initial chip retention"** include:

Georgia - Limited experience with polymerized emulsions has shown superior chip retention both during and after construction.

Illinois - "Have seen this benefit".

Montana	-	In a test section, a polymer modified chip seal showed superior aggregate retention.
Oregon	-	Maintenance forces use polymerized emulsions regularly, and initial chip retention is one important reason for use. Increased chip retention was observed for some polymer modified chip seals in a test project.
Vermont	-	In a test section, a polymer modified chip seal showed superior aggregate retention.

Comments on **"dusty or dirty aggregate"** include:

Illinois	-	"Experimenting with dirty aggregate, but believe that cost the of polymer would be better spent precoating aggregate."

"Other" comments include:

California	-	"Hot-applied asphalt rubber binder used for night work."
Delaware	-	Several polymers have shown "good bleeding resistance".
Iowa	-	"The use of a polymerized emulsion will allow the relaxation of any requirements associated with aggregate, including required dampness."
Louisiana	-	"Polymer modified emulsions have been found to be more forgiving with respect to application rates."
Montana	-	In a test section, a polymer modified chip seal showed greater resistance to tracking during initial use.
South Carolina	-	A stone retention study is underway.
Texas	-	"One of the benefits... is more rapid cure - the ability to open the roadway to traffic sooner without rock loss. This property seems to be a function both polymer type and emulsifying agent type, dosage, etc. We have a cure rate requirement which has been included on some projects."
Wisconsin	-	Polymer modified chip seals have been effective on a short term basis.

Question No. 4, contd: "What are you reasons for using polymer modified rather than non-modified emulsions:

b) Long Term Performance

- chip retention?" yes_____ no____
- reduced bleeding?" yes_____ no____
- improved crack sealing?" yes_____ no____
- other? Explain."

Of the 38 respondents having experience with polymerized chip seals, the following percentages indicated their reasons for using polymer modified products based on long term performance:

- **61%:** chip retention
- **39%:** reduced bleeding, and,
- **26%:** improved crack sealing.

Comments on **"chip retention"** include:

Delaware - In test sections, there have been mixed results in chip retention compared to control sections.

Louisiana - Polymers tested have shown the ability to retain chips. Some polymers have done this on high volume roads.

Oregon - Long term chip retention is not a significant reason for use. However, higher volume roads have been sealed with polymerized chip seals. These surface treatments may have failed if conventional emulsions were used.

Comments on **"reduced bleeding"** include:

California - Regarding pavement bleeding, the state "may be specifying softening point requirements in the future for this reason but is not currently doing so".

Delaware - Some polymers have given chip seals good bleeding resistance.

Louisiana - Polymers tested have resisted bleeding. Some polymers have done this on high volume roads.

Minnesota - "Have noticed reduced bleeding in our test sections using modified emulsions compared to control sections using the same application rates."

Texas	-	"These (polymer) materials also offer better chance for success when attempting to correct flushed surfaces by sealing with lean shot rates."

Comments on **"improved crack sealing"** include:

Louisiana	-	Polymers tested have shown "self healing (crack sealing) properties". Some polymers have done this on high volume roads.
Oregon	-	Some polymer modified emulsions have shown improved crack sealing ability.
Texas	-	"We have seen some improvement in crack sealing with polymer modified when compared to conventional emulsions."

Comments on **"other"** include:

Colorado	-	Polymer modified emulsions are selected for their better long term performance.
Minnesota	-	Better chip retention under snow plows.
Pennsylvania	-	"Helps prevent snow plow damage."
Utah	-	Polymerized chip seals are chosen due to their resistance to "hot weather rutting".
Wisconsin	-	Polymer modified chip seals have not been effective in long term performance.

3.3 Product Usage and Experiences

In the first part of this section, Questions 5, 6, and 7 are stated as they appeared in the questionnaire.

The second part of this section contains a table listing product names or types and the number of users reporting experience with the product. This table is followed by a listing of the products with both users and comments. The comments are taken from either the questionnaire form or research reports submitted by the user. The items in the list have the same numbering as the chemicals and products shown on the table in Question 5.

3.3.1 Text of Questions 5, 6, and 7

5) Which polymer types do you use in chip seal emulsions? Circle the product name.

I. Thermoplastic Polymers
- A. Polyisoprene (Unvulcanized Natural and Synthetic Rubber)
- B. Polyolefins
  - 1. Polyethelene
    - a. Accorex "Accorex"
    - b. Novophalt "Novophalt"
    - c. Dow Chemical
- C. Polyamides
  - 1. Nylon
    - a. Solar "Laglugal"
- D. Random Copolymers
  - 1. Ethylene-Vinyl-Acetate (EVA)
    - i. DuPont "Elvax"
    - ii. Exxon "EX042"
    - iii. USI "Ultrathene"
- E. Styrene Block Copolymers
  - 1. Physical Cross-link Triblock
    - a. Styrene-Butadiene-Styrene (SBS)
      - i. Shell "Kraton" Rubber
      - ii. American Petrofina "Finaprene"
      - iii. Dow Chemical
    - b. Styrene-Isoprene-Styrene (SIS)
      - i. Shell "Kraton" Rubber
      - ii. Dow Chemical
    - c. Styrene-Ethylene-Butylene-Styrene (SEBS)
      - i. Shell "Kraton" Rubber
  - 2. Chemical Cross-link Diblock
    - a. Styrene-Butadiene
      - i. Elf-Aquitane Asphalt "Styrelf" Process

II. Thermoset Polymers

- A. Polyisoprene (Vulcanized Natural or Synthetic Rubber)
- B. Polychloroprene (Neoprene)
  - 1. DuPont
- C. Random Copolymers
  - 1. Styrene-Butadiene Rubber (SBR)
    - a. Latex
      - i. Goodyear "Ultrapave"
      - ii. BASF Chemical (formerly Polysar)
      - iii. Dow "Downright"
      - iv. Asphalt Supply and Service
    - b. Ground Tire Rubber
      - i. Baker Rubber/Atlos Rubber
    - c. Styrene Based Co-polymer "Ductilad D1002"
  - 2. Ethylene-Propylene Rubber (EPR)
- D. Terpolymers
  - 1. Ethylene-Propylene-Diene Rubber (EPDM)
    - a. BASF Chemical (formerly Polysar)
    - b. Exxon
    - c. DuPont

Parts of this table were copied from:

T.S. Shuler and R.D. Pavlovich, Characterization of Polymer Modified Binders, Research Report 52001-1F, (Albequerque: University of New Mexico, 1987), pp. 60-61.

6) Are there any particular polymer types or products that work best for you?

List and explain.

7) Are there any polymer types that work poorly for you?

List and explain.

3.3.2 Listing of Products with Users and Comments

Number of Users by Product

Product	Number of Users Having Experience with Product
Elf-Aquitane Asphalt "Styrelf" Process	17
Goodyear "Ultrapave"	15
BASF Chemical (formerly Polysar) SBR	10
DuPont "Neoprene"	8
DuPont "Elvax"	6
Styrene Based Co-Polymer (Ductilad D1002)	6
Latexes- no brand name specified	3
Ground Tire Rubber- no brand name specified	3
Dow Chemical polyethylene	2
Styrene-Butadiene Rubber (SBR)- no brand name specified	2
Asphalt Supply and Service	2
BASF Chemical (formerly Polysar) EPDM	2
Dow "Downright"	2
Shell "Kraton" (SBS)	2
Exxon "EX042"	2
Styrene-Butadiene-Styrenes (SBS)- no brand name specified	1
Polyisoprene (Vulcanized Natural or Synthetic Rubber)- no brand name specified	1
"Atlos" Rubber	1

Note: If the user described experience with products from a particular chemical family instead of a brand name, the chemical family is noted. The products and chemical families listed above are found in the table on pages 17 and 18.

These products were not listed in the table:

Exxon "Polybilt 103"	1
Goodyear "Pliopave L-170"	1
Koch Asphalt Company's CRS-KP and HF-KP	1

I.B.1.c. Dow Chemical polyethylene

Users: Minnesota Virginia

Comments:

Minnesota	-	One test section under evaluation.
Virginia	-	Under evaluation.

I.D.1.i. DuPont "Elvax"

Users: Delaware Oregon Virginia
Minnesota Pennsylvania Washington

Comments:

Delaware	-	Product has shown good bleeding resistance. Test sections with a conventional emulsion and asphalts containing "Neoprene" and DuPont "Elvax 150" were placed in 1987.
Minnesota	-	One test section under evaluation.
Oregon	-	One test section under evaluation. At end of one year the product is performing well.
Virginia	-	Under evaluation.
Washington	-	Under evaluation.

I.D.1.ii. Exxon "EX042"

Users: Colorado Pennsylvania

Comments:

Colorado	-	"We have had some problems with Exxon EVA used in a medium setting high float emulsion."
Pennsylvania	-	In use two construction seasons.

I.E.1.a. Styrene-Butadiene-Styrene (SBS)

Users: California

Comments:

California	-	"Are allowed but are not cost competitive."

I.E.1.a.i. Shell "Kraton" Rubber (SBS)

Users: Oregon Pennsylvania

Comments:

Oregon - Under evaluation.

Pennsylvania - In use for two construction seasons.

I.E.2.a.i Elf-Aquitane Asphalt "Styrelf" Process

Users:

Arizona	Louisiana	Pennsylvania
Arkansas	Michigan	South Carolina
Colorado	Mississippi	Texas
Delaware	Missouri	Vermont
Illinois	New Mexico	Virginia
Kansas	Oregon	

Comments:

Arizona - Under evaluation.

Arkansas - "The Styrelf has worked very well for us."

Illinois - "Styrelf modified asphalt does not appreciably improve surface treatment performance. The added cost is not justified by the performance of the Styrelf modified asphalt."

Kansas - Test sections laid down in 1983 and 1988.

Louisiana - Styrelf has "been successful on high speed high volume roadways up to 20,000 ADT/4 lanes. It has the ability to retain chips, not bleed and has indicated self healing (crack sealing) properties. After 1 1/2 years in the field, SBR latex products have demonstrated similar characteristics..."

Michigan - Approxamately 100 miles of chip seal have been placed on state trunk lines using Styrelf.

Mississippi "We have had good results with Styrelf."

Oregon - Styrelf is used by maintenance forces statewide with good results. Better initial chip retention is a reason for use. One test section is being evaluated in comparison to eight other products.

Pennsylvania In use for two construction seasons.

So. Carolina — Under evaluation.

Texas — Compared to SBR latexes, "the Styrelf system seem to be faster curing - better initial rock retention".

Vermont — No problems with Styrelf test section to date. See Vermont's comments on "Ultrapave".

Virginia — Under evaluation.

II.A. Polyisoprene (Vulcanized Natural or Synthetic Rubber)

Users: Pennsylvania

Comments:

In use for two construction seasons.

II.B.1. Du Pont "Neoprene"

Users:

California	Idaho	Washington
Colorado	Oregon	West Virginia
Delaware	Pennsylvania	

Comments:

Delaware — Product has "shown good bleeding resistance". Test sections with a conventional emulsion and asphalts containing "Neoprene" and DuPont "Elvax 150" were placed in 1987.

Idaho — In use in 1988.

Minnesota — Test sections using a conventional asphalt and "Neoprene" were constructed in 1988.

Oregon — One test section is under evaluation. At the end of one year it is performing well. One distributor load of emulsion modified with Neoprene was placed on a job in Southern Oregon. All of the other emulsion used on this project contained "Styrelf". Both of the seals on this project are performing well. However, there was slightly better initial chip retention on the Styrelf section.

Pennsylvania — In use for two construction seasons.

Washington — Under evaluation.

West Virginia "Used polymer modified asphalt as an experimental project to evaluate its performance compared to non-modified asphalt. The material remained "sticky" and tracked in the same manner as the department's regular emulsion."

II.C.1. Styrene-Butadiene Rubber (SBR)

Users: Nebraska New Hampshire

II.C.1.a Latex (SBR)

Users: California North Carolina North Dakota

Comments:

North Carolina "Have experimented with a Latex Emulsion and the results seem to be very encouraging."

North Dakota "No demonstrable benefit" was observed when SBR latexes were added to high-float emulsions and RC-800.

II.C.1.a.i Goodyear "Ultrapave"

Users:

Alabama	Louisiana	South Carolina
Arizona	Michigan	Texas
Connecticut	Mississippi	Utah
Delaware	Missouri	Vermont
Georgia	Pennsylvania	Virginia

Comments:

Alabama - Under evaluation.

Arizona - Under evaluation.

Connecticut "No appreciable difference has been noted to date" between test sections containing "Ultra pave" and non-modified asphalt.

Delaware - Product has "shown good bleeding resistance". Ultrapave and conventional test sections were constructed in 1986.

Georgia - Under evaluation. "Limited experience has shown improved chip retention during and after construction."

Louisiana - See Louisiana's comments on "Styrelf".

Mississippi- Under evaluation.

Pennsylvania- In use for two construction seasons.

So Carolina- A study is in progress comparing "Ultrapave", "Styrelf", and an Owens Corning experimental additive.

Texas - "Emulsions produced from AC modified with SBR latex are slower curing" than Styrelf "-must hold traffic off longer. Once cured, these systems perform satisfactorily. They may possibly have better low temperature properties than the Styrelf system".

Vermont - In a test section, the emulsion containing Ultrapave showed superior chip retention compared to a standard seal. No problems have occurred on the section to date.

Virginia - Under evaluation.

II.C.1.a.ii. BASF Chemical (formerly Polysar) SBR

Users:

Alabama	Minnesota	Pennsylvania
Georgia	Missouri	Texas
Louisiana	Montana	
Michigan	Oregon	

Comments:

Alabama - Under evaluation.

Georgia - Under evaluation. "Limited experience has shown improved chip retention during and after construction."

Louisiana - See Louisiana's comments on "Styrelf".

Minnesota - Two test sections under evaluation.

Montana - A study is underway comparing conventional and "Polysar" modified chip seals.

Oregon - One test section is under evaluation.

Pennsylvania- In use for two construction seasons.

Texas - See Texas' comments on Goodyear "Ultrapave".

II.C.1.a.iii. Dow "Downright"

Users: Louisiana Texas

Comments:

Louisiana - See Louisiana's comments on "Styrelf".

Texas - See Texas' comments on Goodyear "Ultrapave".

II.C.1.a.iv. Asphalt Supply and Service

Users: Oregon Utah

Comments:

Oregon - One test section is under evaluation.

II.C.1.b Ground Tire Rubber

Users: California Illinois Maine

Comments:

California- "Used in hot applied binder."

Maine - "We have experimented with natural rubber (melted tires) chip seals. These have performed well but are very expensive."

Oregon - Chip seals using melted tires and cutbacks were tried in the early 80's. These seals worked well but were comparatively expensive. A heavy chip application was needed during construction. This caused a surplus of loose chips on the roadway.

II.C.1.b.i "Atlos Rubber"

Users: Pennsylvania

Comments: In use for two construction seasons.

II.C.1.c. Styrene Based Co-Polymer "Ductilad D1002"

Users: Illinois Mississippi Pennsylvania
Iowa Oregon Virginia

Comments:

Iowa - Under evaluation.

Mississippi Under evaluation.

Oregon - One test section is under evaluation. At the end of one year it is performing well.

Pennsylvania- In use for two construction seasons.

Virginia - Under evaluation.

II.D.1.a. BASF Chemical (formerly Polysar) EPDM

Users: Idaho Virginia

Comments:

Idaho - Supplied by Idaho Asphalt.

Virginia - Under evaluation.

Products not listed in the table on pages 17 and 18:

Koch Asphalt Company's CRS-KP, HF-KP

Users: Illinois

Goodyear "Pliopave L-170"

Users: Florida

Comments:

Florida - Two test sections constructed in early 1970's comparing Pliopave to conventional emulsions.

Exxon "Polybilt 103"

Users: California

3.4. Specifications and Reports

Questions 8 and 9 of the questionnaire requested specifications and or reports on chip seal emulsions with polymer modified asphalts.

The following organizations submitted specifications:

Arkansas	Iowa	Montana
California	Louisiana	Nebraska
Connecticut	Michigan	Oklahoma
Idaho	Minnesota	Oregon
Georgia	Mississippi	Texas
Illinois	Missouri	Virginia

The following users included reports:

Connecticut	Illinois	Vermont
Delaware	Minnesota	
Florida	Montana	

These specifications and reports are included in the December 1988 ODOT Research Report titled: Responses to the Questionnaire: "Use of Chip Seal Emulsions Containing Polymer Modified Asphalts".

4.0 LIST OF CONTACTS

Each respondent was asked to give a contact within their organization for further questions about polymer modified emulsions. These contacts are listed below. Also included are the names of the respondents if no contacts were given.

Larry Lockett
Materials & Tests Engineer
State of Alabama Hwy. Dept.
1409 Coliseum Blvd.
Montgomery, Alabama 36130
(205) 832-5794

Alan Meadors or
Jerry Westerman
Materials & Research Division
Arkansas Hwy. & Transp. Dept.
P.O. Box 2261
Little Rock, Arkansas 72203
(501) 569-2369

Alan Held
FHWA-Central Direct Federal Division
P.O. Box 25246
Denver, Colorado 80225
(303) 236-4394

James E. Mitchell
Senior Materials Testing Engineer
Research & Materials
Connecticut Dept. of Transp.
280 West Street
Rocky Hill, Connecticut 06067

G.C. Page or
K.H. Murphy
Materials Office
Florida Dept. of Transp.
P.O. Box 1029
Gainesville, Florida 32602
(904) 372-5304

Frank K. Uyehara
Quality Assurance Engineer
Hawaii State Dept. of Transp.
Highway Testing Laboratory
2530 Likelike Hwy
Honolulu, Hawaii 96819
(808) 841-2876

Don Corum
Bituminous Engineer
Materials Section - 127A
Arizona Dept. of Transp.
206 S. 17th Ave.
Pheonix, Arizona 85007

Ron Reese
Senior Materials & Research Engineer
California Dept. of Transp.
5900 Folsom Blvd.
Sacramento, California 95819
(916) 739-3951

Robert LaForce
Colorado Dept. of Hwys.
4340 E. Louisiana Ave.
Denver, Colorado 80222
(303) 757-9298

David R. Mills
Pavement Engineer
Materials & Research
Delaware Dept. of Transp.
P.O. Box 778
Dover, Delaware 19903

Ronald Collins
Bituminous Construction Engineer
Materials & Research
Georgia Dept. of Transp.
15 Kennedy Drive
Forest Park, Georgia 30050
(404) 363-7501

Alohn F. Stanley P.E.
Quality Control Supervisor
Idaho Dept. of Transp.
P.O. Box 7129
Boise, Idaho 83707-1129
(208) 334-8443

John L. Saner
Bureau Materials & Physical Research
Illinois Dept. of Transp.
126 E. Ash Street
Springfield, Illinois 62704-4766

B.C. Brown
Materials Testing Engineer
Office of Materials
Iowa Dept. of Transp.
826 Lincoln Way
Ames, Iowa 50010
(515) 239-1452

Dwight Walker or
Carol Andersen
Division of Materials
Kentucky Transportation Cabinet
State Office Building
Frankfort, Kentucky 40622
(502) 564-3160

Warren T. Foster
Engineer of Research & Development
Technical Services Division
Maine Dept. of Transp.
State House Station #16
Augusta, Maine 04330

Gino J. Bastanza
Research & Materials Engineer
Research and Materials Section
Massachusetts Dept. of Public Works
99 Worcester Street
Wellesley, Massachusetts 02181

Roger Olson
Research Operations Engineer
Physical Research Section
Minnesota Dept. of Transp.
Transportation Building
St. Paul, Minnesota 55155
(612) 296-8068

Kenneth M. Mellinger
Chief- Materials & Tests
Indiana Dept. of Transp.
120 S. Shortridge Rd.
Indianapolis, Indiana 42619-0389
(317) 232-5280

Rodney Maag
Field Engineer
Materials and Research
Kansas Dept. of Transp.
8th Floor
Docking State Office Building
Topeka, Kansas 66612

Harold Paul
Louisiana Transp. Research Center
La. Dept. of Transp. & Development
P.O. Box 94245
Baton Rouge, Louisiana 70804
(504) 767-9124

A. Haleem Tahir
Materials Engineer
Maryland Hwy. Administration
Maryland Dept. of Transp.
2323 Joppa Road
Brooklandville, Maryland 20122
(301) 321-3538

Steve Dembicky
Staff Engineer
Maintenance Division
Michigan Dept. of Transp.
P.O. Box 30050
Lansing, Michigan 48909

J. H. Cruse
Assistant Testing Engineer
Mississippi State Hwy. Dept.
P.O. Box 1850
Jackson, Mississippi 39215-1850

William L. Trimm
Division Engineer
Materials & Research
Missouri Hwy. & Transp. Dept.
P.O. Box 270
Jefferson City, Missouri 65102
(314) 751-2551

Laird E. Weishahn
Flexible Pavement Engineer
Nebraska Dept. of Roads
P.O. Box 94759
Lincoln, Nebraska 68509-4759

Orville Abbott
Project Engineer- Materials
New Jersey Dept. of Transp.
999 Parkway Ave.
Trenton, New Jersey 08625

Tom Wohlscheid
Materials Bureau
New York State Dept. of Transp.
1220 Washington Ave.
Albany, New York 12232
(518) 457-4582

Robert T. Peterson
Materials and Research Engineer
North Dakota State Hwy. Dept.
300 Airport Road
Bismarck, North Dakota 58504
(701) 224-4377

Reynolds H. Toney P.E.
Plant Mix Bituminous Engineer
Materials Division
Oklahoma Dept. of Transp.
200 N.E. 21st St.
Oklahoma City, Oklahoma 73105
(405) 521-2677

Dale B. Mellott P.E.
Research Unit Engineer
Pennsylvania Dept. of Transp.
1009 Transportation and Safety Building
Harrisburg, Pennsylvania 17120
(717) 787-3580

Robert T. Rask
Chief- Materials Bureau
Montana Dept. of Hwys.
2701 Prospect Ave.
Helena, Montana 59620
(406) 444-6297

Philip McIntyre
Administrator
Bureau of Materials & Research
New Hampshire Dept. of Transp.
P.O. Box 483
Concord, New Hampshire 03301
(603) 271-3151

Douglas Hanson
Chief- Materials Bureau
New Mexico State Hwy. Dept.
P.O. Box 1149
Santa Fe, New Mexico 87505
(505) 827-5645

L.F. Pace
State Road Maintenance Engineer
North Carolina Dept. of Trans.
State Highway Building
P.O. Box 25201
Raleigh, North Carolina 27611

John T. Paxton
Engineer of Tests
Bureau of Testing
Ohio Dept. of Transp.
1600 W. Broad Street
Columbus, Ohio 43223-1298
(614) 275-1301

Keith L. Martin
Research Unit Engineer
Materials and Research Section
Oregon Dept. of Transp.
800 Airport Road S.E.
Salem, Oregon 97301
(503) 378-2318

Colin Franco
Chief Civil Engineer
Materials Section
Rhode Island Dept. of Transp.
018 State Office Building
Providence, Rhode Island 02903

Mike R. Sanders
Research Engineer
South Carolina Dept. of Hwys.
and Public Transportation
P.O. Box 191
Columbia, South Carolina 29202

Donald L. O'Connor
Materials and Tests Asphalt
Pavement Engineer
Materials and Tests Division
Texas Dept. of Hwys. and Public Transp.
P.O. Box 5051
Austin, Texas 78701
(512) 465-7615

Ronald I. Franscois
Research and Development Supervisor
Vermont Agency of Transportation
State Administration Building
Montpelier, Vermont 05602
(802) 828-2561

Robert N. Jester
Division Materials Engineer
FHWA-Eastern Direct Federal Division
1000 N. Glebe Road
Arlington, Virginia 22201-4799

James A. Calvert, Jr.
West Virginia Dept. of Hwys.
1900 Washington Street
Charleston, West Virginia 25305
(304) 348-3030

Tom Atkinson
Materials Engineer
Wyoming State Hwy. Dept.
P.O. Box 1708
Cheyenne, Wyoming 82002-9019
(307) 777-7451

Donald W. Anderson
Materials Engineer
South Dakota Dept. of Transp.
700 Broadway E.
Pierre, South Dakota 57501

Wade B. Betenson P.E.
Engineer of Pavement Design
and Testing
Utah Dept. of Transp.
4501 S. 2700 W.
Salt Lake City, Utah 84119

C.W. Minson
Virginia Dept. of Transp.
1401 E. Broad Street
Richmond, Virginia 23219

Jim Walter
Washington State Dept. of Transp.
P.O. Box 167
Olympia, Washington 98504
(206) 753-7107

Karl H. Dunn
Chief Pavement Engineer
Wisconsin Dept. of Transp.
3502 Kinsman Blvd.
Madison, Wisconsin 53704