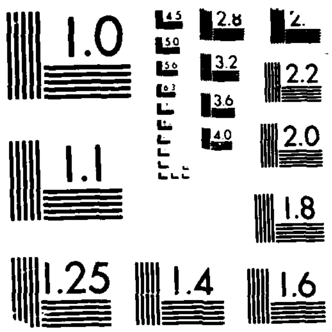
AD-A192 781 ALTERNATE/MODIFIED BINDERS FOR AIRFIELD PAVEMENTS(U) 1/1
DUNDEE UNIV (SCOTLAND) DEPT OF CIVIL ENGINEERING
A F STOCK JAN 88 R/D-5499-EN-01 DAJA45-86-C-0043
UNCLASSIFIED F/G 11/1 NL



MICROCOPY RESOLUTION TEST CHART

IREAU STANDARDS 1963 A

ALTERNATE/MODIFIED BINDERS FOR AIRFIELD PAVEMENTS

by

Dr A F Stock

Department of Civil Engineering
The University of Dundee

Contract No DAJA45-86-C-0043

First Periodic Report August - October 1986
SECOND PERIODIC REPORT
Third Periodic Report JAN 1988

The research reported in this document has been made possible through the support and sponsorship of the US Government through its European Research Office of the US Army. ~~This report is intended only for the internal management of the Contractor and the US Government~~

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FIRST PERIODIC REPORT	2. GOVT ACCESSION NO. ADA192781	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ALTERNATE/MODIFIED BINDERS FOR AIRFIELD PAVEMENTS		5. TYPE OF REPORT & PERIOD COVERED INTERIM AUGUST - OCTOBER 1986
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Dr A F STOCK		8. CONTRACT OR GRANT NUMBER(s) DAJA45-86-C-0043
9. PERFORMING ORGANIZATION NAME AND ADDRESS DEPARTMENT OF CIVIL ENGINEERING THE UNIVERSITY (Scotland) DUNDEE DD1 4HN		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS R&D 5499-EN-01
11. CONTROLLING OFFICE NAME AND ADDRESS US ARMY RESEARCH , DEVELOPMENT AND STANDARDIZATION GROUP - UK		12. REPORT DATE November 1986
		13. NUMBER OF PAGES 11
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

ADDITIVES, MODIFIERS, ASPHALT, SUPPLIERS, COST

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report identifies and classifies all the additives for asphalt which have been identified to date. It also includes a note of the suppliers and where data is available costs.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Two tasks associated with the project have been completed to date.

The first task was to develop a classification system for the modifiers so that they may be grouped for further study. This system is shown in Table 1.

The second task has identified modifiers currently available, to classify them and to obtain some information relating to their characteristics, how they may be used and cost. This data is presented in tabular form in Table 2.

The tasks currently being addressed are as follows.

1. The development of an evaluation procedure for laboratory studies of modifiers. The procedure will be directed towards meeting the performance requirements of reduced permanent deformation under high pressure tyres.

2. The preparation of 'fact sheets' on the following modifiers:

Polybilt
Escorene
Novophalt
Novolastic
3M-Asphadur
Olxobit
Solar-Lagugel
Accerex
Europrene
Bitulastic
Reclaimed rubber
Synthetic latex
Neoflex
Ralumac
Seal gum
Neolastic
Trinidad Lake Asphalt

TABLE 1

PROPOSED CLASSIFICATION

FILLERS/EXTENDERS	(dust, lime, portland cement, carbon black. sulfur, lignin)
RUBBERS	(natural and synthetic latex (styrene butadiene), block copolymer (styrene-butadiene-styrene), reclaimed rubber)
PLASTICS	(polyethylene, polypropylene, ethlylene-vinyl-acelate, polyvinylchloride)
COMBINATIONS OF ABOVE	
FIBRES	(asbestos, rock wool, polypropylene, polyester)
OXIDANTS	(manganese, mineral salts)
ANTIOXIDANTS	(lead compounds, carbon, calcium salts)
HYDROCARBONS	
ANTISTRIP MATERIALS	

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER THIRD PERIODIC REPORT	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ALTERNATE/MODIFIED BINDERS FOR AIRFIELD PAVEMENT		5. TYPE OF REPORT & PERIOD COVERED INTERIM
		6. PERFORMING ORG. REPORT NUMBER —
7. AUTHOR(s) DR A F STOCK		8. CONTRACT OR GRANT NUMBER(s) DAJA45-86-C-0043
9. PERFORMING ORGANIZATION NAME AND ADDRESS DEPARTMENT OF CIVIL ENGINEERING THE UNIVERSITY DUNDEE DD1 4HN		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS R & D 5499-EN-01
11. CONTROLLING OFFICE NAME AND ADDRESS US ARMY RESEARCH, DEVELOPMENT AND STANDARDIZATION GROUP - UK		12. REPORT DATE JANUARY 1988
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

THE REPORT CONTAINS FACT SHEET DATA ON THE FOLLOWING MODIFIERS:- SEALGUM, POLYBILT, ESCORENE, EVA, TRINIDAD NATURAL ASPHALT, CARIFLEX, NEOLASTIC, NEOFLEX AND NOVOPHALT. A PROCEDURE FOR SUCCESSFULLY SCREENING MODIFIERS IS PROPOSED. → (Σ 14739) →

DD FORM 1 JAN 73 1473A EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ALTERATIVE MODIFIED BINDERS FOR AIRFIELD
PAVEMENTS

by

Dr A F Stock
Department of Civil Engineering
The University of Dundee

Contract No. DAJA45-86-C-0043
Third Periodic Report January 1988

The research reported in this document has been made possible through the support and sponsorship of the US Government through its European Research office of the US Army. ~~This report is intended only for the internal management of the contractor and the US Government.~~

Introduction

This report summarizes briefly the conclusions reached in a study of the effect of vectored thrust on asphalt pavement surface, and the analysis of data from a study of asphalt modifiers. An indication of the work still in progress is also provided.

It should be noted that details of the methods used and the *justifications* for these are not presented in this report. This information will be provided in full in the final report which is currently in preparation.

Finally an additional Fact Sheet is provided for the product Olexobit.

An Investigation of the Effects of Vectored Thrust

On the basis of a 'worst case' analysis, which assumed that thrust would be directed at the pavement surface for 10 minutes and that the pavement would be required to support the full weight of the aircraft, calculation showed that the number of coverages for a pavement subjected to vectored thrust was reduced to 9131 from 16,990 for the pavement not subjected to vectored thrust.

Review of studies by the Corps of Engineers of the erosion caused by jet blast indicates that there is a definite possibility that the operation of vectored thrust aircraft will cause additional damage to the surface of asphalt pavements.

Preliminary Analysis of Creep Data

In order to accomplish a preliminary analysis of the creep data the raw data supplied has been transformed so that the variation of the ratio of constant stress to applied strain in a specimen, ie its creep stiffness, as a function of the stiffness of the asphalt cement in the specimen can be examined.

At this stage it is not possible to rank the additives in terms of their ability to modify the creep behaviour of the mix. This is because the mix design for each additive is as based upon the Corps of Engineers 4% void content criteria. Thus mixes with different additives have different binder contents. In this context 'binder' is defined as the base asphalt cement (AC20) plus the additive, with the exception of additives E, F and O. Thus not only does the binder content vary, but the quantity of AC20 in each mix also varies. Since changing the AC20 content of a mix will change its creep characteristics, before the effects of modifier addition are considered, the preliminary analysis is on the basis of the mixes as a whole. Thus the ranking of a given mix could be due solely to the change in AC20 content.

Two parameters have been chosen for ranking the mixes. The first is the stiffness of each mix at a bitumen stiffness of 0.145 psi. The second is the shape of the Log S mix.- Log S bit plot determined from a linear regression. The desirable properties are a high S mix and a small or flat shape.

Table 1 gives the ranking of the mixes and also the value of the relevant parameter. It should be noted that the ranking by shape of the data plot is different to the ranking by level. That is some of the lines which represent the data will cross.

TABLE 1. MIX RANKING

Ranking by Mix Stiffness		Ranking by Shape of S mix & S bit	
Mix Code	Stiffness	Mix Code	Shape
P	135969	L	.1125
C	80494	I	.1490
D	70970	F	.1582
K	66706	D	.1658
L	62272	B	.1787
I	60549	J	.2017
E	57520	K	.2035
H	51607	H	.2038
F	50895	E	.2058
G	48054	P	.2110
J	47889	C	.2234
B	43812	A	.2474
A	42741	G	.2640
O	33626	O	.2657

This indicates that a true comparison between the mixes can only be produced for specific conditions.

At this preliminary stage the more reliable ranking in the one obtained from the level of the curves, ie the Mix Stiffness at a bitumen stiffness of 0.145psi.

The shape of the plot has been obtained from a linear regression of the Log (S mix) -Log (S bit) data. Inspection of the data indicates that for some mixes a curve would provide a much more satisfactory approximation.

<u>Work in Progress</u>

Further effort is being applied to the analysis of the creep data as follows.

1) Curve fitting techniques are being applied to the S mix - S bit data to find a relationship which represents, more closely, the true form of the data. This will permit a more reliable comparison of the differences between the mixes and better identification of areas where both improved or reduced performance can be expected.

2) Inspection of the data suggests that some additives modify the behaviour of the mix so that it is no longer a thermo-rheologically simple material. The creep data obtained at 77°F and 104°F are being analysed independently in an attempt to both quantify this effect and to assess its significance with respect to mix deformation.

3) The method of computing permanent deformation in a flexible pavement, as described by the Shell Pavement Design manual is being used to quantify the differences between the mixes.

4) Attempts are being made to develop a technique for adjustment of the data to a common asphalt cement content so that the effect of the additive can be separated from the effect of changes in binder and/or asphalt cement content. ie so that the additives rather than the mixes can be ranked.

5) The rebound data is being analysed.

FACT SHEET

MATERIAL Olexobit

SUPPLIER Deutch B.P.
(British petroleum, GERMANY)

DESCRIPTION

Olexobit is a blend of asphalt cement and a polymer based on an Ethyl-Propo-Diene monomer (E.P.D.M.). It is supplied as a ready made binder, and may be described, generically, as a rubberised asphalt.

The quantity of additive in the bitumen is regarded as proprietary information by the supplier.

USES (AS RECOMMENDED BY THE PRODUCER)

As the binder for high grade paving applications in West Germany. It's most common use is a binder in Gussasphalt mixes which are subject to heavy traffic.

Alternative formulations of Olexobit are also produced for roofing applications and for emulsification for use in surface treatments.

HANDLING AND MIXING

No detailed information is available, but it is probable that Olexobit is handled in a manner which is similar to conventional materials.

DISCUSSION AND RECOMMENDATION

Olexobit has been in use in Germany since about 1970 and since it is still in use it would appear to be reasonable to assume that it is successful. However its use does not appear to have spread into other European countries, let alone into other continents.

It has been used in comparative trials in the United Kingdom. These trials have been based on Hot Rolled Asphalt, the mix most commonly used for surfacing heavily trafficked roads in the United Kingdom. As yet no results are available.

SUMMARY

The manufacturers do not attempt to give this product a high profile. However the fact that it is still in use some 18 years after its initial introduction supports a view that it provides the type of service required from it.

TABLE 2

Category	Type	Producer	Trade Name	Advantages	Process	Dose (% Total)	Cost: Per Ton (Raw)	(
Rubber	Reclaimed Rubber	All Season's Paving (Kirkland Washington)(Ex Plus Ride Inc.)	Plus Ride	Skid resistance, fatigue, S.A.M.*	Graded particles partially replace aggregate. Added mixing and increase time 15 sec. at 325°F	3	240	
Rubber	Reclaimed Rubber	Royston Labs	Rosphalt	Fatigue, reflective cracking, stable at low void content, S.A.M.	Granular additive for mix. Added during mixing, time increase 6-90 sec. at 390°F	3	4400 ?	
Rubber	Reclaimed Rubber	Crafo, Arizona (Ex. Arco)	Asphalt Rubber		Added at mixer, bulk supply only. Mix at 325°F	7½ - 8	300-400	
Rubber	Reclaimed Rubber	Arizona Refining Co.	Arm-R-Shield	Flexibility, adhesion	Special blender required to pre-mix rubber and asphalt cement			
Rubber	Reclaimed Rubber		Over-Flex	Flexibility, adhesion	Special blender required to pre-mix rubber and asphalt cement			
Rubber	Synthetic Latex (Polychloroprene)	DuPont	Neoprene	Increased elasticity, decreased temp. suscept.	Add at cyclone separator. No change to mix time at 200-300°F	1½-3 of total	1174	
Rubber	Synthetic Latex (Styrene-butadiaene rubber - S.B.R.)	Goodyear	(Pliopave)	Increased elasticity, decreased temp. suscept.	Add to asphalt cement, 6 sec. before mixing. Mix above 285°F	2/3gal/ton		
Rubber	Synthetic Latex (R.B.S.)	Textile Rubber and Chemical (Lamaraida, California)	Ultrapave	Increased elasticity decreased temp. suscept.	Add to asphalt cement, 6 sec. before mixing. Mix above 285°F	2/3 gal/ton		

Stress absorbing membrane

(sheet 1 of 3)

TABLE 2 - Contd

Category	Type	Producer	Trade Name	Advantages	Process	(% Total)	Cost Per Ton (Raw)
Rubber	Synthetic Latex	Firestone	Duradene 710	Low temperature cracking		2-5%	1400
Rubber	Synthetic Latex	Polysar (Chattanooga, Tennessee)	Latex 275	Increased elasticity decreased temp.suscept.	Add to mixing plant mix above 250°F for 8-10 sec.above conventional	2/3 gal	
Rubber	Synthetic Latex (S.B.R.)	Dow Chemical	Downright HML 100L	Increased elasticity, decreased temp. suscept.	Add to mixing plant mix above above 295°F for normal time	2/3 gal	
Rubber	Synthetic (S.B.R.)		Texcrete	Increased elasticity decreased temp.suscept.			
Rubber	S.B.R.	American Petrofina Marketing, Inc.	Finaprene		Uses Goodyear polymer		
Rubber	Natural Latex		Neoflex	Adhesion	Asphalt-latex emulsion requiring special storage		
Rubber	Natural Latex	Raschig Co. (Richmond, Va.)	Ralumac	Cohesion, temperature suscept. rapid set	Asphalt-latex emulsion requiring special storage		
Rubber	Natural Latex		Sealgum	Cohesion, temperature suscept. rapid set	Asphalt-latex emulsion requiring special storage		
Rubber	Block Copolymer (Styrene-butadiaene styrene - S.B.S.)	Shell Oil	Kraton Coriflex Ionol	Flexibility, deformation, temp. suscept.	Blend with asphalt cement prior to mixing at 375°F	5	1940
		Neolastic					
Rubber	Block (?) Copolymer (S.B.S.)	Elf Aquitane	Styrelf	Flexibility, deformation, temp. suscept.	Replaces a proportion of asphalt cement mix at 275°-300°F	Say 3% of total	70-90

TABLE 2 - Contd

Category	Type	Producer	Trade Name	Advantages	Process	Dose (% Total)	Cost Per Ton (Raw)	Cost Per (Ton
Rubber	Block Copolymer	DuPont	Elvax	Flexibility, deformation, temp. suscept.	Pre-blend with asphalt cement by dissolving in low shear vessel. Mix at 275-350°F	3-5% of total	1620	48.6-
			Cariflex					
			Europrene					
			Bitulastic					
			Carbit					
			Mediflex					
			Aspahapol					
			Finpave					

(Sheet 3 of 3)

Category	Type	Producer	Trade Name	Advantages	Process	Dose (% Total)	Cost Per Ton (Raw)
Elastic	Ethylene Vinyl-Acetate (Eva)	Exxon Esso DuPont	Polybilt Scorene Elvax	Deformation resistance temp.susceptibility	Add to asphalt cement before mixing in special blender. Mix at 275-300°F	varies	
Elastic	Polyethylene/ Polypropolene		Novophalt	Stability, stiffness, deformation	High shear blending with asphalt cement. High compaction temp.		
Elastic	Polyethylene/ Polypropolene Polyethylene	Lancushine Tar Distillers	Novolastic 3M-Asphadur	Adhesion, flexibility	Low viscosity emulsion rapid cure		
Plastic	Ethylene Propylene	Olexobit		Deformation, temp. suscept.	Supplies blended with asphalt cement		
Plastic	Polyamide	Solar-Laglugel					
		Escorene					
		Accorex			Preblend with asphalt cement in high shear mixer	1%	2000
Elastic	Functionalized Polyolefin						
Elastic	Polyvinylchloride (PVC)						
		Elvax					

Category	Type	Producer	Trade Name	Advantages	Process	Dose (% Total)	Cost: Per Ton (Raw)	Cost: F (Tc
Oxidant	Complex of Manganese	Lubrisol Development Corp. (Ex Chemkrete Technologies)	CTI 101 Chemkrete CTI 102	Stability, stiffness, temp. susceptibility, ageing resistant	Blended with asphalt cement before mixing soft until cured. Cure a function of void content	2-4% of total	2180	4
Oxidant	Metalloamine	Morton Thiokol/ Carstab	Pave Bond	Moisture resistance, ageing rate	Pre blended	0.5-1%		
Oxidant	Metalloamine		BA 2000	Moisture resistance, ageing rate	Pre blended	0.5-1%		
Oxidant		Scanroad, Inc.	Kling-Beta	Moisture resistance, ageing rate	Pre blended	6 lbs/ton (0.3%)	800-1200	

Category	Type	Producer	Trade Name	Advantages	Process	Dose (% Total)	Cost Per Ton (Raw)
Fiber	Polyester	Dupont Kapejo	Bonifibers	Reinforcement, resilience, reflective cracking	Added to aggregate prior to mixing at 300°F	.25-.38%	2400
Fiber	Polypropylene	Hercules Chemical Fibers	Fiber Paver 3010	Reinforcement, resilience, reflective cracking	Add to dry agg and mix for 10 sec. before adding binder or slurry seal. Mix below 290°F	0.3%	2600-3000
Fiber	Polypropylene	Forta Corp.	Fiber ES-6 CR		Add bags to dry agg. Add 45 sec. to mix time.	0.05%	11,000
Fiber	Steel	Mitchell Fibercon	Fibercon Fibers	Increased stability, tensile strength	Fibers introduced into the mix.	1.25%	600
Fiber	Asbestos			Reinforcement, reflective cracking deflection	Added during mixing		
Fiber	Rockwool		Inophil	Reinforcement, reflective cracking deflection, ravelling	Added during mixing		
Fiber	Natural organic	American Filler and Abrasives, Inc.	Kayocel	Improved performance in roof coating.	May require high shear mixing or pre-dispersion in a solvent system. Rapid dispersing fibre available. (Ka 690)	1-2.5%	320-540
Fiber	Glass	Owens/Corning	Road Glass	Reflective cracking	Special treatment of joints and cracks		

Category	Type	Producer	Trade Name	Advantages	Process	(% Total)	Cost Per Ton (Raw)	I (T
Filler	Carbon Black	Cabot Corp	Microfil 8 and 25	Deformation	Add to asphalt before hot mixing			
Filler	Limestone Dust (Hydrate)	Several	Lime	Adhesion	Add during mixing 275°-350°F	3%		
Filler	Sulfur	Several	Sulfur	Asphalt cement replacement	Add during mixing 275°-300°F	10-50% of total		
Filler	Portland Cement							
	Lignin							
	Mineral Fillers							
	Baghouse Fines							
	Fly Ash							
	Hydrated Lime							

Type	Producer	Trade Name	Advantages	Process	(% Total)	Cost	
						Per Ton (Raw)	Per Dose (Ton of Mix)
	Trinidad Lake Asphalt						
	Gilsonite						

ALTERNATE/MODIFIED BINDERS FOR AIRFIELD
PAVEMENTS

by

Dr A F Stock

Department of Civil Engineering
The University of Dundee

Contract No. DAJA45-86-C-0043

Second Periodic Report

The research reported in this document has been made possible through the support and sponsorship of the US Government through its European Research Office of the US Army. ~~This report is intended only for the internal management of the Contractor and the US Government~~.

Task 1

It was indicated in report 1 that 'facts sheets' were under preparation for several modifiers. All possibly relevant computer data bases have been searched in relation to performing this task and sheets on the following modifiers have been prepared:

Sealgum

Polybilt)
Escorene) One product with several trade names
EVA)

Trinidad Natural Asphalt

Cariflex European equivalent to Kraton

Neolastic

Neoflex

Novophalt

Some difficulty is currently being experienced with obtaining information on the other modifiers listed in report 1. The computer search has assisted in obtaining further information and it is anticipated that definitive comments will be presented and the fact sheets completed in the next report.

Appendix A contains the facts sheets prepared to date.

The Shell group of companies produce a range of block copolymers in both Europe and the USA. These polymers are sold under the trade name 'Cariflex' in the UK and 'Kraton' in the USA. When the products have the same reference number, e.g. 'Cariflex' TR1184 and 'Kraton' D1184, the polymers are identical. However the Company advises that there are some polymers produced in the USA which are not manufactured in Europe and vice versa. Hence it is necessary to obtain the full reference to the product in order to determine comparability between data obtained in Europe and the USA.

Task 2

Tables 1 and 2 contain a brief review of the tests used to characterize bituminous binders and asphalt mixes together with a comment upon their applicability to modified binders and mixes.

Task 3

Procedure for screening modifiers

A stepwise system has been adopted for evaluation of the modifiers. This procedure has been utilized to make the most efficient use of the resources available by progressively eliminating candidate modifiers from the study. This will permit the investigation to focus on the materials which are most likely to give the performance improvements required without having to undertake extensive test programs on modifiers with little promise.

The following is a description of the process. Figure 1 is a diagrammatic representation of the program of mechanical tests which start with Step 3 of the process.

Step 1. Development of a general classification system for modifiers. Table 1 shows the proposed classification system. It is possible to eliminate modifiers which fall into the following categories from the studies because their primary function is not to improve resistance to permanent deformation. The categories are: Antioxidants, Hydrocarbons (with one exception), Anti-strip Materials. In addition combination of Fillers/Extenders, and/or Rubbers and/or Plastics were eliminated because there are an infinite number of possibilities in this group. The Hydrocarbon included is Trinidad Lake Asphalt, a naturally occurring material which has been blended with conventional asphalt cement to produce deformation resistant mixes.

Step 2. Generation of a data base intended to include all the modifiers available in the following categories: Fillers/Extenders, Rubbers, Plastics, Fibers, Oxidants.

The data base is being prepared in an abbreviated tabular form, and as a series of fact sheets to which a Bibliography of relevant literature should be attached. This data base should be used to make a preliminary selection of materials for further investigation. The following points should be considered when making choices.

1) Selection of one modifier from a group of similar modifiers.

2) Availability of data on the modifier from both laboratory studies and field trials.

3) At least one modifier selected from each group.

4) Experience with modifiers, used to assess the probable potential of some candidates.

5) Health hazards.

Table 2 is a list of the modifiers suggested for initial study.

Step 3.

Initial Mechanical Tests

The objective of this series of tests is to select 5-7 modifiers for further study from the list in Table 2.

The various mechanical tests used on asphalt mixes and the rationale behind their selection for this study is discussed in Tables 3 and 4.

The tests will be performed on mixes and will utilize crushed limestone, the standard aggregate used by the Materials Research Center, Waterways Experiment Station, with an aggregate grading as closely as possible to the center of the band permitted by the Corps of Engineers Specification.

A preliminary study will establish the binder content for the aggregate and each combination of asphalt cement and additive. This binder content will be used in all tests performed during this phase of the investigation, and will be determined on the basis of the quantity required to produce a mix with 4% air voids.

A single modifier content, the one recommended by the supplier, will be used for this part of the study, the objective being to reduce the number of modifiers from the 15 listed in Table 2 to between 5 and 7 for the next step. It should be noted that while AC-20 and AC-40 are included in the list they are not modifiers. Both are included as controls, the AC-20 to see what effect the modifiers have on the base asphalt and the AC-40 to determine if similar changes in performance can be achieved with a harder asphalt cement.

The tests selected for step 3 are

1) Penetration.

2) Creep-Rebound at 25°C (77°F) and 40°C (104°F).

3) Resilient Modulus at 40°C (104°F) 25°C (77°F) 4°C (39°F) and -15°C (0°F).

4) Marshall Test at 60°C (140°F).

5) Indirect tensile testing at 25°C (77°F) and 4°C (39°F)

In order to economize on specimen preparation the specimens used for resilient modulus testing will also be used for the creep-rebound test.

Nine specimens will be required for the creep test (3 tests each on a stack of 3 samples) 6 for the Resilient modulus (provides 6 of the 9 creep samples) 3 for Marshall and 3 for the indirect tensile test. The number of specimens to be prepared for test are as follows:-

Specimens/modifier	=	21
14 modifiers + 2 A.C.	=	16
Total	=	21 x 16
	=	336

Step 4

Mix parameter study

Objective

To extend the data obtained in the previous series of screening tests on the most promising modifiers. Depending upon project constraints, 5 to 7 modifiers will be chosen. It is also recognized that this recommendation is tentative and may have to be modified in the light of experience.

1. Determine the amount of additive to add to the asphalt cement. Three values should be selected, one being equal to, one being greater than, and one being less than the value used in the previous test. This selection should be made to provide significant variation in additive content. In selecting

these values, existing data on effect of variation should be considered, if available, as well as cost constraints and possible physical limitations on producing blends.

a. Mix these selected quantitites with the AC-20 as used in the previous test series.

b. Mix three quantities (optimum, high value, and low value) with the second supply of asphalt cement.

2. Select binder contents for the test series. The requirement is to both change the binder content and to change the ratio of asphalt cement to modifier. This is most easily accomplished if the combination of asphalt cement and modifier is considered to be the binder. One binder content below optimum and one binder content above optimum, as determined by previous testing, should be selected for the original asphalt cement ±0.7 percent is suggested. These values should also be used, together with the optimum binder content, with the second asphalt cement. This leads to the following additive-asphalt cement-binder content combinations.

Original AC-20

Lean of optimum binder content, low, "optimum" high additive content.

Rich of optimum binder content, low, "optimum" high additive content.

Optimum binder content, low, high additive content.

(8 combinations)

Second binder selected

Lean of optimum binder content, low, "optimum" high additive content

Rich of optimum binder content, low, "optimum" high additive content

Optimum binder content, low, "optimum" high additive content.

3. Run penetration tests at 77°F on each binder (i.e. asphalt cement type/asphalt cement/modifier blend).

4. Run viscosity tests at 140°F, 225°F, and 275°F.

5. Run standard ductility test.

6. Run standard thin film oven test.

7. Run the WES resiliency test.

8. Make up 33 samples at each combination of asphalt/modifier and binder content, compacted in a gyratory machine using 200 psi, 1 degree angle, and 30 revolutions. Store at room temperature for at least 1 week but no more than 2 weeks. It will, therefore, be necessary to coordinate specimen production with testing.

9. Run resilient modulus at 4 temperatures with 3 samples at each temperature. Temperatures are 0°F, 39°F, 77°F, and 104°F. Start at 0°F and conduct tests on the same 3 samples at all temperatures. These tests will require 3 of the 27 samples.

10. Stack 3 samples on top of each other and run creep-rebound test at 77°F and 104°F. Three samples per test, 3 tests per temperature, 2 temperatures. These tests will require 18 of the 27 samples.

11. Run indirect tensile test at 4 temperatures 0°F, 39°F, and 77°F. Three samples at each temperature. These tests will require six of the 27 samples.

Proposed Test Plan to Screen Alternate/Modified Binders

Test plan for each of 16 materials:

1. Determine optimum amount of additive to add to asphalt cement from manufacturer. Mix this with AC-20 from WES.

2. Run penetration test at 77°F on modified binder.

3. Perform mix design using limestone aggregate, 3/4 in. maximum size meeting Corps of Engineers' criteria.

4. Compact samples in gyratory machine using 200 psi, 1 degree angle, and 30 revolutions.

5. Select optimum binder content. Optimum binder content should be selected at 4 percent voids unless other properties are not satisfactory at this void content. In this case, the asphalt content should be modified so that all criteria are met. Determine Marshall stability at optimum binder content.

6. Make up 27 samples at optimum asphalt content and let set at room temperature for at least 1 week but no more than 2 weeks.

7. Run resilient modulus at 4 temperatures with 3 samples at each temperature. Temperatures are 0°F, 39°F, 77°F, and 104°F. Start at 0°F and conduct tests on the same 3 samples at all temperatures. Three samples to be prepared.

8. Stack 3 samples on top of each other and run creep-rebound test at 77°F and 104°F. Three samples per test, 3 tests per temperature, 2 temperatures. Eighteen samples to be prepared.

9. Run indirect tensile test at 2 temperatures 39°F and 77°F. Three samples at each temperature. Six samples to be prepared.

Future Work

1. A theoretical study to estimate the thermal effects of operation of vectored thrust aircraft from asphalt surfaced areas.

2. Commence analysis of data derived from the test program.

TABLE 1

PROPOSED CLASSIFICATION

FILLERS/EXTENDERS	(dust, lime, portland cement, carbon black. sulfur, lignin)
RUBBERS	(natural and synthetic latex (styrene butadiene), block copolymer (styrene-butadiene-styrene), reclaimed rubber)
PLASTICS	(polyethylene, polypropylene, ethlylene-vinyl-acelate, polyvinylchloride)
COMBINATIONS OF ABOVE	
FIBRES	(asbestos, rock wool, polypropylene, polyester)
OXIDANTS	(manganese, mineral salts)
ANTIOXIDANTS	(lead compounds, carbon, calcium salts)
HYDROCARBONS	
ANTISTRIP MATERIALS	

Table 2

Modifier Selected for Study

Extenders/Fillers

- Sulfur
- Carbon black
- Lime

Rubber

- Reclaimed rubber
- S.B.R. (Polyser, Downwright or Ultrapave)
- S.B.S. (Block Copolymer, Kraton or Styr-Elf)
- Natural Latex (Neoprene)

Plastic

E.V.A.	
Polyethylene	High melt flow
	Low melt flow
PolyVinyl Acetate	

Fibers

- Hercules

Oxidants

- Chemkrete

Hydrocarbons

- Trinidad Lake Asphalt

Table 3

Test	Conventional Purpose	Applicability to Modified Asphalt
Penetration	Measure of consistency. Specification and quality control test (ASTM D5-83).	Subject to error and excessive variability in non-homogeneous materials particularly if they contain agglomerations of an incompletely dissolved/dispersed additive.
Softening Point	Measure of tendancy to flow. Specification. ASTM D36-84.	Will not function in non-homogeneous materials particularly if they contain agglomerations of an incompletely dissolved/dispersed additive.
Viscosity (Efflux)	Sabolt Furon (ASTM D88-81), Engler (ASTM D1665-83), characterize products determine consistency.	Will not function if the liquid to be tested contains agglomerations larger than the orifice. Agglomerations may also disturb flow causing inconsisteny in replicate measurements. Empirical.
Viscosity (Capilliary)	Kinematic (ASTM D2170-85), Vacuum (ASTM D2171-85), characterizes flow behavior. Specification and uniformity of supply.	There is evidence to indicate that some additives produce a non-newtonian fluid, thus invalidating the test. Problems can also be encountered due to the presence of agglomerations of undissolved/undispersed additive.
Viscosity (Cone and Plate)	Measures viscosity of newtonian and non-newtonian fluids.	No reference to its use with modified asphalt in the literature.
Viscosity (Brookfield)	Used for rubberized tar.	Has been used to control reclaimed rubber/asphalt cement blends.
Viscosity (Sliding Plate)	Suitable for newtonian and non-newtonian fluids.	Problems are likely with the preparation of very thin samples (e.g. 50mm).

Table 3 continued

Test	Conventional Purpose	Applicability to Modified Asphalt
Ductility	Measures tensile properties specification. ASTM D113-85.	The presence of inclusions such as rubber creates stress concentration in the thread. This in turn leads to early and eratic fracture.
Force-Ductility	Designed to overcome the problems associated with using the ductility test on rubber-asphalt.	Reported as being successful in characterizing rubber-asphalt blends.
Fraass	Describes low temperature fracture. Used in Canada and much of Europe.	Could be of considerable use in evaluating low temperature fracture of modified asphalts. Difficulties have been reported with respect to sample preparation.
Adhesion (Soaking)	Quick field test for the effect of water on bituminous-coated aggregate.	Would appear to have merit in relation to testing modified binders.
Adhesion (Tray Test)	To test for adhesion between binder and chips sprinkled onto the surface.	Designed specifically for Polymer modified binders.
Flash Point	To test for combustability of binders.	Has merit with respect to testing blends with additives which could increase the fire risk.
Oven Test	Thin film oven (ASTM D1754-83), Rolling thin film oven (ASTM-D2872-85) California tilt.	Aging test on binders. One of these three tests is essential with respect to the assessment of modified asphalts.

Table 3 continued

Test	Conventional Purpose	Applicability to Modified Asphalt
WES Recovery Test	Research on modified asphalts.	Modified ductility test designed to measure the recovery of a thread of pre-stretched asphalt.
Schweyer Rheometer	Research on asphalt.	
Tensile Test	ASTM (?)	
Resiliency		
Torsional Recovery		

Table 4

Test	Conventional Purpose	Applicability to Modified Asphalt
Marshall	Mix design, quality control ASTM D1559-82, Mil Std 620A	Will provide a point of comparison between conventional and modified mixes. The empirical nature of the test prohibits prediction of mix performance.
Hveem	Mix design, quality control ASTM D1560-81.	Less popular than the Marshall test, but will provide a point of comparison with existing data. An empirical test.
Compressive Strength (Unconfined)	Mix design, pavement design ASTM D1075.	No particular difficulties are envisioned with this test.
Resilient Modulus	Relative quality of mixes, pavement design, ASTM D4123-82.	No particular difficulties are envisioned with this test.
Tensile Strength	Modification of resilient modulus test.	Could provide an indication of the effects of modifiers on the fracture of mixes
Creep (Static Unconfined)	Mix design, pavement design.	Simple test to indicate susceptibility to deformation. Recovery should also be measured.
Creep (Static Confined)	Research	Similar to unconfined test with confinement providing greater simulation of the stress conditions existing in a pavement.
Creep (Dynamic Unconfined)	Research	Will provide data concerning the deformation of the mix under loading simulative of moving traffic.
Creep (Dynamic, Static Confinement)	Research	Similar to the previous test with some refinement.

Table 4 continued

Test	Conventional Purpose	Applicability to Modified Asphalt
Creep (Dynamic plus Dynamic Confinement)	Research	A complex test which is most simulative of pavement stress conditions for the purpose of comparing the deformation characteristics of mixes.
Fatigue	Research, pavement design.	Necessary in order to assess the effects of modifiers on the resistance to repeated loading of asphalt mixes.
Pedestal test	To measure the resistance to moisture damage.	Not widely used throughout the U.S.A.
Lottman	To measure the resistance to moisture damage.	Probably the most popular test for moisture damage when used in its "short" form.
Saturation (static)	To measure the resistance to moisture damage.	Regarded as under estimating moisture susceptability.
Saturation (vacuum)	To measure the resistance.	Popular with the Corps of Engineers.
Gyratory	Detection of flushing.	Apparently straight forward.

STEP 3	STEP 4	STEP 5	STEP 6
INITIAL MECHANICAL TESTING	MIX PARAMETER STUDY	SPECIAL PROBLEMS	FINAL DETAILED INVESTIGATION
15 Additives 1 Concentration 1 Asphalt content 1 Asphalt cement	5-7 Additives 3 Concentrations 3 Asphalt contents 3 Asphalt cements	Steps 3 and 4 will probably indicate some difficulties not envisaged when the programme was designed initially. These will be considered here.	5 Additives 1 Concentration 1 Asphalt content 1 Asphalt cement
Tests Penetration Creep Rebound Resilient Modulus Marshall Indirect Tensile	Tests As for Step 3	Tests As required	Tests Detailed Creep Fatigue Thermal cracking

Figure 1. Program of mechanical tests

APPENDIX A

Fact Sheets

MATERIAL

Sealgum

SUPPLIER

Pavement Technologies Inc
15042 NE 40th Street Suite 201
Redmond
Washington 98052
Tel 206-883-6860
Telex 323680(PaveTech)

DESCRIPTION

Sealgum is a cold laid, rough textured waterproof, latex modified binder-based micro-asphalt concrete. The binder is in the form of an emulsified latex-modified asphalt. The mix has a high filler content to maximize its waterproofing characteristics and minimize the risk of bleeding.

USES (AS RECOMMENDED BY THE PRODUCER)

It is recommended for use in Urban streets, in parking lots, industrial areas and school yards. It is also recommended for surfacing emergency stopping lanes and parking areas, and as a new wearing course on asphalt stabilized base courses. Surfacing of damp, compacted sand/gravel base courses is possible, after curing. Airfield runways and taxiways can be can be resurfaced with Sealgum and it is suitable for the maintenance of rural pavements under rapid, medium and high denisty traffic.

HANDLING AND MIXING

The material is proportioned mixed and placed directly onsite by a single batch or continuous machine. A special mechanical spreader is incorporated in the machine which can operate on pavements of any width. The machine is claimed to be capable of covering up to 25,000 sq yd of surface per working day. Light compaction is recommended if the newly treated surface is to receive some traffic. Sealgum sets rapidly and so a treated pavement can be reopened to traffic very quickly.

DISCUSSION AND RECOMMENDATIONS

Sealgum is offered as an alternative to surface treatment by slurry seal and by thin hot mix overlays.

The advantages claimed over slurry seals are -

A) More durability;

B) Greater skid resistance;

C) Better levelling and finishing characterisitcs;

D) Thicker and more flexible surfacing;

The advantages claimed over thin hot mix overlays are -

A) Simplification of detailing in the region of joints with shoulders etc;

B) Localized treatment is possible eg. in wheel track ruts;

C) Improved adhesion to existing pavement surface;

D) Since only light compaction is required the risk of disruption to underground utilities is minimised;

E) The equipment can readily adjust to the variable cross section of old surfaces.

SUMMARY

Sealgum appears to be a mix based on the latex modified binder Neoflex produced by the same company for use in simple surface treatments. In describing the material Remillion(1) postulates that for materials used in thin layers cohesion rather than internal friction is primarily responsible for the performance of the mix. No data is currently available to verify the advantages claimed for the mix. No improvement in the resistance to permanent deformation have been claimed for this material, therefore it is not recommended for inclusion in this study.

MATERIAL Polybilt, Escorene, EVA

SUPPLIER/MANUFACTURER

USA Exxon Oil Co

UK Esso Chemical Ltd
Arundel Towers
Portland Terrace
SOUTHAMPTON
SO9 2GW
England

DESCRIPTION

Polybilt, which is also referred to in the literature as Ethylene Vinyl Acetate (EVA) is a thermoplastic copolymer of ethylene and vinyl acetate. It is supplied as small solid pellets which are sometimes described as 'tear drops'.

USES (AS RECOMMENDED BY PRODUCER)

An additive to hot asphalt mix to improve resistance to deformation, to improve poor aggregates, increase mix stiffness and improve workability.

HANDLING AND MIXING

EVA products are normally added to asphalt binder at a rate of 2-5% by weight. Good Homogenous blends can be obtained with low shear mixers of the following practice is adopted:-

1. Mix at 160-180^{o}C (320-356^{o}F)
2. Add EVA progressively, not in one slug.
3. Use of a mixer which will create splash or that draws a vortex. (This is to negate the effect of EVA's low specific gravity).
4. Circulate a blend which has been kept in hot static storage to eliminate concentration gradients which may farm with time.

EVA can withstand temperatures up to 230^{o}C (444^{o}F) without degradation, but prolonged storage at temperatures above 200^{o}C (392^{o}F) is not recommended. Degradation leads to the formation of acetic acid, the vapour from which can be an irritant to the people who come into contact with it. The acid can also cause metal corrosion over prolonged periods.

DISCUSSION AND RECOMMENDATIONS

Most of the development of the use of EVA copolymers as additives in asphalt has taken place in Europe.

Extensive laboratory studies carried out by the Transport and Road Research Laboratory (TRRL) in England have indicated that the copolymer reduces temperature susceptibility; increases resistance to deformation except at low temperatures and very short loading times; increases the elastic component of an imposed strain; does not have a detrimental effect on compaction; and can reduce the effects of ageing in an oven.

EVA copolymers can be manufactured to a wide range of vinylacetate contents and molecular weights. An EVA containing 18% vinyl acetate with a molecular weight of about 16000 is a good compromise. However it is possible that EVA copolymers with different compositions may be advantageous for some applications.

Limited field trials indicated that EVA modified mixes could be too soft to roll at conventional temperatures, but that this difficulty could be overcome by decreasing the rolling temperature. The TRRL judged the field experiment to be "extremely promising".

SUMMARY

The manufacturers claims appear to be supported by the TRRL's laboratory studies. It is particularly relevant that the claim to improve resistance to permanent deformation is supported.

It is recommended that this modifier be included in the study of Alternate/ Modified Binders for Airfield Pavement.

MATERIAL

Trinidad Natural Asphalt

SUPPLIER/MANUFACTURER

I J Dussek
Wells (Trinidad Lake Asphalt) Ltd
Tubs Hill House
London Road
Sevenoaks
Kent TN13 1BX
England (0703) 460338

Dr Ing D Knobig
Trinidad Asphalt Corporation of America
One Stone Place
Bronxville
NY 10708
(914) 793 5100
(212) 324 2858

DESCRIPTION

Trinidad Natural Asphalt, (TNA) sometimes called Trinidad Lake Asphalt is refined from the crude natural asphalt excavated from the lake located in Trinidad. In its crude form it is a complex emulsion of water, gas, bitumen and mineral and vegetable matter. The refined products, sometimes known as Epuré has the following composition and properties.

Bitumen Soluble in CS_2	53-55%
Mineral Matter (Ash)	36-37%
Insoluble Organic matter	8-11%
Specific Gravity	1.4
Softening Point	94-97
Penetration	1.5-4

USES (AS RECOMMENDED BY THE PRODUCER)

Use of TNA as an additive improves impermeability, resistance to deformation, skid resistance, fatigue and overall durability.

HANDLING AND MIXING

TNA is usually supplied in its refined form in disposable drums each weighing about 500 lbs (227 kg) although it is available fluxed to some standard road building viscosities. The first stage in using TNA is to heat it until it is sufficiently fluid to pump. After this it can be handled for blending and/or mixing as if it is a conventional asphalt cement. Robust and well maintained equipment is recommended as the high mineral content present in TNA can lead to accumulations and blockages in pipe work. The minerals can also accelerate wear particularly in pumps and bearings. TNA suppliers may recommend equipment on request.

DISCUSSION AND RECOMMENDATIONS

TNA has been in use in highway construction in England since 1840 and in North America since 1870. It has been used successfully to provide good and durable skid resistant characteristics in many heavily trafficked roads and has been included in specifications for surfacing materials on principal highways in Great Britain. TNA has also been used successfully in New York, New Jersey and Virginia on very heavily trafficked sections of highways where access for maintenance is very difficult. Whilst there is no quantitative data on resistance to permanent deformation it is reported that overlays made from mixes including TNA have not needed maintenance after 9 years of service, when conventional overlays have been replaced after 2 years. TNA blends have also been used for surfacing several major bridges in both the USA and the UK. Further reports of good performance under arduous traffic conditions have come from Hong Kong, Finland, Germany, Japan and Austria. Successful applications have been reported at several civil airports, notably La Guardia, Munich-Rein, Bremen, Copenhagen and Luxembourg, and at Pterdsfeld and Bremgarten military airfields.

Claims for improved fatigue performance are based upon an unpublished consultants report from the University of Maryland.

SUMMARY

TNA is a well established additive. Indeed it is so well established that it tends to be overlooked. There are many and strong claims for its efficiency in reducing deformation based on experience though little quantitative data to support these.

It is recommended that this modifier be included in the study of Alternate/ Modified Binders for Airfield Pavements.

MATERIAL

Cariflex

SUPPLIER

Shell Elastomers
Shell Centre
LONDON

DESCRIPTION

Cariflex is described as a Thermoplastic Rubber (TR). The title is general and describes a family of block copolymers based on styrene and either butadiene or isoprene which are produced for a wide range of industrial applications as well as for use in blending with bitumen. The products promoted for use in paving applications are as follows:

Cariflex TR-1101 - A clear linear block copolymer based on styrene and butadiene, with a styrene content of 30% by mass, and a viscosity of 4.0 Pa.s measured on a 25% by mass solution in toluene at 25°C in a Brookfield viscometer.

Cariflex TR-1184 - A clear branched block copolymer based on styrene and butadiene, with a styrene content of 30% by mass, and a visocsity of 20.0 Pa.s measured on a 25% by mass solution in toluene at 25°C in a Brookfield viscometer.

Cariflex TR-KX71 - Similar to TR11184 but containing 50 phr of oil for the purpose of decreasing the mixing time. The oil content is 33.3% by weight of the total. The viscosity, measured as above is 2.3 Pa.s

USES (AS RECOMMENDED BY THE PRODUCER)

Blends of Cariflex and bitumen are recommended for a very wide range of uses in the paving industry. It is claimed that Cariflex will reduce permanent deformation, and increase fatigue life, characteristics which make it ideal for use in wearing courses and thin overlays. Improved durability and reduced post construction compaction suggest its use in porous friction course material. As a stress absorbing membrane it can absorb horizontal crack mouth movements of several millimeters, maintain elastic characteristics over a wide range of temperatures, adhere efficiently to the old surface, and placed successfully in thin layers. Surface treatments are enhanced by better initial chip retention and tensile properties and an extended range of use. The three Cariflex binders described above are usually supplied in pellet form. The pellets are bagged and supplied in quantities of approximately one tonne on a shrink film wrapped pallet.

HANDLING AND MIXING

The manufacturers of Cariflex indicate that the product does not present any unacceptable hazard when used in accordance with normal safe handling procedures adopted in the industry.

The following specific recommendations are made by the supplier with regard during processing;

1) Avoid inhalation of fumes and vapours from the hot rubber/compound.
2) Prevent skin contact with hot rubber/compound surfaces.
3) Observe the safety regulations for the chemicals used in rubber processing.

Care is necessary with regard to the selection of mixing equipment. The mixing temperature should not exceed 185^{o}C and the blending time should be as short as possible consistent with their being time to dissolve the TR as completely as possible in the bitumen. Mixing is easiest if the pellets are preground into a fine powder. The modest shearing action of a paddle mixer may be adequate depending on the type of bitumen. Immersion mixers with serrated rotors and stators give the best results because of their high rotation speed and the cutting action of the teeth.

Addition of Cariflex is usually recommended in quantities of 12-14% by mass of the total binder.

DISCUSSION AND RECOMMENDATIONS

Cariflex is claimed to improve nearly all aspects of the performance of bituminous paving mixes. There is a relatively large volume of supporting data derived from laboratory tests. However much of this work has been directed towards supporting the use of Cariflex as an additive in roofing mixes. To date no information is available concerning the performance of blends in highway applications other than in surface treatments. It is believed that Cariflex is very similar to if not identical with the Shell USA additive Kraton.

SUMMARY

The manufacturers claims are based on relatively extensive laboratory studies. However the lack of data from full scale trials in highway mixes is not particularly encouraging. Since Kraton is being included in the study and is almost certainly similar to Cariflex it is recommended that Cariflex be excluded from the study.

MATERIAL

Neolastic

SUPPLIER

Pavement Technologies Inc
15042 NE 40th Street Suite 201
Redmond
Washington 98052
Tel 206-883-6860
Telex: 323680(PaveTech)

DESCRIPTION

Neolastic is a cationic thermoplastic co-polymer modified bitumen-based emulsion. It is supplied as a ready made liquid binder.

USES (AS RECOMMENDED BY THE PRODUCER)

As the binder in single or double chip seal treatment on either flexible or rigid pavements carrying heavy traffic.

Maintenance of primary and secondary road system pavements carrying medium or high densities of traffic.

Preventative maintenance for heavily trafficked highways.

HANDLING AND MIXING

Neolastic, is handled in the same way as a conventional asphalt emulsion. It is applied by spraybar also in a manner which is largely conventional.

In the European trials it was usually applied at a rate of spread of about 2kg/sqm though two trials at a rate of 1.6kg/sqm have been completed successfully.

DISCUSSION AND RECOMMENDATIONS

The particular advantages claimed for Neolastic are

A) It provides good immediate strength even when applied under adverse conditions.
B) It does not require that either the underlying surface or the chippings added subsequently be dry in order to obtain a successful treatment.
C) It does not penetrate the asphalt substrate and so will not contribute to any potential fatting problems.

Several trials of Neolastic were carried out in Europe in 1980. They were recorded as performing satisfactorily in 1983. There is very litte data in the literature relating to measurements of the performance of Neolastic under traffic. It is therefore impossible to be certain of its performance in a North American environment.

SUMMARY

The manufacturers claims are supported by a limited number of trials carried out in Europe. Whilst it is likely that it would function successfully in the USA a strong recommendation should await further successful data.

Since Neolastic is designed for use in Chip Seal type applications it is not recommended for use in this study.

MATERIAL

Neoflex

SUPPLIER

Pavement Technologies Inc
15042 NE 40th Street Suite 201
Redmond
Washington 98052
Tel 206-883-6860
Telex: 323680(PaveTech)

DESCRIPTION

Neoflex is a cationic latex modified bitumen-based emulsion. It is supplied as a ready made liquid binder.

USES (AS RECOMMENDED BY THE PRODUCER)

As the binder in single surface treatments to restore skid resistance and drainage in Urban streets and on the pavements of primary and secondary road systems.

As the binder in double surface treatments when a high degree of wear resistance and surface drainage is required. For example, accident black spots, heavily trafficked pavements.

HANDLING AND MIXING

Neoflex, is handled in the same way as a conventional asphalt emulsion. It is applied by spraybar also in a manner which is largely conventional.

In the European trials it was usually applied at a rate of spread about 2kg/sqm though two trials at a rate of 1.6kg/sqm have been completed successfully.

DISCUSSION AND RECOMMENDATIONS

The particular advantages claimed for Neoflex are

A) It provides good immediate strength even when applied under adverse conditions.
B) It does not require that either the underlying surface or the chippings added subsequently be dry in order to obtain a successful treatment.
C) It does not penetrate the asphalt substrate and so will not contribute to any potential fatting problems.

Several trials of Neoflex were carried out in Europe in 1980. They were recorded as performing satisfactorily in 1983. There is very little data in the literature relating to measurements of the performance of Neoflex under traffic. It is therefore impossible to be certain of its performance in a North American environment.

SUMMARY

The manufacturers claims are supported by a limited number of trials carried out in Europe. Whilst it is likely that it would function successfully in the USA a strong recommendation should await further successful data.

Since Neoflex is designed for use in Seal Coat type applications it is not recommended for use in this study.

MATERIALS

Novophalt

SUPPLIER/MANUFACTURER

Murray Jelling
21 Spring Hill Road
Roslyn Hts
NY 11577
516 621 0060

DESCRIPTION

Novophalt is a pre-blended mixture of polyethelyne and asphalt cement.

USES (AS RECOMMENDED BY THE PRODUCER)

Improved resistance to deformation and increased stiffness.

HANDLING AND MIXING

The Novophalt process usually involves the addition of about 7% by weight of polyethelyne to asphalt cement. Because polyethelyne is not soluble in asphalt it is necessary to use a high sheer mixer to blend the two components.

After prolonged storage the asphalt cement and polyethelyne will separate, the polyethelyne rising to the top. If the blend is stored at high temperature for a period of days, high shear mixing will be required to eliminate the separation. However continuous or frequent low shear mixing is sufficient to maintain a homogeneous blend.

DISCUSSION AND RECOMMENDATIONS

The Novophalt process was developed primarily as a means of disposing of waste polyethelyne, in Europe.

The Transport and Road Research Laboratory (TRRL) in Great Britain have evaluated Novophalt in the laboratory, and to a limited extent, in the field. This program concluded that Novophalt "is capable of conferring substantial improvements in stiffness and resistance to permanent deformation", but also indicated that significantly increased control is probably necessary in order to achieve the improvements.

Several full scale trials have been built in Europe, the earliest being constructed in 1977. The limited information available from these trials indicates that they are performing satisfactorily and show improved resistance to deformation.

SUMMARY

Novophalt appears to provide improved resistance to deformation, however it does require greater care in processing the conventional asphalt mixes.

It is recommended that this modifier be included in the study of Alternate/ Modified Binders Airfield Pavements.

END
DATE
FILMED
DTIC
JULY 88