Engineering Brief # 45

February 22, 1990

Subject: INFORMATION : Engineering Brief No. 45
Polyethylene Modified Asphalt Cement

FROM: Manager, Engineering and Specifications Division, AAS-200
TO: All Regions

Attn: Managers, Airports Division and AAC-960

Engineering Brief No. 45 provides information and guidance for the use of a polyethylene modified asphalt cement.

The purpose of engineering briefs is to keep Airports field offices informed of construction materials and methods which are being tried, but which are not necessarily known to the Regions and ADO's. The information contained in this brief is not to be construed as general approval by the Office of Airport Safety and Standards. Any use of polyethylene modified asphalt cement will require approval by this office.

Any comments you have concerning this brief will be appreciated.

ORIGINAL SIGNED BY
ROBERT BATES
Robert Bates

Attachment

ENGINEERING BRIEF NO. 45

POLYETHYLENE MODIFIED ASPHALT CEMENT

BACKGROUND
In recent years asphalt technologists have focused their attention on designing a pavement that will be less temperature susceptible and provide greater resistance to deformation caused by the higher tire pressures and loads imposed by today's commercial aircraft.

It is an accepted fact in the asphalt industry that the addition of modifiers to asphalt cement has the potential to alleviate these problems. One such modifier that has shown promise is polyethylene.

Polyethylene modified asphalt cement is a bi-phase binder system containing polyolefin additives and paving grade asphalt cement. It can be used to improve the performance of an asphalt pavement in the following areas:

1. Reducing pavement deformation.
2. Increasing fatigue resistance.
3. Greater adhesion of the asphalt to the aggregate.

Polyethylene modified asphalt has been used successfully in Europe since 1976 and was introduced into the United States in 1986. Since then over one dozen field demonstration projects have been constructed. Runway 17-35 at the William P. Hobby Airport in Houston, Texas was reconstructed about one year ago using 20,000 tons of polyethylene modified asphalt. To date, the sponsor is satisfied with the performance of the pavement.

CONSTRUCTION

Modified Asphalt Cement. The polyethylene modified asphalt cement consists of 4-6 percent virgin or recycled polyolefins, primarily a low density polyethylene, and asphalt cement. Modification with polyethylene will generally increase the viscosity of the asphalt cement by a factor of three to four. Since polyolefins do -not dissolve in asphalt cement, modification is accomplished by blending the polyolefin and the asphalt using a high-shear blending process. At present, Novophalt America, Inc. holds a patent on a process to blend the materials in a high-shear mill. The modified asphalt is supplied to the hot mix producer as a ready-made blend. It is available in either of the following methods:

1. In a mobile blender at the plant.
2. In a central asphalt cement terminal from where it is shipped in agitated tank trucks to the asphalt plant.

The mobile blending unit is self-contained. It requires an area 75 x 15 feet at the asphalt plant and can be connected to most plants in one day. The unit produces 12 tons of modified asphalt cement per hour.

The modified asphalt must be stored in containers equipped with mechanical agitators in order to prevent stratification. If not agitated, the polyethylene may migrate.upwards resulting in non-uniform dispersion. The mobile blenders are equipped for agitated storage. Delivery from a central asphalt cement terminal requires an agitated storage tank at the asphalt plant.

Mixing With Aggregate. Modified asphalt is mixed with aggregates using conventional equipment. Either drum mix plants or batch plants may be used. The mixing temperature is slightly higher than with unmodified asphalt cement and ranges between 300 and 330 degrees F.

Laydown and Compaction. Laydown and compaction of the modified asphalt is performed using conventional equipment and construction techniques. Because of the higher viscosity of the asphalt, the laydown temperature should be about 300 degrees F. The initial breakdown compaction should be accomplished between 280 and 300 degrees F. Compaction of the mix below 265 degrees F is ineffective due to the crystallization of the polyethylene and the resulting high viscosity of the modified asphalt below this temperature.

Cost. The use of polyethylene modified asphalt cement adds about 6 to 7 dollars per ton of hot mix, which is equivalent to a cost increase of about 20 percent. Because the pavement life may be increased by 50 percent, the life cycle cost is likely to be lower.

RESEARCH.
Studies conducted by the U.S. Army Corps of Engineers,Waterways Experiment Station, Texas Transportation Institute, Texas A&M University, and The Asphalt Institute Research Laboratory indicate that polyethylene modified asphalt can be effective in reducing rutting and fatigue cracking. Thermal cracking can be minimized by selecting soft base asphalt cements for modification.

CONCLUSION.
Based on the studies and field installations we believe the use of polyethylene modified asphalt may be beneficial where rutting, fatigue cracking, or thermal cracking is a problem. When this product is specified on a project, the design engineer must furnish evidence to show that equal or better performance can be achieved than with conventional pavements, so as to at least offset any increase in costs.

Approval for each project will be required by AAS-200 so that we will be aware of locations where it has been used and can evaluate its performance.

Attached for your information and use are the modifications required to Item P-401 when polyethylene modified asphalt is

specified.

ORIGINAL SIGNED BY
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MODIFICATIONS NEEDED TO ITEM P-401
WHEN SPECIFYING POLYETHYLENE MODIFIED ASPHALT

401-1.1
After" mineral aggregate" in the first sentence insert "polyethylene"

401-2.4
Add new paragraph as follows: ASPHALT MODIFIER. The polymer additive shall be polyolefinic, primarily low density polyethylene, and shall meet the following requirements:

Test Property	Criterion	Specification
Melt index	1.0-15.0	ASTM D 1238
Density	0.910 min. 0.940 max.	ASTM D 792
Melting point	230-275 F	

The type and grade of asphalt cement used for modification shall conform to the requirements of paragraph 401-2.3.

The modified asphalt cement shall have the properties indicated in the Table below, for Grade [.]

Property	PM FLX GRADE	PM STD GRADE	PM HMF GRADE	Specification
Viscosity @ 140 F				ASTM D 2171
Maximum (poises)*	2500	5000	15000	
Minimum	1000	2500	5000	
Penetration @ 77 F				ASTM D 5
Maximum (d@M) 1	120	90	60	
Minimum	60	40	30	
Retained Penetration				ASTM D 1754
% after TFOT Aging	50+	55+	60+	
Softening Point F,				ASTM D 2398
min	115	120	125	

* Viscosity or penetration value should be used as a basis for specifications

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The Engineer shall designate PM FLEX, PM STD, or PM HMF based on the geographical location, climatic conditions, and the desired stress-strain characteristics of the pavement. For example, PM FLEX would perform best in colder climates and in strain controlled applications, such as in thin overlays supported by pavement structures which react with significant deflections in response to load applications. PM HMF allows one to construct stiffer pavements to resist primarily high temperature deformation and to limit strains in response to a particular design load. The manufacturer of the modified asphalt cement will offer advice on the most suitable grade of modified asphalt to be used for the project.
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401-3.1 COMPOSITION OF MIXTURE.
After "filler if required" in the first sentence, insert "polyethylene"

401-3.2 JOB MIX FORMULA.
Delete second sentence and substitute the following: The polyethylene content shall be 4-6% by weight of the total polymer modified asphalt cement. The job mix formula will be developed by the polyethylene supplier using aggregate and asphalt cement furnished by the Contractor. The formula shall be submitted in writing to the Engineer at least [ ] days prior to the start of paving operations and shall indicate the definite percentage of each sieve fraction of aggregate, the percentage of asphalt cement, the percentage of polyethylene, and the temperature of the completed mixture when discharged from the mixer.

401-4.2 BITUMINOUS MIXING PLANT. Add new paragraphs as follows :

b. Blending of Asphalt Cement and Polyethylene. Blending of the asphalt cement and polyethylene will be accomplished by the supplier of the modifier in a mobile mixing plant located at the asphalt plant. The plant shall provide a level and stable site for the mobile plant with dimensions of at least 65 feet by 12 feet. A clear height of at least 20 feet is required for production. The site shall be situated adjacent to both the base asphalt cement storage tank and the asphalt proportioning pump. The blending unit will be connected to the existing pipe lines of the asphalt plant by the supplier. The supplier will also provide fittings and lines for the connection. The contractor shall make available valves and gates to access the storage tank, the line to the proportioning pump, and when needed, to install a return line.

c. Production Limitations. The capacity of one mobile mixing unit is 12 tons of modified asphalt per hour. More than one unit can be set up at the plant to support a larger operation. No additional compensation will be considered or allowed by reason of the effects of the above limitations on mix production or placement.

401-4.6 PREPARATION OF BITUMINOUS MATERIAL.
Delete the second sentence and substitute the following: The temperature of the modified bituminous material delivered to the mix shall be sufficient to produce a suitable viscosity for adequate coating of the aggregate particles, but shall not be less than 300 degrees or greater than 330 degrees.

401-4.9 TRANSPORTING, SPREADING, AND FINISHING.
Delete the third and substitute the following: The modified asphalt mix shall be delivered to the paver at 305 degrees + 10 degrees F. Breakdown rolling must be completed at a temperature greater than 265 degrees F.