Engineering Brief # 23

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In Reply Refer To: AAS-200

Subject: INFORMATION: Engineering Brief No 23,
Open-Graded Asphalt Emulsion Mixes

From: Chief, Engineering and Specifications Division, AAS-200
To: All Regions

Attn: Chief, Airports Division

Engineering Brief No. 23 discusses the use of an open-graded asphalt emulsion mix at various airports in the Rocky Mountain region.

The purpose of engineering briefs is to keep FAA field offices informed of construction 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 Standards. Any use of an emulsified asphalt mix will require prior approval by this office.

Any comments you care to make concerning this brief will be appreciated.

ORIGINAL SIGNED BY:
EDWARD AIKMAN

Enclosure

Engineering Brief No. 23

Open-Graded Asphalt Emulsion Mixes

INTRODUCTION

During the past few years several factors have contributed to renewed interest in the use of emulsified asphalt mixes, namely:

1. The energy crisis that prompted conservation measures. Asphalt emulsion does not require a petroleum solvent to make it liquid.

2. Reduced atmospheric pollution. There are little or no hydrocarbon emissions from asphalt emulsions.

3. Potential cost savings. Less fuel; construction costs reduced due to elimination of heating and drying of aggregate and screening of aggregates. Also the preparation of

emulsified asphalt mixtures can be accomplished with a cold-mix pugmill operating as a continuous mixer. The mixtures are placed and compacted with conventional equipment and construction procedures.

In an effort to take advantage of these factors the Rocky Mountain Region has permitted the use of open-graded asphalt emulsion mixtures on several ADAP projects within their region.

Open-graded emulsified asphalt mixtures are characterized by the use of asphalt emulsion, crushed stone or gravel with less than 10 percent passing the number 10 sieve, and less than 2 percent passing the number 200 sieve, and 20 to 30 percent air voids in the compacted pavement. The open-graded texture of the pavement offers an added benefit in that skid resistance is increased and hydroplaning potential is reduced since the pavement performs like a porous friction course.

INSPECTION

On September 4, 1980, I inspected pavements at three sites in order to evaluate the use of this material for airport pavements. I was accompanied by Craig Sparks, ARM-600, Nabi Taskin, ARM-600, and Bud Brakye, The Asphalt Institute.

The first site inspected was Bert Mooney Airport at Butte, Montana. The airport serves commercial aircraft and had 4634 air carrier operations in 1979, including 1412 B-727 operations. The project plans call for a 4 inch overlay of the primary runway with an open-graded emulsified asphalt mix.

A visual inspection of the material placed approximately 2 hours prior to arrival on the job site revealed that the mix had "set up." That is, the asphalt had separated from the water phase and formed a continuous film of asphalt on the aggregate, thereby producing a stable pavement. This is in contrast to a mix placed several weeks earlier which had failed to set. The only apparent difference in the mixes was the source of the emulsion. Job mix formulas for each of the emulsion sources were developed by the Federal Highway Administration laboratory in Vancouver, Washington. This laboratory has extensive experience in design of open-graded asphalt emulsion mixes for highways over the past few years.

It was surmised that the reason for failure of the first mix to set up was that the emulsion used in the field production of the mixture was formulated slightly different from that used in the mix design. Although both emulsions met the ASTM standard for CMS-2h asphalt emulsion specified for this job, asphalts with the same grade designation can be different chemically, which in turn can effect the compatibility of the emulsion with the aggregates.

The next site visited was Sheridan County Airport, Sheridan, Wyoming. This is a general aviation airport serving commuter aircraft.

A ten-inch pavement placed in the apron area 3 days earlier was still tender and had not been opened to traffic. Examination of

the in-place material revealed the presence of a brownish film under the pavement surface, indicating that the mix had not "set". It is believed that failure to set may be due to use of a slow set emulsion in lieu of the medium set specified, the use of kerosene as a diluent to facilitate placement of the material, and the high percentage of limestone aggregate. Use of diluents, up to 8 percent, was allowed by the specification. Temperatures in the 5O's and 6O's during this period may also have contributed to the slow setting rate.

In an effort to correct this problem the source of the emulsion was changed, resulting in a mix that set up within 2-3 hours.

A check with the Regional office on September 29 revealed that the material placed on the apron area had set up in the two-week period since September 4.

The last site visited was Gillette-Campbell County airport, Gillette, Wyoming. This is a general aviation airport serving commuter aircraft. A 3-inch open graded mix placed on the runway and apron area 3 weeks earlier had set up within the normal time frame and provided a stable pavement. There were no apparent problems during construction.

EVALUATION

After inspection of the pavements, discussions with the Asphalt Institute, and a review of available literature it is evident that there are many factors that affect the use and performance of an asphalt emulsion. They include:

1. Chemical properties of the base asphalt cement.
2. The property of the emulsifying agent.
3. The type of chemical modifiers added.
4. Hardness and quantity of the base asphalt cement.
5. Asphalt particle size in the emulsion.

These factors can be varied to suit the available aggregates or construction conditions. Successful performance of asphalt emulsion mixes requires selecting the proper type for the intended use. While general guidelines for selecting emulsions are given in ASTM standard D 3628 a laboratory evaluation of the emulsion and aggregate to be used must be performed. Different types and quantities of emulsion should be tried with the aggregate to find the best combination. Consultation with the emulsion supplier must be maintained during the job mix design phase, with respect to the emulsion-aggregate combination, as there are few absolute rules that will work the same under all conditions. In order to achieve optimum results, it is necessary to control the sizing of the aggregate or to adjust the emulsion formulation to meet the specific requirements of the aggregate.

Close coordination must also be maintained between the testing laboratory, the emulsion supplier, and the contractor, during construction to ensure that the type and combination of materials do not vary from those used in the job mix design.

The resident engineer also plays on important part during placement of an asphalt emulsion mixture. If the mixture does not set within the normally accepted time period, work should be stopped and the reason determined. The rate of setting is controlled primarily by the specific type and concentration of the emulsifying agent used as well as atmospheric conditions. Some of the factors that affect the setting rate of an asphalt emulsion mixture include:

1.Weather conditions - temperature, humidity, and wind velocity.
2.Moisture content of the aggregate prior to mixing.
3.Size distribution and mineral composition of the aggregate. Fine aggregates tend to break faster. The mineral composition also affects the rate of set. There may be some type of chemical reaction between the emulsifier and the aggregate surface.
4.The type and amount of emulsifying agent used.
5.Intensity of charge on aggregate versus intensity of emulsifier charge.

To date, state highway departments have shown little interest in using emulsions as an alternate to hot mixtures in areas where there is heavy traffic or where hot mix plants are readily available. This is due mainly to problems with respect to weather limitations and slow curing of the material because of the diluent added to promote mixing. In addition, long range durability and stability of this type pavement must be evaluated. However, in rural areas where hot mix plants are not available and where high transportation costs for fuel and other materials would be expected, asphalt emulsion mixes offer potential advantages.

COST

The cost of emulsified asphalt at each of the sites visited is shown below:

Location	Type Emulsion	Cost/Ton
Butte, Montana	CMS-2h	180
Sheridan, Wyoming	CMS-2h	190
Gillette, Wyoming	CMS-2h	220

The average cost for cutback asphalt in these locations is $150/ton. Although the cost for emulsified asphalt was higher it is believed that the cost will decrease as contractors become more familiar working with this type of material.

RECOMMENDATIONS

Based on the above report, use of an open-graded emulsified asphalt mixture is not recommended for use on airport pavements unless the following elements are present:

1.A testing laboratory with experience in the job mix design of emulsified asphalt mixtures. To date, most job mixes have been designed by the FHWA laboratory in the

state of Washington. The FHWA laboratory in Denver also has experience in this area.

2.An emulsion supplier that will work closely with the testing laboratory during both job mix design and placement of the material. This is considered a critical item since the emulsion must be compatible with the aggregate if a stable pavement is to be attained.

3.A resident engineer experienced in the use of asphalt emulsion mixes.

In the event an open-graded asphalt emulsion mix is proposed for use on a trial basis it is suggested that an end product type specification be used. For example, in lieu of specifying a medium set emulsion, the specification might indicate that the emulsion used must produce a mixture that will set within 2-3 hours of placement.

Additional information pertaining to asphalt emulsion mixtures may be obtained from the Department of Transportation Publication FHWA-IP-79-l, A Basic Asphalt Emulsion Manual, volumes 1 and 2.

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