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16. Abstract

The overall objective of this study was to determine the most economical and effective uses for asphalt pavement millings. Specific objectives include (1) determine existing effective uses of milled RAP, (2) determine effectiveness of new untried ideas and improvements on existing uses through field experimentation, and (3) provide the Department with a mode of implementation. Most of the uses addressed in this study refer to routine maintenance applications.

This document presents guidelines on the use of RAP in routine maintenance activities. Guidelines are offered concerning proper procedures for collecting and stockpiling RAP. Cold-mix design procedures and field tests are outlined for aid in determining appropriate recycling agent quantities, and instruction is given for field processing procedures to improve the quality of RAP for maintenance mixtures. Guidelines are also provided as to the appropriate uses for RAP and treated RAP in routine maintenance activities.

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DISCLAIMER

GUIDELINES ON THE USE OF RAP IN ROUTINE MAINTENANCE ACTIVITIES

by

Cindy K. Estakhri

Sponsored by the
Texas Department of Transportation

Study Technical Coordinator: John Bohuslav
Study Advisory Committee: Richard Derryberry
Ken Fults
Jim Freeman
Otis Jones
Robert Lindley

Texas Transportation Institute
Texas A&M University
College Station, Texas 77843

February, 1993

INTRODUCTION

Cold milling of asphalt pavements to correct surface irregularities, maintain curblines, or to remove a poor-quality pavement layer is a common rehabilitation procedure used by the Department.

Most often the material being milled was originally purchased as a high-quality paving material; therefore, it would seem to be economical to find uses for these asphalt-pavement millings. This fact has long been recognized by engineers within the Department and as a result, the Texas Department of Transportation (TxDOT) has developed many innovative uses for RAP.

Recent legislation (Senate bill 352 from the 72nd Legislature) has also prompted an increase in the use of RAP by the Department. This law requires the Department to retain title to all RAP (with authority to transfer title to other governmental entities), to maximize the use of RAP, to keep inventory of RAP, and to report on the use of RAP to the legislative audit committee.

Recycling asphalt pavements is not new to the transportation community; therefore, guidelines are well established on both hot and cold recycling of asphalt concrete pavements. The reader is referred to the following publications for a thorough presentation of these guidelines.

"Guidelines for Recycling Pavement Materials," National Cooperative Highway Research Program Report No. 224, Transportation Research Board, National Research Council, Washington, D.C., September, 1980.

"Cold-Recycled Bituminous Concrete Using Bituminous Materials," National Cooperative Highway Research Program Report No. 160, Transportation Research Board, National Research Council, Washington, D.C., July, 1990.

The objective of this manual is to provide maintenance personnel with guidelines on using stockpiled RAP in routine maintenance operations, with minimal to no laboratory testing and minimal material processing and handling. Minimizing the testing and processing should keep the cost of the recycled mix well below that of new maintenance mixes.

COLLECTING AND STOCKPILING RAP

Maintenance personnel are often responsible for using stockpiled RAP; however, they have may have little input into the handling of the RAP until after it is stockpiled. Careful attention must be given not only in the obtaining of the product, but also in the transportation and stockpiling. RAP should be as carefully handled as all other valuable products. If maintenance personnel are responsible for using the RAP, every effort should be made for maintenance personnel to supervise the collection and stockpiling of the RAP.

Collection of RAP

It is recommended that the pavement removal be accomplished through a cold-milling operation. This ensures that the RAP material will generally be in pieces of a size that will require no further crushing. During the milling process, the truck tends to become a "catch-all" for everything on the road. Employees should be told the materials are to be recycled, and not to throw cans, wood, etc., into the loads. A great part of the needed quality control of any RAP can be accomplished during the removal process by taking extreme care to keep contaminants at a minimum. Proper education of all personnel involved in the process (i.e., field operators, laborers, drivers, yard supervisor, etc) is necessary to ensure a high quality final product.

Stockpiling RAP

Choose a location to stockpile the RAP where the material can also be processed and stored for maintenance uses. In other words, keep material handling to a minimum: stockpile raw RAP, process RAP, and store final product at one location, if possible. This is important in terms of keeping the cost of the RAP well below that of new maintenance materials.

Separate stockpiles of varying quality and uniformity. Improved quality control will be achieved by the visual differentiation of individual truck loads and their being directed to different RAP stockpiles.

Space considerations may dictate the number of stockpiles required. If material from different jobs must be placed in one stockpile, build the pile in horizontal layers. When stockpile is ready to be reused or processed, dig stockpile from bottom to top.

RAP tends to stick together if stockpiles are high. The lowest stockpile height that space will permit should be used. The maximum height of the stockpile should be 10 feet. To prevent consolidation of the material, vehicles should be kept off the RAP stockpile.

In general, RAP should be processed or used within 6 months to 1 year after stockpiling in order to avoid a situation where the stockpile sets-up becoming an immovable mass.

COLD MIX DESIGN GUIDELINES FOR RAP MAINTENANCE MIXES

General

Determination of the appropriate quantity of recycling agent to be blended with the RAP is often difficult due to the variability inherent in most RAP stockpiles. Based on field experience, the quantity of recycling agent must be adjusted throughout the mixing process to correct for this variability. A procedure is summarized here for estimating the asphalt demand of the RAP with minimal laboratory testing. This estimate can be used as a starting point to be adjusted as needed in the field.

Stockpile Sampling

Samples of the stockpile should be obtained for laboratory testing. The objective of the sampling operation is to obtain representative samples which will characterize the RAP material in the stockpile and will indicate its variability. The number of samples acquired from a stockpile should be based on the judgement of the maintenance supervisor and should depend on the uniformity of the stockpile. If a stockpile contains a consistent, uniform material throughout, it is recommended that a minimum of three samples be obtained for testing. If the stockpile is not uniform, the number of samples should be greater.

The requirements for sampling RAP stockpiles include some of the same principles for sampling aggregate stockpiles (AASHTO T-2). Procedures are summarized below.

In sampling material from stockpiles it is very difficult to ensure unbiased samples, due to the segregation which often occurs when material is stockpiled, with coarse particles rolling to the outside base of the pile. Every effort should be made to enlist the services of power equipment to develop a separate, small sampling pile composed of materials drawn from various levels and locations in the main pile after which several increments may be combined to compose the field sample. If necessary to indicate the degree of variability existing within the main pile, separate samples should be drawn from separate areas of the pile.

Where power equipment is not available, samples from stockpiles should be made up of at least three increments taken from the top third, at the midpoint, and at the bottom third of the pile. A board shoved into the pile just above the sampling point aids in preventing further segregation. In sampling RAP stockpiles, the outer layer may have become age-hardened and crusty. Therefore, at least 6 inches of the outer layer should be removed and the sample taken from the material beneath.

Laboratory Testing

Once representative RAP samples have been obtained from the stockpile, the following laboratory tests are required on each sample:

1. *TEX-210-F "Determination of Asphalt Content of Bituminous Mixtures by Extraction", and*

2. *TEX-200-F "Sieve Analysis of Fine and Coarse Aggregates".*

The results from these tests will be used to provide an estimate of the available void space in the RAP which may be filled with new binder. These tests can usually be performed in an area laboratory or in the district laboratory.

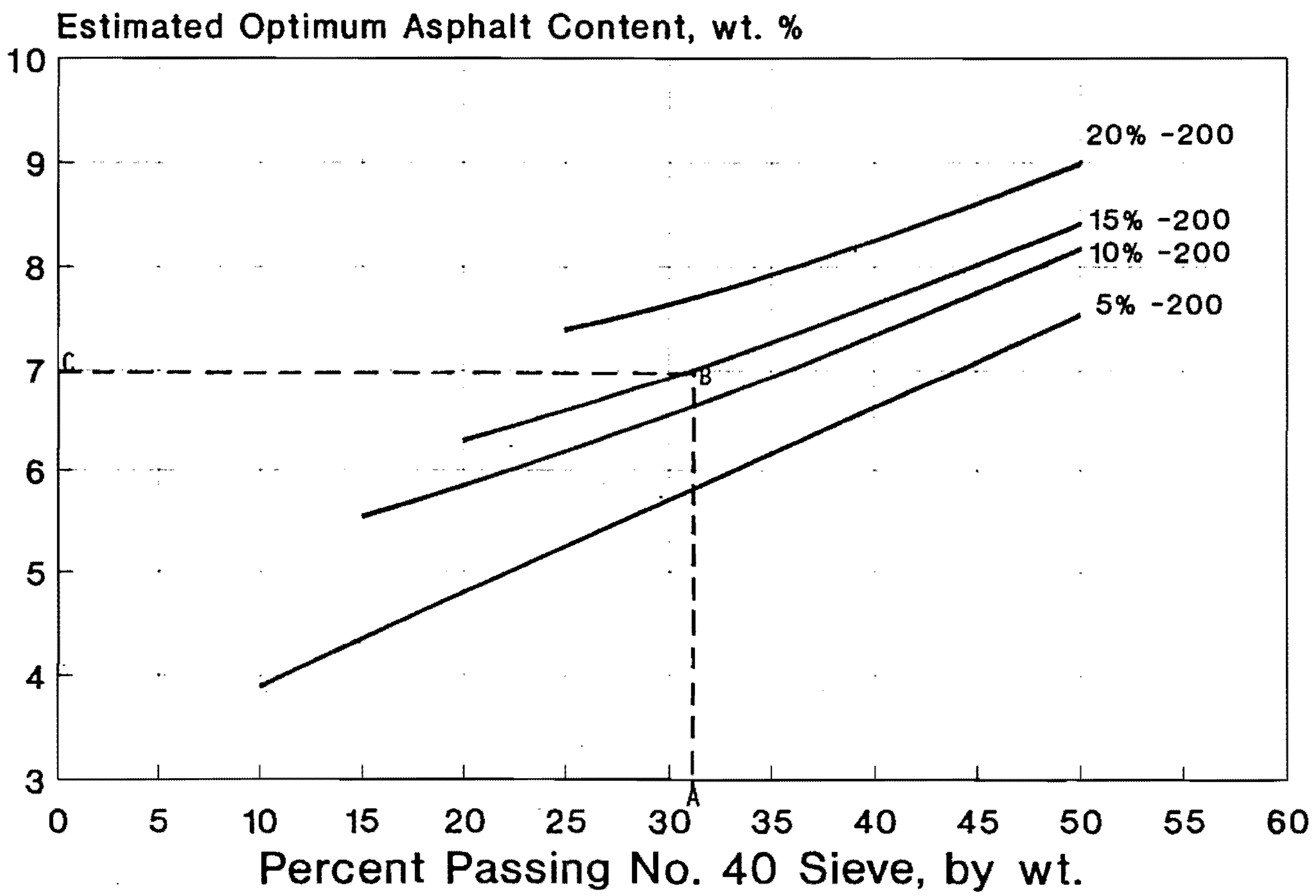
A portion of each RAP sample should also be sent to D-9 (Division of Materials and Tests) in Austin for the following tests:

1. *TEX-211-F "Recovery of Asphalt from Bituminous Mixtures by the Abson Process", and*
2. *ASTM D2170 or D2171 "Viscosity of Asphalt at 140°F".*

The results from these tests will provide an indication of the hardness of the asphalt binder present in the stockpiled RAP.

Estimate of Optimum Binder Content

The approximate total asphalt needed is determined using aggregate surface area formulas applied to the RAP aggregate after extraction of the asphalt. The calculations have been simplified for purposes of this field manual into the following nomograph:



<u>Example</u>. A RAP stockpile is sampled and found to have the following gradation of extracted aggregate:

Sieve Size	*Percent Passing, by wt.*
5/8 in.	*100.0*
1/2 in.	*95.1*
3/8 in.	*87.3*
No. 4	*66.2*
No. 10	*50.0*
No. 40	*31.4*
No. 100	*17.7*
No. 200	*14.9*

The extracted asphalt content is 5.4 percent by weight of total mix.

Enter the nomograph with point A as 31.4 percent passing the No. 40 sieve. Draw a vertical line to Point B: 14.9 percent passing the No. 200 sieve. Then draw a line horizontally to point C to determine the estimated optimum percentage of asphalt. In this case the optimum percentage of asphalt is estimated to be 7.0 percent. The existing asphalt content is 5.4 percent; therefore, an additional 1.6 percent emulsion residue can be added.

The recycling emulsion used for this example is AES-300RP. The residual asphalt in AES-300RP is typically 65 percent; therefore the total emulsion to be added to the mix is

$$\frac{1.6}{0.65} = 2.5 \text{ percent AES-300RP}$$

Adjustment in the Field

The calculations shown above will provide a starting point for determination of asphalt content in the field. Experienced field personnel report that, generally, adjustments need to be made throughout the mixing process based on visual evaluations of the mix. It is reported that the mixture should have just enough emulsion so that the mix bonds together in a cohesive mass when squeezed by hand.

Visual determination of the correct asphalt quantity is sometimes difficult and often requires a very experienced eye. Existing moisture in the stockpile and the addition of moisture in the emulsion can sometimes give the mix a cohesive nature; therefore, it is recommended that samples of the recycled mix be obtained throughout the mixing process and air-dried. The following is a procedure which may be used as a guide for adjusting asphalt content in the field.

1. *Spread the sample out on a clean surface allowing it to air dry. Once the sample appears to be dry, pack the material together as tightly as possible with your hand, as if you were making a snowball.*

2. *Drop the ball of recycled mix from waist height (approximately 3 feet).*

3. *Examine the ball of material to determine if asphalt content should be adjusted based on the following criteria:*

EXCESS ASPHALT

- *The ball of material slumps upon impact, or only cracks slightly.*
- *Your hands are covered with a thick layer of asphalt.*

INSUFFICIENT ASPHALT

- *The ball of material breaks into many small pieces.*
- *Specks of asphalt remain on your hands.*

CORRECT QUANTITY OF ASPHALT

- *The ball of material breaks in half, or into several large pieces.*
- *Your hands are covered with a slight film of asphalt.*

Selection of Emulsified Recycling Agent

There are a number of emulsified recycling agents on the market, and many are of a proprietary nature. Some are specifically designed to be used for recycling RAP which is to be stockpiled. One of these which has been used quite successfully for this purpose and is not proprietary is designated AES-300RP. Specifications for this emulsion are shown in Appendix A.

Standard emulsified asphalts recommended for cold mix recycling include soft residue, slow and medium-setting cationic and anionic emulsions which conform to TxDOT specification Item 300. These standard emulsified asphalts are recommended for use when material will be used immediately or stockpiled less than six weeks. TxDOT Item 300 Standard Specifications for Emulsions are shown below.

ANIONIC EMULSIONS

TYPE	Rapid Setting				Medium Setting						Slow Setting	
GRADE	RS-2		RS-2h		MS-2		MS-2h		MS-1		SS-1	
Properties	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Furol Viscosity at 77 F, sec	—	—	—	—	—	—	—	—	30	100	30	100
Furol Viscosity at 122 F, sec	150	400	150	400	100	300	100	300	—	—	—	—
Residue by Distillation, %	65	—	65	—	65	—	65	—	60	—	60	—
Oil Portion of Distillate, %	—	2	—	2	—	2	—	2	—	2	—	2
Sieve Test, %	—	0.1	—	0.1	—	0.1	—	0.1	—	0.1	—	0.1
Miscibility (Standard Test)	—	—	—	—	—	—	—	—	Passing		Passing	
Coating	—	—	—	—	—	—	—	—	Passing		—	—
Cement Mixing, %	—	—	—	—	—	—	—	—	—	—	—	2.0
Demulsibility 60 cc of N/10 $CaCl_2$, %	—	—	—	—	—	—	—	—	—	70	—	—
Demulsibility 35 cc of N/50 $CaCl_2$, %	60	—	60	—	—	30	—	30	—	—	—	—
Storage Stability, 1 day, %	—	1	—	1	—	1	—	1	—	1	—	1
Freezing Test, 3 Cycles *	—	—	—	—	Passing		Passing		Passing		Passing	
Tests on Residue: Penetration at 77 F, 100 g, 5 sec	120	160	80	110	120	160	80	110	120	160	120	160
Solubility in Trichloroethylene, %	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—
Ductility at 77 F, 5 cm/min, cms	100	—	100	—	100	—	100	—	100	—	100	—

* Applies only when Engineer designates material for winter use.

HIGH FLOAT EMULSIONS

TYPE	Rapid Setting		Medium Setting	
GRADE	HFRS-2		AES-300	
Properties	Min.	Max.	Min.	Max.
Furol Viscosity at 77 F, sec	—	—	75	400
Furol Viscosity at 122 F, sec	150	400	—	—
Residue by Distillation, %	65	—	65	—
Oil Portion of Distillate, %	—	2	—	7
Sieve Test, %	—	0.1	—	0.1
Coating	—	—	Passing	
Demulsibility 35 cc of N/50 $CaCl_2$, %	50	—	—	—
Storage Stability Test, 1 day, %	—	1	—	1
Tests on Residue:				
Penetration at 77 F, 100 g, 5 sec	100	140	300	—
Solubility in Trichloroethylene, %	97.5	—	97.5	—
Ductility at 77 F, 5 cm/min, cms	100	—	—	—
Float Test at 140 F, sec	1200	—	1200	—

CATIONIC EUMLSIONS

TYPE	Rapid Setting				Medium Setting				Slow Setting			
GRADE	CRS-2		CRS-2h		CMS-2		CMS-2h		CSS-1		CSS-1h	
Properties	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol at 77 F, sec	—	—	—	—	—	—	—	—	20	100	20	100
Viscosity, Saybolt Furol at 122 F, sec	150	400	150	400	100	300	100	300	—	—	—	—
Storage stability test, 1 day, %	—	1	—	1	—	1	—	1	—	1	—	1
Demulsibility*, 35 ml 0.8 percent sodium dioctyl sulfo-succinate, %	40	—	40	—	—	—	—	—	—	—	—	—
Coating, ability and water residance:												
Coating, dry aggregate	—	—	—	—	good		good		—	—	—	—
Coating, after spraying	—	—	—	—	fair		fair		—	—	—	—
Coating, wet aggregate	—	—	—	—	fair		fair		—	—	—	—
Coating, after spraying	—	—	—	—	fair		fair		—	—	—	—
Particle charge test	positive		positive		positive		positive		positive		positive	
Sieve Test, %	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10
Cement mixing test, %	—	—	—	—	—	—	—	—	—	2.0	—	2.0
Distillation: Oil distillate, by volume of emulsion, %	—	3	—	3	—	12	—	12	—	3	—	3
Residue, percent	65	—	65	—	65	—	65	—	60	—	60	—
Tests on Residue from Distillation Test:												
Penetration, 77 F, 100g, 5 sec	120	160	80	110	120	200	80	110	120	160	80	110
Ductility, 77 F, 5 cm/min., cm	100	—	100	—	100	—	100	—	100	—	100	—
Solubility in trichloroethylene, %	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—

* Demulsibility test shall be made within 30 days from date of shipment.

The American Society for Testing and Materials (ASTM) provides a standard classification for hot-mix recycling agents (ASTM Designation D4552). These recycling agents may also be used for cold-mix recycling. This practice describes recycling agents (RA) as belonging to one of the following six groups: RA 1, RA 5, RA 25, RA 75, RA 250, and RA 500, as shown in the following table. The choice of RA grade will depend on the amount and hardness of the asphalt in the aged pavement. In general, the lower viscosity RA types can be used to restore aged asphalts of high viscosity. Grades RA 1, RA 5, RA 25, and RA 75 will generally be most appropriate when recycling 100% RAP.

TABLE 1 Physical Properties of Hot-Mix Recycling Agents

Test	ASTM Test Method	RA 1		RA 5		RA 25		RA 75		RA 250		RA 500	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity • 140°F, cSt[A]	D 2170 or D 2171	50	150	200	800	1000	4000	5000	10000	15000	35000	40000	60000
Flash Point,COC,F	D 92	425	...	425	...	425	...	425	...	425	...	425	...
Saturates,wt,%[B]	D 2007	...	25	...	25	...	25	...	25	...	25	...	25
Tests on Residue from RTFO or TFO oven 325°F	D 2872 or D 1754												
Viscosity Ratio[C]	•	...	3	...	3	...	3	...	3	...	3	...	3
Wt Change,±,%	•	...	4	...	4	...	3	...	3	...	3	...	3
Specific Gravity	D 70 or D 1298	Report		Report		Report		Report		Report		Report	

[A] A recycling agent having a viscosity value outside the specified range is acceptable providing it meets all the above criteria, except viscosity, and has a minimum to maximum viscosity range comparable to the nearest RA grade.

[B] A recycling agent having a Saturates weight % above 25 and below 30 is acceptable providing it meets all the above criteria except Saturates weight %.

[C] $\text{Viscosity Ratio} = \frac{\text{Viscosity of Residue from RTFO or TFO Oven Test • 140°F,cST}}{\text{Original Viscosity • 140°F,cSt}}$

ASTM Designation D4887 provides a method which can be used to aid in the selection of an appropriate recycling agent.

PROCESSING STOCKPILED RAP

The quality of RAP can be substantially improved by mixing it with recycling agents or conventional maintenance mixtures. Guidelines are presented below for cost-effective methods of processing RAP which can then be stockpiled for future use.

BLENDING RAP WITH RECYCLING AGENTS

RAP may be blended with recycling agents as discussed in the previous section on mix design. This is generally accomplished at ambient temperature in one of two ways: pugmill mixing or blade mixing.

Pugmill Mixing. Use of a pugmill plant to blend the recycling agent with the RAP is the preferred method of mixing. It is generally more efficient than blade mixing: production capacity of most pugmill plants is 600 to 700 cubic yards per day whereas about 150 cubic yards per day can be blade-mixed. It is also possible to achieve a more uniform blend and maintain greater quality control on the quantity of recycling agent added to the RAP. However, since districts typically do not own pugmill plants, this type of mixing operation must be by contract. It is recommended that the hopper of the pugmill be equipped with a screen to remove large chunks of RAP greater than 2 inches.

It is advisable to have at least 5000 cubic yards of RAP to be recycled in one contract. This is necessary in order to attract bidders for the contract. However, it is quite common to have several stockpiles throughout the district recycled under one contract. The pugmill can simply be transported to each stockpile for mixing on site.

If the contractor is providing a pugmill to the district, it is desirable that he also be contracted to do the mixing as well. The district should provide a front-end loader and operator to load the RAP into the pugmill and to stockpile the final recycled product at the mixing site for future use. The district should also provide a person to inspect the mixing process and to determine appropriate recycling agent quantities.

Blade Mixing. Blade mixing is perhaps the simplest method, but it is usually slow and inefficient. It is most appropriate for very small RAP stockpiles. More thorough and uniform mixing of the recycling agent and the RAP is accomplished with a pugmill; however, excellent results have also been obtained through the use of a blade. Some districts may have access to a pulver-mixer which can also aid in this type of mixing operation.

The basic mixing sequence involves:

* Using a motor grader to windrow the RAP.
* Adding the prescribed amount of recycling agent, normally in two or three passes, using an asphalt distributor.
* Using the grader to fold the material around the applied recycling agent, followed by working the mixture back and forth across the mixing pad until the recycling agent is uniformly distributed.

When To Use Processed RAP. When blending RAP with recycling agents, such as AES-300RP, it is very important that the stockpiled material be allowed to "cure" before use. The recycling agent supplier should be consulted as to the amount of time needed for cure; however, based on field experience with AES-300RP, the processed stockpile should cure for at least three weeks before using.

Once the recycled RAP stockpile has cured, it is recommended that a minimum of three samples be obtained for testing. Hveem stability should be determined for each sample. The measured stability can be used as a guide for determining applicability of recycled RAP. This will be discussed further in the section on entitled "Uses of RAP".

The stockpile life of the recycled RAP is dependent on a number of different variables: the type and quantity of recycling agent used, the hardness of the aged asphalt in the RAP, and environment. The recycling agent supplier should also be consulted to provide guidance concerning stockpile life. It is generally recommended that the recycled RAP be used within one year of processing.

What If Too Much Recycling Agent Was Mixed with the RAP? Once the RAP has been recycled and cured, it may be detected that too much recycling agent was used in the blending process. This will also be evidenced by very low Hveem stability values. This problem can be corrected by mixing the recycled RAP with raw RAP or with conventional maintenance mixtures such as hot-mix, cold-lay asphalt concrete pavement or cold-mix limestone rock asphalt (usually at a 50/50 ratio) as will be discussed further.

BLENDING RAP WITH CONVENTIONAL MAINTENANCE MIXTURES

Research study 1272 revealed that both laboratory properties and field performance of raw RAP and processed RAP can be significantly improved when blended with commonly available conventional maintenance mixtures such as hot-mix, cold-lay (HMCL) asphalt concrete pavement and cold-mix limestone rock asphalt (LRA).

When mixing a conventional maintenance mix with RAP which has been recycled as described above, it is recommended that the two materials be blended at the following ratio:

50% treated or processed RAP
50% conventional maintenance mix.

When mixing untreated or raw RAP with conventional maintenance mixes, a more appropriate proportion is

40% raw RAP
60% conventional maintenance mix.

Two methods for mixing RAP with conventional mixes have been observed. A commonly used method is, of course, blade mixing. If this method is used, mixing should be accomplished at stockpile location or maintenance yard and not on jobsite where material is to be placed. Blade-mixing can be very time consuming and should be done where traffic control is not needed. This will keep cost to a minimum and improve the safety aspects of the operation by being removed from traffic.

Another successful method for blending RAP with conventional mixes involves mixing with a front-end loader at stockpile location. This requires less land area for mixing, less personnel, and less equipment than blade mixing. Only one person is required to operate a front-end loader provided the two materials to be blended are at one location. The loader operator piles one material on top of another in the desired proportions. Mixing is accomplished by scooping material from the bottom of the pile to the top until a uniform blend is achieved.

USES FOR RAP IN ROUTINE MAINTENANCE ACTIVITIES

Conventional maintenance mixes which are purchased by the Department are required to be of a high quality and to conform to a set of specifications. Neither raw RAP nor processed RAP must comply with a set of specifications before it can be used by the Department in maintenance activities. Therefore, caution must be exercised in how RAP is used.

RAP and processed RAP is generally of an inferior quality to conventional maintenance mixtures. The cold milling process which produces the RAP often degrades the aggregate such that there is an excess of fine aggregate. General appearance of RAP and processed RAP is sometimes less than desirable: it is difficult to eliminate all the large chunks and it doesn't have that nice, new, black appearance that conventional maintenance mixtures have. It also lacks the workability that new mixes have.

The methods described in this manual for processing RAP require minimal mix design, testing, and quality control when compared with conventional maintenance mixtures. Therefore, it is not surprising that the quality of the final RAP product is not as high as conventional maintenance mixtures.

Some guidelines follow as to appropriate uses for RAP in routine maintenance activities.

Untreated RAP

Raw or untreated RAP has been used by the Department in the following applications:

* Paving driveway and county road approaches,
* Paving mailbox and litter barrel turnouts, and for
* Pavement edge repair.

These uses for untreated RAP are acceptable for temporary repair; however, processing the RAP with recycling agents or blending with conventional maintenance mixes as described previously should substantially increase the life of the maintenance treatment and prove more cost effective.

Treated RAP

Once a RAP stockpile has been processed by blending with a recycling agent or conventional maintenance mix and is ready for use, it is recommended that a minimum of three samples be obtained and tested to determine Hveem stability.

<u>Hveem Stability < 20</u>

If the RAP was blended with a recycling agent and has a stability less than 20, it is recommended that the material be remixed with raw RAP or a conventional maintenance mix and retested. If this is not possible, the following uses are recommended:

* Driveway approaches,
* Pavement edge repair, and
* Mailbox and litter barrel turnouts.

Hveem Stability Between 20 and 30

If the RAP has a Hveem stability value between 20 and 30, it can of course be used in the above applications in addition to the following:

* Shoulder repave,
* Level up, and
* County road approaches.

Hveem Stability Above 30

If the RAP has a Hveem stability value above 30, it may be used as any other conventional maintenance mix.

In general RAP which has been processed as described in this manual is not recommended for base repair. It cannot provide the structural support that is required of a base material. However, some districts use RAP successfully in base repair by blending it with existing base materials and stabilizing with cement or other stabilizers. One district has successfully used RAP as the base material in the construction of a district office parking lot: the RAP was blade mixed with cement and water to stabilize the RAP and then compacted 8 inches thick before placement of a surface course.

APPENDIX A

SPECIFICATION FOR AES-300RP RECYCLING EMULSION

SPECIFICATION AES-300RP

The emulsion is designed to mix at ambient temperature with reclaimed asphalt pavement (RAP). The resulting mixture is then capable of being stockpiled for future use as a patching material or for overlays. It is recommended that the initial blending of the RAP and emulsion be done during warm summer conditions to aid in proper fluxing of the materials. The purpose of the polymer in the formulation is to improve the cohesion of the mix and improve the resistance to ravelling of the RAP mixture. This emulsion may also be used for surface recycling projects where heat is used to soften aged pavements and are then fluxed with this type of emulsion.

The asphalt shall be polymer modified prior to emulsification. The emulsion shall be smooth and homogeneous and conform to the following specifications:

TESTS ON EMULSION:	MIN.	MAX.
Viscosity @ 122°F, SSF	75	400
Sieve, %		0.1
24-Hour Storage Stability, %		1
Coating Test [1]	PASS	
Residue from distillation @ 350°F, %	65	
Oil Portion from distillation, ml of oil per 100 g. of emulsion		7

<u>TESTS ON RESIDUE FROM DISTILLATION</u>:

Float Test @ 140°F, sec.	1200

<u>TESTS ON RESIDUE FROM ROLLING THIN-FILM OVEN TEST</u>:

Penetration @ 77°F, 5 sec.	300
Torsional Recovery [3], %	20

[1] Texas procedure.

[2] The residue from distillation shall be subjected to the standard rolling thin-film oven test.

[3] Procedure attached.

METHOD OF TEST FOR RECOVERY FROM DEFORMATION OF POLYMER MODIFIED ASPHALT EMULSION RESIDUE (TORSIONAL RECOVERY)

A. SCOPE

This method of test is an indication of the amount of elasticity that a polymer has imparted to an asphalt.

B. APPARATUS

1. Container -

   The container in which the sample is to be tested shall be a flat-bottom, cylindrical seamless tin box, 2.17 in. (55 mm) in diameter and 1.38 in (33 mm) in depth. The container is commonly known as a three ounce ointment can.

2. Disc Assembly -

   The disc assembly is shown in Figure 1. The disc shall be made of aluminum. The spider pointer and nut shall be made of steel.

3. Wrench -

   A 5/16 inch open-end or box-end wrench.

4. Timer -

   A stop watch, clock or other timing device graduated in divisions of one second or less.

5. Scale -

   A flexible plastic scale graduated in millimeters.

C. PROCEDURE

1. Using the residue from the specified method, weight 50 = 1 g. of thoroughly mixed emulsified asphalt residue into one 3 ounce

can. Immerse the disc assembly into the molten asphalt, align the notches in the spider with the can so that the disc is centered, and adjust the disc height such that the asphalt surface is even with the top of the disc. Put the can and assembly in a 325°F oven to allow bubbles to escape and to break the surface tension around the disc. Prepare a duplicate assembly similarly. After ten minutes in the oven, remove the cans and allow them to cool at room temperature for two hours.

2. Mark the can for the reference points of 0° and 180° based on the pointer location after mold preparation. Hold the can and spider rigidly. With a wrench attached to the top of the disc shaft, rotate the disc 180° and release immediately. The rotation should be done at a steady rate taking approximately five seconds to accomplish. Begin timing the recovery at the release of the disc. Mark the pointer location of the can at 30 minutes. Repeat the procedure for the second sample.

D. CALCULATION AND REPORT

1. Calculate the percent recovery from the deformation as follows:

$$\text{Percent Recovery} = 100 \left(\frac{A}{B/2}\right)$$

Where:

A = the arc of the can, in millimeters, between the starting mark and the mark at 30 minutes, and

b = the circumference of the can, in millimeters.

2. Report the percent of recovery as an average of the two results.