PAVEMENT RECYCLING

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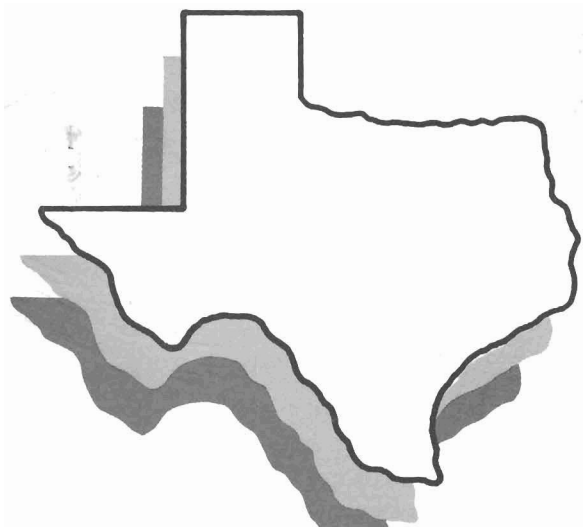

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16. Abstract

Pavement recycling is defined as the reuse of material from in-place pavements which are processed to provide quality paving materials suitable for use in the construction or in the rehabilitation of pavements.

One alternative available to agencies for improving road and street maintenance costs is the recycling of existing materials.

This report outlines some guidelines to consider when proposing to recycle materials and summarizes some of the recycling activities of the Department.

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PAVEMENT RECYCLING

by

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Introduction:

One alternative available to agencies for improving road and street maintenance costs is the recycling of existing materials. The recycling of asphalt concrete started receiving national attention in the mid 70's primarily because of the increase of price of asphalt cement.

Pavement recycling is defined as the reuse of material from in-place pavements which are processed to provide quality paving materials suitable for use in the construction or in the rehabilitation of pavements.

Recycling Considerations:

Asphalt pavement recycling can be done by either a "hot" or "cold" process. In addition to the hot or cold process is the option of in-place versus plant recycling systems.

Hot-mix asphalt pavement recycling is a process in which reclaimed asphalt pavement materials (asphalt and/or aggregates) are combined with new asphalt, recycling agents, and/or new aggregates in a central plant or in-place to produce a new "hot-mix" paving mixture. Cold-mix asphalt pavement recycling is a process in which reclaimed asphalt pavement materials (asphalt and/or aggregates) are combined with new asphalt and/or recycling agents in-place or at a central asphalt plant to produce a "cold-mix" mixture. These finished products meet all standard material specifications and construction requirements for the type of mixture being produced.

Recycling is one of numerous options for maintaining or rehabilitating pavements. Various reasons for considering recycling are:

- The asphalt and aggregates in existing asphalt pavements are valuable resources.

- Asphalt and aggregates are becoming more expensive, and in some areas of the state, good aggregates are getting scarce.

- Recycling saves energy in a time when future energy resources are becoming limited.

- With recycling, existing geometrics of roadways can be preserved.

- In most cases, utilities can remain in place when using the recycling alternative.

When recycling is being considered there are certain questions of importance to remember. Some which need to be answered are:

- Why is this highway a candidate for recycling?

  The cause of pavement distress leading to the need for recycling must be identified and corrected. Typical causes of distress in asphalt mixtures in Texas are:

  - aged or brittle asphalt,
  - moisture susceptible mixtures, and
  - structural inadequacy

- Is recycling going to cure the problem?

  In general, whenever some form of disintegration (severe ravelling, pot holing, stripping) or severe distortion is occurring, the layer(s) that are affected should be removed and recycled. Do not recycle just to be recycling, but instead, be aware of the benefits to be gained by recycling.

- Has proper work been done to determine that this material is recyclable?

  In determining whether the material is recyclable or not, it is important to consider what will be its recycled form. Next a sampling plan should be developed which will ensure representative samples of the mixture to be recycled. This involves identification of subsections of the pavement which have different mixture characteristics, maintenance activities, performance characteristics, the level of variation in asphalt content, and aggregate type and gradation for each subsection and possibly traffic.

  Do not lump unlike sections together to be recycled and do not recycle material unless it is recyclable.

- Has a proper recycled mixture design been developed?

  A proper recycled mixture design method would include the following steps:

  a) Evaluation of the salvaged material, as described above,
  b) Determination of the need for additional aggregates,
  c) Selection of asphalt modified type and amount,
  d) Preparation and testing of the mixture, as detailed below, and;
  e) Selection of the optimum combination of new aggregates and asphalt modifiers.

  The recycled mixtures should be designed under laboratory conditions simulating those expected in the field. The engineering properties of the laboratory designed and prepared mixtures should be evaluated to determine proper additive levels and estimate field performance.

  Properties of concern include:

  a) stability,
  b) unconfined compression,
  c) indirect tensile strength, and
  d) resilient modulus of elasticity, if possible.

- Once the recycling process begins and the product does not meet expectations--stop. Although it is best to minimize modifications of the design mixture once construction begins, do not settle for less than the best, even though it is recycled. It is very important to determine what is causing a less than desirable mixture and then correct it.

Results of Actual Use:

Currently several Districts have used recycling as an experimental procedure or as an accepted practice. Chart 1 summarizes information that has been collected from projects throughout the state.

Roadway Type and Average Daily Traffic	Date Completed and Location	Type of Pavement Recycled	Hot or Cold In-Place or Plant	Length of Roadway and Time Required to Complete	Cost Data	Condition of Pavement Before Recycling	% Salvaged Material Used	Replacement Form	Performance at What Time Increment
US Highway '85 ADT = 6,100	10-22-82 Northwest Texas	Asphalt Stabilized Base (ASB) with hot mix overlay.	Hot Plant	14.5 miles 98 days	$1.961 million 10% savings over other types of restoration	Alligator Cracks, Rutting	Used 100% of salvaged material and this salvaged material composed 70% of the new mix.	In travel lane was placed as ASB. On the shoulders was used as driving surface.	1 year: Very poor performance - extensive cracking and some failures
US Highway '85 ADT = 17,400	11-16-84 East Texas	HMAC on jointed concrete widened with flexbase.	Hot In-Place	16 lane miles 25 days	$241,200	Rutted and Some Shoving	Used 100% of existing surface to 1½" deep. This made up 80% of the new recycled mix.	Driving Surface	1 year: Good performance 2 years: Rutted to pre-construction conditions.
US Highway '85 ADT = 9,000	9-13-85 East Texas	HMAC on flexbase.	Hot In-Place	4 lane miles 10 days	$81,200	Dry and Cracked	Used 100% of existing surface to 1½" deep. This made up 80% of the new recycled mix.	Driving Surface	1½ years: Performed well
US Highway '85 ADT = 14,700	10-23-85 East Texas	HMAC on jointed concrete and flexbase.	Hot In-Place	27 lane miles 45 days	$300,000	Dry, cracked and some shoving.	Used 100% of existing surface to 1½" deep. This made up 80% of the new recycled mix.	Driving Surface	16 months: Performed well.
State Highway '85 ADT = 3,000	7-14-86 East Texas	HMAC on jointed concrete widened with flexbase.	Hot In-Place	4 lane miles 10 days	$83,600	Flushed	Used 100% of existing surface to 1½" deep. This made up 80% of the new recycled mix.	Driving Surface	7 months: Performed well.
City Loop '85 ADT = 19,000	3-24-86 East Texas	Top 1½" HMAC overlay of a flexible pavement.	Hot In-Place	7 lane miles 31 days	Cost = $119,068. Approximate savings over removal and replacement was $54,046.	Badly cracked and rutted	Used 100% of salvaged material and to this added 30 lb/sq. yd. new plant mix HMAC.	Driving Surface initially and added a seal coat about 5 months after completion.	11 months: Performed well.
US Highway '85 ADT = 11,000	6-22-81 South Texas	Type B and C HMAC made from silicous gravel aggregate. Approximately half of the project had a one course surface seal.	Hot Plant	17 miles 160 days	$2.5 million Approximate savings of $165,750	Outside wheel path severely rutted and the HMAC had become unstable.	58% salvaged material in new mix.	Recycled material was used as ASB. A new level up course of Type B HMAC was placed, followed by a new Type D HMAC overlay	2 years: Cracks in wheel paths. Took cores and determined cracks originated in the ASB. 3 years: Sealed with Polymer mod. Emulsion & one coarse agg. 6 years: Has performed fairly well.

Chart 1

Roadway Type and Average Daily Trafic	Date Completed and Location	Type of Pavement Recycled	Hot or Cold In-Place or Plant	Length of Roadway and Time Required to Complete	Cost Data	Condition of Pavement Before Recycling	% Salvaged Material Used	Replacement Form	Performance at What Time Increment
State Highway '85 ADT = 4,700	7-69 Central Texas	PCC with asphalt concrete pavement overlays.	Hot Plant	12 miles 325 days	$1.55 million	Not Available	100% of salvaged PCC with asphalt overlays used. This material was used in amounts varying from 35-85% for ASB and 60-80% for Type B HMAC	Contractor used the crushed PCC with overlays for ASB aggregate, as well as Type B HMAC aggregate	18 years: Base still performing well, surface has received at least two seal coats.
US Highway '85 ADT = 11,000	11-81 Northeast Texas	HMAC and Cement treated Iron Ore Base	Hot Plant	2.9 miles not available	Not Available	Severely cracked and rutted	Used 100% of salvaged material to a 2" depth. This composed about 85% of the recycled mix.	Surface	5 years: Performed very well 6½ years: Somewhat cracked and rutted.
US Highway '85 ADT = 5,650	12-18-85 South Texas	HMAC with seal coat.	Hot Plant	15.7 miles 55 days	$1.285 million Approximate savings of $613,000	Rutting, shoving and stripping in the layer 1½" below the top 1½" layer.	35% old HMAC used	Driving Surface	4 months: Material performing well with some loss of surface fines; asphalt rejuvenator placed. 14 months: Material performing well.
US Highway '85 ADT = 17,000	4-13-81 Southeast Texas	Type D HMAC	Hot Plant	6 miles 79 days	Not Available	Not Available	84% salvaged material in new mix.	Reused as ASB	6 years: Recycled HMAC as ASB has worked well.
Five Interstate Jobs	1. 6-16-78 2. 6-11-79 3. 1-4-84 4. 11-31-84 5. 11-14-86 Northcentral Texas	ACP with seal coats, blade patches and possibly ASB	Hot Plant	1. 2.9 miles 166 days 2. 2.1 miles 170 days 3. 9.0 miles 350 days 4. 6.5 miles 395 days 5. 8.5 miles 397 days	1. $827,076 2. $732,679 3. $3.433 million 4. $2.987 million 5. $2.954 million Approximately 20% savings on each.	Pavement was badly cracked on all the projects. The bases were treated, stabilized or just reworked.	100% salvaged material used. This composed approx. 70% of new mix.	Reused as ASB	Performance is equal to or better than virgin material. The first contract has performed for 9 years and will have its first overlay in the summer of 1987.

Chart 1 (continued)

Roadway Type and Average Daily Traffic	Date Completed and Location	Type of Pavement Recycled	Hot or Cold In-Place or Plant	Length of Roadway and Time Required to Complete	Cost Data	Condition of Pavement Before Recycling	% Salvaged Material Used	Replacement Form	Performance at What Time Increment
Interstate '80 ADT = 18,700	1980 Southeast Texas	2" HMAC (1968) -seal coat (1968)- 1½" HMAC (1965) 1" HMAC (1961) Recycled Material	Hot Plant	14.8 miles Not Available	Not Available	Cracking occurred in the overlays and shoving had developed at the joints.	The new mix was made of between 70 & 100% salvaged material plus on the average about 2% new binder.	Recycled as Type B HMAC base course. A seal coat was placed on the type B HMAC and a 1" Type D HMAC placed above the seal coat	Distress in the form of rutting and shoving was so severe that the material had to be removed before completion.

Chart 1 (continued)

The benefits mentioned above are some associated with recycling of existing pavements. The benefits are very attractive and also a cost effective way to improve and maintain the Department's roadways. It is also important to keep in mind that the knowledge gained this far from recycling experience is only a part of the knowledge that is needed. There must be continued efforts to actively seek improved techniques for recycling pavement materials.