RURAL SURFACE RECYCLING

Rowan J. Peters, Arizona Department of Transportation

Federal, state and local agencies are currently faced with a number of very critical problems which include the reduction in available funds due to inflation, a declining tax base, and declining revenue from taxes on fuel. A possible answer to these current problems is the serious consideration to re-use existing in-place materials be recycling for construction and maintenance needs. By recycling we conserve energy and materials (aggregates, binders, guardrail etc.) and are able to preserve the pavement geometrics and environment. The Arizona Highway Division began using the surface recycling-Reclamite rejuvenating agent process about 12 years ago. Before that time it was using the rejuvenating agent as a surface treatment only to routinely maintain its roads. However, there were limitations to its use since in many instances the pavement surfaces were far too deteriorated for this type of treatment to be effective. The advent of the surface recycling program, in which heater scarification of the old pavement surface and Reclamite rejuvenation treatments are combined, overcame these deficiencies. Control techniques devised by the Highway Division of the Arizona Department of Transportation have played an important part in the success of a continuing program to repair deteriorated asphalt pavements by surface recycling methods. The effectiveness of the quality control practies, which deal primarily with close control of proper scarification depth of the old pavement, has made it possible for the division to gain optimum results from surface recycling which not only produces durable asphalt road surfaces but also helps conserve resources and energy.

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The Arizona Highway Division began using the surface recycling-Reclamite rejuvenating agent process about 12 years ago(1, 2). Before that time it was using the rejuvenating agent as a surface treatment only to routinely maintain its roads. However, there were limitations to its use since in many instances the pavement surfaces were far too deteriorated for this type of treatment to be effective. The advent of the surface recycling program, in which heater scarification of the old pavement surface and Reclamite rejuvenation treatments are combined, overcame these deficiencies.

What is more important about the ability of the process to reduce asphalt consumption is the conservation of resources that are dwindling. This is a very practical consideration. The energy required for making new asphalt pavement and the crude oil-based ingredients of asphalt cement itself are becoming more costly and scarce.

What is presently called asphalt pavement surface recycling in today's environmentally conscious world would have been described in the past by other terms; e.g., heater-scarification or heater remixing, etc. Aside from terminology, the process has always been a multi-step procedure of heating the existing surface, scarifying, remixing, compacting and adding a rejuvenating agent.

Design Objective

The prime purpose behind the use of the strategy of surface recycling is to develop a low modulus layer of bituminous material with the flexibility to retard the propogation of cracks. In effect, the attempt is to break the cracking pattern of the existing pavement surface and form a restructured layer capable of disseminating the stresses that develop in pavements. The restructured layer is only effective if it has been adequately formed and its ultimate performance is dependent upon a number of parameters such as environment, pavement structure and construction.

To this point there has been little consideration given to assigning any structural value to the recycled surface layer. As our experience increases and we improve our ability to achieve the desired objective including the increased depths of

scarification that we can begin to quantify the "structural" improvements and perhaps reduce overlay thicknesses accordingly when they are employed with the surface recycling strategy.

When we consider the fact that we may never again have the opportunity to rejuvenate this particular layer of the pavement structure due to subsequent overlays, seal coats etc, it becomes that much more important that due consideration be given all elements involved. Proper rejuvenation requires an adequate addition of recycling agents to the recycled surface. This quantity of recycling agents should be determined by laboratory testing on cores taken from the surface to be recycled. Assuming a scarification depth of 2cm (3/4 inch), this top 2cm (3/4 inch) of the cores is removed for testing. The asphalt recovered from the 2cm (3/4 inch) slice is tested for absolute viscosity at 60°C (140°F). The quantity of recycling agent required to return the asphalt to a viscosity level which would be comparable to a new asphaltic concrete is determined by trial additions of the agent with the recovered asphalt.

The quantity of the recycling agent specified is dependent upon the complete interaction with the asphalt throughout the 2cm (3/4 inch) depth. Realistically the success of this interaction is dependent upon many factors with the prime factor being our ability to achieve the specified amount of scarified material. The quantity of the rejuvenating agent actually used is also dependent upon the ability of the recycled surface to "accept" the specified fog application of recycling agent. A complete rejuvenating interaction may require 1.13 liter per square meter (0.25 gallon per square yard) of the agent; however, the condition of the recycled surface may be such that a greater or lesser quantity is appropriate. It is suggested that specimens should be formed that approximate the compacted scarified material and varying application rates tested for completeness of penetration or potential flushing problems.

It is further suggested that variations in roadway surfacing be handled separately. For instance, maintenance seal areas that are usually higher in asphalt quantities may not be able to handle the same quantity of rejuvenating agents. The key point is that adjustments to the design must be considered throughout the project as varying conditions arise. We should not expect to set application rates at the beginning of a project and not expect to have need to alter them throughout the course of the project.

Design Decision Criteria

The question is often asked as to when one should consider the use of the surface-recycling strategy. Many times, without firm design criteria at hand, this decision is made based on ones personal experience and intuition. Besides the advantages of rehealing and restoring the surface, we mainly look at the use of the strategy for inhibiting reflective cracking.

In order to determine when to employ the strategy, utilization of a cracking index photo representation is relied upon(3). The cracking index represents the percentage of cracks of a sample of 1000 square feet of roadway. Currently we consider surface recycling a pavement that has greater than 10% cracking. The difficult decision is to determine the point when we begin to more seriously consider hot-mix recycling or in-place cold recycling. At this point, it appears that above 40% cracking we should begin to look at those alternate strategies.

Figure 1. Approximately 10% Cracks

Figure 2. Approximately 35% Cracks

Construction Quality Control

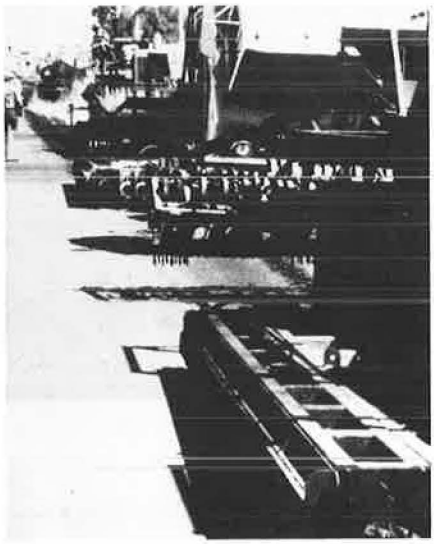
As mentioned previously, the most important aspect of surface recycling needed to produce a satisfactory product is to achieve the design depths of scarification and to add the proper amount of the recycling agent to this total depth. To accomplish this end it is important to exert control over a number of construction details such as:

1. Weather Consideration. It has been found necessary to control the time of year the surface recycling should be done depending on project elevation. The work is generally restricted to the dates shown; however, the beginning date may be moved ahead and the ending date may be extended if, in the opinion of the engineer, weather conditions, surface temperatures and other factors will not have an adverse effect upon the work. At any time the engineer may require that the work cease or that the workday be reduced in the event that weather or other conditions will have an adverse effect upon the product.

Average Elevation of Project, Feet	Beginning and Ending Dates
0 - 3499	February 15 - December 15
3500 - 4999	April 1 - October 31
5000 and over	May 1 - September 30

2. Heating Units. The number of heater units utilized is determined by the contractor; however, if all heater units are equipped with scarifiers, only the scarifier on the last heater unit of the series is allowed to be used for scarification. Multiple heater units are utilized in tandem such that the heat emitted and the rate of travel will achieve the specified depth requirement.

Figure 3. Operating Train - Two Heating Units Followed By a Heating and Scarifying Unit



The existing bituminous surface is heated not less than 15cm (6 inches) nor more than 30.5cm (12 inches) wider than the width of the material to be scarified. The temperature of the scarified material measured immediately behind the scarifier should be not less than 93.3°C (200°F) nor more than 149°C (300°F).

3. Depth of Scarification. Here is where the new quality control practices have proved so valuable(4). One of the keys to successful surface recycling is following the specification for scarification depth, which is critical for achieving proper penetration of the rejuvenating agent. Optimum scarification depth is considered to be 3.3 cm (1 1/4 inches) of loose or 2cm (3/4 inch) of compacted scarified asphalt mix depending upon specific project conditions. Depth probes have not been very satisfactory as a means of determining whether the proper scarification depth is being maintained. Instead the division has devised a new positive method.

Based on a specific weight of 2306Kg per cubic centimeter (144 pounds per cubic foot), the weight of one square foot of scarified mix at the specified depth is 4.09Kg (9 pounds). In order to confirm that specifications are being met, a state inspector periodically monitors weight on-site be setting known-diameter rings into the asphalt surface after the scarifier and ahead of the roller operations. He scoops the loose contents out completely and weighs them to ascertain that they conform to the 4.09Kg (9 pounds) per square foot criterion. Rings are set out at 20-minute intervals and placed in a continous pattern from one side of the road to the other and then to the center. If samples from three successive rings do not weigh out correctly, operations are halted and the speed adjusted until proper depth scarification is achieved.

These specifications and the quality control measures used to enforce them are strict, but they do not help attract the qualified contractors who can provide the kind of results needed for this program.

Note: The complete specification for the "Recycling of Existing Bituminous Surface" can be obtained from the author or is available on a report given to the Asphalt Recycling & Reclaiming Association(5).

The Highway Division is committed to the surface recycling concept because of the very real advantages that can be gained from its use. One is the increase in the quality of new asphalt pavement surfaces. When using a conventional 5.3cm (2 inch) asphalt pavement overlay - an approach employed for many years and still used in many areas - the new surface inherits many of the defects of the old one. Since the overlay is placed on top of a surface containing cracks and other irregularities, overall stability of the new surface is reduced and the need for future maintenance attention is increased.

4. Leveling and Recycling Agent Fog. The width of the bituminous surface processed is limited to the original width of the material scarified. The bituminous surface is compacted immediately after it has been distributed and leveled and while it is still hot. Within 30 minutes after compaction the Emulsified Recycling Agent should be applied. No material to which Emulsified Recycling Agent has been applied can be reheated and rescarified. If the engineer determines that excessive ravelling is or has occurred, he may direct the contractor to apply an Emulsified Asphalt.

Future Needs

As has been said before "nothing is as constant as change itself" and this is so true in the evolution of surface recycling specifications. There is little reason to believe that we will not go through additional alterations as processes and needs dictate change.

It has been repeated on numerous occasions that the addition of a recycling agent is very much a part of the surface recycling strategy. If there is a weakness still remaining in the strategy, it would be the need for a field control method for determining application rates for the recycling agent during construction. As we control depth of scarification so must we be able to adjust application rates of the recycling agent for varying field conditions.

Another need might be to insure that we have optimized the depth achievable or can equipment development obtain additional recycled depth? Greater depths may preclude the needs for cold recycling on some occasions. The basic need being the determination of where and when to surface recycle as compared to hot and cold recycling. With time developments will address these needs and an improved surface recycling strategy should evolve.

References

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