construct the 4 inch base course under the 24 foot wide driving lanes.

Equipment

A new, more sophisticated cold in-place recycling equipment train was required to complete this work. It is designed to be self-propelled and to complete the construction process from milling to paving in one continuous operation along a 12' wide stretch of existing pavement. The equipment train mills the existing bituminous pavement, pulverizes the millings, adds emulsified asphalt, mixes and repaves the material in a continuous operation providing an ability to simultaneously reestablish or improve the existing line, grade and cross-slope.

The actual equipment train consists of four pieces of machinery:

- **Cold Milling Planer** - powers the first three units of the train. This piece of equipment also grinds and picks up the existing pavement then transfers the material to the second unit. This portion of the process results in about 80% of the milled pavement meeting the maximum required specification size.

- **Screening/ Crushing Unit** - picks out the oversized material, runs it through a crusher and rescreening process, then transfers the graded material to the third unit.

Americans with Disabilities Act

The Law is in Effect

Title I of the Americans with Disabilities Act (ADA) became effective in July 1992. The new Act prohibits discrimination in the workplace against qualified individuals with disabilities because of the disabilities. The law bars discrimination in any activity or service operated or funded by state or local government. The federal Equal Employment Opportunity Commission (EEOC) has issued regulations implementing employment provisions (29 CFR Part 1630).

continued on p. 3

--- ALSO IN THIS ISSUE ---

- Tool Tip: Joining corrugated metal pipes with collars ... ...
- Reasons for "Chip Seal" Failures ... 
- Photo Log: Alton & New Durham Asphalt Recycling Project...
- Manual on Uniform Traffic Control Devices (MUTCD) Errata Notification of Corrections...
recycling...
continued from p. 1

- **Blending Unit** - serves as a continuous flow pugmixer to blend the processed material with asphalt emulsion and transfer the new homogeneous mixture to the milled road surface in a measured window for pickup by the fourth unit.

- **Paving Unit** - this unit includes a window elevator attachment. It picks up the new material and places it uniformly on the original milled surface.

- **35 Ton Rubber Tire Roller & Duel Drum Vibratory Roller** - these pieces of equipment provide the compaction necessary to complete the pavement recycling process.

Once a lane is constructed, and after as little as two hours, traffic is allowed to proceed over the compacted recycled material. As with any cold mix, a seal coat or hot-mix wearing surface needs to be placed. This final wearing surface cannot be placed on the recycled material until curing has reduced the moisture content to 1% or less by total weight of the mixture or after a curing period of 14 days has elapsed, whichever comes first.

**Materials**

The requirements specified for the liquid binder was a high float medium set emulsion type of asphalt (HFMS-2T).

Water was added to the pulverized material during the mixing phase of the operation. The gradation requirements for the new recycled product was 100% passing the 1-1/2" sieve and 90-100% passing the 1" sieve.

**Project Description**

The project involved 5.94 Miles of one-inch hot bituminous pavement on recycled asphalt pavement and shoulders in the towns of Alton and New Durham. Table 1 presents a detailed description of the project at a glance. The total project cost was $686,398.00. The cold in-place recycling/train method alone cost $256,500.00. This cost reflects a unit bid of $3.00 per sq. yd. which includes all work and materials barring traffic control.

**Summary of Advantages**

The advantages of cold in-place recycling/train method can be summarized as follows:

1. **Cost Effective** - this is true mainly because the on-site reuse of existing materials reduces or eliminates the cost of buying new material and cost of disposing of old materials. Also, engineering and testing costs are less.

2. **Convenient to the Driving Public** - this becomes an advantage because traffic can be maintained at all times and construction requires the minimum number of days (8 working days for the recycle phase on this project).

3. **Environmentally Preferred** - this is true because it minimizes dust, pollution and smoke; reuses all old bituminous materials and avoids consuming energy resources needed to dispose of old pavement and to produce new pavement.

**Table 1: Description of Existing and Proposed Pavements**

<table>
<thead>
<tr>
<th>Description</th>
<th>Shoulders (10')</th>
<th>Driving Lanes (24')</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Hot Asphalt</td>
<td>1&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Existing Depth Asp.</td>
<td>1&quot;</td>
<td>5-6&quot;</td>
</tr>
<tr>
<td>Recycle Method</td>
<td>Full Depth/Bomag</td>
<td>Partial Depth/Train</td>
</tr>
<tr>
<td>Recycle Depth</td>
<td>3&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Crushed Stone</td>
<td>8&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>Crushed Gravel</td>
<td>8&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>Sand (Minimum)</td>
<td>8&quot;</td>
<td>8&quot;</td>
</tr>
</tbody>
</table>

**Tool Tip**

**Joining corrugated metal pipes with collars**

A frequent problem when working with corrugated metal pipes and using collars to join the pipes is the bolts are so long you cannot use an air impact wrench to tighten up the nuts. Even the deep sockets that you can buy are not deep enough to accommodate the length of bolt.

A tip to handle this is to buy a deep socket that will hold the nut that you have to drive and then cut the deep socket in half. Select a steel piece of pipe to match the socket and the length that you want -- perhaps 8 or 10 inches. Then weld the two halves of the socket on either end of the pipe. You now have an 8" or 10" deep socket that can be used with an electric or air powered wrench. This makes it possible to tighten up the coupling bands on corrugated metal pipes without having to use an open faced wrench. It makes the job much quicker.

The above article was reprinted with minor editing from *Technology Transfer Quarterly*, Vol. 7, No. 3, a publication of the Ohio T² Center. The original article was written by Glenn Sprowls, CEAO.
Reasons for “Chip Seal” Failures

by Peter Messmer, Lab Engineer, Cornell Local Roads Program

Oil and stone surface treatments (chip seals) are steak and potatoes fare on the platter of most town and county construction menus. This article discusses why many chip seals are doomed to an early end.

The good news is that to be forewarned is to be forearmed. To get the most for your “chip seal” dollar, be on the alert for things that can go wrong, such as:

- the aggregate and emulsion spread rates
- construction techniques
- weather
- surface preparation
- traffic control
- material problems

A recent phone survey has shown that chip sealing is a fairly widespread paving and maintenance procedure. Since the survey was not announced, most agencies were unprepared to give accurate cost estimates. However, agencies indicated a range of $6,000 to $8,500 per mile for a single chip seal. Clearly, there is the potential for great financial losses when chip seals fail before a reasonable life expectancy of five years or so.

What constitutes failure?
The main reasons for chip sealing are:

- to provide an all-weather road surface (i.e., seal against entrance of water into base course and subgrade)
- improve skid-resistance
- rehabilitate an old, weathered asphalt surface
- provide demarcation of traffic lanes

If a chip seal ceases to perform these functions, it has failed. Failures occur in two primary forms:

- stripping (loss of cover stone)
- bleeding (excess asphalt on the road surface)

Both conditions ruin the ability of the chip seal to provide the stated functions.

Debunking a Myth

A reason commonly offered for chip seal failures is that the emulsion and aggregate are not well suited to each other.

This idea comes from the difference between anionic and cationic emulsions. All emulsions are a mix of asphalt cement, water, and an emulsifier. Mixing asphalt with water requires an emulsifying agent, since they do not readily mix. As the three ingredients are blended, a suspension of asphalt droplets in water occurs. The emulsifier creates a surface tension between the asphalt particles and surrounding water that permits the asphalt droplets to remain in suspension until the water evaporates. Emulsifiers create an electrical charge on the surface of the asphalt particles that cause them to repel each other, helping them to stay in suspension. An anionic emulsifier is one that makes a negative charge on the asphalt droplets, while a cationic emulsifier creates a positive charge on the droplets.

Traditionally engineers agree that anionic emulsions work best with aggregates having mostly positive surface charges, such as limestone. On the other hand, usually a cationic emulsion works best with aggregates having mostly negative surface charges, such as sandstone. However, recent studies have begun to challenge these concepts.

Perhaps certain asphalt emulsions work better with certain aggregates. Seldom, if ever, is the degree of compatibility so poor that the asphalt will not coat the rocks. Furthermore, once the emulsion has broken, it behaves like an asphalt cement, and the charge on the asphalt film disappears. The fact is that

Reprinted from Nuggets & Nibbles, Vol. 9, No. 3, Cornell Local Roads Program.
Left: Although most of the ingredients required for recycled asphalt are already in the existing pavement, two important ingredients, water & emulsified asphalt, are added. In this photo a water truck is hooked up to the train to ensure uniform mixing of aggregate and emulsion. The nose of the emulsion truck can be seen at the far left.

Right: At the front of the train is the cold milling equipment. It is capable of cutting a full 12' to 14' width in a single pass. Under normal conditions, it will mill three inches deep and average about two to three lane miles per day.

Left: Material from the cold milling is run through a screening and crushing operation to ensure paving aggregate doesn't exceed specified standards. The material is first screened. Excessive fines are eliminated. All oversized material is run through a crusher and then rescreened. There are no large chunks to break apart under compaction.
Left: After the screening and crushing operation the material is blended with emulsified asphalt. This piece of blending equipment is a portable "continuous-flow" pugmill. It creates a homogeneous mixture of aggregate and emulsified asphalt which is placed out the rear in a windrow.

Right: One of the last pieces of specialized equipment in the train is the paver. The machine is designed with a large 25 ton surge hopper to ensure non-stop paving. The aggregate mixture from the blending operation is picked up by the paver and placed on the surface for compaction. Microprocessors control slope, grade, and depth placement.

Left: This is the entire train in action starting with the asphalt emulsion tanker. It continues down the road milling, screening, crushing, blending, paving, and compacting.

Note: all photos were taken during the NHDOT Alton/New Durham project contracted with Gorman Brothers, Inc. For more information contact the P Center at 1-800-423-0060, the NHDOT highway district 3 office at 603-524-6607, or contact Ed Kearney of Gorman Brothers at 518-426-8745.
Chip Seal Failure... continued from p. 3

The emulsion/stone matchmaking is rarely the cause of severe stripping failures. Indeed, most failures result from something gone wrong in the six aspects of chip seal construction, mentioned previously.

The Aggregate and Emulsion Spread Rates

A common practice is to use the same emulsion and aggregate spread rates for every project. This would be like issuing the same size uniform to an entire army! The spread rates must be tailored, like a fine suit, for each project. The source and gradation of stone used, as well as the surface condition and daily traffic of the road, will vary. The spread rates must be selected for each project to account for these conditions.

Ideally, the stones will be embedded in asphalt to a depth of about 70 percent of their height, after rolling and traffic has fully seated them. We will discuss some practical ways to control the spread rates in order to achieve this embedment. The ideal aggregate spread rate will result in a mat one stone deep which uniformly covers the road surface. To determine a good starting spread rate use a 3' x 3' board and cover it completely, one stone deep. Remove the aggregate and weigh it. This tells you the pounds per square yard of stone required. Do not increase this to add a "whip off" factor. You can adjust the starting rate on the job if necessary, but don't use any more aggregate than you need to just keep from "picking" stones on the wheels of the roller.

There is a good "rule of thumb" to figure the gallons per square yard of emulsion. The rule applies to a typical road that has an average daily traffic (ADT) count of approximately 500 to 1,000 vehicles on a surface that is not weathered and porous or excessively flushed with asphalt. It works best when the particle size ratio in the aggregate is two, as for a 1/4" x 1/2" gradation.

Divide the stone spread rate by the residual asphalt content of the emulsion. The residual asphalt content is the percentage, by weight, of asphalt left after the emulsion is fully cured. The vendor should be able to provide you with data on the residual asphalt content.

Example 1: you have a stone spread rate of 25 lbs/yd², and you are using an RS-2 with a residual asphalt content of 63 percent. You are chip sealing a road that has an ADT of 800, and does not have a surface that is absorbent or flushed. The Emulsion Spread Rate = Stone Spread Rate/Residual Asphalt Content (25/63 = 0.396 gal/yd²). For this example, 0.40 gal/yd² would be a good starting point.

The emulsion rate figured from the "rule of thumb" will have to be adjusted if the road surface is absorbent and weathered or flushed, and if the traffic is less than 500 or greater than 1,000 ADT.

For slightly weathered and absorbent surfaces, add 0.03 gals/yd², and up to 0.09 gals/yd² for badly weathered and absorbent conditions. For an ADT of 100, add 20 percent to the emulsion rate; 100-500 ADT, seven percent; 1,000 to 2,000 ADT, subtract seven percent; and 2,000 or more ADT, subtract 15 percent.

Example 2: you have a stone spread rate of 20 lbs/yd², and you are using an RS-2 with a residual asphalt content of 65 percent. You are chip sealing a road that has an ADT of 1,500, and has a badly weathered and absorbent surface.

First, figure the emulsion rate without adjusting for surface condition or traffic. Emulsion Spread Rate = 20/65 = 0.307 gals/yd². Round up to 0.31 gals/yd².

Second, subtract seven percent because there is 1,500 ADT, instead of 500-1,000: 0.31 gals/yd² - (0.07)(0.31) = 0.288. Round up to 0.29 gals/yd².

Third, add 0.09 gals/yd² for the badly weathered surface: 0.29 gals/yd² + 0.09 = 0.38 gals/yd².

When you spread stone and oil too lean or too heavy, failure occurs. Too little stone leads to insufficient cover and causes "picking." It also causes flushing since there will be excess oil due to the shortage of stone. Too much stone wastes money since it will end up in the ditch. Also, the stones are more easily dislodged if they are spread too heavily. The extra stones dislodge their neighbors under the force of many tires.

Too little asphalt emulsion prevents the stones from embedding properly, and the stones will be lost eventually. Too much emulsion drowns the stone in asphalt and reduces the skid resistance one hopes to achieve. Bleeding will cause "fatty" patches to increase as time goes on, creating a skidding hazard.

Checking Application Rates

To check the emulsion spread rate, stick the tank at the start of the job. At the end of the job, restick the tank. You can determine the gallons applied from the difference in the stick readings. Divide this number by the square yards of the job, and the result is the average application rate. Or if the distributor produces a trip ticket, simply read the gallons applied. The amount of the emulsion applied should be within ± 5 percent of the calculated amount for the area of the job.

Example: A lane 10 ft. wide and 500 ft. long has 555 yd² of area. You need 167 gallons of emulsion at an application rate of 0.30 gals/yd². If the trip ticket indicates that 174 gallons were used, this was 7 gallons extra. You calculate that 7/167 equals 4.2 percent. This is within the 5 percent range and is acceptable.

To check the emulsion spread rate another way, use a square yard of material, such as filter fabric. Weigh it, place it on the road, and drive over it with the emulsion distributor. You may find it helpful to tape the fabric to a 3' x 3' piece of sheet metal. Use double-stick carpet tape at the corners to help hold it in place. Weigh it again after the emulsion is sprayed on it. The difference of the weight before and after is the weight of emulsion spread per square yard. Divide this weight by the weight of 1 gallon of emulsion (8.33 lbs/gal), to find the spread rate in gals/yd². If the rate is too high or too low, adjust the distributor application.

continued on p. 9

The following corrections should be included in all 1988 MUTCD'S. Please cut to fit and tape to the inside cover of your 1988 MUTCD.

Errata Sheet - Manual on Uniform Traffic Control Devices

The following pen and ink changes are issued to cover those corrections that can be made simply:

1. Throughout the MUTCD, change HTO-20 references to HHS-30.

2. Table of Contents. Change all references for "Legal Authority" to "Placement Authority." Placement Authority is consistent with MUTCD section 1A-3.1.

3. Page 1A-1, Section 1A-1, Purpose of Traffic Control Devices. First paragraph, last sentence, change "informed" to "uniform."

4. Page 1A-3, Section 1A-3, Responsibility for Traffic Control Devices. Second paragraph, third line of quoted text should read, "...highways within this State."

5. Page 1A-8, Section 1A-8, Color Code. Add "Evacuation Route" to Color Code for BLUE.

6. Page 2A-8, Section 2A-21, Standardization of Location. Modify last paragraph to read, "Typical placement for a number of signs is illustrated in Figures 2-1 to 2-4."

7. Page 2A-10, Section 2A-24, Lateral Clearance. Second paragraph, third line, after the word "areas," add "or at intersections with large radii in rural areas."

8. Page 2A-16, Figure 2-2a. In the upper and lower left-hand corner, change the word "major" to "minor" for the southbound and eastbound lanes.

9. Page 2A-17, Figure 2-3. The two NO LEFT TURN signs are improperly located. Reverse the location of both signs so that they are placed on the opposite sides of the vertical streets. Also, add a note that turn prohibition signs are optional (see page 2A-13).

10. Page 2A-18, Figure 2-3a. Although this figure appears to be one drawing, it is actually two drawings; one depicting alternate one-way signing for medians less than 30 ft. and one depicting alternate one-way signing for medians greater than 30 ft. The bottom diagram should be labeled, "MEDIAN GREATER THAN 30." Also in the bottom diagram, the optional turn-prohibition sign should show a red circle and slash and the first set of edgelines should be white.

11. Page 2A-19, Figure 2-4. Add a note that this figure is not scaled to show standard spacing for pavement markings. See Figure 3-19 and section 3B-20 for proper spacing.

12. Page 2A-20, Figure 2-5. Reposition the railroad crossing pavement marking so that it is adjacent to the railroad crossing warning sign. Also include marginal notation for the official ruling (VIII-12, Rev. 5).

13. Page 2B-19, Section 2B-26 and 2B-27. The last line of the last paragraph, change reference to Section from 2E-41 to 2E-40.


page 7

16. Page 2C-17, Section 2C-32; third paragraph. The reference should be changed to Section 3B-18.

17. Page 2D-8, Section 2D-15. In the last sentence of this section, change the word "should" to "shall" in the discussion concerning the first letter of cardinal directions on guide signs. The required enlargement of the first letter of each cardinal direction word has a compliance date of December 31, 1994.

18. Page 2D-21, second paragraph, Item 2. Correct the spelling of "where."

19. Page 2D-26. The D5-5a sign has been revised to show only the Picnic Table.

20. Page 21-4, Figure 2.53. Change the caption for the Intersection and Advance Signs to read, "Maximum length of business name per line is 54" instead of 5"4.

21. Page 3B-6, Figure 3-5a. The solid line on the right edge of the two-way left-turn lane at the top of the page should be yellow.

22. Page 3B-12, Figure 3-9. In Figure (a), change the yellow broken lines to yellow double solid lines on both the east and west side of the intersection. In Figure (b), delete the single asterisk preceding the word ONLY in the mandatory turn lane and, in the adjacent lane, include the single asterisk so that it precedes the two combination turn arrow pavement markings. In the mandatory turn lanes in Figure (c), delete all asterisks indicating optional. Section 3B-20 states that lane-arrow markings in mandatory turn situations must be accompanied by the word marking "ONLY."

23. Page 3B-14, Section 3B-11. In the first sentence of paragraph four, change -special marking pattern" to "lane drop marking pattern."

24. Page 3B-16, Figure 3-11a, top view. The yellow edgeline should be on the left ramp edgeline rather than on the main roadway right edgeline as shown. Additionally, the figure number should be changed from "Figure 3-11a" to "Figure 3-11c" since the Figure 3-11 on page 3B-15 has an "a" and "b."

25. Page 3B-17, Figure 3-12. In the caption, change the word "dashed" to "broken."

26. Page 3B-24, Figure 3-14. The reference to Section 3B-15 on Figure 3-14b should read -Section 3B-18."

27. Page 6B-4, Figure 6-2. The bridge object markers should be yellow on black.

28. Page 6B-9, Figure 6-7. The Lane Reduction Transition Sign on the left side of the figure should be a W4-2L.

29. Page 6C-1, Section 6C-1. In the first sentence of the first paragraph, add an "s" to "function."

30. List of Official Rulings. Change compliance date for Request IV-58(C) to 12/31/97.
Chip Seal Failures...
continued from p. 6

To check the stone application rate, measure the area that the weighed truckload of material covers. Divide the weight of the load in pounds by the area covered in square yards, to get the pounds per square yard.

Example: A spread rate of 25 lbs/yd² is desired. A 12,000-pound truck load is spread along 300 ft. of a 12-ft. wide lane (i.e., 400 yd²). The rate actually spread is 12,000 pounds/400 yd² = 30 lbs/yd². This is 5 lbs/yd² too much. The gate opening and truck/spreader speed must be adjusted to decrease the spread rate.

Drive a truck or spreader over a square yard of cloth for a quick spot check of the stone spread rate. Weigh the stone dropped on it. The result is pounds of stone per square yard.

Other factors for chip seal failures:
Construction Techniques, Weather, Surface Preparation, Traffic Control, and Material Problems.

Construction Techniques
A sure way to ruin a chip seal job is to have the chip spreader/truck too far behind the emulsion distributor. The aggregate must be spread on the emulsion within 30 seconds after it is applied. Good teamwork between the emulsion distributor operator, aggregate spreader operator, and truck drivers is essential. If the chips are spread too late they will not be adequately “glued” by the breaking asphalt, and stripping will result. If the Stone is slightly damp, this will enhance the wetting by the asphalt emulsion.

Another critical operation in the procedure is rolling, which seats the aggregate in the emulsion and enhances good bonding. You should roll the aggregate immediately after spreading with a pneumatic tired roller. A steel wheel roller will ride on the high spots, crushing the aggregate, and pass over the low spots, failing to adequately seat the stone. It is harmful to roll the aggregate after the emulsion sets. It may dislodge the stones.

During the rolling operation, “picking” may occur. If the problem is great, then increase the aggregate spread rate a little bit. Light brooming is often necessary to remove loose stones. If the sweeping operation is begun too soon, before the emulsion sets hard, it will strip away properly seated pieces also. To prevent this problem, broom during the cool of the next morning after the emulsion sets.

Another common problem associated with construction is an improperly adjusted spray bar. “Fatty” streaks can result where emulsion is applied too heavily, and in between where it is too lean. The stone will strip in the lean areas, and bleeding may occur in the heavy areas. Proper adjustment of spray bar height and nozzle angles will provide a double or triple overlap of the emulsion fans, ensuring a uniform distribution.

Other construction techniques, besides those mentioned, can go wrong on the job. Head them all off before they happen! How about conducting planning and training sessions for everyone from truck driver to foreman? Establish a chip seal construction routine that ensures construction is done properly.

Weather Conditions
A key to successful chip sealing is that the weather be hot and dry for proper setting and curing of the emulsion. Many specifications require at least 50° F in the shade. In New Hampshire the prime time for chip seal construction is during July and August.

Chip seals built before Memorial Day or after Labor Day have a reduced chance of success because during this time humidity is high and temperatures are low. Therefore, evaporation is slight or nonexistent. Under such conditions the emulsion cannot cure properly and the stone will not adhere to the road. Severe stripping will result. To avoid the potential for great losses, plan all chip seal work for July and August, and monitor daily weather forecasts to work around thunder showers.

Surface Preparation
Since a chip seal is a “thin skin” and not a “coat of armor” you cannot expect to remedy the serious faults of an existing pavement. For example, if you chip seal over an array of alligator cracks, you can soon expect to see a new alligator born.

There are cases where a chip seal was placed on an aggregate road that had a clayed fines layer on top. Tires peeled up the chip seal in strips on hot days. The wheel paths were mostly bare within several months. This happened because the emulsion did not penetrate the “dirt” on top and adhere to the aggregate below.

Before chip sealing, you should repair and clean the road surface, fill potholes, level ruts, seal large cracks, repair broken edges, prime excessively absorbent surfaces, and scarify and recompact or stabilize an aggregate base, if necessary.

Traffic Control
We have all heard the war stories. Junior steps into the garage and fires up his hot-rod. In a show of bravado, with his girl friend next to him, he guns the engine and peels out of the driveway spraying stone and oil in a rooster tail that would make a water skier envious. Several repetitions later, a new chip seal looks like a battle-scarred veteran.

This problem is not easy to prevent. But normal traffic can be controlled! For a chip seal program costing some $6,000 to $8,000 per mile, the added cost of traffic control is economical. The goal is to keep traffic under 25 mph, with warning signs, pilot cars, and flagmen until the emulsion sets. A detour is even better.

Remember to control your own construction equipment. Especially avoid having them turn around on the new surface treatment.

Material Problems
Dirty aggregate is a serious concern. Emulsion will not adhere to stones that are coated with fines. This will lead to stripping. The ideal solution is to buy washed stone. Some use stone that has been pretreated with a high application of dilute asphalt emulsion, although it’s unnecessary if the stone is clean and

continued from p. 10
handled carefully.

Another aggregate problem is stone that is too soft. Such material will crush when rolled and under traffic, and it will not stand up well to freeze-thaw cycles or to abrasion by snow plow blades. You should use aggregates from State DOT-approved sources to beat this problem.

The emulsion should be an RS-1, RS-2, CRS-1, or CRS-2, all of which break quickly. For both the stone and emulsion you should take samples. If a serious question concerning material quality arises, you can have the samples tested, although you should recognize that the "shelf life" of a rapid-setting asphalt emulsion is only a few weeks. Furthermore, just taking the samples, when the supplier is watching, will keep them on their toes.

Summary
We have reviewed six aspects of chip seal work where things often go wrong. Extensive failures can occur for a single reason, for example, constructing in cold, wet weather. However, usually they result from a combination of the problems discussed.

The range of problems mentioned cannot be prevented by a single "superman" foreman or highway superintendent. Perhaps the best way to ensure a quality product every time is through team work. Everyone on the job must know what the finished product should look like. They must know how to do their parts correctly and it helps if they know what their work mates are responsible for — then everyone can help each other to get the job done right.

Chip seal planning and training sessions can build such a team. That's something to plan and do now, before the construction season returns! Happy chip sealing!

Suggested references for further reading:

- Surface Treatment Manual, Chevron, Chevron USA, 1985

The above article was reprinted from Nuggets & Nibbles, Winter 1991, a Cornell Local Roads Program publication.