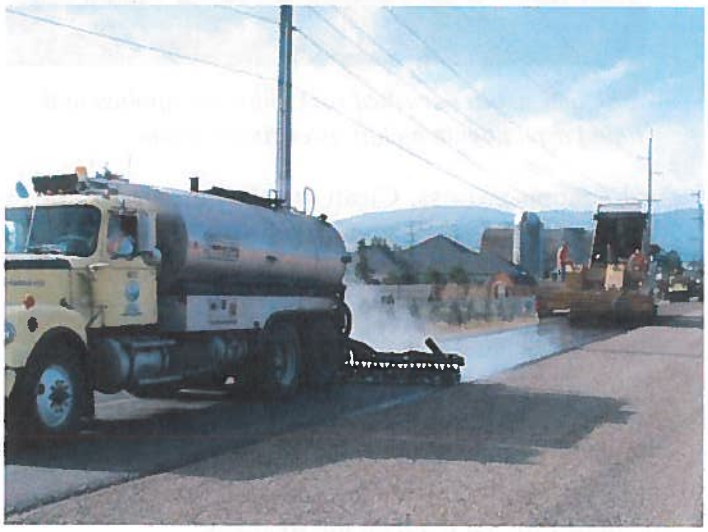
Baystate Roads Program
Local Technical Assistance Program (LTAP)

Tech Notes

Tech Note #53

CHIP SEALING

Chip sealing provides a cost-effective solution to renewing road surfaces, protecting the underlying structure from moisture damage, and sealing minor surface disintegration.



Heated liquid asphalt is applied to the roadway surface

This preventive maintenance technique is typically applied to low volume, asphaltic concrete pavements to avoid or defer major rehabilitation. Past research on the effectiveness of seal coating has shown that both short and medium-term benefits are associated with this treatment. Studies have shown that chip sealing's effectiveness can be measured in relation to the initial pavement condition. Pavements in relatively poor condition were generally associated with higher initial performance jumps but lower reductions in their rate of deterioraton. Pavements in relatively good condition were generally associated with lower performance jumps but greater reductions in their deterioration rates. *(1)*

The topic of chip seals arouses different responses from different municipalities. Many have used them for years and swear by them while others would not use them if they were free. Because the treatment can stretch dwindling municipal funds, this Tech Note identifies some benefits as well as the pitfalls.

There are two main reasons why people are dissatisfied with chip seal performance. One, people often expect too much from them. The purpose of a chip seal is simply what the name implies: it seals the surface of the pavement, repelling water which is the primary cause of pavement distress.

Chip seals also can add skid resistance to worn pavement. Pavement surface integrity can be restored giving new life to a dried-out, raveling surface. The seals are typically applied to roadways under 1,500 average daily traffic (ADT). Roadways with ADT between 1,500 and 12,000 can be sealed successfully if traffic control (speed of traffic) is maintained during and after construction. Chip seals do not add structural strength to pavement. A badly alligatored surface with depressions indicates water problems or base failure that must be corrected prior to placing a chip seal. Sealing an alligatored surface probably will not hold the pavement together. In fact, the cracks will reopen, wasting the expenditure. In such cases, solve the drainage problems, then consider recycling and sealing.

The second reason for dissatisfaction is that the application was executed or inspected incorrectly. The success of chip sealing relies on the use of proper materials, equipment, calibration, weather considerations, and experienced contractors. If small problems are overlooked, big problems result.

First, consider the components of a chip seal. An emulsion is a combination of asphalt, water and an emulsifying agent. The emulsifying agent causes the asphalt to disperse in the water making a mixture stable

enough for mixing, pumping and prolonged storage. Polymer modified emulsions (PME) incorporate polymers into the asphalt prior to emulsifying. PME's have been shown to have better stone retention and longer service life than conventional emulsions. Particular problems are the charges on the emulsions and stone. There are anionic (negative charged) and cationic (positively charged) emulsions and stone. This presents the potential user with the problem of matching the charged emulsion with a stone (aggregate) of the opposite charge. Using a cationic emulsion with a cationic stone will result in a natural magnetic repulsion, which means that the stone will push away from the emulsion. This causes an immediate problem with a chip seal. The most commonly used emulsions RS-2 (E-2) and CRS-2 (E-3) and polymer emulsions RS-2P and CRS-2P are anionic and cationic respectively.

Care must be taken to choose the proper combination of aggregate and emulsion. The emulsion supplier can do a simple test to assure material compatibility. The supplier provides a letter stating that the test showed proper material compatibility.

Although most people know that concrete goes through a "setting-up" process, many don't know that emulsions also have a setting-up process called "breaking". The asphalt separates from the water and forms a continuous film on the pavement. Aggregates must be placed and the first roller pass accomplished before the emulsion breaks or the stone will not adhere properly.

A high percentage of fines (finely crushed or powdered material) in the aggregate causes another problem: the fine material will absorb the emulsion. If the aggregate particles are dusty or coated with clay, the emulsified asphalt may not stick. The dust produces a film that prevents the asphalt from adhering to the aggregate. Using a pre-coated aggregate or a washed aggregate can solve this problem. Approved aggregates are AASHTO #8, #67, and #7. Washed aggregate is required to have less than 1.0% material passing the 200 sieve to meet specification.

PREPARATIONS

Now that we understand the materials and have checked their compatibility, we are ready to start the seal coating process. Clean out the surface cracks between ¼ and 1 inch width and seal them. Clean the grass and weeds from the gutter and curb areas. The seal coat performance is only as good as the surface to which the seal coat is applied. Care should be taken to assure that the roadway is clean and free of any substances that will prevent the emulsion from bonding to the pavement. Power brooms, vacuum trucks, blowers and high-pressure water are some of the equipment and methods utilized to clean the roadway.

5/8" and smaller crushed rock chips are applied to the liquid asphalt with a chip spreading machine

APPLICATION

The contractor must submit a chip seal design at least two weeks prior to the start of the project. It should be noted that even if you are doing the project in-house you should have a chip seal design to assure success of the application.

All equipment, distributors, chippers and rollers should be calibrated annually. The contractor, as well as the municipal equipment if being done in-house, should have a current copy of the equipment calibration. If the temperatures of the air, road surface and aggregate are above 60 degrees and rising you are ready to start. If a current calibration is not available, check the equipment as follows:

1. Check the distribution rates of both the asphalt distributor and the chipper on the small test strip to be sure you have met the design specifications.

Once rock chips are applied to the liquid asphalt they are rolled in with rubber-tired rollers

2. Measure the area of the strip and record the level in the distributor before and after spreading.

3. Check the application rate of the spreader by placing a three foot by three foot (one square yard) flat pan under the spreader as it moves through the test area.

4. Weigh the chips on the pan, subtract the pan's weight and you have the pounds of aggregate per square yard that has been applied.

5. Match both figures to your design and, if they are within acceptable limits, you can start work.

6. Check the color of the emulsion as it is applied. If it is black, the emulsion has "broken", with the water separating from the asphalt too soon. Stop the project and get new emulsion. The emulsion should be creamy dark brown in color before "breaking".

The application should be watched carefully because misaligned spray bars can cause streaking. This means some areas are getting too much asphalt (resulting in bleeding) and some not enough (resulting is loss of aggregate). If this happens, stop the project and have the spray bars recalibrated. If the pads on the roller are worn or missing, the tires will pick up the aggregate. If you see this happening, stop the project and have the pads replaced. Be sure to check the tire pressure on rubber-tired rollers because uneven pressures produce uneven results. The contractor should provide enough rubber-tired rollers for full coverage in one pass. Avoid back rolling, as this will tend to move aggregate exposing asphalt which increases pick up on rollers.

Rubberized chip seals are yet another way to yield high performance out of limited highway department dollars. This chip seal has the added benefits of having a darker color, a higher control of dust, high early chip retention, better adhesion at lower temperatures, and a more efficient sweeping surface. These features allow the rubber chip seal to be used on roads where there are higher traffic volumes and higher travel speeds. High quality asphalt cement is blended with recycled tire rubber at elevated temperatures for a specific amount of time to produce a material that has improved temperature susceptibility, flexibility, and resistance to aging.

Now that you have seen that sealing is a complicated process of many small parts, you can appreciate the need for care in choosing the correct situation and preparing surfaces correctly. By taking your time and following the procedures set forth, your efforts should result in a successful chip seal that will stretch your municipal dollars. Just don't expect this procedure to perform miracles. Chip sealing is a preventative measure. Choose candidates wisely.

TIPS FOR A SUCCESSFUL SEAL COAT

Rubber-tired rollers should be used, allowing equipment to follow contours of the road. Steel-wheeled rollers tend to crush the aggregate. This can cause the aggregate to pop out of the emulsion and also may create more uneven results.

A properly constructed chip seal should have one-half to two-thirds of a typical stone imbedded in the asphalt after the surface is rolled and cured.

Application of too much stone may also be a problem. If the mix is more stone than the emulsion can hold, the loose stone may push the adhered stone out of the emulsion under compaction.

The area can be swept after a day or two but only after the emulsion has broken. Check the emulsion by scraping the chips from the small area and inspecting the asphalt. If it is a brown color, wait. If it is black, the emul-

Aggregate selection should be based on the type of roadway, traffic volume and type, noise, aggregate availability, and freight consideration. After rolling, air voids should account for approximately 20% of the area. Aggregate particles should be 40-50% embedded on low volume roads and 30-40% embedded on high volume roads. Proper embedment depends on having good aggregate particle shape. (3)

sion has broken and the sweeping may be started. To prevent loss of adhered aggregate, it is a good practice to wait as long as possible before sweeping. Through the next week, check the surface and remove any remaining loose aggregate.

Try to keep traffic off the new application for as long as possible. If road closure is not an option consider use of leader or pilot vehicles to control speed of traffic during the operations. Restricting traffic for twenty-four hours will assure a greater chance of success, but may not be realistic. Now, remove the work zone traffic-control devices leaving the loose stone signs in place for an additional week after the project is completed (in reverse order of placement) and allow traffic to follow a leader or pilot car at a slow rate of speed over the newly seal-coated pavement.

Resources

(1) Labi, S. and K.C. Sinha. Effectiveness of Highway Pavement Seal Coating Treatments. In *Journal of Transportation Engineering*, Vol. 130, No.1, American Society of Civil Engineers, pp. 14-23, New York 2004.

(2) *Pavement Distress and Rehabilitation Manual.* MassHighway, Boston, Mass. 1993. **Available as hard copy** from Baystate Roads Program's Library -- MAN 20. **Available as electronic copy from**: David.Blei@MHD.state.ma.us

(3) King, Kevin. " ChipSeal/Best Practices," presented at the Texas Pavement Preservation Seminar, Austin, Texas, October 2005.

(4) Technical Information Sheet #131, Pennsylvania DOT/LTAP, Summer 2007.