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REPAIR OF POTHOLES WITH HOT MIX ASPHALT (HMA)

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Introduction

The performance of a pavement (asphalt or concrete) is directly related to the condition of the base, subgrade and specific material composition of the pavement type on which that pavement is placed. The need for patching can occur for either an asphalt or concrete pavement. No type of pavement is immune. Minnesotan's are experiencing potholes (chuck holing) and beginning to assess the damage to their roads (facilities) caused by the severe winter.

Technical terminology varies somewhat within each industry (asphalt vs. concrete) but a "patch" is an area of the pavement that has been removed, replaced, or covered with new material. It is very important to be done properly.

For hot mix asphalt (HMA), mix laid on top of existing asphalt layer(s), the present or in-place surface should be free of major distress and potholes, be reasonably smooth, and also clean. An attempt to bridge failed areas with the new HMA overlay material is usually foolish unless a very thick overlay is to be constructed. Removal and replacement should be carried out on all pavement areas on which severe load-related distress has occurred. Localized failed areas should be addressed.

Potholes (chuck holing), bowl-shaped holes of varying sizes in the pavement resulting from localized disintegration, are one of the most dangerous of failures and should have immediate long lasting attention. Reduced support for infrastructure improvements also has a price tag that must be paid this spring, in addition to the funds the state hopes to allocate for road improvement. Driving on roads in need of repair or improvement costs motorists (the public) numerous dollars in additional vehicle operating costs. The traveling public perception has a significant impact on the future of transportation funding policies, overall support and credibility.

Why Potholes (Chuck Holing)

Potholes are the most obvious and costly examples of road deterioration, yet these visible signs actually represent for the most part a final stage in a process of deterioration. The primary agents in this process of deterioration are moisture and traffic.

Moisture from rain or snow often works its way into road surfaces and the material(s) underneath. Traffic, particularly from heavier vehicles, puts stress on the road surface, increasing the likelihood that potholes may form. This process is enhanced during periods of freezing and thawing, which typically peak in the late of winter and early spring thus expanding and contracting road surfaces, increases the likelihood of pavement failure.

Strategies For Longer Lasting Facilities

Pavement maintenance is the routine or planned work performed to keep a pavement, under normal conditions of traffic (use) and nature, as nearly as possible in its constructed condition at an economical cost for the geographic area – proactive engineering techniques. The timing of the maintenance and rehabilitation of road (facility) surfaces is critical, affecting the cost-effectiveness of the repair and ultimately the overall quality of a regional network. Research indicates that if pavements can be resurfaced with hot mix asphalt (HMA) while still in fair condition (structural integrity), repairs generally cost about one-fourth the cost of repairing roads in poor condition, reducing overall life cycle costs of that road.[1] Thus, it is critical that pavement surfaces be rehabilitated while still in fair condition by employing preventive maintenance. In Minnesota, HMA as a surface treatment is the most cost effective treatment with least annual cost as illustrated below (Figure 1).[2]

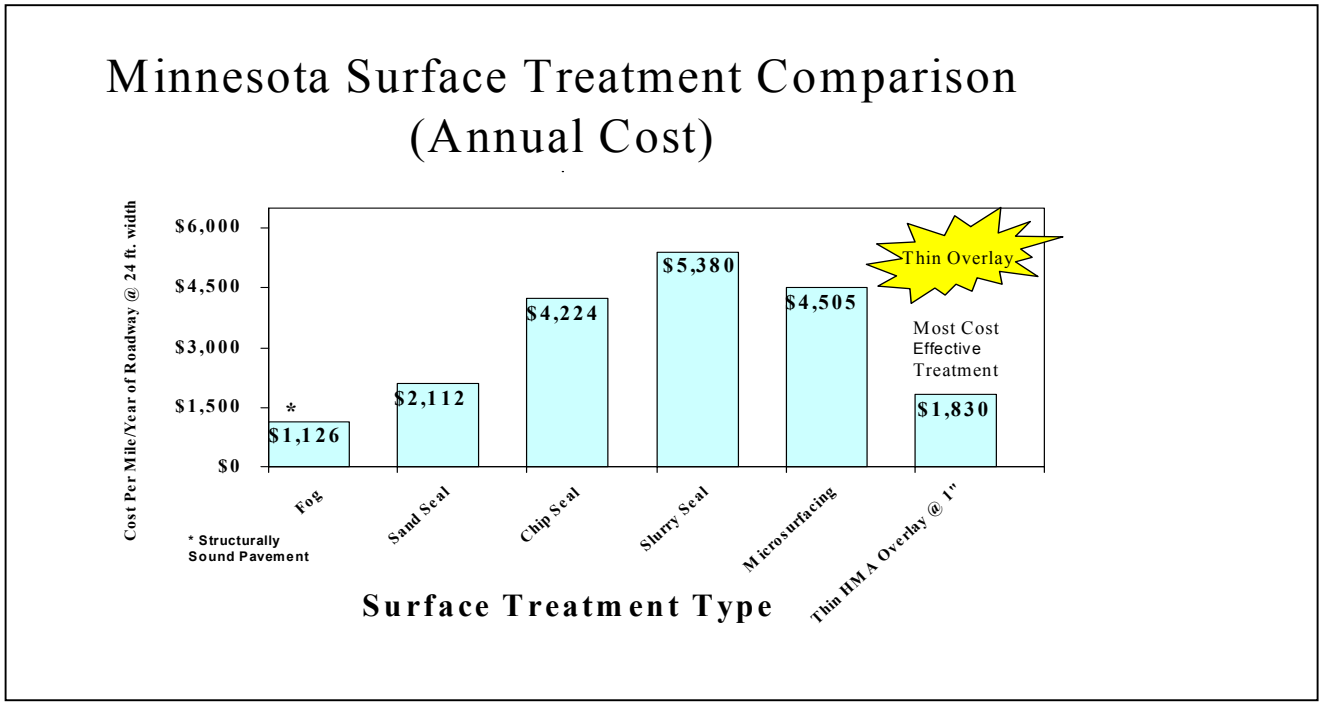

Figure 1. Minnesota Surface Treatment Comparison – Annual Cost

When roads (facilities) need to be resurfaced or repaired, it is desirable that these repairs be as long lasting as possible. Cold mix is usually used as a "temporary" pothole patching material during the off-construction season, winter months, when HMA plants are not operational. Techniques to achieve a more durable roadway employ HMA as the solution for a "permanent" type patch. The hot mix type is laid and rolled while hot. Crushing, gradation of aggregate and amount of asphalt (binder) are as important in a patching mixture as it is for a new pavement.

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[1] TRIP (April 2001) "What Motorists Pay To Drive On Roads In Need Of Repair"
[2] MAPA (April 4, 2001) "Maintenance of Asphalt Pavement" and "Minnesota Maintains with HMA", the Asphalt Contractor, September 2001, by R.O. Wolters, P.E.

If the ingredients have not been properly proportioned, the patch is not uniform in thickness, or the patch adequately compacted, the patch may shove, roll or ravel. The top size aggregate will depend upon the depth of the area to be patched and specifications.

The Way To Repair Potholes (Chuck Holing)

If pothole patching is exercised, care should be taken to insure that the repair lasts as long as possible to delay the need to again divert traffic while the road is repaired. Inadequate pothole patching or repairs quickly show signs of dishing, cracking or fail completely, creating the need for repeated repairs, causing continued traffic delays, public scrutiny, and cost effective debates.

A clean, dry, square-edge hole is important. Mark the area to be patched, extending at least one foot outside the distressed area.[3] The edges of the hole should be cut away to sound material and cut (or removed) vertically so as to provide shoulders (restraint) against the movement of the patch. If a jack hammer is used, do not rock it back and forth (Figure 2). This can cause weakening of the in-place bituminous and deterioration – patch performs but area surrounding the patch many times will then fail. If unstable base material is found which may produce a soft spot, it should be removed and replaced with stable hot mix asphalt.

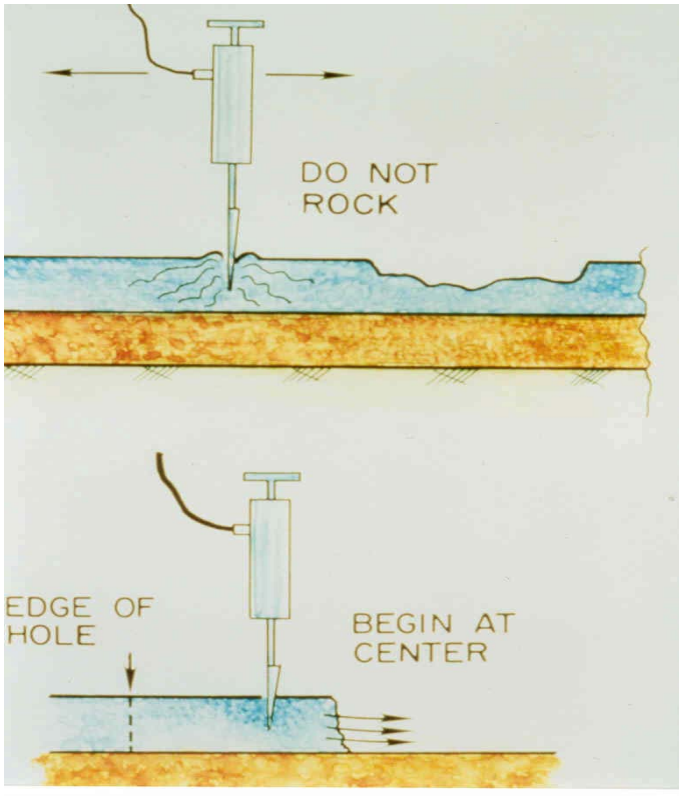

Figure 2. Jack Hammering Operation

[3] MNT²/LRRB/CTS/Un of MN (April 2001) "Asphalt Pavement Maintenance, Field Handbook"

The patch area should be cleaned of debris. If the depression is wet, it should be reasonably dried. Next, the pothole may be tacked with a light application of asphalt material which most likely will be sprayed. An excess of asphalt tack material will certainly cause flushing into the patching mixture and can cause instability. If a spray application of tack is not feasible, utilize tack material to waterproof the surface edges of the new patch. Sand may be considered at pedestrian crossings or other critical areas. A bituminous prime coat is not warranted preparatory to placing the HMA patch.

The HMA mixture should be deposited carefully into place. Excess dumping or dropping can result in non-uniform mixture. If shoveling the patching mixture directly from a transport vehicle or container, place the mix against the edges first. The patch is leveled and spread with rakes, lutes or shovels to get uniform placement of homogeneous material. Too much raking causes small materials to settle to the bottom, leaving coarse material on top. Coarse material should not be left at the edges of the patch.

Getting a dense patch requires care and skill. A straight-edge, string, or eye observation can be used as a guide in finishing the patch so that it will be only slightly higher (1/8" to 1/4") than the surrounding pavement. The patch mixture (HMA) should be placed in one lift with the loose mixture higher than the patch area. The loose mixture should also be luted (or shoveled) so that it aligns with the vertical edges of the patch. One lift is recommended for mixture heat retention and accomplishment of maximum in-place density especially since most pothole dimensions are small in area. A vibratory trench compactor performing compaction on a series of lifts results normally in lower in-place density than a single thick lift compacted with a heavier roller. Patches should be compacted with a conventional power steel wheeled roller, vibratory preferred (Figure 3) especially for one lift greater than 4 inches, so that the prepared patch area can be built to the proper thickness and in-place density before opened to traffic usage.

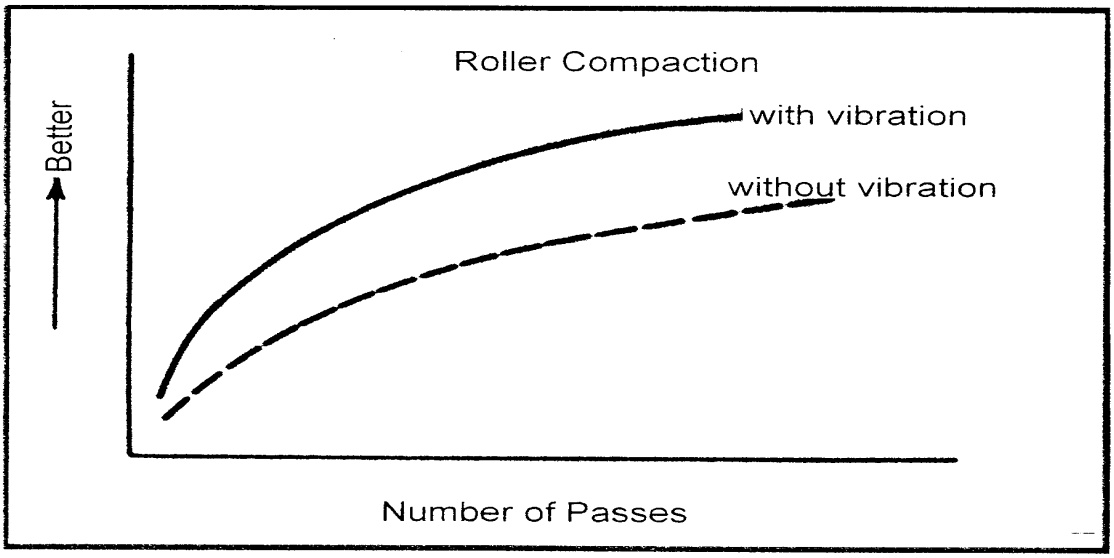

Figure 3. Roller Compaction Comparison

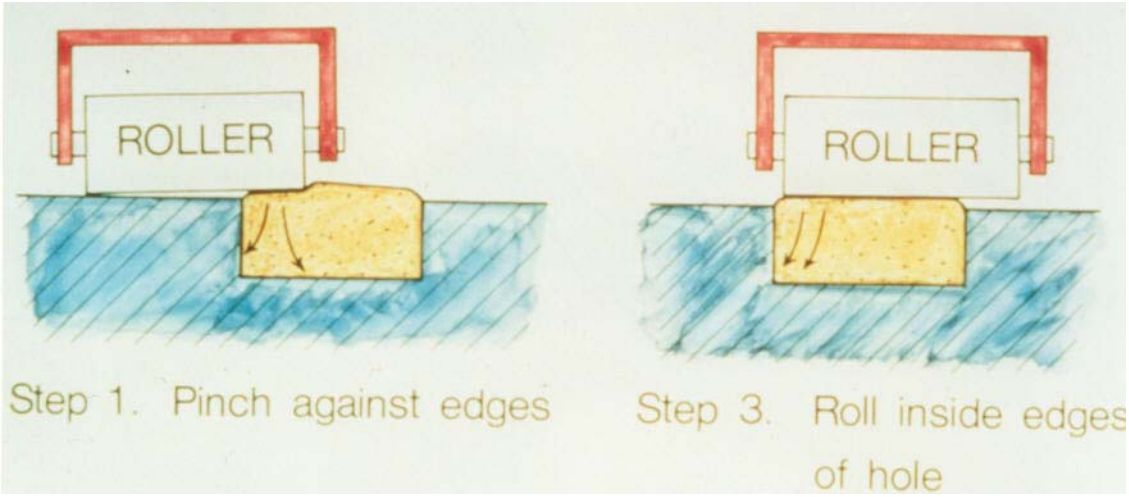

Figure 4. Roller Compaction of One Lift

The resultant patch material (Figure 4, Step 3) which is higher (1/8" to 1/4") than the in-place surface patched area will vary depending upon if the patch area is to remain as is for traffic, be trimmed or be overlaid. The small milling machine has an advantage in its portability and adoptability for use in small random patch areas.

Other key variables impacting the effectiveness of repair is the number and magnitude of potholes in the distressed pavement section. The larger pavement milling machine is the perfect answer to repairing badly distressed pavement sections in a road which is not necessarily in need of complete rehabilitation. Milling can also be a very economical and more practical and durable solution, compared to some conventional labor intense methods. The resultant milled texture also provides an excellent bonding mechanism for the new patch.

A roadway which may have a significant number of isolated random potholes that are of various depth and circumference, uniform milling of the roadway surface will have numerous cost effective advantages:

1. Drainage and rideability restored
2. Safety increased by improved drainage with a more uniform cross-slope
3. Clearance heights maintained
4. Traffic disruption kept to a minimum
5. Blend into intersections, entry/exit lanes and other fixed structures
6. Usage of HMA specifically designed for climate and traffic conditions
7. More durable hot mix repair of uniform thickness and density (in-place voids)
8. The RAP produced by the milling process has salvage value and can be reprocessed for future
9. Automatically controlled removal (milling) of a pavement to a desired depth with specially designed equipment
10. Texture of the milled surface enhances bond for the overlay

11. The resulting textured pavement can be used for a short time as a driving surface until overlaid with HMA
12. A taper cut at curb (Figure 5) is commonly used in HMA overlay applications as opposed to feathering the side edge of an overlay course. When the overlay is applied, the result is a densified uniformly thick vertical butt joint of HMA that will last longer and provide enhanced performance over the feathered edge. The procedure offers a gradual pavement slope, maintaining the cross slope profile with no loss in curb.

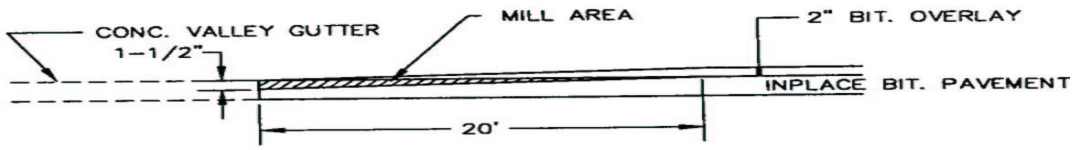

Figure 5. Taper Cut for Overlay

13. Other rehabilitation schemes, with or without prepared patching, have involved surface restoration with overlay with tapered edges (Figure 6) and mill-fill (Figure 7).

Figure 6. Overlay with HMA of Tapered Edges Onto Shoulders

Figure 7. Mill-fill with HMA

Before an asphalt pavement course is placed over an existing surface or milled surface, that surface must be prepared properly for the new layer.

Specifications

Engineers and maintenance personnel responsible for maintenance and construction activities can choose from a variety of applicable functional Mn/DOT hot mix asphalt (HMA) specifications suited for repair, milling and thin overlay. The specifier should determine the major attributes required and select the most appropriate mix type according to traffic, environment, and quality cost effective materials for the geographic area. The current Mn/DOT 2003 specification (Gyratory/ Marshall design) is availableat: www.mrr.dot.state.mn.us/pavement/bituminous/bituminous.asp.

Conclusions

As the facility user continues to demand smooth, quiet, durable and safe riding surfaces, with minimum disruption to traffic, there will be a continued emphasis for HMA surfacings. A single lift thin HMA overlay should not be used when the condition of the existing pavement suggests that significant strengthening of the structure is required.

Roadway (facility) owners are challenged by the need to preserve their pavements through timely cost effective preventive maintenance while keeping the customers (citizens or user) satisfied. Hot mix asphalt (HMA) can accomplish these objectives.

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