Installation and Performance Monitoring of a Pothole Patched Using Asphalt Pavement Millings and a 915 MHz Microwave

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Purpose

This field experiment was performed to provide information on the practicality and usefulness of performing patching with microwave technology. 915 MHz microwave generators should provide heat penetration at relatively greater depths than units that generate at higher frequencies. Recycled bituminous pavement material was used as a baseline for comparison in potential future trials.

Location

The test location was at the intersection of two bituminous surface streets (Calland and 70th St.) in the city of Otsego, MN. The pothole had developed at a transverse crack, and was in the right wheel path of the westbound lane of 70th St. Local traffic included multiple truck passes due to a nearby concrete plant.

Installation Conditions

The pothole work occurred on March 20, 2009. Air temperature was approximately 33 ºF, and pre-treatment pothole temperatures ranged from 27.6 to 37.3 ºF. The area had received a light dusting of snow overnight, and pavements were lightly damp at 9 AM. Loss of pavement material was less on the traffic approach side than on the departure side of the pothole. A small amount of water was visible in the hole. Figure 1 shows the existing conditions immediately prior to patch treatment. Traffic approaches from the right side of the image.

Figure 1 - Pre-patch condition 3-20-2009.

Equipment and Material

The pothole and patch material was heated with a mobile microwave unit typically used for thawing frozen soils (915 MHz). Power was supplied to the microwave unit with a trailer-mounted generator. A contractor supplied the equipment and personnel to operate them. Microwaves traveled from a truck-mounted microwave generator, through a duct-like wave guide, then through a hood that was in contact with the pavement. The hood covered an approximate area of four square feet. A collar was placed around the perimeter of the hood to deter microwave leaks.

The fill material was recycled asphalt pavement (RAP) that had been removed from a highway and placed in an uncovered stockpile. The RAP was not pavement millings, and was estimated to have an asphalt content of less than five percent. The RAP had been air dried for several days to achieve a moisture content of approximately four percent by weight.

The pothole area was cleaned using a shovel. Initial densification and smoothing was performed using a hand-tamper. Final densification was provided with the front wheel of a ½-ton pickup.

Temperature conditions were recorded with an infrared camera. Density was monitored with a nuclear density testing device.

Patching Method

1. Cleaned area with a shovel, removed deteriorated pavement, debris, and loose crack sealant.
2. Applied microwaves to pothole area for 10 minutes to dry the hole and warm the surrounding roadway. Portions of the hole reached 175 ºF.
3. Added half of the required amount of loose patch material (asphalt millings) and treated with microwaves for 20 minutes. The nearby pavement surface reached 47 ºF. 96 ºF was measured at vents in the hood.
    a. After 22 minutes the patch material (millings) reached 226 to 237 ºF. At this point the millings had changed to a darker appearance, indicating the asphalt binder was mobile, and the surrounding pavement material had become workable.
4. A shovel was used to blend the heated millings with in-place pavement material.
5. A second lift of cold millings was added to the heated material and microwaves were applied for 10 minutes.
6. The first and second lifts were blended using a shovel.
7. The patch was compacted using a hand-tamper.
8. The patch was compacted with wheel loading from the front end of a pickup truck.
9. Density measurements were performed at the patch and at a nearby portion of undamaged pavement.

Figure 2 shows the condition of the patch treatment immediately following installation. The patch was smooth with no material loss. Traffic approaches from the left side of the image.

Figure 2 - Pothole filled using microwave and RAP 3-20-2009.

Installation Observations

- The time required to perform the prep work and install the patch was approximately 50 minutes.
- In order to microwave treat larger diameter potholes the hood, or truck/hood apparatus, would have to be moved one or more times.
- The measurement obtained during patching showed that the undamaged in-place roadway had a density of 138 pcf. Hand-tamping the patch provided a density of 118.5 pcf, yielding an 86 percent density relative to the surrounding roadway.
- For additional details on installation conditions refer to the thermal imaging report "Pothole Patch Trial with Asphalt Pavement Millings and 915 MHz Microwave", E. Johnson, 23 March, 2009.

Monitoring and Results

The patch existed until August 2009, when city maintenance crews performed extensive patching in the wheel paths on 70th St. Monitoring was performed after 15, 35, and 123 days of service.

Figure 3 shows the condition at 15 days of service. At that time the pothole patch was developing material loss along five in. of the approach side and at one corner. The total amount of missing material was estimated to be less than 10 percent of the total patch material. Traffic approaches from the left side of the image.

Figure 3 - Condition after 15 days in service 4-4-2009.

Figure 4 shows the condition of the patch after 35 days in service. Increasing regions of material loss were visible. At that point an estimated 10 percent of patch material was missing. Traffic approaches from the left of the image.

Figure 4 - Condition after 35 days in service 4-24-2009.

Figures 5 and 6 show the patch condition after 123 days in service. At that time material loss had increased along the sides of the patch to a depth of two inches. It was estimated that more than 10 percent of the patch material was missing at this time. Traffic approaches from left of image.

Figure 5 - Condition after 3 months in service 7-21-2009.

Figure 6 - Condition after 3 months in service 7-21-2009.