NCHRP-IDEA 148

Cleaning Device to Remove Debris and Chemicals for Crack/Joint Sealing

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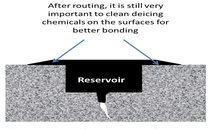
Introduction & Problems

- Over fifty percent of the US interstate system is classified in fair or poor condition.[1]
- Loss of adhesion causes most crack sealing failures
- Traditional air blasting is less effective in cold weather climates due to de-icing chemicals.
- FHWA recommends abrasive crack cleaning methods such as water blasting or wire brushing
- The pavement surface is often ignored during crack preparation
- Labor costs of current crack cleaning/sealing processes are extremely high.

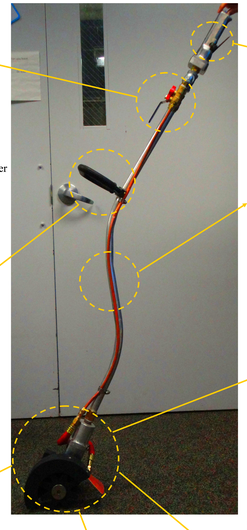


Elevation view of routed crack after sealing

Crack Sealing Process

Innovative Versatile Crack Cleaning Device

Adjustable Air Flow Splitting Design
One for running motor, the other for air blasting to clean debris



Air Amount Control Switch
A convenient trigger mechanism

S-shaped Shaft Design
More comfortable to use for a prolonged period of time compared to the straight one because the s-shape of the shaft allows the operator to stand more erect while pushing down on the device

Handle
For easy directional control of the device

Wire Brush
Cleaning Cracks

Router
Excavate cracks

Masonry Blade
Pothole Repair/Making Saw Joints

Replaceable Attacement Design
A low cost alternative to simply and effectively prepare pavement cracks and joints for sealing or filling

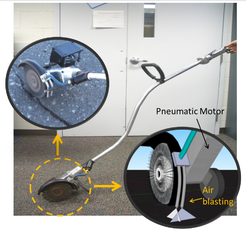
Pneumatic Motor, Angle-adjustable air nozzle , and Debris Guard
The debris guard is not only for the safety and protection of the operator, but also for passing vehicles and pedestrians. The adjustable nozzle trajectory using a funnel to blow out debris away from the crack to the side of the roadway no matter what the direction the device is moving.

Guiding Wheel with Height Adjustable Assembly
Give the operator a choice in the setting the minimum crack depth

Design Concept:

Pneumatic power = Brushing / Routing / Cutting + air blasting

Simple Chicago fitting connection with existing air compressor



Conventional Preparation Method vs. Proposed Preparation Method

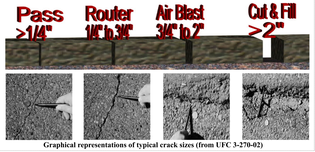
	Non-Routing	Comments
Traditional	Air blasting-> sealing	Does not effectively remove de-icing chemicals and vegetation
Proposed device	Wire brushing & air blasting -> sealing	Remove deicing chemicals and vegetation + air blasting = one process

	Routing	Comments
Traditional	Routing -> air blowing-> sealing	Not effective for wide cracks. Also, routing cannot clean top surfaces of cracks which promotes better bonding between surface and sealant material.
Proposed device	Routing-> wire brushing & air blasting -> sealing	A brush effectively prepare top surface of cracks while air blasting cleans inside and outside of the routed crack simultaneously.

Conventional and Proposed Preparation Method Overview

Crack Size for Sealing

- Crafco Inc. defines cracks ≥ 1/8" (about 3mm) generally require sealing.
- Materials and Procedures for Sealing and Filling Cracks in Asphalt-Surfaced Pavements (FHWA-RD-99-147)[2] recommends crack sealing for 5 to 19 mm width of cracks.
- Unified Facilities Criteria (UFC) provides guidelines for crack preparation based on crack size as follows[3]:



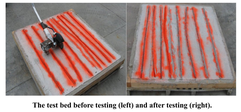
Graphical representations of typical crack sizes (from UFC 3-270-02)

Laboratory Tests

1. Chemical Residue Removal Effectiveness

Considerations:

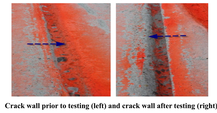
- Chemical removal is the primary objective of device's development
- Aerosol paint was used as simulated de-icing chemical due to its fine mist application and the porous nature of hot mix asphalt.
- Bright colored paint allowed for a straightforward visual analysis of the crack cleaner's effectiveness at removing de-icing chemicals.



The test bed before testing (left) and after testing (right).

Findings :

- Single pass from 3/8" wire brush in 1/2" crack utilizing the crack cleaning device left the side walls of the crack 85%-90% cleaner than air blasting.
- Two passes from the device would likely be needed to ensure both side walls of a wide crack (1/2" >) are prepared to an acceptable level



Crack wall prior to testing (left) and crack wall after testing (right)

2. Previously Sealed Crack

The Problem
Broken bonds between sealant and pavement necessitates the sealant's removal and replacement

The Need
The removal of sealant is made difficult by patchy bonding and warm weather

The Solution
Rotary wire brushing effectively removes worn sealant from pavement voids

Effective preparation of previously sealed crack, with sealant reside buildup being shown on the device

3. Cutting Concrete Test

Easily cutting an area of pothole by replacing a rotary wire brush with a masonry cutting blade

4. Multi-function Test

Versatile functions provided by a single pneumatic powered device developed in this project

Field Tests and Industry Feedback

1. First Field Test with Nebraska Department of Road (NDOR)

On June 8, 2010, the first field test was conducted at an actual crack sealing site with the NDOR highway maintenance crews in District 2.

NDOR crews using a conventional hot air blaster (left) and the new device (middle and right)

Comments:

1. Easy to learn how to use.
2. Powerful enough to clean typical cracks.
3. Easily maneuvered with the aid of wheel.
4. Would not slow down the crack cleaning process if incorporated into state procedures.

Suggested Improvements:

1. Adding a heat lance to the device may benefit the District 2 group to reduce additional tasks.
2. A second handle should be added to the device for the hand not pulling the trigger.
3. The shield needs to be improved to reduce flying debris.

2. Second Field Test with Nebraska Department of Road (NDOR)

On July 28, 2010 the research team traveled to Norfolk, Nebraska to meet with the NDOR Regional Panel that was selected to assist in supporting the development of the crack cleaner.

First regional panel field test and demonstration (Left and Middle) and Second regional panel field test (Right)

Comments:

1. Excited about the device's light weight and nimble design
2. Significantly reduce physical strain on the current crack cleaning crew .
3. Pleased with the effectiveness of the device at cleaning and preparing cracks for sealant
4. Efficiently clean/prepare previously sealed damaged joints

Suggested Improvements:

1. An increased debris guard
2. An angle-adjustable air nozzle

3. Field Test with City of Omaha Urban Maintenance Crew

The final field test was conducted on March 4, 2011 with the City of Omaha roads maintenance group.

City of Omaha Field Test

Comments:

1. High flexibility
2. Effective at preparing pavement cracks .
3. Easily cutting an area of pothole by replacing a rotary wire brush with a masonry cutting blade

Suggested Improvements:

1. An increased debris guard
2. An angle-adjustable air nozzle

Conclusion

- Very effective solution for crack or joint preparation
- Promising lab & field test results: Sealant removal, Chemical removal, Vegetation removal
- Frictional heat generated by the device is not a viable option for crack sealant temperature preparation
- Very Positive Industry Feedback: Lightweight, High mobility, Endorsed by State Highway labor crew
- Specialized brush design is useful to simultaneously prepare the pavement surface adjacent to cracks
- Onboard pavement router capabilities for small sized cracks.

Acknowledgments

- A very special thanks to the NCHRP-IDEA program without their funding this project would not have been possible. (NCHRP-IDEA 148)
- Technical input and feed back from the Nebraska Department of Roads (NDOR) and City of Omaha have been invaluable throughout development of this device.

1. Davies, Robert M., and Jim Sorenson. "Pavement Preservation." *Public Roads* 63.4 (2000): 37. *Academic Search Premier*. EBSCO. Web. 18 Jan. 2011.

2. Smith, K.L., Romine, A.R. "Materials and Procedures for Sealing and Filling Cracks in Asphalt-Surfaced Pavements—Manual of Practice (FHwA-RD-99-147)." *FHWA Pavement Publications* (1999): www.fhwa.dot.gov. 18 Jan. 2011.

3 Basham, D.L. " Unified Facilities Criteria (UFC) Asphalt Crack Repair ." (UFC 3-270-02) *Department of Defense*. (2001): www.wbdg.org/ccb/DOD/UFCulc_3_270_02.pdf. 18 Jan. 2011.

TRB Transportation Research Board of the National Academies

NDOR Nebraska Department of Roads