Spray Injection Pothole Filling

Business Development Case

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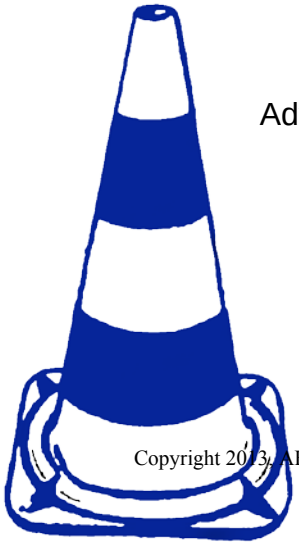

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Program Overview

About the UC Davis Graduate School of Management (GSM):

The mission of the UC Davis Graduate School of Management is to be a leader in management research and education. As part of the world's premier public university, we pursue significance, excellence and scholarly rigor in our research, teaching and service to the people of California. We emphasize curiosity, creativity and high standards in the generation and transmission of theoretical and practical knowledge relevant for business.[1]

About the California Department of Transportation (Caltrans):

Caltrans manages more than 45,000 miles of California's highway and freeway lanes, provides inter-city rail services, assists more than 100 public general aviation airports and works with local agencies. Caltrans carries out its mission of improving mobility across California with six primary programs: Aeronautics, Highway Transportation, Mass Transportation, Transportation Planning, Administration and the Equipment Service Center.[2] Caltrans as a whole has an annual budget of $8 billion, of which $393 million is appropriated for maintenance activities.

About the Advanced Highway Maintenance and Technology Center (AHMCT):

The Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center has been developing robotic equipment and machinery for highway maintenance and construction operations. It is a cooperative venture between the University of California at Davis and the California Department of Transportation (Caltrans). The research and development projects have the goal of increasing safety and efficiency of roadwork operations through the appropriate application of automation solutions.[3]

[1] UC Davis GSM Mission Statement, http://www.gsm.ucdavis.edu/visitors_center/about_us.htm#Mission%20Statement
[2] About Caltrans, http://www.caltrans.ca.gov/aboutcaltrans.htm
[3] "Development Of A Prototype Telerobotic System For Debris Vacuum Positioning," AHMCT Research Report, 12/31/01

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1 Abstract

This project was intended to evaluate the business case for developing new machines or techniques for automating the process of filling potholes for CalTrans. It includes a brief evaluation of existing methods, and suggestions for areas of improvement. Within this paper, we look at the cost of the machines, operation cost, and savings, to determine what opportunities for improvement may be available. .

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2 Project Description

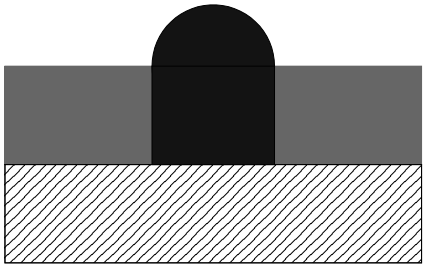
2.1 Elevator Pitch

Automating the pothole filling process may save money, increase safety, and increase the durability of repairs.

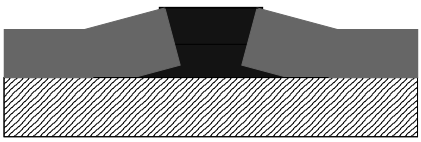
2.2 Value Proposition

2.2.1 Current Pothole Filling Methods

The "Throw-and-Roll" method is the traditional method of filling, it is simplest, and requires the least specialized material. A mixture is placed into the pothole which may or may not be filled with water and debris. Any type of hand tool such as a shovel or pitchfork is used to fill the hole. Workers then fill the hole so that there is a crown in the center. Once filled, workers compact the material by rolling over it 6 to 8 times with truck tires. Some crews have found it useful to cover the patch with sand before rolling a truck over the patch to prevent material from sticking to tires. After rolling, workers check the level of the patch to make sure the center of the patch is ¼" to ½" above the pavement surface. If the patch is low add more cold mix and repeat the patching steps again. [4]



One issue with any compaction method is the concern that overfilled and compacted potholes can "mushroom". As the material is compacted, the material is forced underneath the road surface, causing a mushroom effect that can lead to speedbump like replacements to potholes.



[4] http://www.t2.unh.edu/winter98/pg6.html

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Semi-Permanent repairs are similar to “Throw and Roll”, but more attention paid to the cleaning and shaping the pot-hole before filling. Once believed to be superior to Throw-and-Roll for longevity, recent studies indicate that material choice plays a far bigger role. The FHWA's Long Term Pavement Performance (LTPP) Study found that the "throw-and-roll technique proved just as effective as the semi-permanent procedure for those materials for which the two procedures were compared directly"[5]. Since the semi-permanent technique is more labor and material intensive, the throw-and-roll technique will generally prove more cost effective if quality materials are used. [6]

With Spray injection methods, the damaged area is blown out using the boom arm to direct high-pressure air, cleaning it of water and debris. Then emulsion and aggregate are mixed in the nozzle and pressure blown into the pothole itself, followed by a dry coat of aggregate, which is added so traffic can travel on it immediately. This is generally believed to produce a neater and smoother repair that blends in better with the surrounding asphalt. All of this is a one-person operation done from the inside of the cab, so it is less labor intensive and offers safety benefits. [7] There is still a need to clean up debris that is blown out of the pothole. Spray injection avoids the mushroom problem. (see diagram.) Material is compacted as the hole is filled, achieves 95% compaction. [8]

[5] FHWA, 1998
[6] Numerous sources,
http://www.asphaltwa.com/wapa_web/modules/09_maint_rehab/09_maintenance.htm

[7] http://www.sanjoseca.gov/transportation/sm_potholes.htm

[8] From Pothole_patching.ppt file from AHMCT

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2.2.2 Cost Comparison

A cost comparison was performed to determine if the Spray Injection methods would be more cost effective on a per repair basis and consequently if Spray Injection methods would provide Caltrans with a reasonable return on capital investment. Research for length of repair was based on the assumptions and research found in Numbers are related to SHRP report, Process Evaluation of Spray Injection Method for Asphalt Surface Repair, Prepared by South Dakota State University, Department of Civil and Environmental Engineering Brookings, SD 57006,December 1998.

Input	Throw & Roll A	Throw & Roll B	Semi-Permanent	Spray Injection	Throw and Roll C	Spray Injection South Dakota
Crew Size	2	2	4	2	2	1
Wages/Day	$300	$300	$1200	$300	$300	$150
Traffic Control Cost/Day	$280	$280	$280	$280	$280	0
Repair Life – Months	3	21	12	21	3	21
Cost $/ft3 –w/o delay	$44.38	$8.66	$42.08	$10.54	$44.38	$6.70
Cost $/ft3 – User delay	$106.88	$17.59	$83.75	$19.46	$669.38	$15.63

Higher labor costs for CalTrans will make the Spray Injection method even more clearly favored on a cost comparison basis. (see below)

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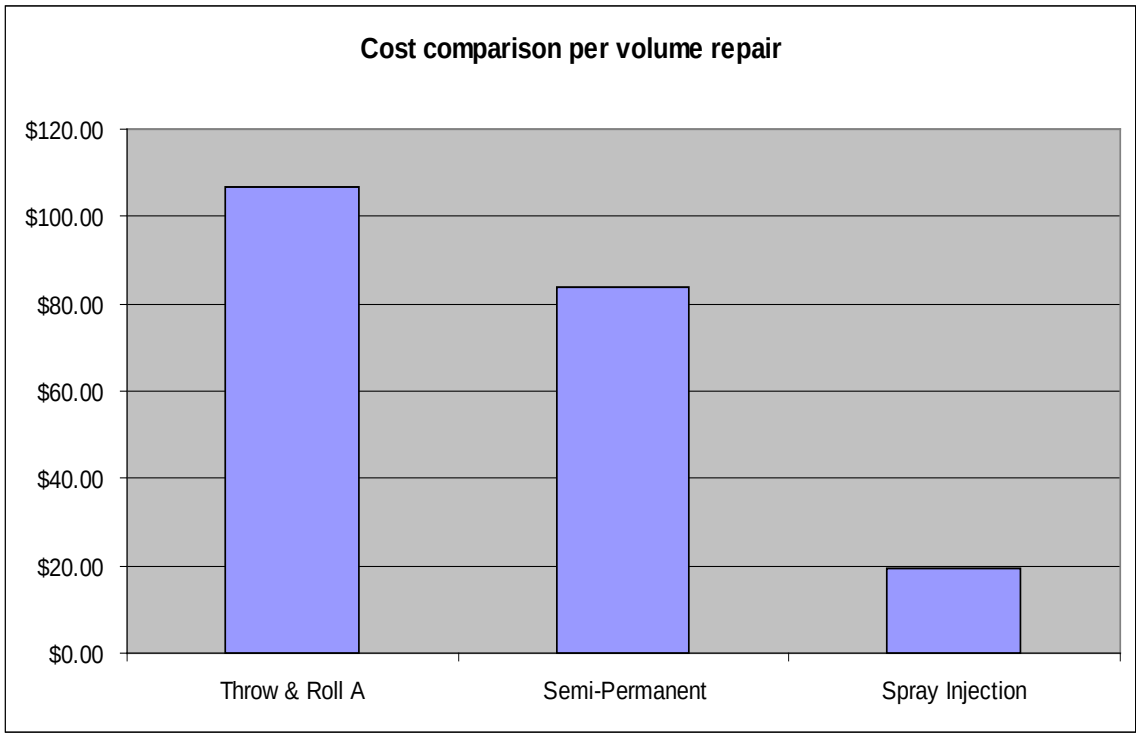

2.2.2.1 Labor Rate

The following are labor rate data for Caltrans workers used in IMMS reporting[9].

- Maintenance Worker: $27.58
- Caltrans Equipment Operator I: $32.26
- Caltrans Equipment Operator II: $34.61
- Caltrans Maintenance Supervisor: $41.74

Typically, a 15% to 20% overhead rate is applied to hourly labor costs. Using this data, an average hourly rate of $39.15 (including 15% overhead) was constructed. Labor costs used in the South Dakota study assumed

2.2.2.2 Equipment Pricing

There are numerous commercial spray injection pothole fillers available, from a wide variety of manufactures. Equipment costs for Spray-Injection methods vary between $40,000 for a trailer mount unit to $120,000 for a self contained unit. This compares to $25,000 for a truck for conventional methods, although trailers require the use of a truck as well. As such, equipment costs is $40,000 to $95,000 more than conventional methods.

[9] Caltrans Courtney Morrison

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A $70 daily rental rate can be estimated based on comparison to other CalTrans equipment, their costs, and other similar uses.

2.2.2.3 Payback Period

Given the clear economic benefits of spray-injection pothole filling, the payback period on new machinery is between 458 and 1478 cubic feet of repair, a relatively small amount.

The exact number of CalTrans potholes filled is not readily available, but San Diego city fills over 30,000 potholes a year, and LA fills over 90,000, indicating that a spray injection machine would likely have a payback period well under a year.

These estimates are consistent with other published reports.

2.3 Project Objective

The purpose of this project is to develop a business case to support the deployment of spray injection pothole filling machines into the Caltrans work place. In addition, to briefly evaluate existing technologies and investigate possible improvements to be made by AHMCT for the pothole filling method.

3 Technology

There are many commercially available pothole filling spray injection machines. Some are trailer based, some are truck based. All feature similar techniques, centered around the spray injection of heated asphalt materials in aggregate will filler materials. A literature review was undertaken to evaluate the state of the technology. Literature and reviews of the technique, as compared to traditional methods, is nearly universally favorable.

In October 1998, CalTrans had a review/demonstration of several available units. “The California Division brought vendors and interested public officials together to learn about equipment and materials available to resolve a serious problem for all highway agencies. The division recognizes (as reported in the September 1998 issue of Asphalt Contractor) that "preservation is the new pavement maintenance philosophy." The Surface Transportation Policy Project reported in November that there is a looming crisis

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in our deteriorating infrastructure, and a recent National Quality Initiative survey found that our customers, the driving public, are most interested in a smooth-riding pavement. We all understand the need to balance requirements and resources prudently, and we know that a reasoned response to a pothole problem can overcome serious problems, if not a crisis, in our ongoing pavement maintenance. That's why our efforts should be directed to these goals." [10]

Any future development will require extensive study of available units. Suggested reading includes:

- Answering El Nino's Challenge, Roads and Bridges, May 1998
- Automated Pothole Patching – Better Patches for Less Money, Road Management and Engineering Journal, http://www.usroads.com/journals/rmj/rm970404.htm, April, 1997.
- Blaha, J.R., Workplan for Pothole Patcher Demonstration Program, Northwestern University Infrastructure Technology Institute, Evanston, IL, May, 1993.
- Garritt, J., Welcome to the Year of the Pothole, Detroit Free Press, February 19, 1997.
- Jebro, Inc., Personal Interview with Kevin Carlson, July, 1997.

New Guidelines Help Highway Agencies Make the Most of Maintenance, Focus, Federal Highway Administration, McLean, VA, March, 1997.

- Rosco Manual Part No. 36640, RA-300 Patcher Operations, Maintenance, Service and Parts Manual, Rosco Manufacturing Company, Madison, SD, January, 1995.

- Wilson, T.P., and Romine, A.R. Innovative Materials Development and Testing Volume 2: Pothole Repair, Strategic Highway Research Program, National Research Council, Washington, DC, 1993.
- http://www.state.sd.us/Applications/HR19ResearchProjects/Projects%5CSD1997_06_final_report.pdf

3.1 Status

CalTrans and the Advanced Highway Maintenance and Technology Center have not yet developed their own spray injection method. Any future development will require extensive review of available units to determine precisely where improvements can be made.

Intellectual Property

Given the large number of commercially available units, an extensive review of patents will be required before investing in the development of spray-injection units.

[10] http://fhwainter.fhwa.dot.gov/cadiv/techapps/potholes.htm

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4 Traffic Control Market

The traffic control market generally consists of two main groups, state highway maintenance crews, and private construction crews. Both would have extensive use for pot-hole filling methods.

5 Recommendations

Our recommendation is for the AHMCT group to work with Caltrans to evaluate existing commercially available units, and implement them into the CalTrans work force. All research points to their cost-effectiveness, and they have added benefits of less road closures and less worker traffic exposure. As they are used, usage can be carefully monitored for problems that will allow improvements by the AHMCT group. At this point, there is little obvious reason for AHMCT to develop their own Spray injection machine.

There is evidence that there might be room for improvement in the aggregate materials used. There is evidence that these materials are the key factor in the length of the repair.

6 Acknowledgements

We'd like to thanks all the Caltrans maintenance workers who patiently answered our questions. Also we'd like to thank Caltrans.

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