RESEARCH BRIEF

# Predicting Performance of Carbide-Insert Plow Blades

As a snowplow logs miles in service, the steel cutting edge on the plow blade wears out through contact with the pavement and must be replaced. To prolong a plow blade's life, many agencies have begun to use plow blades with carbide inserts, which are made of tungsten carbide, a longer-wearing steel alloy.

State DOTs use several thousand carbide-insert blades in a single winter season, at a typical cost of $500,000 to $1 million per state. Historically, some carbide inserts have exhibited poor wear performance, which has led to them having to be replaced prematurely, increasing costs to agencies.

## Need for Research

State DOTs purchase carbide-insert blades from a relatively limited number of suppliers. Most suppliers purchase the carbide inserts from a manufacturer and braze them into steel plates that form the cutting surface of the plow blades. States typically have specifications for the steel plates and for the carbide inserts, but there are no nationwide standards for the purchase of plow blades with carbide inserts, and there is a lack of standard tests that have proven to be good predictors of carbide insert performance. A standard procedure would improve the cost-effectiveness of these blades.

## Objectives and Methodology

The goal of this project was to develop standardized testing procedures for carbide inserts that would improve agencies' ability to predict their performance. Agencies could then use these tests to specify material properties for the inserts and set acceptance and rejection limits as part of a quality acceptance program that would optimize the inserts' performance and longevity.

Researchers tested three sets of plow blades from different suppliers in the laboratory and in a controlled field test to identify laboratory tests that correlated to the field performance of the carbide inserts.

## Results

Researchers identified fracturing of the carbide inserts as a likely cause of poor performance. Both laboratory and field testing confirmed that poorly performing inserts had excessive voids and internal cracks that led to the fracturing. Because these deficiencies are generally due to manufacturing processes, not to material properties, researchers developed a testing procedure that includes the evaluation of manufacturing processes.

The recommended testing process involves evaluating a statistical sample of each lot of inserts using three steps:

- **Step 1** is a new test—a visual examination of the face of the inserts to identify the percentage that have cracks visible with a handheld 3x magnifier. If more than 15 percent of the samples have visible cracks, the lot should be rejected.
- **Step 2** uses hardness and density testing to evaluate the materials used in manufacture of the inserts. If both hardness and density are at the minimum levels, agencies should use caution in accepting the lot.
- **Step 3** evaluates manufacturing quality using tests for porosity and grain size, including the identification of voids and cracks. Researchers recommended limits for the acceptable amount of large voids, void clusters and cracks in the sample inserts.

Researchers recommended that carbide insert manufacturers use the tests in a quality control system, and suggested that the firms assembling the inserts into the plow blades conduct quality assurance tests. The agency purchasing the blades should then undertake a statistically valid qual-

**Investigator**

"The procedures developed for specifying and purchasing carbide blade inserts will address problems in the current process, and have the potential to save money for agencies that use these blades."

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## Project Champion

"This project supplied the research and recommendations needed to develop standard specifications for carbide-insert blades that any state DOT could adopt or use as a model."

**–Tim Croze**
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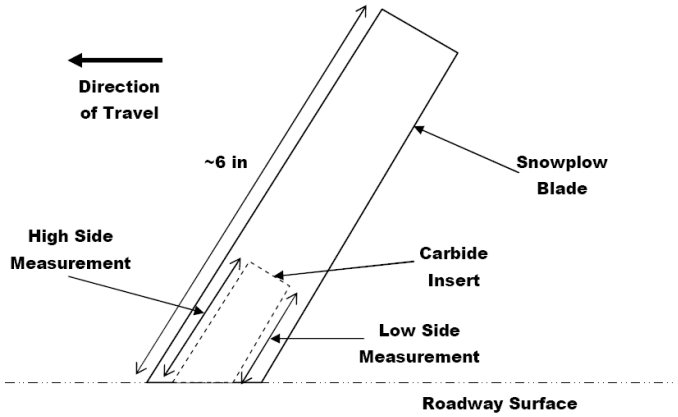


The carbide inserts tested in this study were embedded in the plow blade as shown at left. After 300 miles of field testing, the blade at right exhibited cracks and chips.

ity assurance testing program, performed by a metallurgical laboratory experienced in powdered metals testing.

Researchers found that the recommended tests can differentiate between carbide-insert blades that will perform well and those that will not. That evaluation can be roughly correlated with the life expectancy of the blades. Researchers noted that other factors affect blade life as well, including the speed of plowing required by traffic conditions, agency policy on acceptable roadway conditions, and the plow operator's ability to avoid impacts that could fracture the carbide inserts.

Researchers recommended that the three-step test procedure be publicized to all agencies that purchase carbide-insert blades, and suggested that it be developed into a national standard purchasing process.

## Implementation and Benefits

As agencies begin using the recommended process for testing and acceptance of carbide inserts, poor performance of carbide-insert blades should be minimized. The carbide inserts will last longer, which will reduce replacement costs, and will also reduce the time, cost and equipment downtime associated with changing plow blades.

These benefits would expand if the procedures are accepted as a national standard or are developed into model specifications that any agency could implement. Using standardized tests would improve agencies' purchasing processes, reducing management time and validating purchase decisions.

## Further Research

The winter maintenance community could build upon this research through additional testing to refine the limits of acceptable results for the recommended tests. In addition, this project identified opportunities to improve the life expectancy of carbide inserts by training snowplow operators to avoid the type of blade impacts that lead to fracture.

*This brief summarizes project CR2007-01, "Development of Standardized Test Procedures for Carbide Insert Snowplow Blade Wear," produced through the Clear Roads winter maintenance pooled fund project, TPF-5(092). Clear Roads' lead state for this research project is Wisconsin DOT, 4802 Sheboygan Ave., Madison, WI 53707. (In early 2010, Minnesota DOT took over as the lead state for the Clear Roads winter maintenance pooled fund project under TPF-5(218).) Cliff Spoonemore of Wyoming DOT is the Clear Roads Technical Advisory Committee Chair (cliff.spoonemore@dot.state.wy.us).*

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