WHEN WORK BOOTS WEAR OUT

The National Institute of Occupational Safety & Health is nearing completion of a study measuring work boot tread wear to determine the safety and health of miners

BY **ASHLEY WHITSON AND LYDIA KOCHER**

Safety footwear is a requirement in the mining industry, and work boots have multiple features to help protect workers from hazards.

One of the most commonly known features is the protective toe, which helps to guard against impact or compression hazards. Shoes with electrical hazard ratings help to prevent workers from completing an electrical circuit, thereby reducing the risk of electrocution.

Another equally important safety feature is stacked heels, used for ladder climbing, waterproofing and slip resistance.

The tread – the outer sole of the boot – is important for resisting slips because it provides traction. The channels in the tread allow liquids to evacuate, redirecting it from beneath the foot and giving the boot a better chance to grip the walking surface and keep workers from slipping.

The depth and design of those channels help to determine the amount of liquid that the boot is able to disperse. Therefore, the amount of material worn away from the boot's treads can impact the boot's ability to prevent slips.

Another consequence of worn boots can be the loss of waterproofing. Workers whose feet are wet for prolonged periods can experience illness or injury as a result. Water inside the boot can also reduce the effectiveness of the temperature or electrical hazard insulation.

HOW NIOSH MEASURES BOOT WEAR

Researchers at the National Institute for Occupational Safety & Health (NIOSH) are conducting a study to measure boot wear over the course of two years at multiple mine sites. Participants choose a pair of safety boots and wear them as they normally would. Every three months, researchers return to the mine sites to take measurements of the boots and collect boots from any participants finished with the study.

A three-dimensional laser scanner is used to scan the tread of the boots, both when they are new and every three months until they are returned, so the material worn away from the tread can be assessed and tracked over time. Wear is measured on four different sections of the boot: the heel, arch-ball, ball and toe.

Using metrology software, scans of the new and worn boots are compared. Virtual calipers in the software are used to measure tread depths and determine the percentage change compared to the

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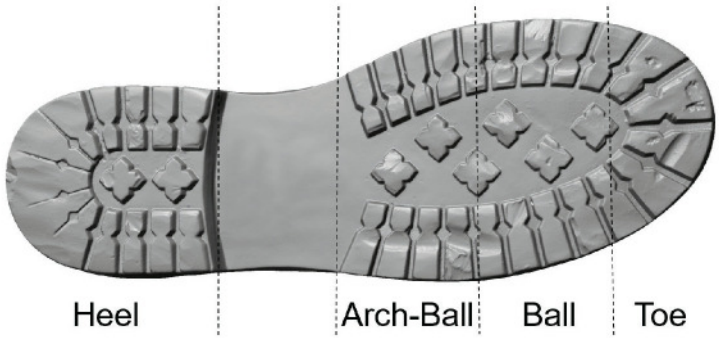
SAFETY FOOTWEAR

Four sections of the work boot are used to measure tread wear. Preliminary results associated with these sections can be found in the two tables presented below.



Tread Wear

	HEEL	ARCH-BALL	BALL	TOE
Maintenance and Utility Workers	-31%	-18%	-29%	-23%
Plant Operators	-29%	-13%	-21%	-17%

Average tread wear based on preliminary study results for the 14 pairs of boots returned at the end of usable life. These boots were returned by nine maintenance and utility workers and five plant operators.

	HEEL	ARCH-BALL	BALL	TOE
Maintenance and Utility Workers	-51%	-41%	-63%	-40%
Plant Operators	-50%	-23%	-29%	-28%

Maximum tread wear based on preliminary study results based on the same boots and participants in the table above.

Source: NIOSH

original. In other words, minus 27 percent would mean that 27 percent of the original tread has worn away. Photographs, surface area prints and hardness measurements are also collected every three months. The mine workers are asked to keep track of the locations and hours they work, along with details of any slip, trip or fall events.

The progression of wear and surface contact area are compared to the job description and work locations to determine which characteristics influence wear. One reason mine workers return the boots to NIOSH is that they consider them to be at the end of their usable life.

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When boots are returned for this reason, they undergo further testing to determine their slip resistance by comparison to that of identical and new soles. An accurate determination of slip resistance over the life of the boot can inform mines and miners to consider replacement intervals based on wear.

All of this information will be combined and analyzed by NIOSH to determine how quickly the boot treads wear out and what factors may contribute to the loss of tread.

PRELIMINARY FINDINGS

The NIOSH study began in March 2017 and ends in July 2019. Participants can wear the boots for a period of up to two years.

Preliminary findings indicate that jobs such as maintenance and utility workers, followed by plant operators, lead to the most wear. In fact, participants in these positions are the only ones who have returned their boots so far, citing the boots as at the end of their usable life. Other jobs being tracked in this study include mobile equipment operators, managers, supervisors and office-based positions.

Forty-two miners from two sand mines volunteered to participate. Fourteen participants returned their boots because they determined the boots reached the end of their usable life.

The average and maximum wear measured for these participants are presented in two tables within this article, in the form of the percentage of the tread worn away. Nine people left the study for other reasons, and the remaining boots are still being worn by the miners.

One of the most common reasons boots are returned is because they leak. Most often, the leak occurs after the outer sole separates from the upper part of the boot. Other reasons cited for return were discomfort or boots not being effective in the particular work environment. Specifically, worker explanations for returning the boots included these comments:

- "They are no longer waterproof."
- "Twisted my ankle several times."
- "Not good in wet places, slipped five times in three weeks."

WHAT'S NEXT?

These preliminary findings suggest boot wear may be a function of job description. NIOSH will further analyze the data to determine if the walking surface or how much of the day a worker spends walking also influence wear.

The images on the top show a 3-D scan, left, and a photograph, right, of a maintenance worker's boot before it was given to a miner. The bottom images show the 3-D scan and photo of that same boot after being worn to work at a mine for 15 months. The treads on the heel are completely worn away, leaving no channels. Treads are also worn away from the ball of the foot to the point that the fluid evacuation channels are severely diminished.

NIOSH

Although not everyone is going to wear through their boots at the same rate, wearing boots down to the point where they can no longer evacuate fluid can lead to more slips.

Once all boots are returned to NIOSH, the new and worn boots will be tested for slip resistance to determine if they are being worn beyond a point where they provide adequate protection against slips. Along with the wear of the outsoles, NIOSH is also gathering information about the other parts of the boots, such as the waterproofing and overall construction, to determine the desirable and undesirable features of safety footwear.

NIOSH's ultimate goal is to combine all of this information to provide mine workers with a reliable way to determine when their boots should be replaced. **P&Q**

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