Mount Mazama Ash Offers Sustainable Solution for ADA Accessibility on Unpaved Trails

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Approximately 7,700 years ago—in a cataclysmic event which the Klamath people retold and passed down for over 300 generations—Mount Mazama erupted, forming Crater Lake in Oregon. With molten rock reaching temperatures of up to 2,200 degrees Fahrenheit, complex chemical reactions ensued. The resulting ash holds some properties that are similar to those in portland cement.

Today, most construction projects use portland cement, which takes an excessive amount of energy to create. Materials are mined from several different sources and transported, then heated to thousands of degrees for a long time. Anything made with portland cement inherently has very high embodied energy. Meanwhile, orange-colored deposits of Mazama ash are plentiful throughout southern Oregon and the Pacific Northwest, and have been identified as far northeast as the Greenland ice sheet.

National Institute for Transportation and Communities (NITC) researcher Matthew Sleep of Oregon Tech investigated whether Mazama ash could be used in place of portland cement, as a natural pozzolan. Results indicate that it can—and unpaved trail surfaces made with Mazama ash are actually firmer and more durable than those made with portland cement alone. Such trails can provide a reliable surface for wheeled mobility devices.

IMPACT ON ADA ACCESSIBILITY IN NATURAL AREAS

"Creating ADA accessible trails is really beneficial for the third pillar of sustainability, which is equity and access: for everybody to be able to utilize the infrastructure," Sleep said. (In a commonly used framework, Environmental Protection and Economic Viability are the first two pillars of sustainability and Social Equity is the third.)

The Americans with Disabilities Act (ADA) provides specific requirements for unpaved trails: the surface must be "firm, stable and slip resistant." Using unpaved trails in natural areas has important environmental benefits, such as increased permeability for rain. So a trail surface that is both unpaved and also ADA-compliant is ideal for keeping parks and other natural areas healthy and accessible.

Some compacted aggregate materials may meet ADA requirements initially, but degrade over time. With Mazama volcanic ash applied topically to unpaved trails, the surfaces are firmer and continue to gain strength for a longer time than trails made with portland cement alone. More recreational areas and trails will be subject to accessibility requirements in the future, and Sleep's work offers a sustainable option for the people who develop and maintain national and state parks and other natural areas.

LAB AND FIELD TESTING

Sleep's team at Oregon Tech conducted an extensive laboratory and field study to determine the effectiveness of using volcanic ash to increase the firmness and stability of unpaved trail surfaces. Volcanic ash was obtained from Klamath County, Oregon, and processed with a commercial rock crusher to make it fine enough for use as a natural pozzolan. Mortar cubes created with volcanic ash showed appreciable gains in strength between 28 and 84 days of curing. A lab-scale testing device was constructed with adjustable confinement to refine the process of applying the topical mix. The team did field-scale testing with 12 lots of applied treatment testing different mixes.

"We showed long-term strength gains with this material that don't happen when you just use portland cement. Portland cement doesn't gain strength after about 28 days, and so far we've continued to see strength gains up to 84 days," Sleep said.

NEXT STEPS FOR MAZAMA ASH AS A NATURAL POZZOLAN

"Everybody is aware of natural pozzolans, but for whatever reason, it has not really caught on in the industry," Sleep said. So what needs to happen to help it catch on?

Mainly, it's a question of scale. Everything the researchers at Oregon Tech have done so far has been small-scale, with testing on small samples and in controlled environments. With the cooperation of more professionals in the materials and construction industry, it would be possible to do this type of testing – and eventually start using the ash as a proven material – on a more commercial scale.

Sleep and his research team have already been in contact with pumice producers in northern Klamath county, who are already mining Mazama ash for pumice and are interested in the possibility of another potential use for the material.

"Using volcanic ash – any natural replacement for portland cement – has a huge environmental impact. We did some research using a sustainability tool from Virginia Tech and found both that embodied energy and CO emissions are significantly less, anytime you can replace portland cement with volcanic ash," Sleep said.

This report is a continuation of work started with a NITC Small Starts grant in 2018. This work furthers the U.S. DOT's goal of continuously modernizing and improving safe, sustainable infrastructure for the traveling public.

ABOUT THE AUTHORS

The research team consisted of Matthew Sleep, Ph.D., and Damian Matzen of the Oregon Institute of Technology.

ABOUT THE FUNDERS

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THE FULL REPORT and ONLINE RESOURCES

To download the full final report **"ADA Accessible Trail Improvement with Naturally Occurring, Sustainable Materials"** or watch the May 19, 2020 webinar, visit the project page at **nitc.trec.pdx.edu/research/project/1131.**

Photo by Matthew Sleep

Oregon Tech grad student Damian Matzen working with Mazama ash