# MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 17-332 (project 411) | October 2017

## Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthworks Projects

## the ISSUE

Improving transportation construction projects requires a broad array of earthworks. Each earthwork project requires earthen materials constructed to obtain optimal engineering performance. The reuse of industrial waste and by-products such as mine waste materials and fly ash has the potential to aid construction needs while decreasing energy consumption, raw material use, and greenhouse gas emissions.

## the RESEARCH

This study evaluated the effect of fly ash amendment on the geotechnical properties of mine tailings and assessed the applicability of using the amended mine waste as earthwork construction material, such as road subbase and subgrade, unpaved roadways, embankments, and fills. Natural and synthetic (i.e., laboratory prepared) mine tailings were used to assess the effects of tailings particle-size and tailings solids content. Three types of off-specification fly ashes and Type I-II Portland cement were used as cementitious binders. There were three main research focus areas: (i) evaluation of the hydraulic conductivity of mine tailings and fly ash mixtures; (ii) evaluation of the unconfined compressive strength of mine tailings and cementitious binder mixtures; and (iii) evaluation of the compressibility of mine tailings and cementitious binder mixtures. Laboratory experiments were conducted for each of the three research focus areas. Results of the laboratory experiments were compared to literature to verify data trends and make inferences as to the reuse potential of fly ash and mine tailings in transportation earthwork applications.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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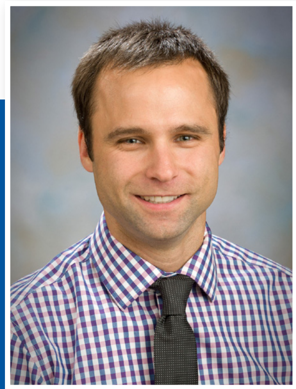


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### Project Title

Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthworks Projects


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### Sponsors | Partners

USDOT, Research and Innovative Technology Administration

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## the **FINDINGS**

The influence of fly ash-amendment on hydraulic conductivity of mine tailings was attributed to molding water content and plasticity of the mine tailings. Silty tailings exhibited a decrease in hydraulic conductivity when amended with fly ash and prepared wet of optimum, whereas clayey tailings exhibited a one-order magnitude increase in hydraulic conductivity with addition of fly ash and prepared dry or near optimum. In general, unconfined compressive strength increased with an increase in tailings particle size, solids content, and/or increase in $CaO$-to-$SiO_2$ ratio of fly ash for amended tailings specimens. An increase in strength of mine tailings amended with fly ash was also observed as a break in slope on a compression curve, which was identified as the breaking stress. The breaking stress increased with an increase in fly ash content, which was attributed to a lower water-to-binder ratio that produced more effective particle bonding.

## the **IMPACT**

Hydraulic conductivity results indicated that curing time had minimal impact on hydraulic conductivity after 7 days of curing, which can shorten test programs on actual projects.

A multivariate regression model was developed to predict unconfined compressive strength of tailings amended with fly ash as a function of (i) tailings water content, (ii) water-to-binder ratio, and (iii) $CaO$-to-$SiO_2$ ratio of fly ash.

Breaking stress in compressibility tests increased with an increase in $CaO$ content and $CaO$-to-$SiO_2$ ratio of fly ash, which resulted in more effective bonding between particles.

An improved understanding of the combined properties of mine waste and fly ash will improve reuse potential of these materials in earthwork construction.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=890


For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.