Enhancing winter mobility of pervious concrete sidewalks, parking lots, and shared-use pathways via incorporation of engineered biochar

Recipient/Grant (Contract) Number: 69A3552348310

Center Name: Pacific Northwest Transportation Consortium (PacTrans)

Research Priority: Improving the Mobility of People and Goods

Principal Investigator(s): Jialuo He (WSU)

Project Partners: N/A

Research Project Funding: $40,000 federal; $40,000 non-federal match

Project Start and End Date: 8/16/2023 – 8/15/2025

Project Description: Pervious concrete pavement is an effective solution for runoff control and stormwater management and is increasingly used for constructing transportation infrastructure (i.e., arterial roads, parking lots, sidewalks, etc.) throughout the state of Washington. In previous PacTrans projects, the evaluation of surface frictional properties showed that pervious concrete had a higher British Pendulum Number than conventional Portland cement concrete under various conditions (i.e., wet, dry, and iced) and a protocol consisting of an image-based porosity characterization method and the Gibbs-Thompson equation was developed for identifying the time of ice formation in pervious concrete to apply timely winter maintenance.

Since pervious concrete has the same constituents as conventional concrete does, the usage of cement in pervious concrete still has a massive carbon footprint. To make pervious concrete environmentally friendly and sustainable, fly ash, a type of supplementary cementitious material (SCMs), was selected to replace the Portland cement partially or fully in pervious concrete. However, there is a huge insufficiency between the limited availability of SCMs (i.e., 1,300 million tons/year) and the required quantity of cement (i.e., 4,600 million tons/year) for the whole world. Therefore, it is urgent to find a new type of SCMs with sustainable sources for the concrete industry. Biochar is a charcoal-like material derived from various biomass and wastes via thermal conversion under oxygen-limited conditions with zero GHG emissions. Previous studies found three advantages of BC in enhancing the quality of concrete [7–14]: 1) improving the formation of Calcium-Silicate-Hydrate (C-S-H) gel and polymerization degree of C-S-H gel by internal curing; 2) providing higher surface area for nucleation and growth of hydration products, with the potential for increased rate of strength gain; and 3) some BC containing high level of amorphous Si for enhancing pozzolanic activity and resulting in the improvement of mechanical strength of concrete.

The overall research goal of this project is to develop carbon-neutral pervious concrete with engineered biochar for application in the Pacific Northwest region. Pacific Northwest especially Washington State is the best ground for the production and use of biochar, with abundant forestry feedstock, diverse agricultural production systems, and strong industrial and academic expertise. This proposed work fits well under the PacTrans thrusts of “Safety and Mobility”, and “Sustainable solution for the diverse

transportation needs of the Pacific Northwest". The results help the State Department of Transportation (DOTs) and other roadway agencies in the region to construct pervious concrete infrastructure with net-zero carbon footprint.

US DOT Priorities: In this project, the carbon-neutral pervious concrete will be developed incorporating engineered biochar. The research results will help to promote the application of pervious concrete with engineered biochar in practice due to its significantly reduced carbon footprint and enhanced durability. From this project, we will develop an effective solution that helps us to improve the mobility of pavements and sidewalks and to deal with stormwater management.

Outputs: This project will produce at least one paper for presentation at the Transportation Research Board (TRB) annual meeting and at least one publication in peer-reviewed journal.

Outcomes/Impacts: The research findings from this project will be widely disseminated. The PI will deliver a presentation at the PacTrans annual meeting and deliver one webinar on behalf of PacTrans to the broader audience. Upon completion of this project, the team will continue to work closely with municipalities and State DOTs to identify opportunities to further improve the carbon-neutral pervious concrete developed in this project.

Final Research Report: *will provide upon completion of the project*