**RELIABILITY-BASED DESIGN OPTIMIZATION OF SEQUENTIAL EXCAVATION METHOD (SEM) OF TUNNELING**

**Grantee:** Colorado School of Mines

**Center Name:** University Transportation Center for Underground Transportation Infrastructure

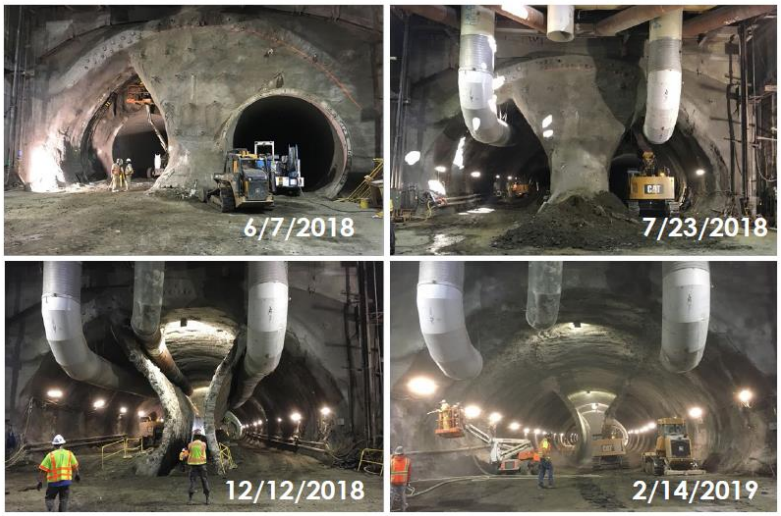
**Research Priority:** Improving the Durability and Extending the Life of Transportation Infrastructure

**Research Project Funding:** $330,000

**Project End Date:** April 30, 2021

**Project Description:** Rapid urbanization is placing huge demands on transportation systems for the improvement of mobility and life quality. To meet these demands, tunnels, particularly those built using mechanized tunneling methods with the help of tunnel boring machines (TBMs), are being widely used. Tunnel construction methods like the sequential excavation method (SEM) are also seeing rapid expansion in urban areas. The goal of this project is to improve the design and construction of urban SEM tunnels by developing a reliability-based design optimization in combination with an observational method that relies on real-time field monitoring of tunnel response during construction.

**Outputs:** The research team has developed a framework for the reliability-based design and construction of SEM tunnels that account for uncertainties in ground parameters and construction variables. To support the reliability-based design framework, a 3D computational technique was established to predict the displacement characteristics of SEM tunnels. The computational technique accounts for the sensitivity of predicted tunnel response to model input parameters and updates the parameter values using a back-analysis procedure that learn from field monitoring data and observations during tunneling. The reliability-based design and construction procedure is a significant improvement of the application of the Load-Resistance Factor Design (LRFD) of SEM tunnels. In collaboration with the Traylor Bros. and Skanska construction companies, the methodology is being tested in the on-going construction of the Los Angeles Regional Connector Transit Corridor (RCTC) Crossover Cavern. A UTC-UTI graduate student was deployed in the site during the construction for this project.



**Sequential excavation method (SEM) applied to the Regional Connector (RCTC) Crossover Cavern (Photo credit: UTC-UTI).**

**Outcomes/Impacts:** The main expected outcome of the research is to improve the design and construction of SEM tunnels with reduced cost, and enhanced safety and reliability. In turn, the impacts of better designed and more economically and safely built tunnels include: 1) Reducing urban traffic congestion and travel times, 2) Reducing fossil fuel use and emissions, 3) Improving land use and development by reducing urban sprawl and traffic noise, and preserving landscape and biodiversity, and 4) Increasing the resilience of communities by providing reliable transport service safe from natural and anthropogenic hazards.