

# Calcined Clays as Alternative Supplementary Cementitious Material and Precursor for Geopolymer Binders in Transportation Infrastructure

**Project Number:**

22CLSU13

**Start Date:**

04/01/2022

**Principal Investigator(s):**

Hassan Noorvand

Louisiana State University

Miladin Radovic

Texas A&M University

**Lead Institution:**

Texas A&M University

**Funding Source(s):**

Tran-SET

Louisiana State University

**Total Project Cost:**

\$ 46,948

*Implementing calcined clays as supplementary cementitious materials*

The use of fly ash in concrete has become a common practice in the US. On the other hand, fly ash has been also used as a key ingredient for geopolymers recently introduced as an ecofriendly and sustainable alternative to ordinary Portland cement (OPC) in concrete. However, the decline in coal-fired power generation and stricter environmental regulations have led to a scarcity of high-quality fly ash in the US and consequently an increase in its price. Calcined clays (CCs) are a promising alternative to fly ash due to their wide local availability. They are rich sources of alumino-silicate species needed for both pozzolanic reaction that takes during the curing of OPC and the geopolymerization reaction. Preliminary results from a previously funded Tran-SET project (20CLSU07) show that several readily available CCs in Region 6 are potentially useful as SCMs in concrete. While preliminary results are promising, further characterization of the CCs and their comprehensive evaluation in concrete is required to develop the necessary engineering knowledge for their use in the field. As a response to the expected shortage of fly ash, the main objective of this project is to evaluate calcined clays (CCs) as a much-needed alternative source for the future of concrete materials for the transportation infrastructure in Region 6. Going beyond the use of CCs as alternative SCMs, the present projects also aims to evaluate the feasibility of using CCs as a precursor for the synthesis of geopolymer binders, which could be used for the production of cost-effective and environmentally friendly geopolymer concrete for the transportation infrastructure in Region 6.

**Problem Statement**

The use of fly ash in concrete has become a common practice in the US. On the other hand, fly ash has been used as a key ingredient for geopolymers that have been recently considered as an eco-friendly and sustainable alternative to ordinary Portland cement in concrete. However, the decline in coal-fired power generation and stricter environmental regulations have led to decreasing supply of high-quality fly ash in the US, and therefore increase of its price. The longterm supply of fly ash is a severe challenge for the

future of concrete materials in the US and must be urgently addressed. Calcined clays (CCs) are a promising alternative to fly ash due to their wide local availability. They are rich sources of alumino-silicate species needed for both pozzolanic reactions during the curing of OPC and geopolymerization reactions. Preliminary results from a previously funded Tran-SET project (20CLSU07) show that several readily available CCs in Region 6 are potentially useful as SCMs in concrete. While preliminary results are promising, further characterization of the CCs and their comprehensive evaluation in concrete is required to develop the necessary engineering knowledge for their use in the field.

**Objectives**

As a response to the expected shortage of fly ash, the main objective of this project is to evaluate locally available calcined clays (CCs) as a much-needed alternative source of SCMs for the future of concrete materials in Region 6. Going beyond the use of CCs as alternative SCMs, the present project also aims to evaluate the feasibility of using CCs as a precursor for the synthesis of geopolymer binders, which could be used for the production of cost-effective and environmentally friendly geopolymer concrete.



**Figure 1. Bridges and pavements build using GPC concrete at Brisbane West Camp Airport, Australia**

## Intended Implementation of Research

**Workforce Development, Education, and Outreach:** This research project will provide funding to a graduate student at Louisiana State University (LSU). This will help recruit and train future leaders in the Transportation Sector specializing in materials for transportation infrastructure. The research team will also prepare educational materials on alternative SCMs to be incorporated in PCC at LSU and share it with other universities. The educational materials will also be summarized and disseminated to government entities and the industry. The results of this work will be also presented and published at national conferences such as TRB and ASCE. This project will offer two internships for undergraduate students to introduce them to research in Transportation and Advanced Materials. Moreover, the developed educational materials prepared in this project will be shared with our partner community colleges to be used to recruit students to the Transportation field. We anticipate to use demonstration materials in multiple K-12 outreach activities traditionally carried out by Women in Materials Science (WiMS) student organization at Texas A&M University.

## Anticipated Impacts/Benefits of Implementation

The outcome of this research project will provide with several fully characterized CCs as alternative SCMs as well as CC-based GP binders that are both cost-effective and readily available. The evaluated CCs and created CC-based GP binders will be available to be implemented in the transportation infrastructure throughout the region as well as in future research projects.

## Web links

- Tran-SET's website  
<https://transet.lsu.edu/research-in-progress/>

## Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

## Learn More

For more information about Tran-SET, please visit [our website](#), LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at [transet@lsu.edu](mailto:transet@lsu.edu).

