# Site -Specific Seismic Ground Motion Analyses for North-east Arkansas

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19GTASU01

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$50,000

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Tran-SET
ArDOT SPR
Nucor

**Total Project Cost:**
$100,015

*Developing seismic and liquefaction hazard maps for northeast Arkansas*

Estimation of liquefaction resistance and shear velocities are key elements in the assessment of potential earthquake damage of existing and new construction sites. Arkansas Department of Transportation (ArDOT) and other agencies in the region need ground motion response analysis (GMRA) data of specific construction sites. As part of a recent ArDOT's Transportation Research Committee (TRC) Project #1603, researchers have surveyed 15 construction sites in northeast Arkansas in the past three years. Another 20 sites are proposed to be surveyed as part of TRC #1901 in the next two years. However, these sites are not enough to cover the entire region. Since site specific GMRA analysis is expensive and time-consuming, the proposed study will use the available data from these sites and develop neural network models to predict earthquake resistance parameters of other locations. Routine soil test data such as standard penetration test (SPT) values available from historical, current, and future construction projects will be used to predict parameters such as liquefaction resistance, peak ground acceleration, and spectrum velocity profiles. Afterward, seismic risk and hazard maps will be developed. Existing literature suggests that the Bayesian analysis-based risk assessment can quantify the uncertainty in a more meaningful way, thus it will be used to develop an alternative decision support tool. Simultaneously, based on uncertainty analysis of GMRA results, standard ground motion prediction equations will be fine-tuned so that they are applicable for regional scales.

## Problem Statement

In the early 1800s, a series of powerful earthquakes in the magnitude around 7.5 rattled the people and establishments in northeast Arkansas. These earthquakes originated in the New Madrid fault zone (NMFZ), which extends from Cairo, Illinois to Marked Tree, Arkansas (Figure 1). This active fault system has high possibilities of generating major earthquakes that can strike the region again. Estimation of shear velocity profiles is a key element in the assessment of sites for potential earthquake ground shaking and damage. According to the AASHTO's seismic design requirements, ArDOT and other agencies in NEA need GMRA for different construction sites, which requires a lot of time. ArDOT has taken some initiatives to analyze the seismic site characteristics of this area. The shear wave velocity profiles of 35 sites available from ArDOT's TRC projects 1603 and 1901 can be used to develop neural network models to estimate share wave velocity profiles (SWVP) of other important locations in the region. To this end, routine soil test data such as SPT values available from historical and ongoing construction projects will be used as predictor variables to predict SWVPs. Seismic site coefficients for developing the design response spectrum of different sites will be estimated using stochastic simulation. Liquefaction potential for important locations will also be estimated used using neural network (NN) modeling works. Additionally, seismic ground motion parameters, liquefaction potentials maps will be updated. Further, the Bayesian analysis-based risk assessment approaches will be followed for the uncertainty analysis. Simultaneously, based on uncertainty analysis of GMRA results, existing standard ground motion prediction equations (GMPEs) will be fine-tuned so that they can be used for the NEA region.

## Objectives

The primary objective of this proposed study is to predict share-wave velocity profiles and seismic site coefficients for various location in NEA. Specific objectives of this study are: (1) collect of shear wave profiling data from previous and current ArDOT projects and nearby states; (2) collect bore log data and penetration test data (e.g., SPT, CPT and/or SCPT) data; (3) predict shear wave velocity profiles, and seismic site coefficients of other significantly important locations within NEA using deep learning approaches; (4) perform uncertainty analysis of soil profile and other seismic parameters; and (5) generate liquefaction and seismic hazard maps after incorporating new analysis results.

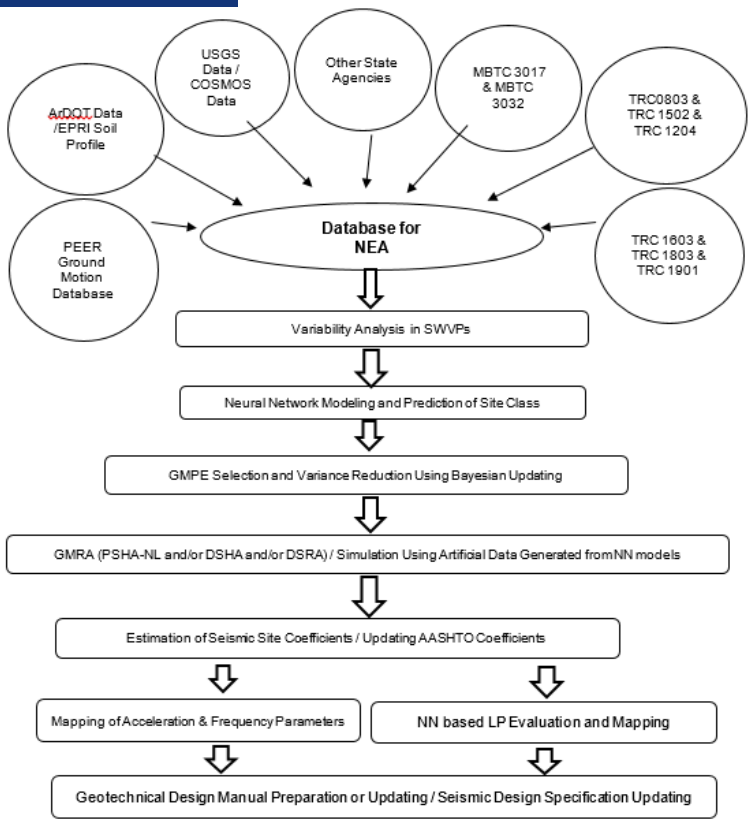


**Figure 1. Data Analysis and Modeling Flow Chart.**

## Intended Implementation of Research

**Workforce Development:** This will be achieved directly by training graduate, undergraduate, and K-12 students interested in pursuing a career in STEM or Transportation Engineering career.

**Education and Outreach:** This task supports the federal initiative to build the next generation of transportation professionals to meet the demands of the rapidly changing 21st-century transportation system. The PI currently supports and mentors five graduate students and three undergraduate students from external grants. The proposed study will help the PI to recruit and train more graduate and undergraduate students in transportation research. The Co-PI teaches Soil Mechanics at undergraduate and graduate levels and plans to develop and deliver a learning module based on the findings of this research for students enrolled in these classes.

## Anticipated Impacts/Benefits of Implementation

Main deliverables from this research project are:

(1) A technical report containing findings, and liquefaction and hazardous maps of northeast Arkansas.

(2) An Implementation report containing major technology transfer initiatives containing at least two presentations to be made annual meetings organized by the ArDOT Technical Research Committee (TRC) and Tran-SET.

The findings of this study will help ArDOT and other industries in the region to use knowledge learned on seismic hazards and liquefaction maps of different soils. It is expected to be a significant cost saving for these agencies in selecting appropriate materials and technologies for transportation infrastructures subjected to a seismic load.

## Web links

- TranSET's website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1642174)

## 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 Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.