Seismic Hazard Analysis for the City of Jonesboro and Surrounding Counties within Northeast Arkansas (NEA)

Project Number:

21GTASU02

Start Date:

08/01/2021

Principal Inverstigator(s):

Zahid Hossain

Arkansas State University

Lead Institution:

Arkansas State University

Funding Source(s):

Tran-SET

Arkansas State University

Total Project Cost:

$ 68,324

Assesing the usefullness of new methodologies in seismic hazard analysis in NEA

Estimation of liquefaction resistance and shear velocities are key elements in the assessment of potential earthquake ground shaking and damage of existing and new construction sites. The 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 recent ARDOT's Transportation Research Committee (TRC) Projects 1603 and 1901, researchers have surveyed 35 construction sites in northeast Arkansas in the last five 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 models to predict earthquake resistance parameters of other locations. The proposed study aims at analyzing 15 critical sites in NEA near the City of Jonesboro. 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

Jonesboro, a city in Craighead County, is located within Northeast Arkansas (NEA). The NEA lies within the Mississippi Embayment (ME) and has a deep deposition of soft soil (ranging from 200m~1000m) overlying the bedrock. Besides, the ME lies within the heart of the New Madrid Seismic Zone (NMSZ) where the demand for seismic hazard analysis is very high. This deep deposition of soft soil overlying bedrock imposes challenges in the evaluation of local site effects during the propagation of earthquake ground motion. Generally, the code-based design procedures such as the American Association of State Highway and Transportation Officials (AASHTO) guidelines do not account for the impact of deep deposited soft soil overlying bedrock. During the propagation of earthquake ground motions, short-period spectral acceleration may be attenuated and long-period spectral acceleration may be amplificated while performing the site-specific ground motion response analysis (SSGMRA), which cannot be anticipated by following the code-based design procedures. Since the impact of deep deposited soft soil overlying bedrock is not accounted for, the code-based approach may lead to over-designing the short-period structures at significant cost and under-designing the long-period structures at significant risk. Therefore, the AASHTO recommends performing SSGMRA if there is a deep deposition of soil overlying bedrock. In recent years, several new bridges have been constructed or proposed by the Arkansas Department of Transportation (ARDOT) in NEA. With this existing vulnerability due to the presence of a nearby active fault and deep deposition of soft soil overlying the bedrock, future investment in the construction or repairment of bridges has become a critical issue. The purpose of this study is to estimate the seismic site coefficient and bring out the usefulness of performing SSGMRA over a code-based approach.

Objectives

The main objective of this study is to bring out the usefulness of performing SSGMRA (site specific ground motion response analysis) over code-based approaches such as AASHTO. Specifics objectives of the current study are given below:

- Collect Shear Wave Velocity Profile (SWVP) data from the previously completed projects within NEA and the ME.
- Gather relevant routine geotechnical properties (unit weight, over

consolidation ratio, angle of friction, plasticity index, etc.) of subsoils.

- Collect and adjust appropriate input earthquake acceleration time histories based upon the target spectrum.
- Simulate the propagation of input ground motions from bedrock to the ground surface using a 1-D site response analysis platform such as DEEPSOIL 7.0 (both EQL and NL), SHAKE2000 (EQL), D-MOD2000 (NL), etc.
- Estimate seismic site factors after developing the DDRS.
- Develop a map/chart of seismic site co-efficient by following AASHTO general procedure.
- Develop a map/chart of seismic site co-efficient by following SSGMRA.
- Develop a map/chart of percent reduction/increase in seismic site co-efficient by following SSGMRA over AASHTO general procedure.
- Update liquefaction hazard maps/charts from the estimated seismic site coefficient i.e. PGA (peak ground acceleration)

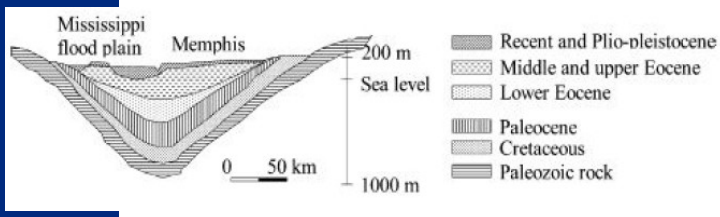

Figure 1: Idealized cross-section of the Mississippi Embayment

Intended Implementation of Research

The findings from this research study will be disseminated at seminars, ARDOT TRC Meetings, Tran-SET Conference, technical papers, and final report. Technical articles, posters, and presentations will be delivered at national and local conferences and symposia such as ASCE, Transportation Research Board, and Create@State.

Anticipated Impacts/Benefits of Implementation

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. The main deliverables of this project are as follows.

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.

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.