EVALUATING DIFFRACTION IMAGING AS AN EFFECTIVE TOOL FOR LEVEE ASSESSMENT

Parsa Bakhtiari Rad[1], Leti, T. Wodajo[1], Craig J. Hickey[1], Md Abdus Samad[1]

1. National Center for Physical Acoustics, University of Mississippi, MS, USA

Abstract

Levee and dam failures due to flooding from hurricanes or heavy rainfalls occur with little early warning and cause catastrophic damages. Excessive and uncontrolled seepage is the second leading cause of dam and levee failure behind overtopping. Thus, it is crucial to identify, localize, and mitigate seepage paths at the early stages before internal erosion is initiated. We present the results of a second study of the Francis Levee site. This site is a Mississippi River levee section in Bolivar County, MS which experienced internal erosion, as evidenced by the formation of three sand boils during the 2011 Mississippi River flooding. In 2012, the University of Mississippi conducted electrical resistivity tomography and traditional seismic refraction tomography surveys on the water and dry side toes of the levees. The data isolated a geomorphologically consistent seepage path responsible for forming the sand boils. An additional inference of this study was that surveys on the levee toes allowed for the zones of interest to be sufficiently shallow to image using tomography. However, the data acquisition was slow, and difficult and there needed to be prior information to determine locations for the geophysical surveys. For this study, a 527 m long seismic data was collected on the crest of the Francis Levee site. The seismic data were collected on the levee's crest to expedite seismic data collection and evaluate if surveys on the crest can be used to identify seepage paths in the foundation. Using this seismic data we present the results of two time-domain seismic processing techniques; traditional reflection processing and advanced diffraction processing. While shallow seismic reflection processing delivers low-resolution but reliable information about the general geometry of the subsurface, seismic diffraction imaging reveals high-resolution information related to sub-wavelength subsurface heterogeneities such as cracks, fractures, gaps, or internal erosion. Such heterogeneities in earthen structures such as dams and levees produce diffractions in seismic sections. The data processing results and obtained seismic sections show good consistency with the older geophysical results, indicating a promising future for applying seismic diffraction processing to assess earthen dams and levees from data collected from the crest.

[The authors acknowledge the support provided by the U.S. Army Engineer Research and Development Center (ERDC) under contract W912HZ24C0005. Permission to publish was granted by the ERDC Geotechnical and Structures Laboratory.]