Florida Department of Transportation Research

Development of a Sinkhole Risk Evaluation Program

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Current Situation

Florida is one of the most sinkhole-active areas in the United States, and sinkholes can sometimes cause severe damage to homes, roads, or other infrastructure. Sinkholes form when groundwater interacts with underlying deposits of soluble, porous, carbonate limestone causing dissolution and creating cavities. Overlying soils begin to fill these cavities in the limestone to produce severe subsidence or collapse of the ground surface. Understanding the potential for sinkhole formation is vitally important.

Research Objectives

University of Central Florida researchers developed an integrated program that can evaluate the level of sinkhole risk and provide guidance to geotechnical engineers for design and remediation projects.

Roadway damaged by a subsidence sinkhole.

Project Activities

The researchers combined geotechnical, hydrogeological, and numerical modeling methods to develop four techniques which can be used individually or in combination to evaluate the risk of sinkhole formation. The researchers applied these techniques at two project sites in Florida.

In the first technique, the researchers monitored groundwater elevations for irregular behavior, which can indicate concentrated groundwater recharge areas that can trigger internal soil erosion (movement of overlying soils into cavities of deeper limestone deposits). This field monitoring program can be used for known high-risk sites for sinkhole activity, especially for new or proposed construction to occur nearby. Data collected can be used to identify potential trouble spots based on groundwater patterns. In addition, these data are required for calibration of the groundwater recharge model (second technique below).

For the second technique, the researchers developed high-resolution groundwater recharge maps. These maps can show areas where there are high levels of recharge occurring. Recharge is the process in which groundwater flows downward though soil layers from surficial aquifers that are close to the ground surface to the much deeper Floridan aquifer system that runs under the entire state. This process is widely accepted as a major cause of sinkhole formation. Once calibrated, the models used to develop these recharge maps can assist in identifying high-risk areas for consideration and planning of future construction projects.

The third technique used the cone penetration test (CPT), a standard geotechnical field test method, to investigate the geological structure of a project site. Using refined analysis methods, the researchers used CPT data to add another dimension to sinkhole risk assessment to identify zones of raveled soils. Researchers developed an index parameter, Sinkhole Resistance Ratio (SRR), that can be used to assess and quantify the risk of surface subsidence from the CPT data.

The fourth analysis technique involved the development of stability charts using numerical modeling. Based on CPT data, these charts provide another estimate of stability of a project site and can be helpful when estimating how additional surface loading caused by future construction may affect site stability.

These four techniques can be used together or separately for site evaluation. The researchers demonstrated their application for two Central Florida sites in Marion County and Lake County.

Project Benefits

Selecting sites or remediating sites to avoid sinkhole damage can prevent costly repair or replacement of roads or other transportation structures.

For more information, please see www.fdot.gov/research/.