Kansas Department of Transportation

TECHNICAL SUMMARY

Capacity of Scour-Damaged Bridges, Part 2: Integrated Analysis Program (IAP)— A Program for the Analysis of Lateral Performance of Pile-Supported Structures under Scour Conditions

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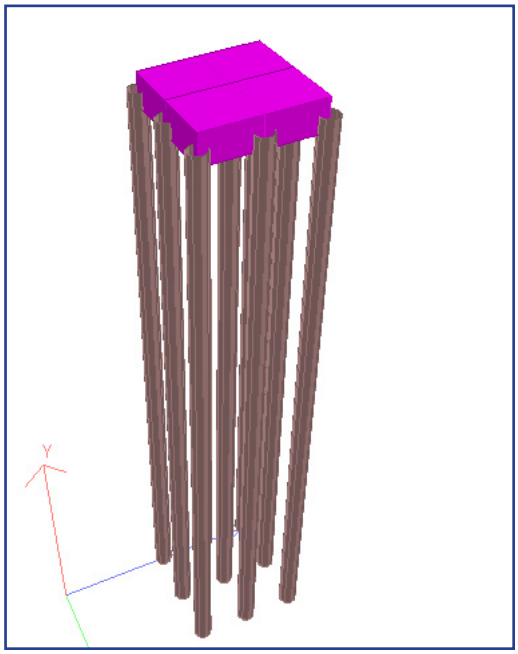
Introduction

Scour is the removal of soils in the vicinity of bridge foundations, resulting in a reduced capacity of the foundations, which can increase the risk of bridge failure. To minimize bridge failure, the Federal Highway Administration (FHWA) has established a requirement that all state highway agencies should evaluate whether bridges in their inventory are scour-susceptible. Accordingly, it is critical that state Departments of Transportation (DOTs) are able to determine quickly and effectively which bridges in their inventories are scour-critical, enabling responsible management of those bridges during and after scour events. It is of importance to identify and explore analytical methods for determining bridge system susceptibility to scour events.

Project Description

To analyze bridge behavior under scour conditions, the bridge should be considered as a whole system including interactions between soil, foundation, and bridge superstructure behavior. To this end, the Integrated Analysis Program (IAP) has been developed; the IAP software is specifically aimed at analyzing lateral behavior of pile-supported bridges under scour conditions. However, the IAP is also able to deal with a variety of other structures (e.g. water/oil tanks, offshore platforms, and buildings) in addition to bridge structures. The IAP consists of two components: the Soil Spring Module (SSM) and the structural analysis software, STAAD.Pro 2007. The purpose of the SSM is to capture the effects of soils that support pile foundations as a series of nonlinear soil springs based on the soil load-displacement curves (i.e. p-y curves). With the seamless link between the SSM and STAAD.Pro 2007 using OpenSTAAD 2.6 functionality, the soil model (expressed as nonlinear soil springs) is successfully integrated with a traditional structural analysis model. In this report, operation of the IAP, technical development, and four examples are presented.

Pile Group Model in STAAD.Pro



Project Results

The first section of this report has been devoted to the operation of the IAP (Chapters 2 and 3). Most of the content of this section is focused on the operation of the SSM, since operation of STAAD.Pro is well-documented in its proprietary user's manual. The description of the operation of the SSM includes topics such as how to retrieve pile parameters from STAAD.Pro, input soil parameters, and how to perform a scour analysis.

The second section of this report presents the technical development of the SSM (Chapters 4 and 5), including descriptions of the p-y curves for different soil types (e.g. sand, soft/stiff clays, and rocks), generation of multilinear soil springs from the p-y curves, and the approximate approach chosen to account for second-order structural stability effects. Methodology for code development is also presented in this section.

Finally, four examples demonstrating use of the IAP are presented in Chapter 6. These examples cover the topics of a laterally loaded single pile, a laterally loaded pile group, an entire bridge, and determining the buckling capacity of a bridge and bridge piles. The step-by-step instruction for each example is shown during the analysis. Results obtained from using the IAP approach for analyzing the laterally loaded single pile and pile group were compared to results obtained from analyses performed using both LPILE and FB-Multiplier, and the calculated results were shown to agree very well. Finally, behavior of an entire bridge was investigated using IAP and a discussion regarding scour effects on the lateral behavior of the bridge and buckling capacity of the bridge and bridge piles has been presented.

Report Information

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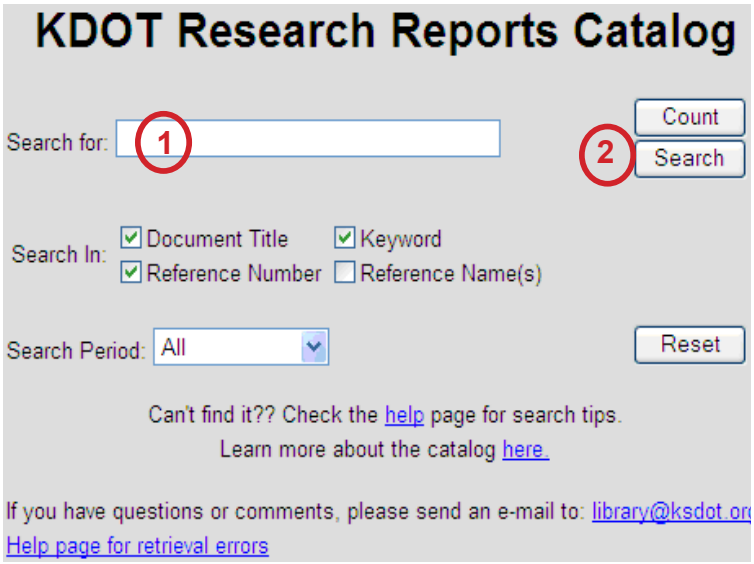

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