Research Project

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Capsule

Technology Transfer Program

LTRC

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Calibration of Resistance Factors Needed in the LRFD Design of Driven Piles

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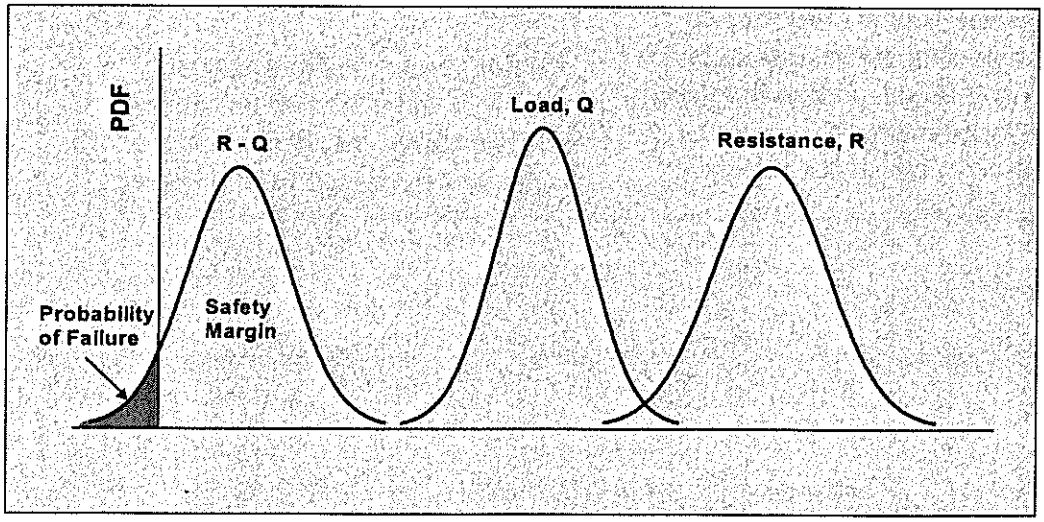
Problem

The allowable stress design (ASD) method has been used for years in the design of bridge superstructures and foundations. The method applies a factor of safety (FS) to account for uncertainties in estimates of applied loads and soil resistance. The magnitude of FS depends on the importance of the structure, the confidence level of the material properties, and the design methodology. In 1994, AASHTO introduced the Load and Resistance Factor Design (LRFD) method for bridge design. In this method, the reliability of estimates for applied loads and resistances are analyzed separately, based on probability of failure.

Currently in Louisiana, bridge superstructures are being designed using the LRFD method, while bridge substructures are designed using the ASD method due to problems associated with LRFD application to foundation design. However, FHWA and AASHTO have set a transition date of October 1, 2007, after which all federally funded new bridges (superstructures and substructures) must be designed using the LRFD method.

AASHTO recommends calibration of resistance factors to produce an overall reliability level that is consistent with local practice. Direct application of AASHTO-recommended resistance factors without



Load and Resistance Factor Design (LRFD) Concept

calibration may result in either overly conservative (costly) design or inadequate (unsafe) design since the recommendations are based on data obtained from sites that are not representative of Louisiana conditions.

Objectives

The purpose of this research is to calibrate resistance factors for both driven piles and drilled shafts based on Louisiana's conditions and experience. For each pile/shaft design method used by Louisiana Department of Transportation and Development, corresponding resistance factors will be developed along with target reliability values and efficiency factors. Procedures for LRFD implementation in Louisiana will also be recommended.

Methodology

A comprehensive literature search will be conducted to collect relevant published work. The review will include current Louisiana methods (static, dynamic, and in-situ) for predicting ultimate bearing capacity of deep foundations and reliability-based methods for the calibration of resistance factors.

The state of practice from other state DOTs will also be researched.

A database will be compiled and a data management framework will be developed to facilitate evaluation of LRFD parameters. LADOTD files will be searched to collect pile load test reports for identification and analysis of soil properties and in-situ data obtained near the piles. To be included in the database, a pile must have been loaded to failure during the static load test. The data will be sub-grouped according to properties such as pile type, geographic location, and predominant soil type.

Pile capacity will be determined from the load-settlement curve using the Davison method and Butler-Hoy method. LADOTD static analysis will be used to estimate the pile capacity from soil borings. The "Louisiana Pile Design by CPT" software will be used to facilitate the prediction of pile capacity from CPT measurements. Pile capacity predictions using dynamic analyses will also be collected.

All pile design methods currently used by LADOTD will be calibrated. The values for ultimate pile capacity determined from pile load tests and predicted using different design methods will be entered into the statistical database for use during reliability analysis.

Target reliability indices will be evaluated based on implied levels of uncertainty in current Louisiana design practice. Based on the selected target reliability levels and current reliability theory, resistance factors for the different design methods and means to evaluate their efficiency will be recommended.

Implementation Potential

Resistance factors will be recommended for implementation in the design of new driven piles and drilled shafts. To assess feasibility and costs/benefits of implementation, resultant designs will be compared to designs obtained from AASHTO LRFD specifications and ASD procedures.