MONTANA Department of Transportation
Research

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Implementation Report
FHWA/MT-23-003/9630-628

CONCRETE-FILLED STEEL TUBE TO CONCRETE PILE CAP CONNECTIONS - FURTHER EVALUATION/IMPROVEMENT OF ANALYSIS/DESIGN METHODOLOGIES

https://www.mdt.mt.gov/research/projects/structures/seismic.aspx

More Info:

The research is documented in Report FHWA/MT-23-003/9630-628

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Introduction and Purpose

The Montana Department of Transportation (MDT) has found concrete-filled steel tube (CFST) piles connected at the top by a concrete pile cap to be a very cost-effective support system for short and medium span bridges.

This type of system offers low initial cost, short construction time, low maintenance requirements, and a long service life. While the gravity load performance of these systems is well understood, their strength and ductility under extreme lateral loads (e.g., seismic events) is more difficult to reliably predict using conventional design procedures.

The primary objectives of this research were to (a) further validate/improve MDT's CFST to concrete pile cap connection design/analysis methodologies, (b) ensure the efficacy of these methodologies for a wide variety of potential design configurations, (c) gain further insights on the basic connection behavior under extreme lateral loads, and (d) determine possible improvements in the design methodology.

Implementation Summary

The research involved a comprehensive literature review and an experimental program with four specimens designed to test various configurations and material strengths. The first specimen was a half-size model that provided continuity between previous tests and this test series. The subsequent tests were 2/3rd-size specimens that varied concrete strength and reinforcing scheme. The final specimen included U-bars to assess their impact. These tests revealed that (1) scale did not alter the observed failure mechanisms, (2) a linear relationship existed between concrete strength and ultimate capacity of the cap, and (3) U-bars significantly enhanced cap capacity. Despite the moment-rotation methodology being generally accurate, it needs refinement for better prediction in varied conditions.

This research significantly advances the understanding of CFST to concrete pile cap connections, providing validated methodologies and practical recommendations for future implementations. The proposed enhancements and standardizations aim to improve the design, construction, and performance of bridges utilizing this system, particularly under seismic loading conditions.

Implementation Recommendations

Based on the research findings, the following recommendations are proposed:

1. Refinement of Prediction Methodology: Enhance the moment-rotation prediction methodology, particularly addressing the effects of U-bars and global flexural failures. This includes refining the model to account for the role of longitudinal reinforcement and potentially applying to a larger dataset of test results conducted outside of MSU.
2. Development of User-Friendly Software: Create a simplified and accessible interface for the methodology's software, making it easier for engineering practitioners to use.
3. Standardized Design Details: Develop standardized design details for CFST pile cap connections under predefined conditions, such as seismic activity and bridge geometry. This will ensure consistency and reliability in construction.

MDT RESPONSE:

MDT recognizes the potential benefit of the proposed recommendations, which may be addressed by MDT in-house, or through a collaboration between MDT and MSU in a future research project.