Texas Department of Transportation

CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY REPORT

0-7117: Strut-and-Tie Method for Reinforced Concrete Members with Cold Joints

Background

Cold joints frequently occur in reinforced concrete structures. However, current design provisions offer limited guidance for assessing their effect on load transfer and failure mechanisms, particularly when cold joints intersect critical load paths in disturbed regions. To address this technical gap, the Texas Department of Transportation (TxDOT) initiated Project 0-7117 to investigate the effect of cold joints on the behavior of reinforced concrete structures. The project aimed to develop design guidelines by integrating interface shear behavior of cold joints into the strut-and-tie design framework, explicitly focusing on evaluating the strength of struts intersecting by cold joints.

What the Researchers Did

The research team adopted a comprehensive approach that combined experimental investigations with advanced analytical techniques, as presented in Figure 1. The research began with a comprehensive literature review and industrial survey to investigate the behavior of cold joints and identify key design parameters. These findings informed the development of experimental program with practical and representative design configurations and influential parameters.

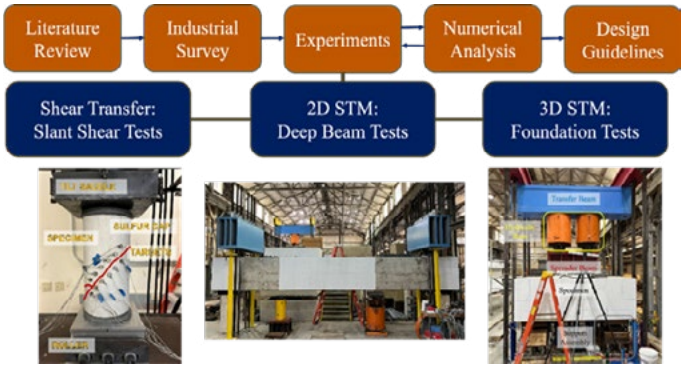

Figure 1. Research approach for Project 0-7117

Comprehensive experimental investigations were conducted, including 54 small-scale slant shear experiments, 4 slant shear column tests, 10 deep beam experiments and 1 drilled-shaft footing experiment. These experiments facilitate the assessment of the cold joint effect on structures performance with various critical design parameters. Finite element models were developed to simulate the behavior of structures with cold joints. Based on these experimental and numerical findings, an analytical approach and detailed design guidelines were proposed, offering practical recommendations accounting for the interface shear behavior of cold joints within the strut-and-tie modeling framework.

What They Found

The The researchers identified the interface roughness, aggregate size and interface reinforcement as the most influential variables affecting the shear capacity of cold joints. A modified design expression was proposed to account for all levels of interface

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Project Completed:
06-30-2025

roughness by linear interpolating interface shear factors based on the roughening amplitudes. The deep beam experiments revealed that cold joints without roughening or intersecting reinforcement were found to significantly reduce the shear capacity. For deep beams and drilled-shaft footing governed by cold joint failure, significant ductility and discontinuity in shear cracks were observed along the cold joints, confirming that the effect of cold joint is comparable in both two- and three-dimensional structural systems. The experimental findings informed the development of detailed design recommendations based on the load transfer mechanisms and potential failure patterns within a single-panel strut-and-tie model incorporating cold joints, as presented in Figure 2. This proposed method accurately predicted the failure mechanism and provided reasonably conservative estimates of shear capacity for deep beams with cold joints.

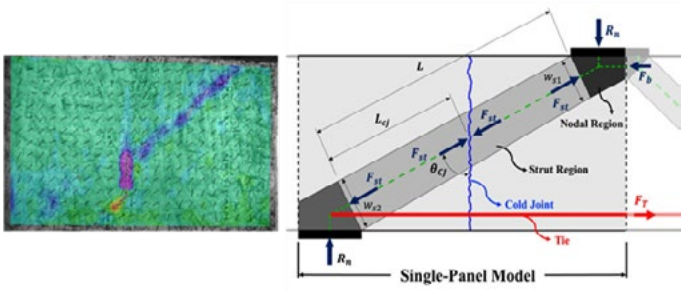

Figure 2. Experimentally inspired load transfer model

What This Means

TxDOT Project 0-7117 marks a significant advancement in understanding the structural implications of cold joints. The proposed analytical approach provides a reliable and practical framework for assessing structures with cold joints. The proposed approach allows for the consideration of the shear contribution from the cold joints, potentially reducing the costs for structural retrofit and avoiding unnecessary reconstruction if the existing capacity is deemed adequate. By integrating experimental results with analytical models, the project has bridged the gap between empirical data and design methodologies, supporting both practical implementations and further research on cold joint behavior across various structural systems.

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www.txdot.gov
Keyword: Research

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