Texas Department of Transportation

CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY REPORT

0-7089: Develop and Validate Precast Column Solutions for Texas Bridges

Background

The Texas Department of Transportation (TxDOT) initiated Project 0-7089 to explore the potential of using precast bridge substructures, particularly focusing on precast column solutions for multi- column bents. The project aimed to address the challenges and benefits associated with precast columns, which are known to expedite construction processes but face constraints such as lifting weight and transportation difficulties. The goal was to develop innovative design concepts and construction details that would make precast columns more practical and efficient for use in Texas bridges.

What the Researchers Did

The research team undertook a comprehensive approach that combined experimental investigations with advanced analytical techniques. They began with an extensive review of past studies and successful implementations of precast columns, identifying knowledge gaps and opportunities for innovation. Building on this foundation, the team developed new design concepts for precast concrete columns, arriving at a system that consists of a precast prestressed shell filled with cast-in-place (CIP) concrete and steel reinforcing bar connectors for bent caps and footings. The system eases shipment and almost eliminates field formwork, saving time and effort considerably.

Comprehensive experimental investigations were carried out, including 27 push-off tests to study interface shear strength between precast elements and CIP cores, exploring various surface preparations and concrete types to ensure optimal composite action. The research team also evaluated the structural performance and constructability of the proposed precast column systems through large-scale laboratory tests. The experimental program included one control specimen based on current TxDOT standard and four test specimens based on the developed system, assisting in understanding the behavior of the system under realistic conditions.

Additionally, the research included the development of finite element models to simulate the performance of the precast columns and their connections. These models were validated against experimental results and used to conduct parametric studies, providing deeper insights into the factors affecting the performance of the precast systems. Based on these experimental and analytical findings, detailed design guidelines for implementing precast columns in Texas bridges were developed, offering practical recommendations for dimensions, reinforcement, connections, and construction practices.

Research Performed by:
Center for Transportation Research

Research Supervisor:
Dr. Oguzhan Bayrak, CTR

Researchers:
Emmanuel Montero-Carvajal
Chakravarthi Kotha
Luke Small
Lucas Zilveti
Chunsuk Park
Hansol Jang
Elias Saqan
Zach Webb
Hwa-Ching Wang
Juan Murcia-Delso

Project Completed:
08-31-2024

What They Found

The researchers discovered that circular interfaces between precast and CIP elements showed higher shear strength compared to square interfaces, with modest surface roughening significantly increasing interface strength. Hybrid precast prestressed columns with a CIP core proved viable without altering existing mix designs, which is beneficial for implementation. The research provided comprehensive data on unreinforced core-shell concrete interfaces.

The effectiveness of the developed precast column solution was confirmed. The experimental results indicated that precast columns demonstrated greater stiffness and capacity at low and high eccentricities compared to control specimens, which is a positive indicator for their use in real-world applications, given sufficient embedment length of connectors is provided. It was also indicated that proper vibration at the column base is crucial to prevent voids, especially as column height increases. Finite element analysis played a crucial role in this project. The developed models accurately mirrored experimental behavior, enhancing the understanding of the performance of the developed precast column solution.

These findings led to the development of efficient hybrid precast column system designs and detailing recommendations. A robust analytical method for estimating the capacity of the developed precast column system was proposed, expanding structural designers' toolbox.

What This Means

The research has substantial implications for the future of bridge construction in Texas. The findings emphasize the benefits of using hybrid precast systems, which can significantly reduce installation time and costs while maintaining structural performance. The detailed design guidelines and innovative construction techniques developed through this project provide a comprehensive framework for implementing precast columns, ensuring better performance and durability, and setting new standards for future precast column applications. By integrating experimental results with analytical models, the project has bridged the gap between theory and practice, supporting both practical applications and further research in the field of precast concrete technology.

TxDOT Project 0-7089 has made significant strides in advancing the use of precast bridge substructures in Texas. The project's comprehensive approach and robust findings pave the way for more efficient, durable, and practical bridge construction methods, ultimately enhancing the state's infrastructure resilience and performance.

For More Information

Project Manager:
Jade Adediwura, RTI (512) 486-5061

Research Supervisor:
Oguzhan Bayrak, CTR (512) 965-2875

Project Monitoring Committee Members:
Jonathan Boleware, Graham Bettis and David Fish

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research

Technical reports when published are available at **https://library.ctr.utexas.edu.**

This research was sponsored by the Texas Department of Transportation and the Federal Highway Administration. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented here. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product endorsement.