



## 0-6978: Synthesis of Precast Column Designs for Texas Bridges

### Background

Using prefabricated bridge elements and systems minimizes on-site operations and closure times during bridge construction and contributes to improving durability and reducing the environmental impact of construction. Prefabrication of bridge columns has been very limited as compared to bridge superstructures and bent caps. Nevertheless, some states have started to develop and implement design concepts for precast concrete columns.

This synthesis project evaluated the state of the art of national research and construction projects involving precast columns for bridges, pursuing these objectives: (a) review and synthesize published literature and current DOT practice on precast columns, (b) compile lessons learned from previous projects and studies, (c) evaluate the suitability of existing precast column solutions for Texas bridges, and (d) determine criteria for the selection of precast columns over conventional cast-in-place (CIP) solutions for Texas bridges.

### What the Researchers Did

The CTR team conducted the following tasks:

1. *Review and synthesis of published literature:* The researchers conducted a comprehensive review of literature on precast bridge columns, including previous research studies and projects, and guidelines for design and construction.
2. *Survey and synthesis of current DOT practice:* The researchers conducted a survey to identify and characterize current experience of state DOTs with precast bridge columns. In all, 39 of 50 state DOTs responded (78% response rate). Figure 1 provides a sample of the survey results.
3. *Evaluation of existing precast column systems:* The researchers evaluated different precast column systems and connections details, considering aspects such as fabrication, construction, and durability. This evaluation yielded some recommendations for Texas implementation, informed by lessons learned in national practice and input from industry experts in Texas.

### What They Found

This project evaluated a variety of precast bridge column systems:

- *Full-height precast reinforced concrete columns:* The system uses a full-height column designed and detailed like CIP columns. While the most practical system, its application may be limited by column weight and erection equipment capacity.
- *Precast segmental column:* The system comprises precast column segments joined together through post-tensioning or grouted splice couplers. For some bridge projects, this is the only feasible system due to the height (weight) of the piers.
- *Precast column shell:* Used in one Texas bridge project, this system comprises a precast shell filled with CIP concrete; it can be used to reduce the weight of the precast column element(s).

Summarized here are some of the conclusions and recommendations regarding the design, construction, and connection of precast column systems:

- *Size and shape of the column:* A way to optimize the use of precast columns is to limit their weight (or that of the column segments) to the maximum weight of the precast elements in the superstructure. This will allow the contractor to use the same lifting equipment for the erection of the superstructure and substructure. In terms of shape, cross-sections with straight faces are preferred over circular geometries due to ease of fabrication and transportation.

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- *Connection details:* A critical aspect of the design and construction of precast column systems is the connection between the column and adjacent members, and between column segments in segmental columns. For the column to bent cap connection, connection details currently used for precast bent caps and CIP columns—grouted ducts and pocket connections—can also be used with precast columns. Post-tensioned joints have a well-established record of use and good performance to connect column elements in segmental systems. Finally, pocket and socket connections, rebars extended into corrugated grouted ducts, and grouted sleeve splice couplers can be used to connect precast columns to footings.
- *Criteria for selecting precast columns over CIP columns:* No state DOT is using specific criteria for selecting precast columns over conventional CIP systems. The research team recommends the *Framework for Prefabricated Bridge Elements and*

*Systems Decision-Making of the Federal Highway Administration* as a decision-making tool.

- *Future research:* The authors recommended further investigation of some technical gaps and challenges affecting the implementation of precast column systems, as detailed in the full report (0-6978-1).

### What This Means

The project findings can help TxDOT implement precast column systems in bridge projects. Some systems can be directly implemented based on previous U.S. experiences, while other systems will require further investigation. The research team encourages the engineering community to raise awareness about the benefits and lessons learned from using precast columns in other states. With the engagement of industry, TxDOT can also execute demonstration projects to help develop standards and allow more effective use of precast columns.



Figure 1: Number of bridge projects involving precast columns (per state)

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