Bridge Deck Overhang Construction:

A Precast Concrete Solution

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An experimental investigation was conducted at the Ferguson Structural Engineering Laboratory at the University of Texas at Austin to evaluate conventional bridge deck overhang construction practice and develop a simpler, precast concrete solution. This article provides a summary of the precast concrete bridge deck overhang system developed by the authors.[1,2] (For another precast concrete overhang construction method, see the Concrete Bridge Technology article "Precast Concrete Overhang Panels for Safer and Faster Bridge Deck Construction" in the Fall 2017 issue of *ASPIRE*®.)

Context

The overhang construction method discussed in this article has been developed and tested as part of the master's research of the primary author, supervised by the second author. The authors do not know if the concept, or its variants, have been implemented in practice. Implementation of the concept will likely result in further refinements. It is the hope of the authors that dissemination of this concept will help its consideration by the industry.

Advantages and Disadvantages

To illustrate the potential benefits of a precast concrete deck overhang system, the advantages and disadvantages of the precast concrete solution and the conventional cast-in-place deck approach that is supported by overhang brackets are outlined. The conventional, overhang bracket system referred to in this article is the system of bridge deck overhang brackets and embedded hangers, as shown in Fig. 1, that support the deck forms, screed rail, and walkway. The proposed system involving a precast concrete deck overhang solution, also shown in Fig. 1, is described in detail in this article. The precast concrete deck overhang solution presented herein serves as stay-in-place formwork and is part of the deck overhang for structural purposes.

Advantages of current overhang construction technique:

- Contractor flexibility: The bracket system allows for last-minute changes at the bridge site to the overhang design, and the casting profile can be adjusted as needed to fit the specified profile.
- Current practice: The system is in use today and has been for decades.

Disadvantages of current overhang construction technique:

- Time: Installation and disassembly of overhang brackets are time-consuming. The time required to adjust the brackets and to construct the form overhang at the bridge site is significant.
- Cost and safety: The system demands significant resources for formwork, crane time, and possibly a form-stripping buggy. Brackets and non-reusable embedded hangers are costly, and the labor costs of installation, forming, and disassembly are also substantial. In cases where a bridge is constructed over traffic, safety is an issue.
- Reduced stiffness: Overhang brackets and formwork can undergo noticeable deflections during placement of deck concrete that may lead to an uneven finished surface, especially if the overhang brackets slip as they engage to support the deck concrete.
- Screed rail movement during concrete placement: The authors of the paper are aware of cases in which the screed rail that supports the bridge paver moved due to overhang bracket slip.

Advantages of precast concrete deck overhang system:

- Cost: The new construction technique will likely lead to a more efficient, and ultimately cheaper, construction process and result in a more economical bridge. A similar economy was achieved when the use of partial-depth precast concrete stay-in-place deck panels was first implemented.
- Stiffness: Because the precast concrete overhang is a very stiff element and will not deflect significantly during the finishing process, it will lead to a smooth riding surface. Bracket slip problems are eliminated.
- Time: Eliminating the need for assembly and disassembly of overhang brackets and wooden formwork greatly reduces the onsite time required to construct the bridge deck and eliminates safety concerns when working over traffic.

Disadvantages of precast concrete deck overhang system:

- New concept: As with any new procedure in construction, the refinement and optimization of the process will involve a learning curve.
- Planning time: Because a portion of the overhang may be constructed at the fabrication yard, certain characteristics of the bridge geometry must be determined with enough lead time to be applied in the fabrication yard.

Overview of Proposed Procedure

Figure 2 shows the recommended steps of the precast concrete solution from girder fabrication to the completed bridge. The procedure is:

1. During the casting of the fascia girder, add supplementary reinforcement (L-shaped bar shown in Fig. 2) for the precast concrete overhang during the casting of the fascia girder.
2. After prestress transfer and prior to girder erection, move girders and form a 4-in.-thick concrete overhang on the fascia girders.

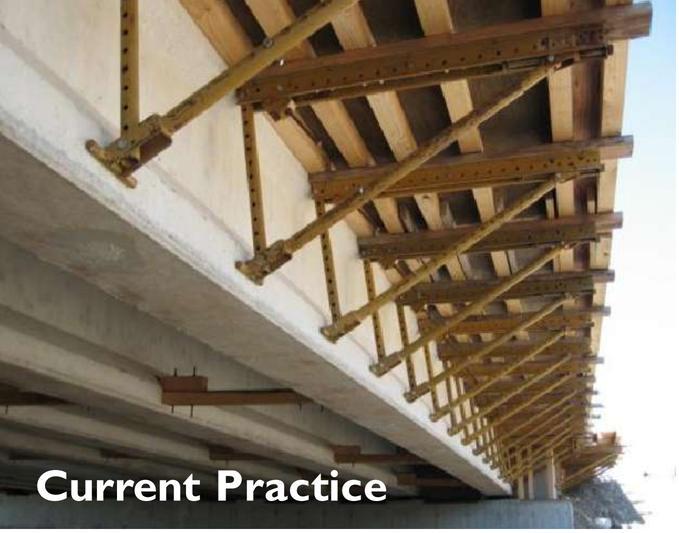

Figure 1. The current deck overhang bracket system and the proposed precast concrete overhang system.. All Figures and Photos: Sean P. Clifton.

3. Cast a 4-in.-thick concrete overhang on the fascia girders. The precast concrete overhang is an eccentric load that creates stability challenges in lifting, transportation, and erection; however, methods exist to address these challenges.
4. Install the work platform.
5. Install the screed rail.
6. Install side forms and the forming system for other bays of the bridge.
7. Place cast-in-place concrete deck.
8. Construct bridge rail.

Load Testing

To verify the strength and stiffness of the precast concrete overhang, two sets of directly comparable tests were performed on a 70-in.-deep I-beam specimen (Tx70) fabricated in the laboratory. To balance the load applied to the precast concrete overhang, standard overhang brackets were attached to the inside of the fascia girder and loaded simultaneously with the precast concrete overhang. Figure 3 shows the test setup. On the precast concrete overhang, two 3 x 3 x ¾ in. plates placed 6 in. from the overhang edge and 36 in. apart were used as loading points.

In both tests, the precast concrete overhang cracked under a vertical load of approximately 6300 lb per load point (a total of 12,600 lb on the precast concrete overhang). The overhang cracked at the location where the 4-in.-thick overhang meets the top flange of the girder, which is 21 in. from the overhang edge. While the precast concrete overhang was shown to be very robust, cracking in the overhang is undesirable during construction, and the cracking load is therefore the design limit state. Cracking is important because the stiffness of the precast concrete overhang lessens after the formation of flexural cracks. Using conservative load estimates for typical construction loads, a design margin factor of approximately 2 was determined to prevent cracking and should be used to prevent cracking of the precast concrete overhang during construction.

Loading the test girder on both the precast concrete overhang and the overhang

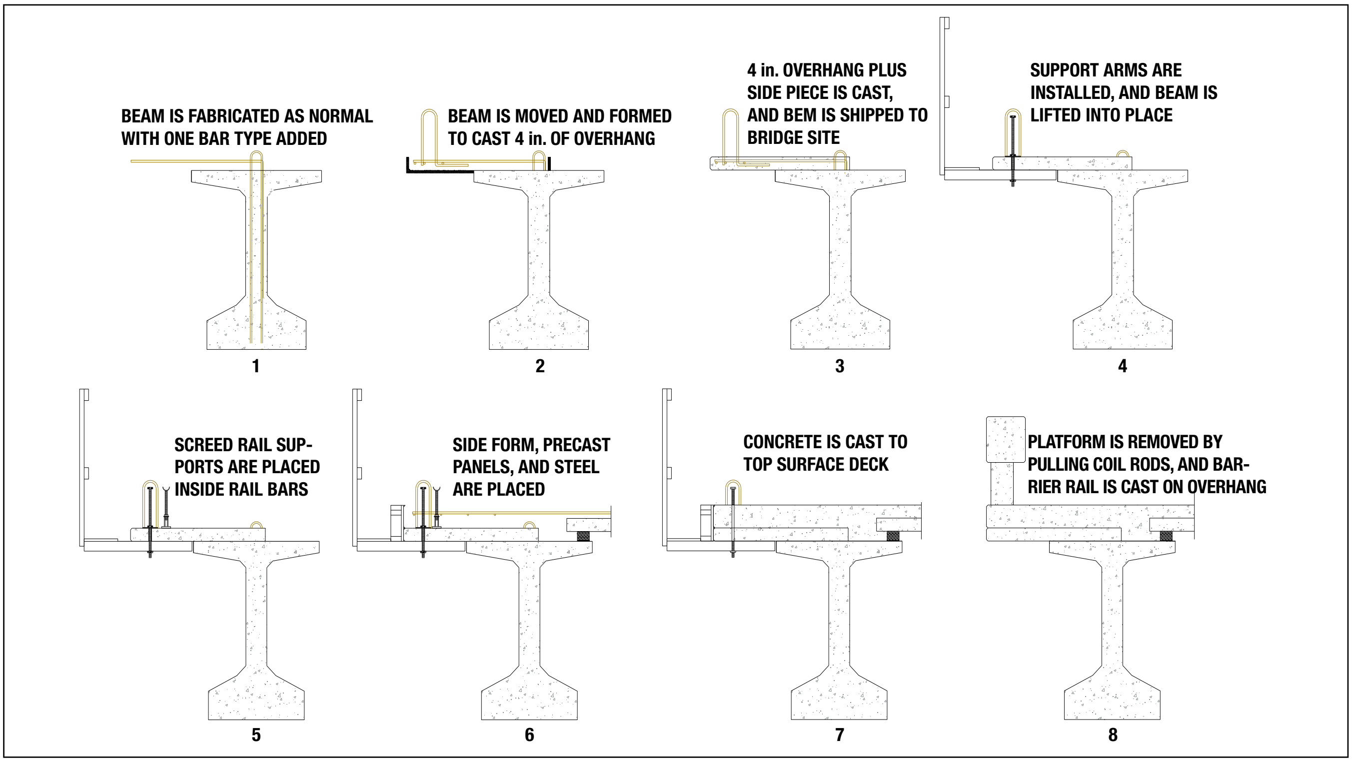

Figure 2. Steps in constructing the precast deck overhang and the remainder of the bridge.

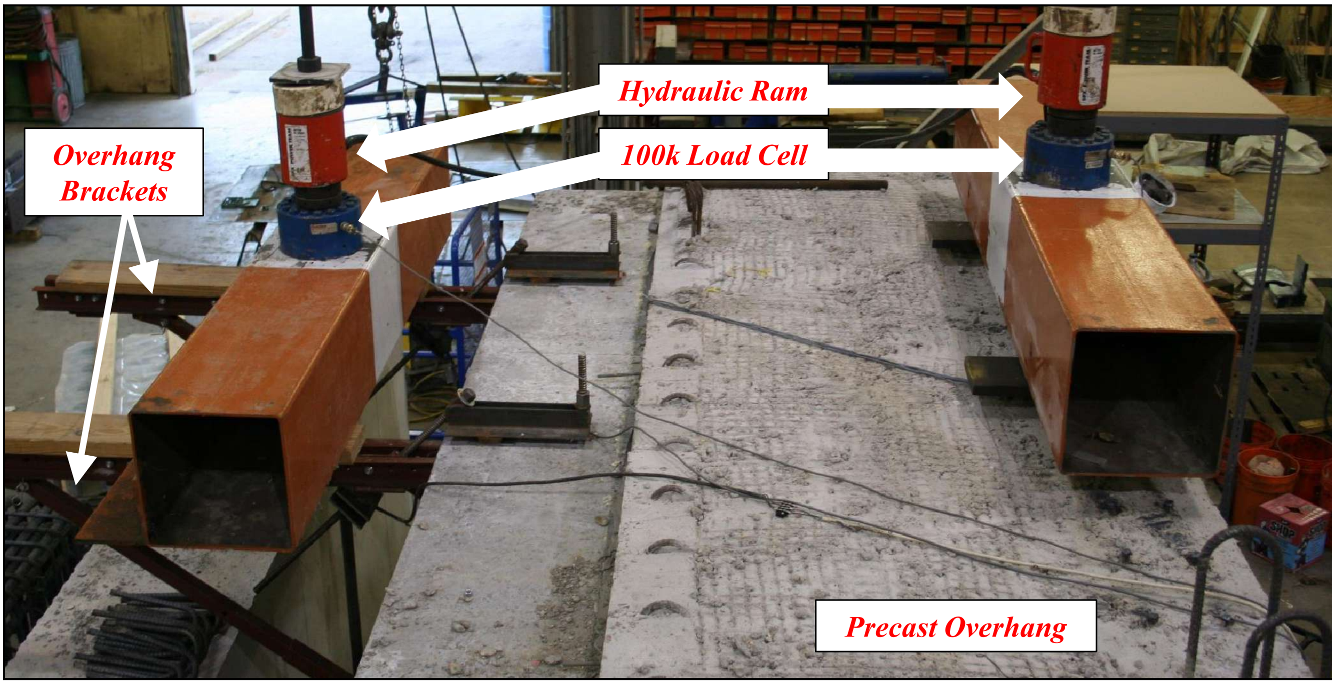

Figure 3. Setup for testing

brackets allowed for a direct comparison of the stiffness of the two systems. String potentiometers were used to measure deflections directly beneath the load points on each side of the girder.

Figure 4 illustrates the significant difference in stiffness of the precast concrete overhang compared to the overhang bracket system. The deflection of the bracket system at the load point is more than five times the deflection of the precast concrete overhang. The overhang brackets tested were also significantly stiffer than other, previously tested brackets.[1] Hence, for the specimens tested in this study, it can be concluded that, on average, the precast concrete overhang was at least five times stiffer than the tested bracket system.

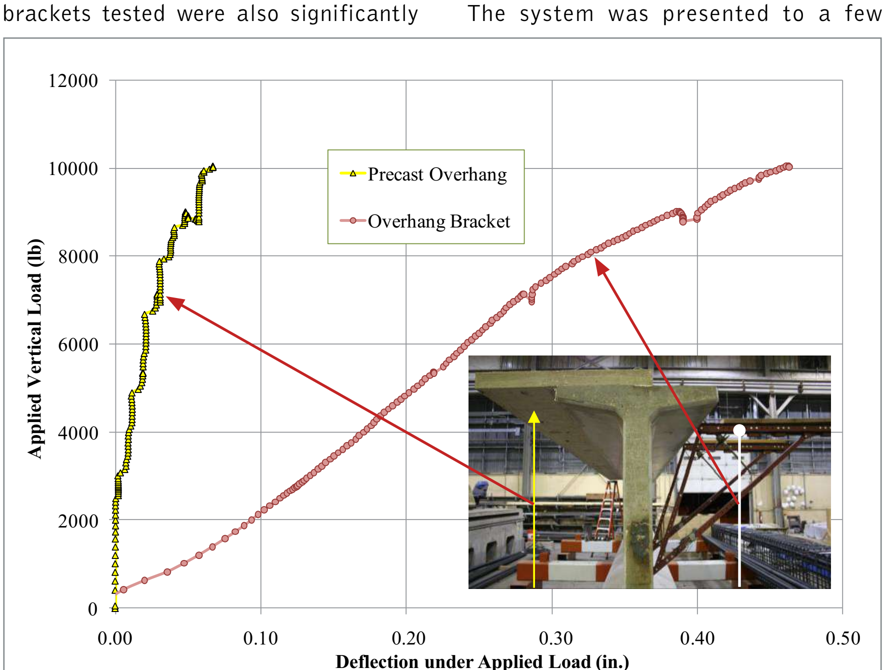

Figure 4. Load versus deflection comparison of the two deck overhang systems.[2] The yellow arrow in the photo corresponds to the location where the precast overhang deflections were measured. The white line in the photo corresponds to the location where the overhang bracket deflections were measured.

Summary

A precast concrete deck overhang system was developed during the course of this study[1,2]. Its feasibility was investigated by building a full-scale mock-up in the laboratory and load testing the specimen. The system was presented to a few precast concrete producers and several general contractors. While some concerns and recommendations were expressed by some of the contractors, most favorably received the concept of a new precast concrete deck overhang alternative.

Acknowledgments

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