Section shapes for precast short-span ultra-high-performance concrete bridges

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- This paper introduces redesigned short-span bridge superstructure sections using ultra-high-performance concrete (UHPC).
- Optimized UHPC section shapes derived from conventional short-span bridge types are presented and practical span ranges for each are identified.
- Sample design aids for modified UHPC box beams illustrate achievable span lengths and required prestressing strand areas.
- The advantages of UHPC over conventional concrete are demonstrated through hypothetical bridge design case studies.

There are many advantages to using ultra-high-performance concrete (UHPC) primary structural components. UHPC structural components can be optimized to be significantly lighter than conventional concrete section shapes, making them easier to transport and erect. Wider components may also be possible, which would decrease the number of connections between elements and decrease the number of crane lifts during erection, though the practical width of components may be bounded by the limitations of transportation. UHPC structural components can be designed to be stronger than conventional concrete components, allowing for shallower sections, longer spans, and wider girder spacing. Longer spans can facilitate the removal of intermediate piers on multispan bridges. Wider girder spacing and shallower optimized section shapes can create significantly lighter superstructures, which decreases the demand on the substructure. Shallower section depths can increase the overhead clearance for intersecting features. UHPC structural components can be designed with an integral deck, eliminating the need for a separate cast-in-place concrete deck, which facilitates accelerated bridge construction. UHPC structural components are expected to be significantly more durable than conventional concrete or steel structural components, extending the service lives of bridge superstructures by reducing maintenance demands over the lives of the structures.

Short simple-span bridges are likely an early entry point for UHPC primary structural components for several reasons. Short-span bridges make up the largest portion of the national bridge inventory. As of December 2025, approximately 94% of the current inventory has a maximum span length of less than 125 ft (38.1 m).[1,2] Many of these short-span bridges are past their original design lives and in need of rehabilitation or replacement. Of the bridges in the national bridge inventory with a maximum span length less than 125 ft, more than 41% are more than 50 years old, approximately 10% have an operating rating factor less than 1.0, and approximately 4% have a superstructure condition rating of poor or worse.[1]

Engaging innovative technologies for construction is less risky for short-span bridges than for bridges with longer spans. A large portion of the short-span bridge inventory has a low average daily traffic (ADT) count. These low-ADT bridges are typically at lower risk for implementing new technologies. Shorter span bridges are also typically less expensive and can be constructed faster than longer span bridges. Additionally, beams used for short-span bridges can possibly be cast using a single mix from the precaster's batch plant or ready-mix trucks, reducing the risk for the precaster.

To help facilitate the use of UHPC primary structural components for short-span bridges, this paper provides design aids and tables for several different section shape families and presents several hypothetical case studies to illustrate some of the advantages of using UHPC primary structural components over comparable conventional concrete systems.[1] Key concepts and results are included herein, while a greater depth of coverage can be found in the Federal Highway Administration (FHWA) report, *Section Shapes for Short-Span Bridges*.[1]

Section shape development for spans less than 125 ft

Using existing conventional concrete section shapes as a starting point can be beneficial when developing optimized UHPC section shapes. Precast concrete producers likely already have forms for existing shapes; therefore, there would be reduced upfront formwork costs if the same forms can be used for UHPC section shapes. In addition, engineers, contractors, and owners would already have some familiarity with existing section shape families, which should decrease perceived risk.

Section shapes optimized for use with conventional concrete are widely used for short-span bridges. The four section shapes that were investigated in this study are the solid slab, voided slab, box beam, and northeast extreme tee (NEXT) D beam (**Fig. 1**). These sections can vary from 12 to 42 in. (305 to 1067 mm) deep, can be used in an adjacent beam configuration with or without a cast-in-place deck, and can span up to 120 ft (36.6 m) (based on available design aids).[3,4,5] These conventional concrete section shapes were used as a starting point for the optimized UHPC section shapes discussed herein.

Several factors need to be considered when optimizing a section shape for UHPC. The increased strength and durability of UHPC allows for thinner flanges and webs; however, there are limits to the acceptable thinness of these components, based on the following factors:

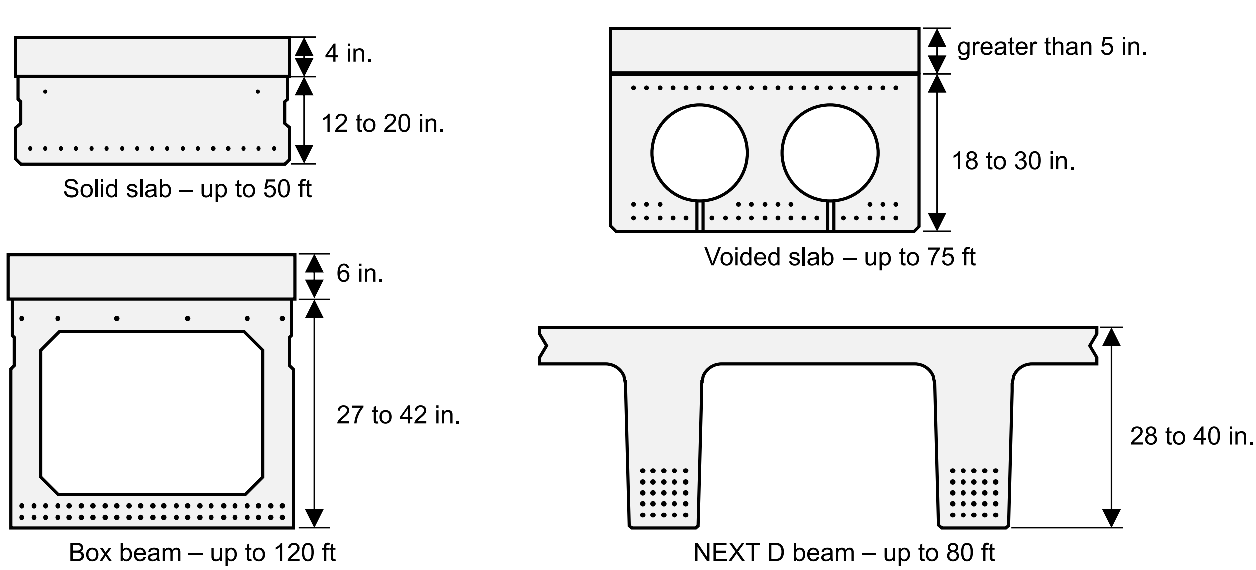

Figure 1. Four common sections for short-span bridges using conventional concrete. Note: NEXT = Northeast extreme tee. 1 in. = 25.4 mm; 1 ft = 0.305 m.

- Cover specifications: The American Association of State Highway and Transportation Officials (AASHTO) *Guide Specifications for Structural Design with Ultra-High Performance Concrete*[6] specifies a minimum cover of the greater of 1.5 times the fiber length or 0.75 in. (19 mm) (see article 10.1). AASHTO's UHPC Guide is not regulatory, and its use is not required under federal law. The cover specification is 0.75 in. for the most common 0.5 in. (13 mm) long steel fibers. The cover specification may control the minimum thickness of webs and top and bottom flanges.

- Design considerations for top flanges: If the top flange of a UHPC structural component is used as the riding surface for a short-span bridge without a composite deck, the minimum top-flange thickness should be determined considering transverse flexure between supporting webs and punching shear caused by a wheel load on the top flange. Previously constructed UHPC sections have used approximately 4 in. (102 mm) thick top flanges with spacing between webs from 43.5 to 50.5 in. (1.10 to 1.28 m).[1]

- Stability considerations: UHPC primary structural components will likely be more slender than similar-depth conventional concrete elements, which may lead to stability concerns. UHPC primary structural components have been constructed and tested with webs as thin as 3 in. (76 mm).[7] This may be a reasonable minimum thickness without considering a specialized stability analysis.

- Constructibility and tolerances: The component should still be constructible and have reasonable allowable tolerances for section geometry (including the location of internal voids) and reinforcement location. Reasonable tolerances should be considered with the minimum cover specifications and other considerations discussed in the previous bullet points.

- Casting volume: It may be advantageous to design initial projects to use UHPC structural components that can be constructed with a single batch of UHPC. For example, if a precast concrete producer can comfortably mix and place 10 yd^3 (7.6 m^3) of UHPC, it would be advantageous to design a UHPC component that requires less than 10 yd^3 of material.

The four conventional concrete shapes shown in Fig. 1 were starting points for optimizations based on these considerations. **Figure 2** shows a comparison of the original conventional concrete 39 in. (990 mm) deep (AASHTO BIII-48) box beam section shape, the area removed as part of the UHPC optimization process, and the related final UHPC section shape used in the analyses.

Figure 3 shows the optimized UHPC section shapes for the four different section shape families used in the analyses performed for this effort. The modified solid slab is similar to the UHPC three-ribbed deck panels used for the Bricker Road Bridge replacement.[8] The UHPC modified voided slab and modified box beams have similar exterior geometry to Washington State Department of Transportation voided slab shapes[5] and AASHTO box beam shapes,[3] respectively, with larger void inserts to decrease the thickness of the webs and top and bottom flanges. In addition, the modified UHPC voided slabs and box beams do not need a cast-in-place composite deck. The modified NEXT D beam section is similar to the pi-girder developed as part of an FHWA research effort[9] and used on the Jakway Park Bridge in Iowa.[10] The modified NEXT D beam could be constructed using a blockout on the side of the webs in the existing NEXT D beam forms that can be released from the outside of the form to allow the beam to still be lifted out of the forms.

Transverse reinforcement will be needed in the top flange of the different sections to facilitate the connection of adjacent

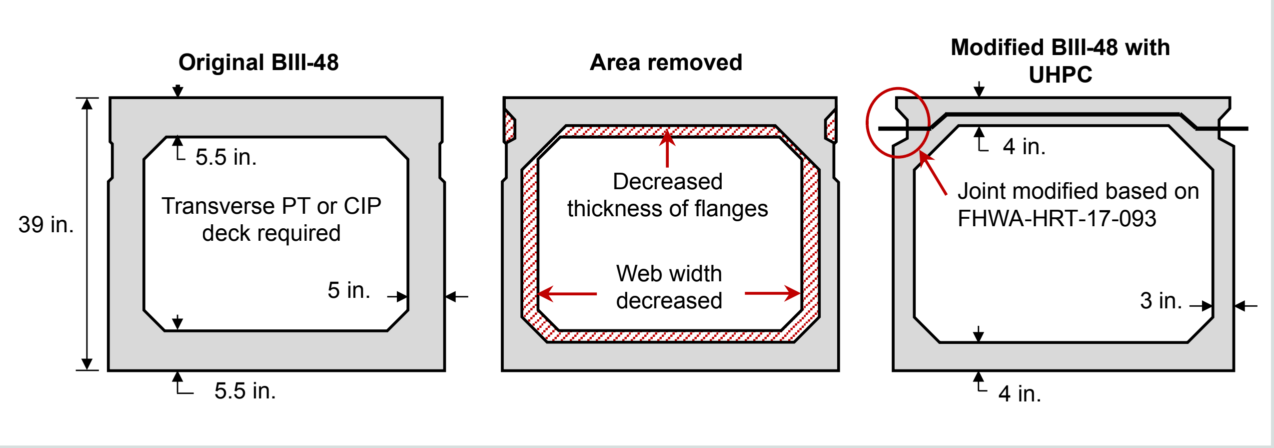

Figure 2. Example of section optimization for BIII-48 box beam from the existing section shape for conventional concrete to a possible section using ultra-high-performance concrete (UHPC). Source: Adapted from Yuan et al. (2018). Note: CIP = cast-in-place; FHWA-HRT-17-093 = *Adjacent Box Beam Connections: Performance and Optimization*; PT = post-tensioning. 1 in. = 25.4 mm.

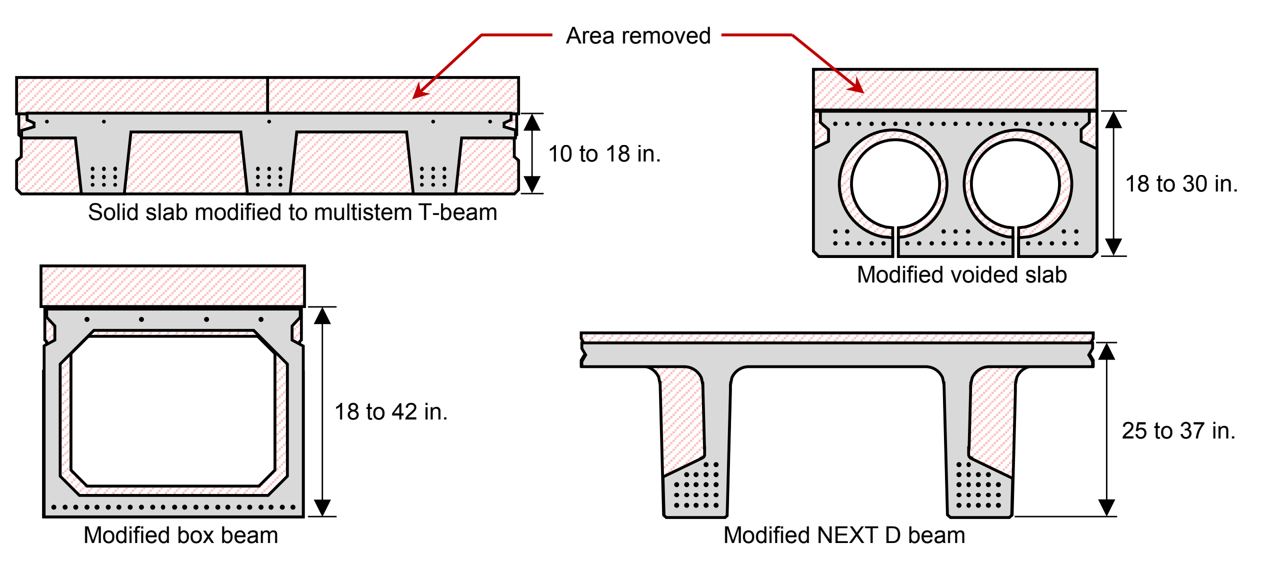

Figure 3. Modified ultra-high-performance concrete section shapes investigated. Note: NEXT = northeast extreme tee. 1 in. = 25.4 mm.

beams and provide the transverse flexural reinforcement for the deck. A transverse deck design like the one described by Aaleti et al.,[11] updated to use the AASHTO UHPC guide,[6] could be performed to proportion the transverse reinforcement. It may be reasonable to relax the service and cyclic strain and stress checks for the deck design; however, a full discussion on this is outside the scope of this paper.

Design considerations for UHPC primary structural components

The design process for UHPC primary structural components is similar to that for conventional concrete components (which are designed by calculating service, fatigue, and strength limit state checks) using the AASHTO UHPC guide[6] and the *AASHTO LRFD Bridge Design Specifications*.[12] The AASHTO LRFD specifications is an enforceable regulatory standard under 23 Code of Federal Regulations 625.4(d)(1)(v). Garber et al.[13] provide more details on the general design procedure for UHPC primary structural components.

The following checks may control the design of UHPC primary structural components used for short-span bridges:

- Transfer stress at top of beam at transfer length: Similar to a conventional concrete pretensioned component, the stresses in the top of a UHPC pretensioned component at the time of prestress transfer may exceed the allowable stresses at transfer at the beams' ends. The tensile stresses at transfer should be limited to $\gamma_u f_{t,cri}$ per AASHTO UHPC guide article 5.2.1.3a, where γ_u is a reduction factor to account for the variability in the UHPC tensile stress parameters and $f_{t,cri}$ is the effective cracking strength for UHPC at time of transfer.
- Service stress in extreme tension fiber: Stress in the extreme tension fiber should be limited to $\gamma_u f_{t,cr}$ per AASHTO UHPC guide article 5.2.1.3b, where $f_{t,cr}$ is the effective cracking strength for UHPC. This stress limit is tightened to $0.95\gamma_u f_{t,cr}$ in article 5.2.3 of the AASHTO UHPC guide for components subjected to cyclic stresses, which applies to bridge beam elements. The Service I load combination, according to the AASHTO LRFD specifications article 3.4.1, should be used to check the stresses in components subjected to cyclic stresses. This design check may control the total area of prestressing strands necessary or the depth of section needed for longer spans, depending on the properties of the UHPC.
- Minimum flexural reinforcement: The minimum amount of flexural reinforcement is specified in AASHTO UHPC guide article 6.3.3. This design check may control the number of strands necessary for shorter spans within a possible span range for a section. Nonprestressed reinforcement may be added instead of additional prestressing strands to satisfy this requirement.
- Nominal flexural resistance: The nominal flexural resistance calculated using AASHTO UHPC guide article 6.3.2 must be greater than the demand calculated using the Strength I load combination from AASHTO LRFD specifications article 3.4.1. Calculate the nominal flexural resistance using the strain compatibility procedure. This design check may control the total area of prestressing strands necessary or the depth of section needed for most designs, depending on the properties of the UHPC.
- Optional live load deflection criteria: AASHTO LRFD specifications article 2.5.2.6.2 provides an optional live

load deflection check, where the live load deflection is calculated using AASHTO LRFD specifications article 3.6.1.3.2. UHPC structural elements can be shallower than conventional concrete elements for similar span lengths, which means that this deflection criteria may control for longer spans within a possible span range for a section.

- Nominal shear resistance: The nominal shear resistance calculated using AASHTO UHPC guide article 7.3 must be greater than the demand calculated using the Strength I load combination from AASHTO LRFD specifications article 3.4.1. This design check may show that transverse reinforcement is necessary for sections with narrower single webs; however, many UHPC primary structural components used for short-span bridges will not need any transverse shear reinforcement.

The aspect of design that controls the section depth and prestressing will depend on the UHPC material properties and section shape. Further details on how varying the UHPC material properties affect the design of UHPC primary structural components are provided in Garber et al.[1]

Sample design aids for short-span UHPC bridges

The authors completed the design of the primary structural components for over 200 different bridge design configurations with different span lengths and section shapes. **Figure 4** shows the typical bridge cross-section configuration used for all of the analyses. This configuration is similar to example 9.4 from the *PCI Bridge Design Manual*.[3] The same UHPC material properties were used for all design configurations as follows:

- compressive strength f'_c of 17.5 ksi (121 MPa)
- effective cracking strength $f_{t,cr}$ of 1.0 ksi (6.9 MPa)
- crack localization strength $f_{t,loc}$ of 1.0 ksi
- crack localization strain $\varepsilon_{t,loc}$ of 0.0035
- tensile reduction factor γ_u of 1.0.

Additional details on the designs performed can be found in Garber et al.[1]

Figure 5 shows practical span lengths for using UHPC multistem T beams, modified voided slab beams, modified box beams, and modified NEXT D beams. Based on the completed designs, the modified NEXT D beam is a reasonable solution for short spans with approximately 30 to 85 ft (9.1 to 25.9 m) span lengths. The modified voided slab is a reasonable solution for spans up to approximately 90 ft (27.4 m). The modified box beam is a reasonable solution for spans up to approximately 125 ft (38.1 m). The multistem T beam is a reasonable solution for spans up to approximately 35 ft (10.7 m).

Practical span lengths are shown in Fig. 5, both with and without considering the AASHTO LRFD specifications live load deflection criteria. Gross section properties were used with the calculated modulus of elasticity associated with a compressive strength of 17.5 ksi (121 MPa) to calculate the live load deflections. Longer span lengths should be possible while still meeting the deflection criteria if transformed section properties are used or if the modulus of elasticity of higher-strength UHPC is used in the live load deflection calculations. Deflections are closely related to the frequency of the bridge and comfort to pedestrians. Longer spans exceeding live load deflection limits may be checked against fundamental frequency limits in AASHTO's *LRFD Guide Specifications for the Design of Pedestrian Bridges*.[14] Exceeding live load deflection criteria may also lead to larger camber variations and differential camber between members. These factors should be considered when evaluating whether to exceed the live load deflection criteria.

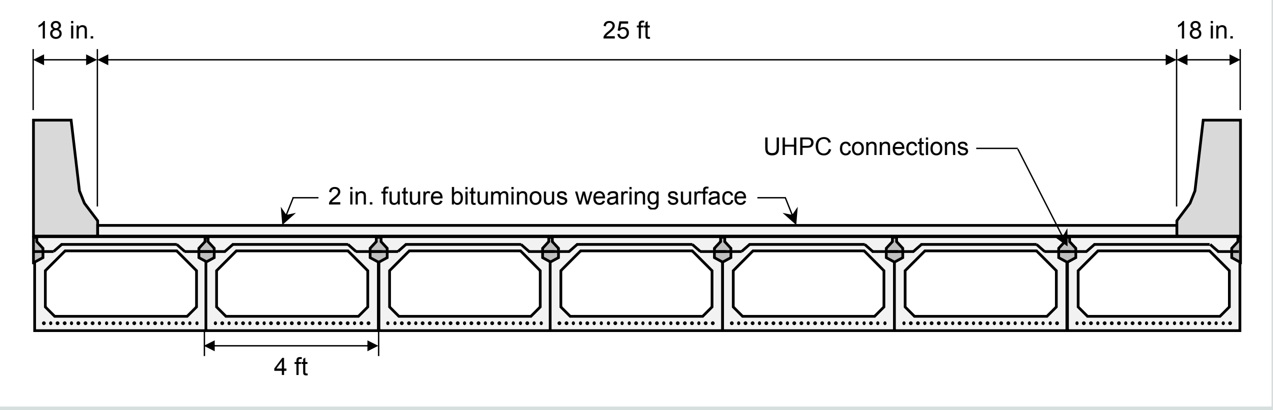

Figure 4. Typical bridge cross section for the configuration used to develop design tables and design aids. Note: UHPC = ultra-high-performance concrete. 1 in. = 25.4 mm; 1 ft = 0.305 m.

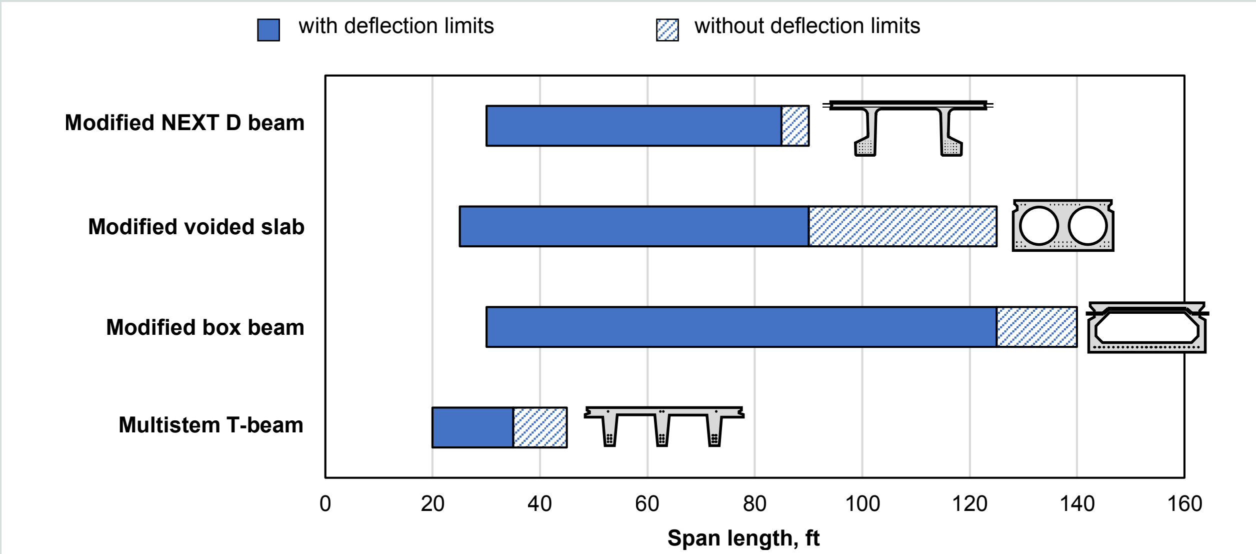

Figure 5. Practical span length ranges for ultra-high-performance-concrete multistem T beams, modified voided slab beams, modified box beams, and modified NEXT D beams. Note: NEXT = northeast extreme tee. 1 ft = 0.305 m.

Additional design resources were created for each of the cross-section families. **Figure 6** shows the practical span ranges for UHPC-modified box beam sections with depths *h* ranging from 18 to 42 in. (457 to 1067 mm) in an adjacent beam configuration without a cast-in-place deck. The practical span ranges are shown for designs both with and without consideration of the AASHTO LRFD specifications optional live load deflection criteria. Two box beam sections with depths shallower than the 27 in. (690 mm) deep, AASHTO BI-48 box beam were included in these designs to show the possible span ranges for these sections.

Figure 7 shows the required area of prestressing steel versus span length for the six different UHPC modified box beam sections. This design aid could be used to preliminarily select the amount of prestressing steel necessary for a known span length and section shape. Design aids like those shown in Fig. 6 and Fig. 7 were also developed for multistem T beams and modified NEXT D beams.[1]

Complete design tables are provided in Garber et al.[1] for multistem T beams, modified box beams, and modified NEXT D beams. The following parameters are provided for

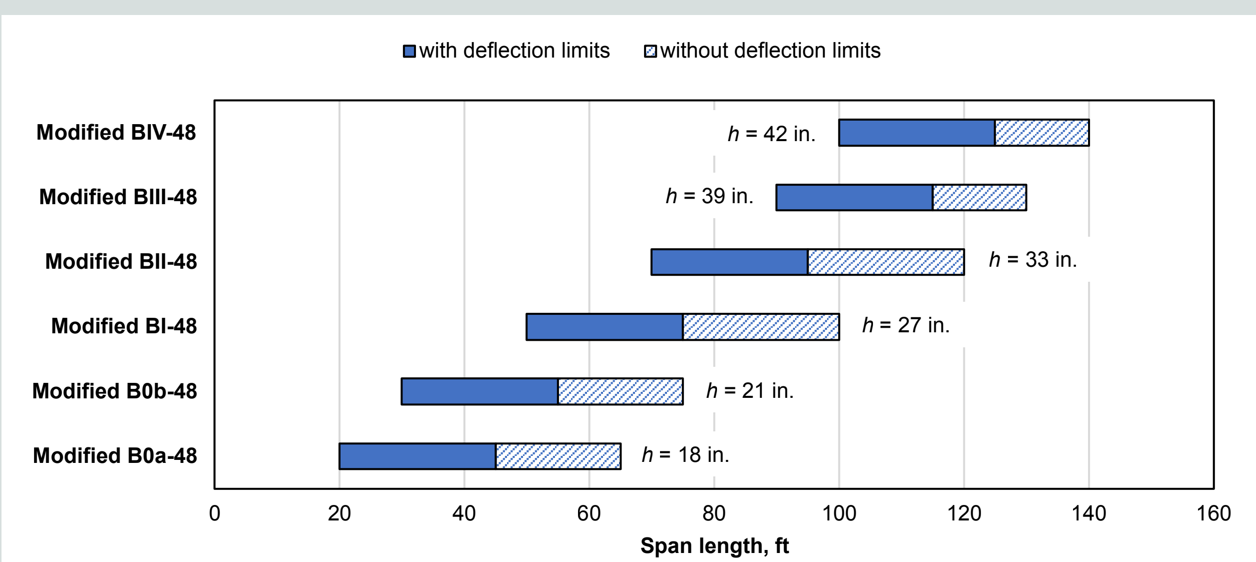

Figure 6. Practical span ranges for ultra-high-performance-concrete box beam series. Note: *h* = section height. 1 in. = 25.4 mm; 1 ft = 0.305 m.

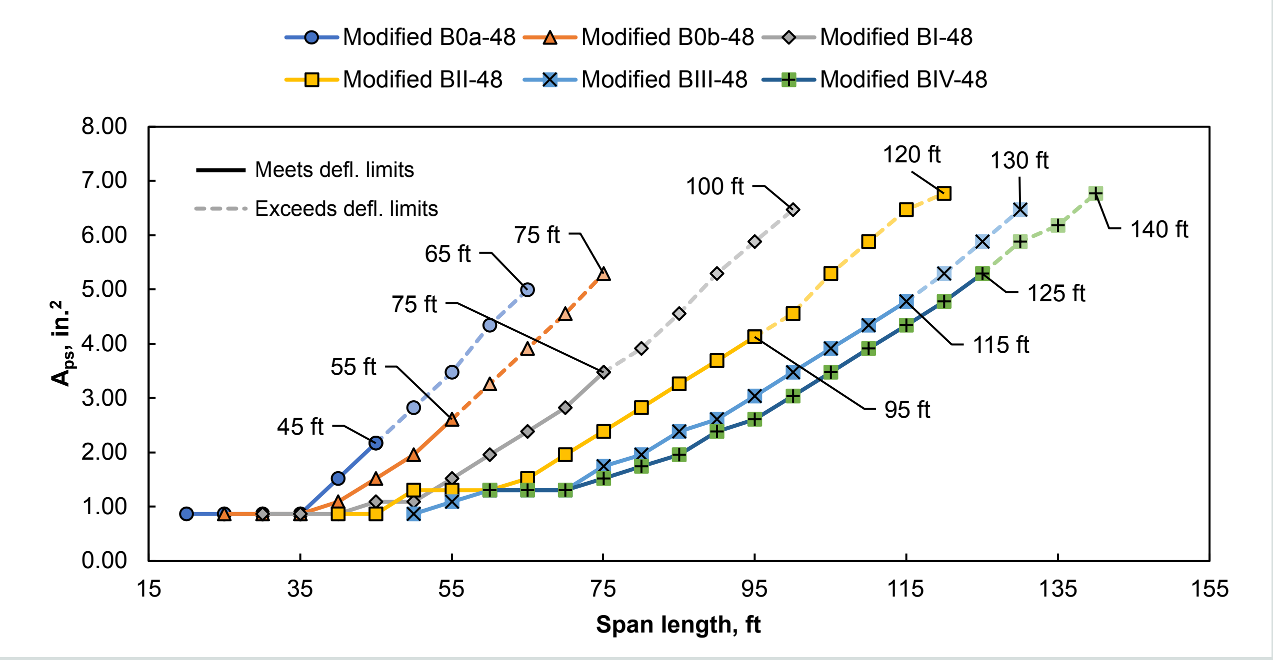

Figure 7. Required prestressing steel versus span length for modified ultra-high-performance-concrete box beam series. Note: A_{ps} = required area of prestressing steel; defl. = deflection. 1 ft = 0.305 m; 1 in.² = 645 mm².

each section shape, section depth, and span length investigated:

- total area of prestressing steel required for design
- stress in extreme tension face at midspan due to Service I loading (to compare against cyclic stress limits)
- stress in extreme compression face at midspan due to Service I loading
- factored flexural demand at midspan
- factored flexural resistance at midspan
- cracking moment at midspan
- long-term deflection due to sustained loads
- maximum live load deflection used for optional live load deflection check
- the controlling aspect of the design

Sample case studies of short-span bridges with UHPC primary structural components

Hypothetical case studies were developed to demonstrate some of the advantages that UHPC short-span primary structural components may offer over conventional concrete solutions. These case studies were based on hypothetical bridges that are representative of many bridges found in the national bridge inventory. The design aids developed as part of this study[1] formed the basis for the UHPC designs, while the design aids provided in the *PCI Bridge Design Manual*[3] formed the basis for the conventional concrete designs.

The first hypothetical case study was a single 120 ft (36.6 m) span for a bridge slated for replacement. **Figure 8** shows the elevation of the existing bridge in the case study, which had a low overhead clearance (14 ft 6 in. [4.42 m]) and an existing superstructure depth (deck and girder) of 58 in. (1.47 m). The superstructure was in poor condition, but the substructure was generally in good condition. However, the substructure was designed using older design specifications and would not meet design criteria for new construction in the AASHTO LRFD specifications[12] considering the design loads.

Adjacent box beams were considered for the new bridge because they would enable an accelerated construction schedule and a decreased superstructure depth, resulting in increased overhead clearance for the highway under the bridge. **Figure 9** shows the two designs that were considered. The conventional concrete box beam design is based on the *PCI Bridge Design Manual*[3] preliminary design example 2. The UHPC box beam design is based on the design tables in Garber et al.[1] While both designs use a 42 in. (1.07 m) deep section, the conventional concrete design needs a 6 in. (152 mm) composite cast-in-place deck. On the other hand, the UHPC design features an optimized section shape (approximately 28% lighter than the conventional concrete section alone) and eliminates the need for the cast-in-place deck, resulting in an overall superstructure that is 6 in. shal-

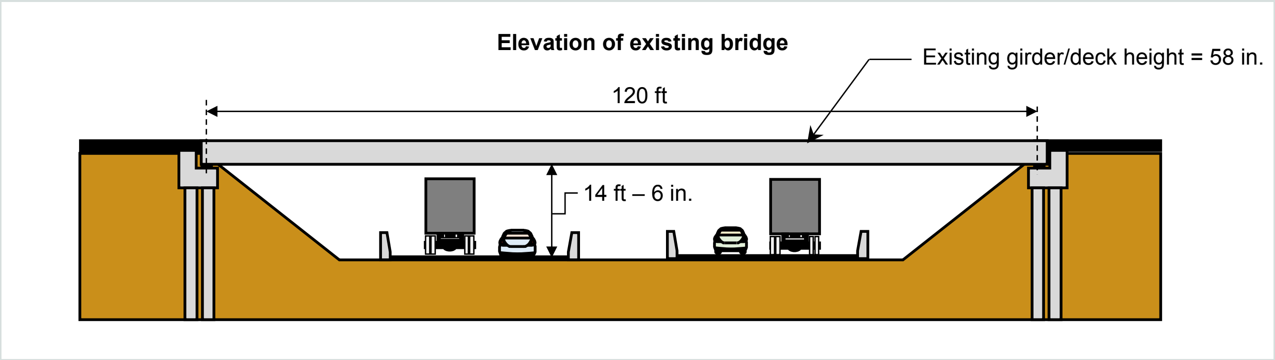

Figure 8. Elevation of the existing bridge replaced in case study 1. Note: 1 in. = 25.4 mm; 1 ft = 0.305 m.

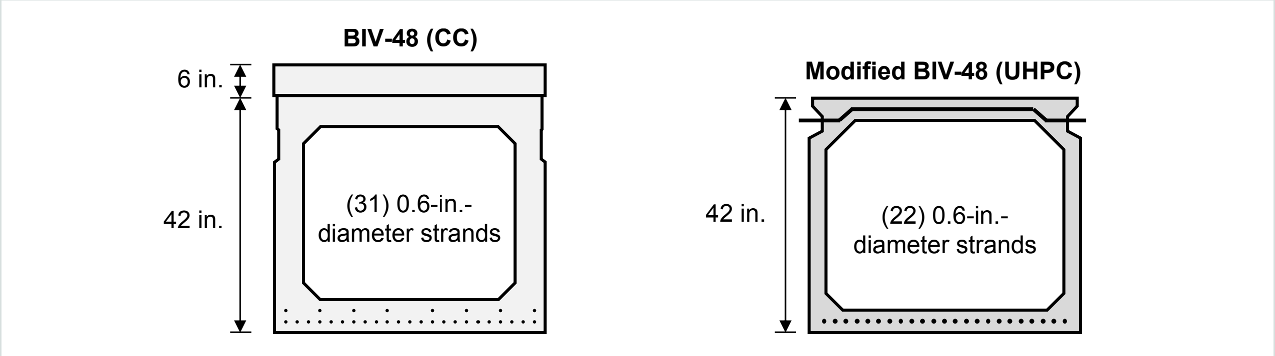

Figure 9. Design options for case study 1 using conventional and ultra-high-performance-concrete box beams. Note: CC = convention concrete; UHPC = ultra-high-performance concrete. 1 in. = 25.4 mm.

lower and 41% lighter. **Table 1** shows more details on the composite height and weight of both design options.

The UHPC box beam option would offer several advantages over conventional concrete design:

- Overhead clearance: The original overhead clearance (14 ft 6 in. [4.42 m]) is less than the typically desired overhead clearance (16 ft [4.88 m]), creating a risk of accidents involving vehicles striking the low bridge. Both the conventional concrete and UHPC design options would improve the overhead clearance compared with the existing superstructure. Using the UHPC superstructure would allow for an increase in overhead clearance to 16 ft (4.88 m) without the need to raise the grade of the existing bridge. While the grade would not need to be altered, the use of shallower UHPC beams would necessitate raising the beam seats at the abutment by 18 in. (460 mm) if the substructure was to be reused.

- Possible reuse of substructure: If the existing substructure was in good condition, but did not meet the design

Table 1. Superstructure weight for a 120 ft span with conventional concrete and ultra-high-performance-concrete adjacent box beams

Material	h_c, in.	w_g,* kip/ft	W_{beam},† kip	W_{bridge},‡ kip
Conventional concrete	48	1.178	142.5	1925
Ultra-high-performance concrete	42	0.676	81.8	1136

* Weight includes the cast-in-place concrete deck for the conventional concrete design.

† Weight of a single beam, including the cast-in-place concrete deck for the conventional concrete design.

‡ Total weight of superstructure, including the barrier weight.

Note: h_c = composite section height; w_g = unit weight of beam; W_{beam} = total beam weight; W_{bridge} = total weight of superstructure (including barrier weight). 1 in. = 25.4 mm; 1 kip = 4.448 kN; 1 kip/ft = 14.593 kN/m.

criteria based on the AASHTO LRFD specifications.[12] The use of the UHPC primary structural components would result in a superstructure that is 789 kip (3510 kN) lighter than the conventional concrete option (41% lighter overall), allowing for the substructure to be reused, which would not be possible with the conventional concrete design option. Reusing the substructure would reduce construction time and overall project costs.

- Long-term durability: The UHPC superstructure would be expected to have a longer service life and require less maintenance compared with a conventional concrete superstructure, which are important considerations for high-ADT routes. These considerations would also be beneficial for bridges in aggressive corrosion environments or those with long detours or high importance.

- Construction time: The conventional concrete box beam design typically requires the placement of a 6 in. (152 mm) cast-in-place concrete deck, which adds time to the construction schedule and may necessitate staged construction. The 42 in. (1.07 m) deep conventional concrete box beam cannot be used without a composite deck for a 120 ft (36.6 m) span, and no deeper box sections are available. The UHPC box beam does not need any concrete deck or overlay, and its top surface can serve as the riding surface. The UHPC joints connecting the adjacent beams can be opened to traffic when they reach a compressive strength of 14 ksi (97 MPa), which can be achieved with some UHPC mixtures within one day. It may be possible to replace this superstructure with a weekend closure using the adjacent UHPC box beam configuration.

The following additional hypothetical case studies are detailed in Garber et al.[1] to demonstrate other possible advantages of using UHPC primary structural components.

- Case study 2 (**Fig. 10**) demonstrates the advantage of increasing span lengths to eliminate piers in water. This case study shows how an existing multispan bridge with

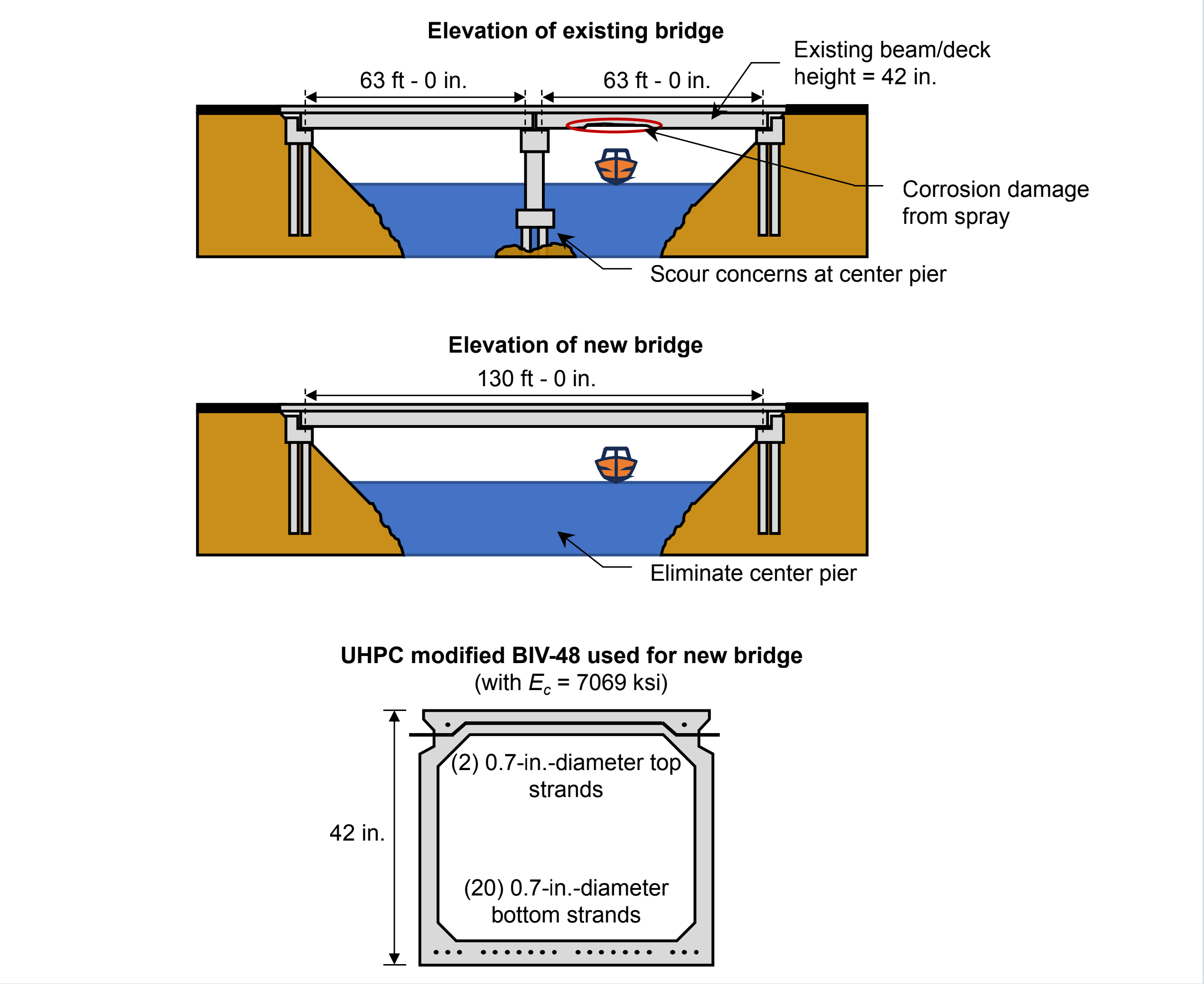

Figure 10. Details related to case study 2. Note: E_c = modulus of elasticity of concrete; UHPC = ultra-high-performance concrete. 1 in. = 25.4 mm; 1 ft = 0.305 m; 1 ksi = 6.895 MPa.

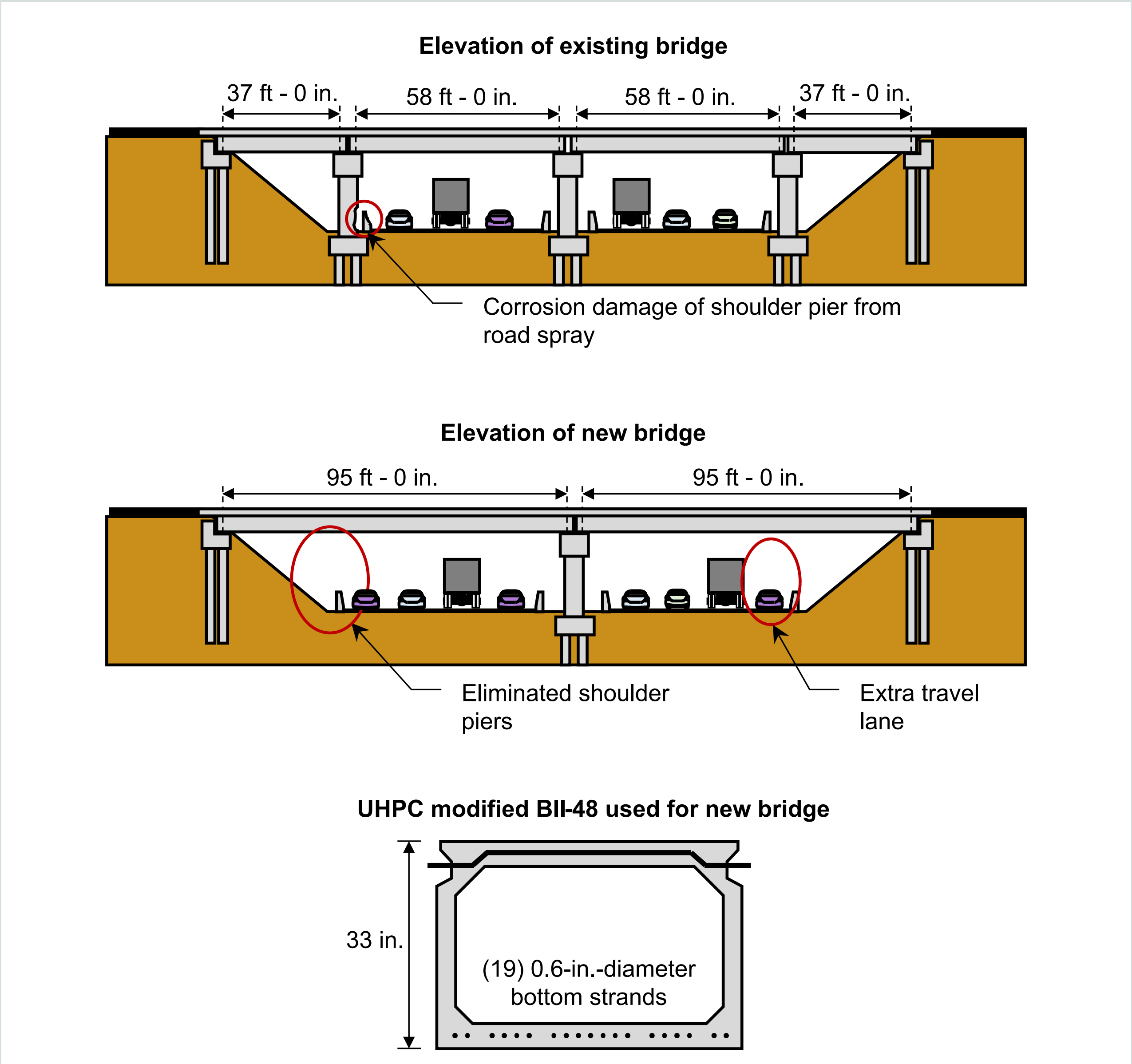

Figure 11. Details related to case study 3. Note: UHPC = ultra-high-performance concrete. 1 in. = 25.4 mm; 1 ft = 0.305 m.

a pier in the water experiencing significant scour could be reconfigured into a single-span UHPC superstructure with the same superstructure depth as the existing two-span superstructure. Eliminating a pier in the water may also be beneficial in streamlining approval processes.

- Case study 3 (**Fig. 11**) shows how using UHPC can eliminate shoulder piers and add lanes. This case study shows how an existing four-span bridge could be reconfigured to a two-span bridge to eliminate shoulder piers and add an additional lane of traffic in each direction without increasing the superstructure depth.

- Case study 4 (**Fig. 12**) provides an alternate lighter-weight option to solid slab beams. This case study compares a superstructure constructed with conventional concrete solid slab beams to one constructed using UHPC multistem T beams. The UHPC superstructure is approximately one-third of the weight of the conventional concrete option. These lighter-weight structures could be used with integral or semi-integral abutments over water to decrease the risk of floating if overtopped by water.

- Case study 5 (**Fig. 13**) demonstrates options for increased hydraulic clearance. This case study compares five different conventional concrete and UHPC design options for a 60 ft (18.3 m) span length. The UHPC superstructure options are significantly lighter and can provide up to an additional 14 in. (0.36 m) of hydraulic clearance compared with the conventional concrete options.

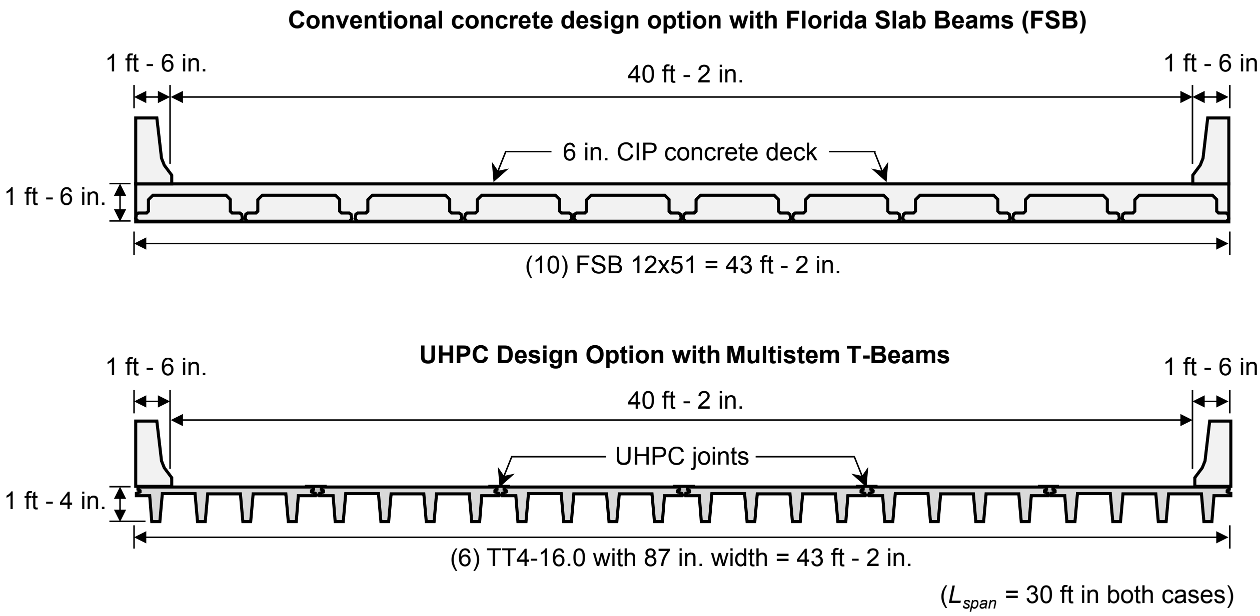

Figure 12. Details related to case study 4. Note: CIP = cast-in-place; FSB = Florida slab beams; L_{span} = span length; TT4 = multistem T beam; UHPC = ultra-high-performance concrete. 1 in. = 25.4 mm; 1 ft = 0.305 m.

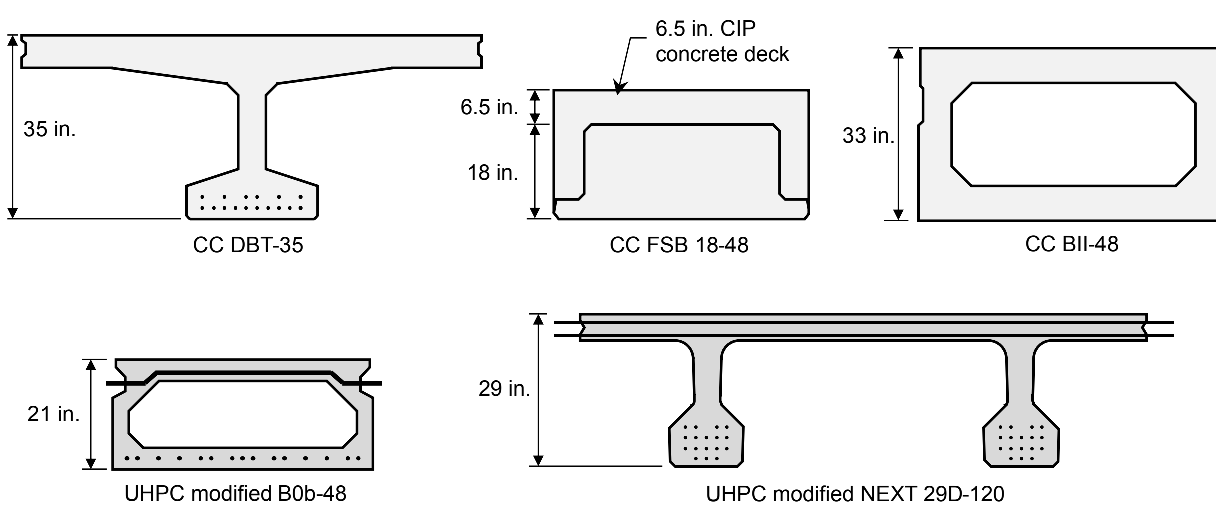

Figure 13. Design alternatives for 60 ft span length for case study 5. Note: CC = conventional concrete; CIP = cast-in-place; DBT = deck bulb tee; FSB = Florida slab beams; NEXT = northeast extreme tee; UHPC = ultra-high-performance concrete. 1 in. = 25.4 mm.

These hypothetical case studies demonstrate several advantages that UHPC superstructures may have over conventional concrete alternatives that can help to offset the additional cost of the fabrication of UHPC superstructure components. The use of UHPC superstructures may lead to lower overall project cost or lifecycle costs when looking at the project holistically and comparing the design requirements with conventional design alternatives.

Conclusion

Short- to medium-span bridges with span lengths less than 125 ft (38.1 m) are expected to be a primary entry-point application for UHPC structural components. Using UHPC primary structural components for these applications offers many advantages over conventional concrete options and may facilitate bridge configurations that are otherwise not possible. This study considered four different UHPC section shapes for short-span bridges, each based on existing conventional concrete formworks (multistem T beams, modified voided slab beams, modified box beams, and modified NEXT D beams). To enable widespread use, design aids have been developed to show the span lengths and configurations possible with UHPC primary structural components. Case studies have also been developed to demonstrate some situations where UHPC primary structural components may be the most beneficial and to quantify some of these advantages.

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Notation

A_{ps} = area of prestressing steel

E_c = modulus of elasticity of concrete

f'_c = compressive strength of concrete for use in design

$f_{t,cr}$ = effective cracking strength for ultra-high-performance concrete

$f_{t,cri}$ = effective cracking strength for ultra-high-performance concrete at time of transfer

$f_{t,loc}$ = crack localization strength for ultra-high-performance concrete

h = section height

h_c = composite section height

L_{span} = span length

w_g = unit weight of beam

W_{beam} = total beam weight

W_{bridge} = total weight of superstructure (including barrier weight)

γ_u = reduction factor to account for the variability in the ultra-high-performance-concrete tensile stress parameters

$\varepsilon_{t,loc}$ = crack localization strain of ultra-high-performance concrete for use in design

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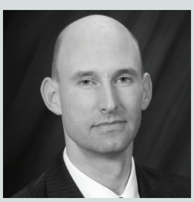

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Abstract

Short-span bridge superstructures are commonly made of conventional precast concrete components. The emergence of ultra-high-performance concrete (UHPC) and the publication of the American Association of State Highway and Transportation Officials *Guide Specification for Structural Design with Ultra-High Performance Concrete* create new possibilities for the redesign of short-span bridge superstructures. Several section shapes optimized for use with UHPC are introduced based on existing short-span section shape types along with practical span ranges shown for each section type. Sample design aids for modified UHPC box beams are presented to show possible span lengths and their necessary strand areas. Hypothetical case studies are discussed, showcasing many of the advantages of UHPC primary structural components over conventional concrete alternatives.

Keywords

Box beam, design aids, multistem T beam, NEXT D beam, northeast extreme tee D beam, short-span bridge, UHPC, ultra-high-performance-concrete section shapes, voided slab.

Review policy

This paper was reviewed in accordance with the Precast/Prestressed Concrete Institute’s peer-review process. The Precast/Prestressed Concrete Institute is not responsible for statements made by authors of papers in *PCI Journal*. No payment is offered.

Publishing details

This paper appears in *PCI Journal* (ISSN 0887-9672) V. 71, No. 5, September–October 2026, and can be found at https://doi.org/10.15554/pcij71.5-01. *PCI Journal* is published bimonthly by the Precast/Prestressed Concrete Institute, 8770 W. Bryn Mawr Ave., Suite 1150, Chicago, IL 60631.

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