Design, Fabrication and Construction of the New England Bulb-Tee Girder

Alexander K. Bardow, P.E.
Bridge Engineer
Massachusetts Highway Department
Boston, Massachusetts

Rita L. Seraderian, P.E.
Regional Director
Precast/Prestressed Concrete Institute
Belmont, Massachusetts

Michael P. Culmo, P.E.
Director of Structural Engineering
CME Associates, Inc.
Woodstock, Connecticut
Formerly,
Connecticut Department of Transportation

The authors discuss the benefits of a partnership approach to problem solving through a case study examination of the development of the New England bulb-tee precast concrete bridge girder. A committee, named the Precast/Prestressed Concrete Institute (PCI) New England Technical Committee for Bridges was formed and consists of a unique public/private partnership of all six New England state highway departments, area precasters and private consultants. The members of this committee have joined together to develop regional solutions to precast concrete bridge problems shared by the New England states. This paper discusses the development of the committee, the partnering approach to problem solving used by the committee, and the application of this approach in the development of a new precast, prestressed concrete bridge girder. The new bulb-tee girder is already being used in several bridge projects in New England.

Historically, the New England region of the United States has been known for its independence and individualism. This pioneering spirit has manifested itself in politics, education, and private enterprise as well as other endeavors. Not as well known are the achievements of a small, grassroots committee that during the past decade has collectively effected major changes in the manner in which bridges are constructed in the New England states. Called the Precast/Prestressed Concrete Institute (PCI) New England Technical Committee for Bridges, it is a unique
public/private partnership of all six New England state highway departments, area precasters and private consultants.

The members of this committee have joined forces to develop regional solutions to precast concrete bridge problems shared by the New England states. The six New England states are Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, comprising a total population of about 12 million and a geographical area of 66,610 square miles (175,027 km²).

This paper discusses the benefits of a partnership approach to problem solving through a case study examination of the development of the New England single-tee precast concrete girder. The new bulb-tee girder moved from initial concept to an accepted standard and has been used in actual designs in less than 2 years. In achieving this milestone, the committee had to balance the constraints of the New England environment, the practical concerns of the precasters, and the anticipated demands that would be required of these girders in the future.

The main principle involved in any partnership is the realization among its members that a mutual approach to problem solving will result in a better product as opposed to an approach where only one party makes the decisions for the others to follow. Traditionally, the latter approach has been taken in developing bridge standards.

As illustrated in Fig. 1, state highway departments would develop details from their own unique perspective. Bridge engineers would then be given these details to use in their designs. If the engineers had difficulties applying the details, they could request the state highway department to accept changes or modifications. After the project was bid, the fabricator would then see the details and would either try to construct components according to the plans or, in the course of preparing shop drawings, ask for changes.

In either case, it would be up to the state highway department to make the final decision on the need for changes or revisions. In addition, this approach is usually not flexible enough to keep up with dynamic changes in materials or methods of fabrication. Generally speaking, highway departments are conservative and reluctant to make radical changes.

In a partnership, as illustrated in Fig. 2, each party is accorded equal decision making responsibility. By working in a non-adversarial atmosphere of cooperation and compromise, a better and more efficient solution is arrived at more quickly. This solution benefits all parties because the needs and operational constraints of all parties concerned have been considered in its development. This is the spirit that has characterized the work of the PCI New England Technical Committee.

The relationships and trust required to make this committee work effectively took years to develop. In addition, nothing would have been accomplished if the state highway departments had not decided to join the committee as partners.

PCI NEW ENGLAND TECHNICAL COMMITTEE

PCI New England was established in 1978 by the region’s precast concrete producers to promote the use of precast concrete products. A Technical Committee, originally made up of chief engineers from these precasters, was also set up at this time to work on typical precast concrete details to be marketed in this region. The work of the Technical Committee was, and is still today, overseen by the PCI New England Steering Committee comprising executives from the member precasters.

During this period, the committee worked primarily on precast concrete products that were sold to private clients, such as owners/developers of parking structures or building projects. The committee attempted to work on

---

**Fig. 1. Traditional approach used in the development of details.**

**Fig. 2. The partnership approach to development of bridge details.**
bridge beam details in the early 1980s. This resulted in a revision of the standard Massachusetts Highway Department details for butted deck (voided slab) and box beam bridges.

Unfortunately, when the committee presented its revised details to the state highway department, the proposals were ignored because these details differed from the state standards. The matter was seemingly laid to rest, so the committee no longer pressed the issue.

In 1989, a new generation of highway department engineers began to question the disparity between the Massachusetts standards and industry practice. They found that precasters routinely substituted shear reinforcement details on shop drawings that differed from the state standards. In fact, they found that the existing standards actually violated the AASHTO shear reinforcement provisions.

Paul Sullivan, the Massachusetts State Bridge Engineer during this time, felt that industry input was vital in developing a new standard. His decision coincided with the efforts of the new PCI New England marketing director, Rita Seraderian, to have the state highway departments join the Technical Committee. Massachusetts was the first state to join in 1990. Rhode Island and Connecticut joined the committee in 1991.

With the involvement of the state highway departments, the committee revisited its previous attempts to update the deck and box beam details. This partnership effort resulted in new standard details, which were adopted by the Connecticut DOT in 1992, the Rhode Island DOT in 1993, and the Massachusetts Highway Department in 1994. The most important decision made by the participating states at this time was that they would adopt the same beam details as their standards. In this way, precasters could invest in one set of forms that would produce beams that are marketable to several states. Prior to this development, each state had standards that differed to some degree from those of the others.

The committee continued to grow with Maine joining in 1993 and New Hampshire joining in the spring of 1994. The committee truly became a regional committee in July 1994 when Vermont joined. These states are also using the committee's deck and box beam details, so they have in fact become regional standards.

The committee also pursued topics related to butted beam bridges such as shear key grouts, waterproofing membranes and proper construction sequences. The Federal Highway mterication mandate that was imminent at the time prompted the committee to reticulate all previously developed details in order to preserve a regional standard.

WHY DEVELOP THE BULB-TEE GIRDER?

Having completed most of the work associated with updating the butted beam details, the committee faced the question of whether to disband or to continue. If the decision was to continue, then what should the committee work on next?

The unanimous decision was for the committee to continue its work. The committee chose to review the region's precast girder standards, an area that they had not previously examined. Although the New England standard was the AASHTO I-girder, this particular girder was beginning to suffer limitations in its range of applicability in New England. Area precasters did not own the forms for the deeper sections that were needed for longer spans. Structural steel was already a strong and versatile competitor, with a solid foothold in the New England market.

The committee also realized that other states were using more efficient precast concrete girder shapes, such as the bulb-tee girder. Trapezoidal precast girders were also being used. Finally, the use of post-tensioning to splice beams and to achieve continuity was extending the achievable length of bridge spans beyond what was practical with simple spans.

The goal the committee set was to establish a precast girder standard for the region that would be competitive with steel, would meet the constraints posed by the New England environment, and could be adapted to meet the future needs of the region.

CONSTRANTS OF THE NEW ENGLAND ENVIRONMENT

Any prestressed girder used in New England has to meet two diametrically opposite requirements. On the one hand, the depth, shipping length and weight of the beams have to be kept to a minimum; on the other hand, highway design considerations are pushing designers to use longer spans.

Limitations on Beam Depth

New England has some of the oldest highway systems in the United States. The present transportation system, with the exception of the interstate highways, was inherited to a large degree from previous generations. This system had itself evolved over time as new transportation modes appeared and grew and infrastructures were built for them.

The roads of this period, originally built for horse drawn vehicles, would later form the basis of the automobile roadway network. The bridges on these roads, many of which were over railroads, were built providing low vertical under-clearances on highway alignments that minimized span length. These alignments are generally inadequate by today's standards.

As these bridges are replaced today, design engineers usually must provide more vertical clearance for the taller modern railroad and higher truck loads. Because in most areas private property ownership extends up to the bridge site, raising the roadway profile has a significant impact on access to abutters, especially in urban areas. Therefore, a premium is placed on obtaining the shallowest superstructure possible.

Limitations on Shipping and Erection

For reasons similar to those discussed above, it is difficult to transport long sections of beams. Turning radii are tight and many roads, particularly rural roads, are narrow. Minimizing shipping weight is also important because many roads and bridges cannot accommodate heavy loads.

Likewise, large cranes are difficult to transport to remote construction
sites. Interference from utility lines and private property boundaries limit the crane boom height and pivot radius. Smaller, more versatile cranes are preferred; however, lifting capacity is reduced with smaller cranes.

**Highway Design Considerations**

Straightening out winding roads to improve the alignment typically results in longer bridge spans, which require deeper beams. Safety improvements on roadways under a bridge require greater side clearances, also resulting in wider bridge openings and longer spans. In order to minimize the impact on environmentally sensitive areas such as wetlands, design engineers prefer to span over them with longer bridges. On the other hand, the damming effect of a deeper superstructure can affect the hydrology of a river or stream.

**DEVELOPING THE NE BULB-TEE GIRDER**

Remarkably, the basic development of the New England bulb-tee girder by the committee took place during a single all-day meeting on March 2, 1994, when the committee met for the first time to discuss the issue of a New England precast girder standard. During this meeting, the committee established the parameters for the girder, reviewed existing precast girder standards, and developed the basic geometry of the new bulb-tee shape.

**Girder Parameters**

For a girder to be practical in New England, the committee decided that it should achieve a simple span of 125 ft (38.10 m) with a maximum beam depth of 6 ft (1.83 m) and a typical girder spacing of 8 to 9 ft (2.44 to 2.74 m). Fig. 3 shows a typical section of a New England bulb-tee girder bridge. Because longer spans could be required in the future, the committee also decided that the web of the precast girder should be wide enough to accommodate post-tensioning ducts for beam splicing or for achieving full continuity.

The span length of the girder is a reflection of the typical maximum shipping length of 110 to 125 ft (33.53 to 38.10 m) that most New England states can normally accommodate. The maximum beam depth and girder spacing were based on the deepest beams and widest spacings that are typically used by the states, whether they be structural steel or precast beams. The girder spacing, although closer than what other states may use, is typically needed for stage construction and future deck replacement considerations.

**Review of Existing Standards**

Next, the committee reviewed the latest precast girder standards across the United States. The trapezoidal tub was considered because it had the advantage of better aesthetics and suitability for use in curved girder applications. However, this section was rejected early in the review process because it could not meet the established parameters. Shipping would be difficult due to its size and weight, thereby limiting its practical span. Longer spans would require more splices than a bulb-tee girder.

The committee agreed that a bulb-tee section would be better able to meet the prescribed parameters, would be more versatile in its range of applications, and would be more competitive with steel sections. Upon making this decision, the committee began to review existing bulb-tee standards from Florida, Kentucky, PCI and the newly developed University of Nebraska (NU) bulb-tee girders, among others.

Although most of these examples had some feature that the committee liked, no single standard completely met all of the committee’s requirements. The NU girder was not considered a good option because of its wide and narrow bottom bulb. Precasters were concerned that, even with superplasticizers, they would have trouble getting the concrete properly placed in the corners of the bulb.

**Development of the New England Bulb-Tee Girder**

Having completed this review, the committee concluded that the only bulb-tee standard that would meet all of the parameters would be one developed specifically for New England. The committee unanimously decided to develop its own bulb-tee girder, to be called the New England bulb-tee girder (NEBT), which would incorporate the best features of the existing bulb-tee girders while meeting the established parameters. The states also decided that the new shape would ultimately replace the AASHTO I-girder as the New England standard.

The remainder of the March 2 meeting was spent working out the geometries of the shape. The basic Florida bulb-tee shape was adapted for the New England bulb-tee girder. The large radius curves proved to be aesthetically attractive and can potentially discourage nest-building birds.

**Hard Metric Units Used**

Because this new shape would require precasters to purchase new forms and mindful of the imminent federal metrication deadline, the committee decided to develop the new section exclusively in hard, rational metric units. This way, the new girder would accommodate future metric use.
in the United States rather than representing a soft converted relic of an inch-pound past.

The participation of the precasters was essential in this decision. They agreed that the committee should strive first and foremost to achieve what was best for the future and that each of the precasters would be responsible for adapting their production lines to make beams that met the metric dimensions.

The basic shape the committee developed had a top flange 1200 mm (47.24 in.) wide and 85 mm (3.35 in.)
thick at the edge. The committee considered thinner and wider top flange sections, but issues such as handling, slab formwork and the durability of the flange when subjected to future deck replacement equipment persuaded the committee not to modify these dimensions. The bottom bulb was set at 710 mm (27.95 in.) wide, 200 mm (7.87 in.) deep with an additional 100 mm (3.94 in.) high sloping face and a 120 mm (4.72 in.) corner radius. This bulb would be capable of holding up to 42 strands.

The width of the web was the subject of much discussion among the committee members. A thin web is desirable for pretensioned concrete girders in order to reduce the weight of the section, but the committee was looking to satisfy the demands of the new generation of precast concrete bridge girders where longitudinal post-tensioning is more often the standard. The width of the post-tensioning ducts combined with shear reinforcement and end region reinforcement results in a wider web than the optimum web in a pretensioned member.

Other states have detailed two sets of bulb-tee girders (one for pretensioning and one for post-tensioning), but the committee felt the standardization of one set of beam sections would simplify design and fabrication and would result in a more durable beam. For these reasons, the web was set at a width of 180 mm (7 in.) with a variable depth depending on the overall depth of the beam. This way, only one top flange and bottom bulb form would be required for the entire range of sections.

Four beam depths were initially selected: 1200, 1400, 1600 and 1800 mm (47.24, 55.12, 62.99, and 70.87 in.). These paralleled the AASHTO Type III through Type VI girders. Shallow box beams were not considered at this time because it was felt that at shallow depths, precast box beams would typically be used. However, the committee subsequently decided that a 1000 mm (39.37 in.) depth was desirable, and this beam was added at the May 16, 1995, meeting.

Initial Detailing

The Massachusetts Highway Department took the lead in drawing up the section in detail and working out the maximum strand patterns. MassHighway also ran the first trial designs, which confirmed that the possible span lengths met the required parameters.

**INDEPENDENT REVIEWS**

Independent reviews of the proposed New England bulb-tee sections were performed by the University of Nebraska and the Portland Cement Association.

**University of Nebraska**

By the July 1994 meeting, the Technical Committee was satisfied enough with the developed bulb-tee shape to solicit independent reviews of the section. Maher Tadros of the University of Nebraska, who developed the NU bulb-tee girder, was asked to perform the first review.

Professor Tadros compared the NEBT shape with the NU shape. His review resulted in several recommendations to improve the efficiency of the section. Based on his suggestions, the committee decided that the bottom bulb should hold more strands. Consequently, the width of the bottom flange was increased from 710 to 810 mm (27.95 to 31.89 in.) and the depth of the flange was increased from 200 to 210 mm (7.87 to 8.27 in.).

**Portland Cement Association**

After these revisions, Reid Castrodale, who at the time worked for the Portland Cement Association, was asked to perform another independent review. Dr. Castrodale ran trial designs on the New England shape and compared them with both the AASHTO I-girder and the PCI bulb-tee girder. This head-to-head comparison confirmed the section's capabilities (see Fig. 4). He also reviewed the dimensions of the section for conformance with the minimum clearance requirements of the new AASHTO LRFD Specifications using a 15.2 mm (0.6 in.) diameter strand and a #16 metric reinforcing bar used for shear and bottom bulb reinforcement.

As a result of this review, the committee modified the depth of the bottom flange, increasing it from 210 to 220 mm (8.27 to 8.66 in.) and decreasing the corner radius from 120 to 100 mm (4.72 to 3.94 in.) (see Fig. 5). This bottom bulb could contain 52 strands and maintain adequate cover on the bottom bulb reinforcement. Fig. 6 compares the shape of the NEBT 1600 to that of the PCI BT-63 and the AASHTO Type V girder. The section properties of the NEBT series are shown in Fig. 7.

The committee spent considerable time reviewing the layout of the mild steel reinforcement and its relationship
to both the pretensioning strand and post-tensioning ducts. The New England states currently use mild steel reinforcement for web shear, end blocks and the top flange. The beam section was evaluated for both conventional mild steel reinforcement and for the possible future use of welded wire fabric in the web. The committee is currently evaluating the impact that welded wire fabric has on the design, fabrication and total cost of the bulb-tee girder. Fig. 8 is a bulb-tee section showing a typical layout of mild steel reinforcement and its relationship to

Fig. 8. Bulb-tee section showing general reinforcement layout.

<table>
<thead>
<tr>
<th>NEBT 1000</th>
<th>NEBT 1200</th>
<th>NEBT 1400</th>
<th>NEBT 1600</th>
<th>NEBT 1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Designation</td>
<td>Depth</td>
<td>Area</td>
<td>Centroid to Bottom</td>
<td>Moment of Inertia</td>
</tr>
<tr>
<td>mm</td>
<td>mm² x 10⁸</td>
<td>mm</td>
<td>mm⁴ x 10⁸</td>
<td>mm² x 10⁸</td>
</tr>
<tr>
<td>NEBT 1000</td>
<td>1000</td>
<td>461</td>
<td>463.2</td>
<td>62.1</td>
</tr>
<tr>
<td>NEBT 1200</td>
<td>1200</td>
<td>517</td>
<td>574.8</td>
<td>99.1</td>
</tr>
<tr>
<td>NEBT 1400</td>
<td>1400</td>
<td>553</td>
<td>667.3</td>
<td>146.5</td>
</tr>
<tr>
<td>NEBT 1600</td>
<td>1600</td>
<td>589</td>
<td>760.9</td>
<td>204.8</td>
</tr>
<tr>
<td>NEBT 1800</td>
<td>1800</td>
<td>625</td>
<td>855.1</td>
<td>274.9</td>
</tr>
</tbody>
</table>

Fig. 7. New England bulb-tee section properties.
the pretensioning strand and post-tensioning ducts.

Durability of the bulb-tee girder was a major topic of discussion among the committee members. All New England states use epoxy-coated mild steel reinforcement. Even with this protection, the need for adequate concrete cover was still a concern. Fig. 9 shows the typical bottom bulb layout and the 40 mm (1 1/2 in.) cover that can be maintained with a #16 bottom bulb reinforcing bar and 15.2 mm (0.6 in.) diameter strands.

THE BOSTON CENTRAL ARTERY PROJECT

While the Technical Committee was developing the New England bulb-tee girder, Boston’s Central Artery/Third Harbor Tunnel (CAT) project staff independently began to look for a bulb-tee girder to use on the project. The CAT is a branch of the Massachusetts Highway Department created to oversee the replacement of Boston’s elevated Central Artery with an underground tunnel as well as the completion of I-90 with the construction of a third underwater highway tunnel to East Boston.

Although the CAT has developed details specifically for use on this project, it nevertheless tries to stay in step with overall MassHighway design and construction policies and standards. The CAT staff learned about the development of the NEBT through Ria Seraderian. Because the bulb-tee sections they were investigating were similar to the NEBT, and since MassHighway was prepared to adopt the NEBT once the section was fully developed, the CAT decided to adopt the section as well.

The new Summer Street Bridge over the West Service Road Extension was the first project for which the New England bulb-tee girder was specified.

The project was Contract C01A2 - South Boston Phase I Surface and Detour Roadway for the Central Artery Project. The designers for the state were HDR Engineering, Inc., Boston, Massachusetts.

Design

The project is a single-span bridge 61 ft (18.6 m) in length with a cross section width of 100 ft (30.5 m). The girders are spaced either 8 ft or 9 ft 7 in. (2.4 or 2.9 m) apart and the superstructure was built in two phases. The original design called for a three-phase construction schedule but the contractor working with the city of Boston was able to reduce the schedule to two phases.

The substructure utilizes a precast retaining wall system that proved to be more cost-effective than the cast-in-place system. The precast system also handled the seismic requirements (Boston is in Seismic Zone 2) better than the cast-in-place system.

The designers were also concerned about potential settlements due to nearby tunnel work. The precast retaining wall system can handle these larger displacements more efficiently than other systems.

The bridge was designed with integral abutments at each end. The 1200 mm (47.24 in.) deep section was chosen for the superstructure. The New England bulb-tee girder was designed as a hard metric section but for the Central Artery project metric units were not required, so the dimensions of the first application were converted to U.S. customary units using a soft conversion. HDR designed the girders with two different prestressing strand patterns, namely, a draped strand pattern and a debonded strand pattern. Both patterns were shown on the construction drawings and the pattern selection was left to the fabricator.

Fabrication

The project was awarded to Modern Continental Construction Company of Cambridge, Massachusetts. Northeast Concrete Products in Plainville, Massachusetts, was hired by the contractor to fabricate the prestressed concrete girders. Northeast Concrete conducted
a study to determine what type of form should be purchased. After dealing with several form suppliers, they elected to purchase a two-piece forming system from Bonnybrook Custom Steel Forms Ltd. The reasons for their decision were as follows:

1. The ease of handling, alignment and assembling the two-piece form vs. a three-piece form. There would be cost savings in terms of setup time and labor.

2. There is only one visible seam.

3. The two-piece form was more costly but would exhibit superior long-term performance.

The fabrication of the form took about 6 weeks with another 4 weeks required for casting bed preparation. The girders were cast in December 1996 over a 2-week period. The fabricator elected to use the debonded strand pattern for the project. Girders were cast with a 6000 psi (41 MPa) mix using Type III cement. Figs. 10, 11 and 12 show the first New England bulb-tee girder.

Construction

The first phase of the project was completed and shipped to the project site in March 1997. The second phase was shipped in May 1997. The contractor reported no difficulties with erection of the girders. The project was completed in August 1997. Views of the completed project are shown in Figs. 13 and 14.

NEW PROJECTS

Since the first New England bulb-tee girder project was awarded, there have been four additional projects bid and awarded. The second bulb-tee project is for the State of New Hampshire and was designed by the New Hampshire Department of Transportation. This project is located on Route 135 crossing the Johns River in Dalton, New Hampshire. The 1400 mm (55.12 in.) deep section has been specified. The precaster for the project is J. P. Carrara & Sons of Middlebury, Vermont. The girders were fabricated in July 1997 and construction started in August 1997.

The third project is for the State of Connecticut and was designed by
STV, Inc. The project is located on I-95 in Bridgeport, Connecticut. The girders will be manufactured by Blakeslee Prestress, Inc., Branford, Connecticut. The 1000 mm (39.37 in.) section was specified for this project and the girders will be cast in the spring of 1998.

The fourth project is for the Massachusetts Highway Department and was designed by HDR Engineering, Inc. This project is located in Shrewsbury, Massachusetts, and carries Route 20 over Flints Pond. The 1400 mm (55.12 in.) section was specified for this project and will be manufactured by Northeast Concrete Products, Plainville, Massachusetts.

The fifth project is for the Maine Department of Transportation, who also designed the project. This project is called Kittery Point over Spruce Creek in Kittery, Maine. The 1600 mm (62.99 in.) deep section has been specified. The girders will be manufactured in the spring of 1998 by Northeast Concrete Products.

There are also several projects now in the design phase and several more in the type-study phase. The CAT project staff alone has specified the New England bulb-tee girder on eight design contracts.

CONCLUDING REMARKS

The PCI New England Technical Committee has been working together for nearly eight years. The working relationship within the committee has been excellent. During this short time period, the committee has effected significant changes whereby more structurally efficient, cost-effective and aesthetic bridges will be constructed now and in the future. The NE bulb-tee girder is only one outstanding example.

The committee will continue its work on developing regional standards for precast concrete bridge products. Massachusetts and Connecticut are currently working on standards for the

Fig. 13. The completed Summer Street Bridge over the West Service Road Extension in Boston, Massachusetts.

Fig. 14. Underside of Summer Street Bridge showing integral abutment details for the New England bulb-tee girders.
Fig. 15. Members of the PCI New England Technical Committee for Bridges (from left to right): Rita L. Seraderian, PCI New England; Edward Barwicki, Lin Associates; Alexander Bardow, Massachusetts Highway Department; Peter Stamnas, New Hampshire DOT; Michael Culmo, CME Associates (formerly, Connecticut DOT); Robert Aubrey, New Hampshire DOT; Alton Herron, Unistress Corporation; Michael Savella, Rhode Island DOT; Ronald Rideout, Maine DOT; Robert Juliano, New Hampshire DOT; Vartan Sahakian, Commonwealth Engineers and Consultants; Ned Newton, Massachusetts Highway Department; George Colgrove, Vermont Agency of Transportation; and Reid Castrodale, Ralph Whitehead Associates (formerly, Portland Cement Association). Members not shown in the photograph include: Frank Nadeau, Metromont Materials Corporation (formerly, Blakeslee Prestress, Inc.); Tony DeCosta, Rotondo Precast; Chris Fowler, Rotondo Precast; Devin Anderson, Maine DOT; and John Weaver, Vermont Agency of Transportation.

bulb-tee girders. Once these standards are issued, AASHTO girders will no longer be used.

The committee is currently working on regional standards for achieving precast girder continuity and for integral bridges using precast beams. The committee continues to review and update existing standards for box girders and deck slabs and to show that a partnership approach to problem solving is the best way to continually improve the quality of bridges in New England in order to better serve the public.

ACKNOWLEDGMENTS

The authors would like to acknowledge the members of the PCI New England Technical Committee for Bridges for their dedication and persistence in helping to develop the New England bulb-tee girder. Fig. 15 lists the members of the committee present at the casting of the initial girder as well as those not present.

The authors would also like to thank Maher Tadros from the University of Nebraska for his early review and recommendations and Reid Castrodale from Ralph Whitehead Associates, formerly with the Portland Cement Association, for all his assistance in finalizing the bulb-tee girder shape and its capacity.

Finally, the authors would also like to acknowledge the following people for their contributions to this article: Chuck O’Leary; Julio Camargo, Ken Ferris and Roger Bessette from Northeast Concrete and Joel Luenger from HDR Engineering, Inc.