Development of the Northeast Extreme Tee (NEXT) Beam for Accelerated Bridge Construction

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ABSTRACT

The Northeast Region of PCI has had a bridge technical committee for over 18 years. This committee is made up of state bridge engineers, precast producers, and consultants. The diverse committee has developed numerous standards for the region including the development of the Northeast Bulb Tee Girder (NEBT), Full Depth Precast Concrete Deck Slabs, Bridge Member Repair Guidelines and Guidelines for Accelerated Bridge Construction. The committee has recently developed a standard for a new beam called the Northeast Extreme Tee Beam or NEXT Beam. The goals of this new section are to provide a fast construction option for variable width bridges with spans up to 90 feet. The section resembles a standard double tee, except that the stems are wider in order to handle the moment and shear demand for bridge loadings. The top flange of the beam is kept thin and is intended to provide a deck form for a cast-in place concrete deck, thereby saving substantial time during construction. The beam is designed to be fabricator friendly, which will inevitably lead to lower bridge costs. The paper will focus on the committee's work in developing the beam and summarizes the design criteria and how it accomplished those goals.

Keywords

Accelerated Bridge Construction, Double Tee

HISTORY AND MAKEUP OF COMMITTEE

The PCI Northeast Bridge Technical Committee is a unique public/private partnership of six New England States and New York. The partnership of State Highway Departments, Area Precasters and Private Consultants was launched in 1990. The committee originally began with Massachusetts, Connecticut and Rhode Island with its focus on updating bridge standards. The committee over the years has grown and now has over 20 active members and is made up of Massachusetts, Connecticut, Rhode Island, New Hampshire, Maine, Vermont and New York. The committee meets five times a year and has been instrumental in developing State of the Art reports which it posts on it's website for use by the Northeast Region designers. The committee has also conducted workshops as a means to disseminate and train designers on current bridge standards and practices. Some of its important milestones have be the Development of the New England Bulb Tee (PCI Journal Article November-December 1997), Full Depth Deck Panel Guidelines and its most recent document the Guidelines for Accelerated Bridge Construction. This document was in line with FHWA's initiative for Accelerated Construction of bridges. The document which took two years to develop was authored by a subcommittee of the Bridge Technical Committee. This report is available on-line (www.pcine.org).

WHY DEVELOP THE NEXT BEAM?

Adjacent Box Beam bridge systems have typically been the solution of choice for medium span bridges in the northeast region. The system does have limitations and over the years has not worked well for all types of bridge replacements. One major limitation is the accommodation of utilities across the width of the bridge. The box beam itself is a relatively difficult beam to produce because it involves multiple steps. The construction out in the field also has had issues with grouting procedures involving the shear keys.

The idea for the NEXT beam was modeled after the author had visited a precast plant in September 2006 and noticed a precast section that was developed for High Level Rail Road Platforms (see Figure 1). This section which was relatively short had attributes that would work well for a medium span bridge. The High Level Platform shape was developed by Rotondo Precast in Rehoboth, MA. Chris Fowler the General Manager provided the drawings of the section with some modifications to help with the early analysis.

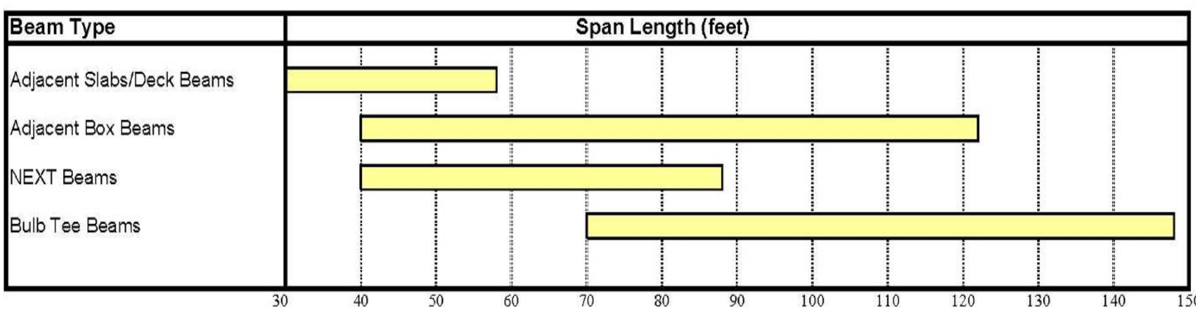
Fig. 1 –High Level Railroad Platform Slab

Rita Seraderian contacted Michael Culmo of CME to determine the feasibility of modifying this shape and moving into the highway bridge arena. Some quick calculations and parameters were set. Upon evaluation the authors felt this new section could provide the needed solutions for areas where Box Beams or Deck Slabs did not work well. The new section was proposed in concept to the PCI Northeast Bridge Technical Committee in October 2006. All members felt this would be an excellent solution and approved the development of the new beam. The committee kept costs in mind while establishing the basic parameters for the new beam.

The section would be used for bridge spans from 45’ to 90’. The section would vary in depth from 24” to 36”. The section would not compete with the Northeast Bulb Tee which starts at a depth of 39”. The width would vary from 8’-0” to 12’-0” using magnetic side rails. These rails have been developed to assist fabricators by allowing quick adjustment of forms. They consist of flexible steel panels that are attached to the steel base form through the use of high power magnets (in place of bolting or welding). A single form could be used that would allow variation in the beam by adjusting the depth with fillers and the width by adjustable side forms. This would reduce the upfront cost of purchasing several form shapes. The new section would be easier to fabricate and it would require less pieces to construct a typical bridge. Shipping weights were also discussed and a weight limit was set at approximately 120,000 lbs.

The top flange would be kept at 4” and would act as a stay in place form. The bridge would have an 8” deck cast over the section out in the field. The construction of the bridge would eliminate deck forming, joint details and parapet details would be easier which in turn should accelerate the construction of the bridge and reduce construction costs. All of these parameters are discussed in more detail in subsequent sections of this paper.

The chart shown in Figure 2 shows how the new beam would work within the existing beam sections available in the northeast.



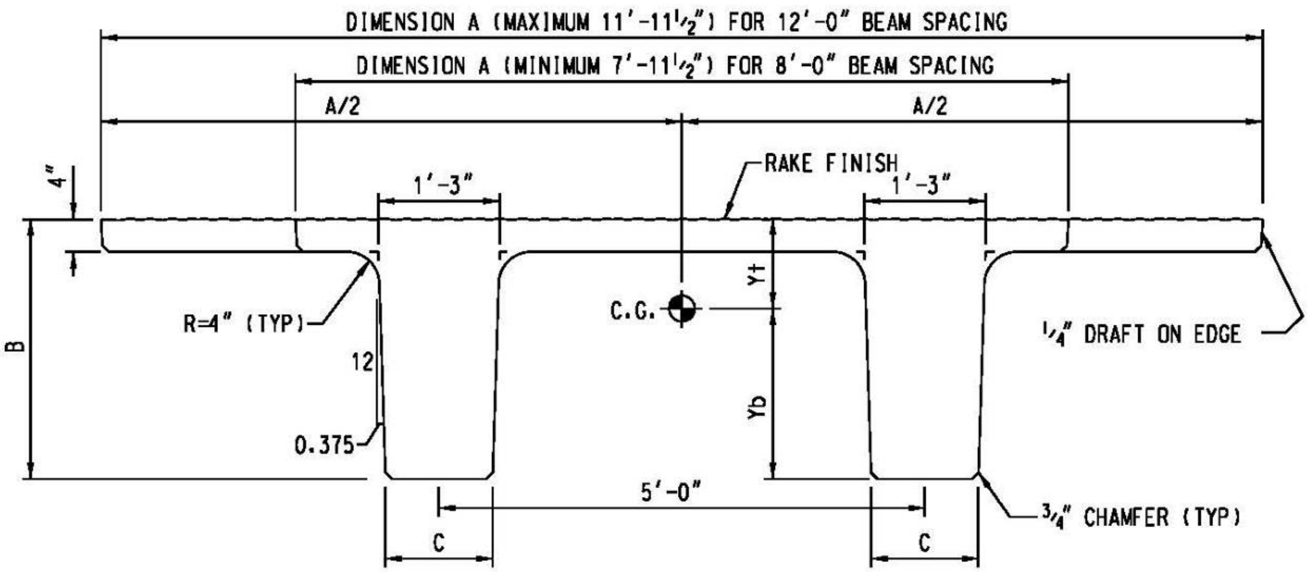
Notes:

1. This chart is for information purposes. It should not be construed to mean specific limits.
2. Common span ranges are shown for the type of beams listed.
3. Minimum spans shown are based on common bridges. Shorter spans can be used for all beams. For instance, a bulb tee bridge can be built to a 40 foot span, but this is not common.
4. Maximum spans are approximate based on previous and current studies. The maximum span length will vary depending on many factors such as number of beams, size of parapets and sidewalks, concrete strengths, etc.

Fig. 2 –Common Span Ranges for Prestressed Beams

BEAM SECTION DEVELOPMENT

Prior to the development of a new beam section, the committee studied the key features of a beam that would address the goals of the new section. The following sections discuss the features that were studied and the conclusions reached by the committee. The final beam section is shown below in Figure 3.



NEXT BEAM - SECTION PROPERTIES

BEAM DESIGNATION	BEAM WIDTH INCHES	BEAM DEPTH INCHES	BASE STEM WIDTH INCHES	AREA IN^2	I IN^4	Yb INCHES	Yt INCHES	St IN^3	Sb IN^3	WEIGHT PLF
	A	B	C			D	E			
MINIMUM WIDTH BEAMS										
NEXT 36	95.50	36.00	13.00	1287	160240	21.77	14.23	11261	7361	1341
NEXT 32	95.50	32.00	13.25	1182	115813	19.51	12.49	9272	5936	1231
NEXT 28	95.50	28.00	13.50	1075	79901	17.24	10.76	7426	4635	1120
NEXT 24	95.50	24.00	13.75	966	51823	14.95	9.05	5726	3466	1006
MAXIMUM WIDTH BEAMS										
NEXT 36	143.50	36.00	13.00	1479	185525	23.36	12.64	14678	7942	1541
NEXT 32	143.50	32.00	13.25	1374	134258	20.98	11.02	12183	6399	1431
NEXT 28	143.50	28.00	13.50	1267	92661	18.57	9.43	9826	4990	1320
NEXT 24	143.50	24.00	13.75	1158	60045	16.12	7.88	7620	3725	1206

Fig. 3 – Final Beam Dimensions and Properties

GENERAL APPROACH

Double tee sections have been used for years in parking garage structures and on bridges. In some cases, the tees were installed without toppings, having the vehicles supported directly on top of the top flange. In order to accommodate truck loadings and adequate concrete cover, the committee determined that the top flange would need to be approximately 8" thick. The committee was concerned with the shipping and handling weight of a double tee beam with a thick top flange. A 90 foot long section would weigh approximately 160,000 pounds. The committee decided that a shipping and handling limit of 120,000 pounds was a reasonable beam development criterion because it would be fairly easy to obtain trucking permits at this level.

Another concern with a full thickness top flange is the transverse connection between adjacent beams. Connections used in un-topped parking garage double tees would most likely not hold up to the rigors of heavy weight truck loadings. Several DOT's have developed high capacity connection details; however the committee was concerned about the durability of these connections over time.

For these reasons, a decision was made to develop a section that would have a thin top flange that would essentially act as a deck form for the installation of a full depth cast-in-place concrete deck in the field. Precast deck forms are commonly used for interior bays of stringer bridges; however the deck overhangs still need to be formed using cantilever brackets. A double tee top flange has the benefit of being able to support the overhang loads as well as the interior bays. This will greatly reduce the construction time on site since very little forming is required in the field.

The committee also decided that it would be possible to migrate the design to a full thickness top flange in the future. Subsequent to the development of the initial beam standards, the committee has moved forward with the development of a full thickness top flange section. This section, which is currently under development, will most likely initially be used for short span secondary roads with low truck volumes.

UTILITIES

Another purpose for the development of a double tee section is the need to accommodate under bridge utilities. Many streets in the northeast have underground utilities. The current precast bridge system of choice for short to moderate spans is precast adjacent box beams or slabs. These systems do not have the ability to accommodate utilities, since there is no space between the beams. In many cases, the utilities are hung from the fascia beams and parapets, which is not a desirable approach. The new NEXT Beam will be able to support several utilities between the stems, thereby eliminating the need for parapet attachments.

VARIABLE BRIDGE WIDTHS

The notion of a typical bridge in the northeast United States is not realistic. The highway system in the northeast is very old, and many of the roadways were developed prior to introduction of the automobile in the early 1900's. Many roadways are constructed in very limited right-of-way with little room for expansion. In many cases, new bridges must be constructed to very specific widths in order to fit within the tight confines of the highway geometric constraints.

In order for a precast adjacent beam system to be viable in these conditions, there is a need for a section that can accommodate an almost infinite amount of different bridge widths. Previous short span bridges in the northeast were constructed with precast adjacent box beams. Often engineers needed to widen the bridge to beyond what was required in order to accommodate the standard beam width (3 feet and 4 feet), which at times was problematic.

The simple top flange of a precast double tee beam offered an option to have top flanges that could accommodate any beam width. Recent developments in precast beam forming techniques make adjustment of steel forms very easy. Magnetically attached side forms can be used and can be adjusted very easily to produce a top flange of any width. In addition, these side forms can be made somewhat flexible, therefore curved flange edges can also be produced for bridges on curves. With this approach, designers can specify precise beam dimensions that can produce site specific bridge beams without significant added cost. In order to facilitate beam shipping, it was decided to limit the maximum beam width to 12 feet. Sections wider than this can be shipped in the northeast; however special permits and escorts are required, which corresponds to higher shipping costs.

The minimum beam width is limited by the size and location of the beam stems. The stem spacing is fixed in a standard double tee form. The following section discusses the development of the stem size and spacing, which ultimately defined the minimum beam width.

STEM SPACING AND DIMENSIONS

In order to accommodate a significant variable top flange width, the spacing of the stems needed to be studied. In order to make the cost of fabrication low, the committee decided to standardize the spacing and size of the stems. With this approach, the fabricators could produce an entire family of beams with one set of forms.

At first a stem spacing of 6 feet was considered. The committee wanted the beam section to be as narrow as 8 feet. With 6 foot stem spacing, an 8 foot wide section would produce essentially an inverted U-beam with virtually no top flange overhang and a very narrow gap between stems at the beam joint. The committee had concerns that this section would have an adverse effect on the cast-in-place deck performance. There were concerns that the tight stem spacing between beams would lead to high shear stress in the slab that could lead to cracking and potential failures. Because of this, the committee wanted to keep the minimum stem spacing to approximately 3 feet. If a 6 foot stem spacing was used, the minimum beam width would need to be limited to 9 feet. The committee wanted to have a minimum beam width of 8 feet; therefore a decision was made to reduce the stem spacing to 5 feet to accommodate this. An added benefit to this design was that it produces relatively even stem spacing across the bridge width for most designs.

Figure 4 shows details of the use of the maximum and minimum width NEXT beams in a typical bridge cross section.

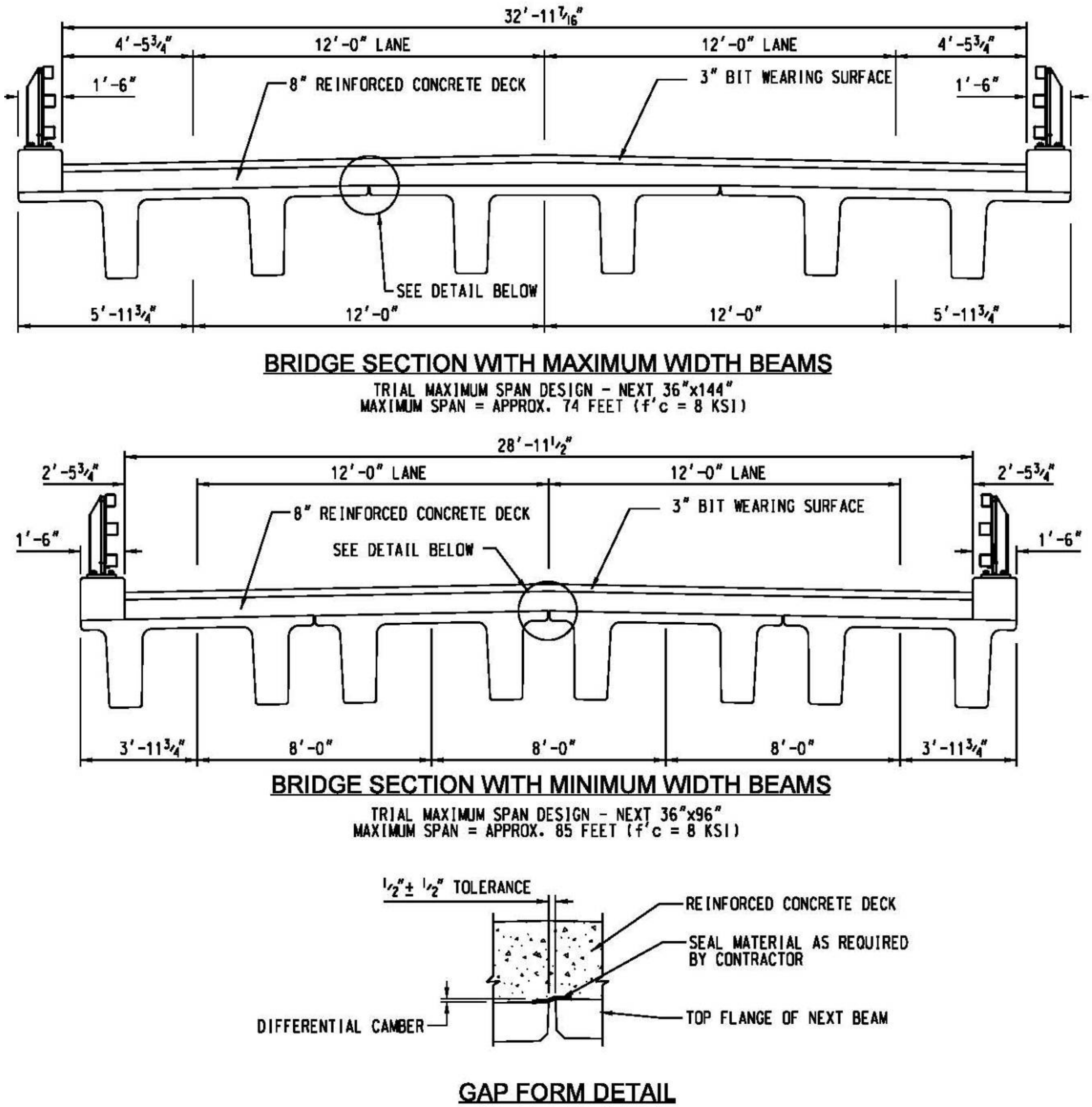


Fig. 4 – Typical Bridge Sections using NEXT Beams

Note: The bituminous wearing surface would be installed over a membrane waterproofing system. A high performance concrete wearing surface or a high performance concrete deck without a wearing could also be used.

The depth of the beam was the subject of much discussion among the committee. Many bridges in the northeast have limited or even substandard vertical clearances. For the span lengths being considered, the committee felt that limiting the beam depth to 36 inches was appropriate. In order to keep the forms constant, a maximum stem depth is required. Shallower beams could be achieved by inserting blockouts in the bottom of the stem forms. Production of deeper sections would require new forms, costly modifications to the top flange forms, and possible overstressing of the fabrication bed abutments.

The initial width of the bottom of the stem was set at 11 inches. This width was set after looking into a number of factors that included typical strand spacing, the anticipated size of shear reinforcing, and the desired concrete cover. An 11 inch wide stem had enough room to accommodate 4 columns of strand and a number 4 shear stirrup.

The slope of the sides of the stem has an effect on the fabrication process. Vertical side faces are possible; however fabrication would be more complicated and expensive. In order to remove a beam from the forms with vertical stems, a forming system comprised of complicated collapsible formwork would be required. The committee opted for sloping sides on the stems, similar to conventional double tees. The amount of slope of the stems has an effect on the removal of the beams from the form. After consultation with form manufacturers and fabricators, it was decided to use a slope of 0.375 inches per foot. This slope should allow easy removal of the beams from the forms.

TOP FLANGE DESIGN

As previously stated, the top flange was not intended to be the structural slab for the bridge. The intent was to use the top flange as a form for a cast-in-place concrete deck. The flange needs to resist both positive and negative bending moments; therefore concentric mid-depth reinforcing is desirable. Figure 5 depicts typical beam reinforcing.

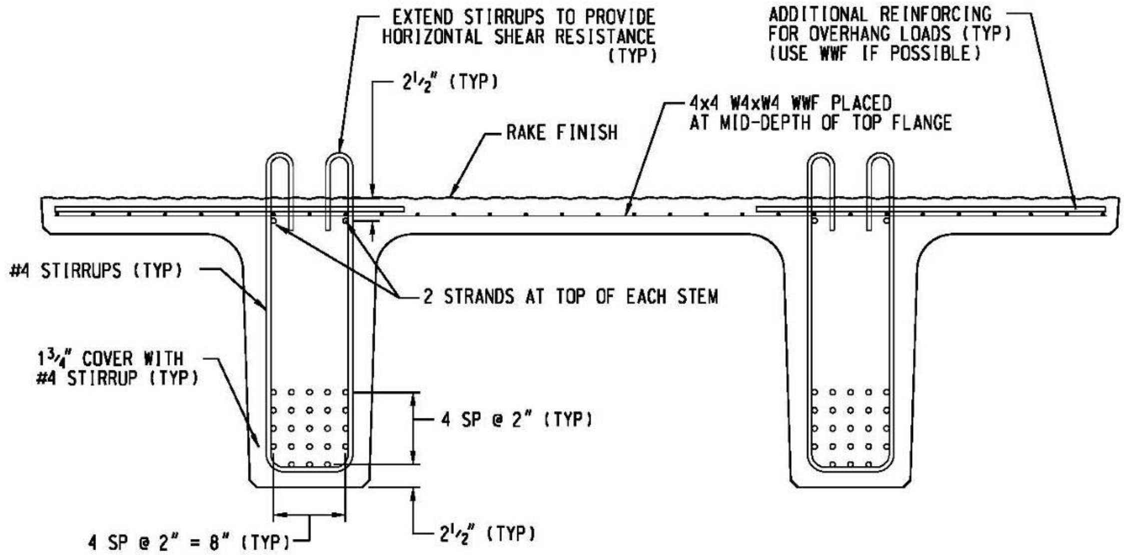


Fig. 5 – Typical Reinforcing Details

By using the top flange for a deck form, there is a potential to make better use of precast concrete curbs and parapets. One of the major difficulties with precast concrete curbs and parapets is the need to make a significant connection at the base. There are several precast concrete systems that have been crash tested. These systems involve the use of bolts to resist the truck impact forces. Many DOT's do not have approved precast railings; therefore they are normally limited to the use of cast-in-place parapets. The overhang flange of the NEXT beam can be used to support a precast curb or parapet prior to deck concrete placement. The main reinforcing of the curb or parapet can be extended horizontally into the deck pour and lapped with the transverse deck reinforcement. This type of connection is essentially the same as a conventional cast-in-place connection. In place of a horizontal construction joint, a vertical construction joint is used. The precast curb or parapet would also act as a side form for the deck pour. Since this connection is essentially the same as a cast-in-place connection, crash testing of the system should not be required. Designers should be able to convert standard cast-in-place curbs and parapets to precast using this approach. Figure 6 shows a typical installation of a precast concrete curb and its connection to the cast-in-place deck. Other standard parapets could be used with similar details.

Precast decks have not been considered for the NEXT beam at this time by the committee. In theory a precast deck could be used since the stems of the NEXT beam are similar to stringer beams.

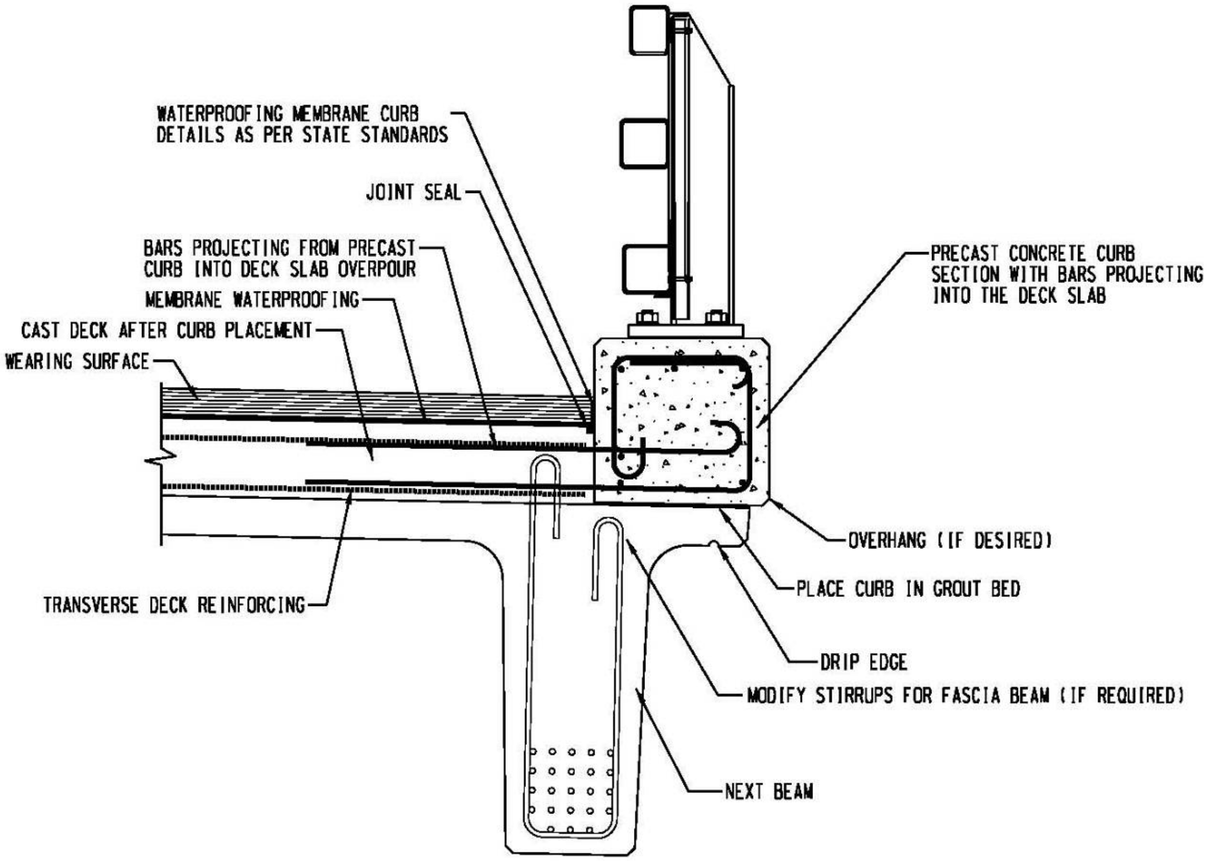


Fig. 6 – Precast Curb Installation Details

For interior beams, it was determined that standard welded wire fabric can resist the bending moments due to the casting of wet concrete. Additional reinforcing may be required for the fascia beam cantilevers if a precast parapet is used. In this case the welded wire fabric can be supplemented with additional mild reinforcement place near the top of the flange.

DIAPHRAGMS

Normally diaphragms are used in stringer bridges. The primary purpose of diaphragms is to provide better live load distribution and lateral support of the top flange so that lateral torsional buckling of the flange can be prevented. Double tee beams are extremely stable and resistant to lateral buckling. The top flange combined with the concrete deck will provide significant live load transfer between beam stems. For these reasons, the committee decided to forgo the use of intermediate diaphragms. This approach is consistent with the design of parking garage double tee beams. End diaphragms will still be used to support the un-stiffened slab edge at the supports.

DEBONDING VERSES DRAPING

In order to keep the cost of the new beam down, it was decided to use debonding of strands in lieu of draping. Draping brings several costly fabrication factors into play. Draping requires hold-downs or push downs in the forming system. The hold-down forces must be resisted by footings under the forms. Draping not only complicates fabrication, it also increases the cost of the form set-up. By limiting the beam design to debonding only, it may be possible for fabricators to build self stressing fabrication beds. The elimination of draping will inevitably lead to some loss of efficiency in the section; however the committee felt that this would be offset by the lower cost of production. This is an example where a committee comprised of both fabricators and designers can work together to come up with the lowest overall cost of a product. Designers will often only look at the overall efficiency of the section. Achievement of this efficiency can result in a more expensive fabrication process that can offset the savings in efficiency.

The decision by the committee to eliminate strand draping does not completely eliminate the potential to make the section more efficient. The width of the stems opens up the potential to design a beam with a combination of pre-tensioning and post-tensioning. This approach would significantly increase the span length capabilities of the beams. The added cost for the post tensioning is significant; therefore it would only be used where structure thickness requirements were critical.

POTENTIAL USE WITH INTEGRAL ABUTMENTS

Integral abutment designs require a significant connection between the beams and the abutment stems. This connection is very difficult when precast adjacent butted beams are used without a cast-in-place concrete slab. The NEXT Beam has a full depth cast-in-place concrete slab; therefore the connection to the abutment is greatly simplified. Longitudinal reinforcing in the slab can simply be extended into the integral abutment closure pour to resist negative bending moments. Reinforcing or strand extensions can be extended beyond the beam end to resist positive bending moments.

SPEED OF CONSTRUCTION

One might think that construction of a precast bridge with a cast-in-place deck might be a slow process. The NEXT Beam offers significant advantages over typical stringer beam bridges. The top flange of the beam is designed to support the weight of the cast-in-place concrete. There is virtually no installation or stripping of formwork required in the field. No diaphragms are proposed for the NEXT Beam. The installation of diaphragms on stringer bridges is also a time consuming process. End diaphragms are proposed to support the free edge of the deck at the supports. It is possible to install these diaphragms as a secondary pour in the precast plant, which will further accelerate the construction process. All of these features should lead to a fast construction process.

TRIAL DESIGNS

Before a beam section can be finalized, it is necessary to complete trial designs to ensure that the beam meets the goals set by the committee. The PCI Northeast Technical Committee is comprised of seven different DOT's, each with different standards for items such as concrete strengths, parapets styles, overlays, etc. In order to make the trial designs useful, the committee decided to pick design parameters that were representative of the majority of the states on the committee. The following parameters were chosen for the trial designs:

1. Two lane Four Beam Bridge
2. Parapets consist of concrete curbing supporting a steel railing system
3. 8 inch thick reinforced concrete cast-in-place slab
4. 3 inch thick bituminous concrete wearing surface
5. Concrete strengths (three different designs)

At Release	Final
8 ksi	10 ksi
6 ksi	8 ksi
4 ksi	6 ksi

6. Debond up to 25 percent of strand
7. AASHTO LRFD[1] Designs with full allowable tension stresses
8. Straight Strand Only
9. No utility loads
10. Design as an interior Beam

The determination of a live load distribution factor for the trial designs was not straight forward. The AASHTO LRFD[1] Design Specification has live load distribution factors for double tee beams; however the factors are based on the use of adjacent double tees that are connected using transverse post tensioning, which is essentially a hinged joint. The proposed use of the NEXT Beam includes a composite cast-in-place concrete slab; therefore it was determined that the most appropriate live load distribution factor was to treat each stem as a stringer beam. This corresponds to the AASHTO distribution factor for cross section Type K as depicted in Table 4.6.2.2.1-1. This factor is based on a precast stringer supporting a concrete deck. The NEXT Beam has a concrete deck; therefore it will behave in a similar fashion to a stringer bridge. Designers may choose to treat the beam as a channel beam with a concrete overlay as depicted in cross section H in the AASHTO table. It is the opinion of the committee that the minimum stem spacing of 3 feet is sufficient to warrant the use of the Type K distribution factor.

Initial beam designs revealed an issue with the initial beam section. The width of the stems limited the amount of prestressing strand that could be placed in the section, which in turn limited the maximum span lengths. A decision was made to increase the width of the stems from 11 inches to 13 inches, which allowed the addition of one more column of strand. The additional stem width and strand pattern had a significant favorable impact on the maximum span length of each section, therefore the stem width was finalized at 13 inches (at the bottom).

The maximum span length for the largest NEXT Beam is approximately 87 feet. This is well within the original limit set by the committee. This span limit is based on the narrowest beam width of 8 feet.

EFFECT OF SLAB OVERPOUR THICKNESS

There was discussion within the committee about using the top flange as the bottom portion of the deck slab in a similar fashion to a partial depth precast deck slab. This would reduce the concrete overpour thickness to approximately 4 inches (as opposed to 8 inches in the original concept). In order to do this, the top flange would require a special design since the overhang portion between beams would be discontinuous at mid-bay. A welded tie connection could be employed; the committee was not aware of any research of designs that could verify this type of design. Even with this concern, committee members were curious about the effect of reducing the thickness of the slab overpour. Trial beam runs were made for this approach. It was found the reduction in overpour thickness had little effect on the maximum span length. It was found that there was an increase in dead load stresses in the beams with thicker overpours; however there was also a reduction in live load stresses due to the increased composite section properties with the thicker overpour. This option was abandoned due to the issues with the joints between the beams and the limited change in span capacity. In lieu of this, the committee decided to pursue a full depth top flange in the future.

Once the first trial runs were complete, the committee decided to develop a series of beam tables for use in preliminary designs. The same parameters were used as in the previous trial runs. The final beam tables are included in the Appendix A. The tables include the approximate maximum span length of each section and the approximate number of strands for each section. With these tables, a designer can determine a preliminary beam depth for a particular span length and beam spacing. These tables are intended for preliminary designs. Design parameters for a specific bridge will vary for each project; therefore the beam chosen would need to be verified with detailed calculations.

CONSTRUCTION SEQUENCE WITH NEXT BEAMS

The following construction sequence is proposed, which is based on the parameters developed by the committee.

1. Construct Foundations: The bridge seats should be cast to match the cross slope of the final roadway.
2. Erect the NEXT Beams: The beams should be installed to the spacing shown on the plans with ½” nominal joints between the beams.
3. Form the deck ends and side faces and place deck reinforcing. (precast curbs or parapets set in grout beds can be used in place of side forms).
4. Cast the bridge deck and end diaphragms: It may be possible to pre-pour the end diaphragms in the fabrication shop prior to shipping.
5. Complete the parapets:
6. Install membrane waterproofing and pavement overlay.

During construction, construction vehicles would normally be prohibited from the top of the beams prior to deck placement. It may be possible to drive small vehicles across the beams after placement. Designers may want to check the top flange for these loads and either allow or prohibit them during construction.

The weigh of the screed would not normally be accounted for in the design of the beam flange overhang in the northeast region. This is because the weight of the screed is somewhat unknown to the designer. Contractors normally place the screed rails over the fascia beam; therefore the overhang design is not normally an issue. If contractors were to use the overhang, they would need to check the overhang and possibly place additional reinforcing in the overhang to support the screed.

The rendering shown in Figure 7 depicts a completed NEXT Beam bridge constructed on a precast integral abutment and with a precast open rail parapet. The abutment and parapets were previously developed by the Northeast PCI Bridge Technical Committee.

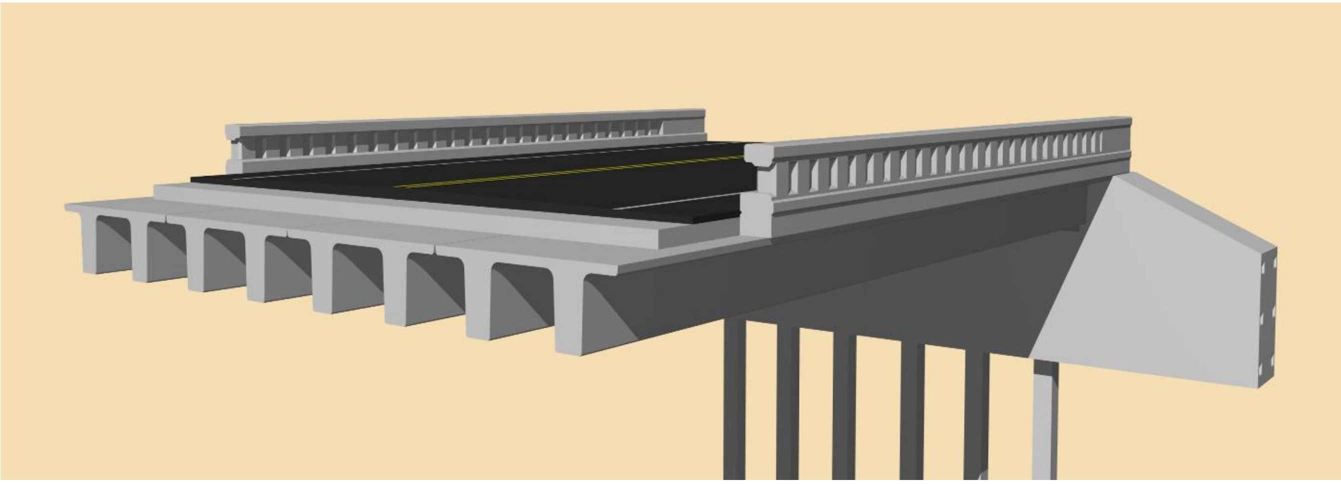


Fig. 7 – Complete NEXT Beam Bridge

FUTURE WORK

FULL DEPTH TOP FLANGE OPTION

As previously stated, the committee initially started with a beam design based on a full thickness concrete slab overpour. There was always a desire by the committee to develop a fully precast butted beam section without an overpour. This design consists of a full thickness (8”) top flange that acts as the structural slab for the bridge. The sections are butted and the longitudinal joint is connected using welded ties spaced at five feet combined with a grouted shear key. Once connected, the entire bridge is covered with a waterproofing membrane and a bituminous concrete overlay. The committee had concerns with regard to the transverse welded tie connections. Several states have standard butted bulb tee and double tee sections with these details. The details from Texas DOT and Washington DOT are being investigated for possible use. The Texas details were studied by researchers in Texas and found to be adequate to support typical truck loads; however long term fatigue testing has not been done because Texas uses these beams for rural roads with low truck volumes.

The success of this research prompted the committee to move forward with a full depth deck design. The intent is to use these beams for short span town roads and low volume state roads. As of the time of this writing, the development of the full depth deck sections is well underway and should be completed and published in 2008. Initial trial designs indicate that the un-topped beam will be capable of span lengths that are similar to the topped section. The weights of the full thickness sections are high, but the committee felt that the section will be an attractive option for short span local bridges.

USE OF LIGHTWEIGHT CONCRETE

The shipping and handling weight of the NEXT Beam has always been a concern with the members of the committee. The reason for the high weight is that each piece is essentially two stringers tied together; therefore it is approximately twice the weight of a similar stringer beam of the same span length. The committee is investigating the use of lightweight concrete mixes for the NEXT Beam. These concretes have the potential to significantly reduce the shipping and handling weights, which would correspond in a reduction in handling and erection costs. It would also make the full thickness top flange beam a more viable option.

PILOT PROJECTS

The development process has recently been completed and standards have been approved and issued by the committee. They can be found at the Northeast PCI website (www.pcine.org). Each state is currently looking into locations where the new section can be used as a pilot project. Typical project design schedules may slow the transition of widespread use of the section, but the commitment of the committee states indicates that over time, the NEXT Beam will be a very useful section for the region.

COSTS

No projects using the NEXT Beam have been let to date, therefore specific cost data is not available. The fabricators on the committee all feel that the NEXT Beam will produce a bridge with lower overall costs when compared to adjacent butted box beam bridges. There are several factors that will keep the cost of a NEXT Beam low. The NEXT Beam has virtually no deck forming. It uses only straight strand patterns, in place of costly draping techniques. There are fewer pieces to ship and erect.

CONCLUSIONS

1. The development of the NEXT Beam is example of an owner/industry committee collaborating to produce a product that is both owner and fabricator friendly. The Northeast PCI Bridge Technical Committee is familiar with this approach. The Northeast Bulb Tee Girder was developed in a similar fashion. The Bulb Tee Girders have gone on to become the standard stringer beam for moderate to long span precast beams in the region. The NEXT Beam is a product that fulfills the needs of both the owners and fabricators. It has the potential to be used for most short to moderate span bridges in the region (These types of bridges are currently being built using adjacent precast box beams).
2. The NEXT beam has the ability to support under bridge utilities. The current use of adjacent box beam systems for short span bridge cannot accommodate under bridge utilities. The utilities are often hung from brackets attached to the bridge parapets.
3. The NEXT Beam was developed for ease of fabrication. It will only have straight strands (no draping), which should reduce the cost of forms and simplify fabrication. Since bridge beams are bid competitively, the savings in fabrication will be passed on to the owners through the bidding process. The elimination of strand draping has an effect on the efficiency of the section, but the committee felt that the production savings would offset the loss of efficiency. If a designer wants to push the limits of a particular section, there is the potential for designing a beam with a combination of pre-tensioning and post-tensioning.
4. The use of a full thickness structural slab on top of the beam may seem inefficient; however the initial trial designs show that the span lengths for each section are similar to beams with thinner concrete slabs. The cast-in-place concrete deck will provide a very durable bridge that will be very easy to build. The NEXT Beam will support the wet concrete overpour, thereby eliminating time consuming and costly deck forming in the field. The top flange can even be used to support the beam overhangs, which are often the most difficult portion of the bridge deck to form. The result of this approach is that overall construction time for the NEXT Beams should be significantly lower than typical decked stringer bridges such as spread box beams and bulb tees.
5. The use of the NEXT Beam top flange as a deck form will greatly reduce construction time of typical bridges. There is no need for deck forming and form stripping. Intermediate diaphragms are not required, which further reduces construction time. End diaphragms are proposed; however these can be precast as a secondary pour in the fabrication yard prior to installation.
6. Initial pricing from fabricators indicates that a NEXT Beam bridge will be significantly less expensive than a precast adjacent box beam bridge.

REFERENCES

1. *AASHTO LRFD Bridge Design Specifications*, American Association of State Highway and Transportation Officials, Washington, D.C., Fourth Edition 2007

CREDITS

The NEXT beam has been developed for the purposes of promoting a greater degree of uniformity among DOT's, engineers and industry of the Northeast, with respect to planning, designing, fabricating and constructing highway bridges with the FHWA's philosophy of accelerated bridge construction. We would like to acknowledge the PCI Northeast Bridge Technical Committee for their dedication and recommendations in developing the new section.

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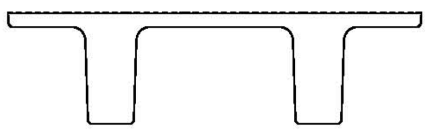
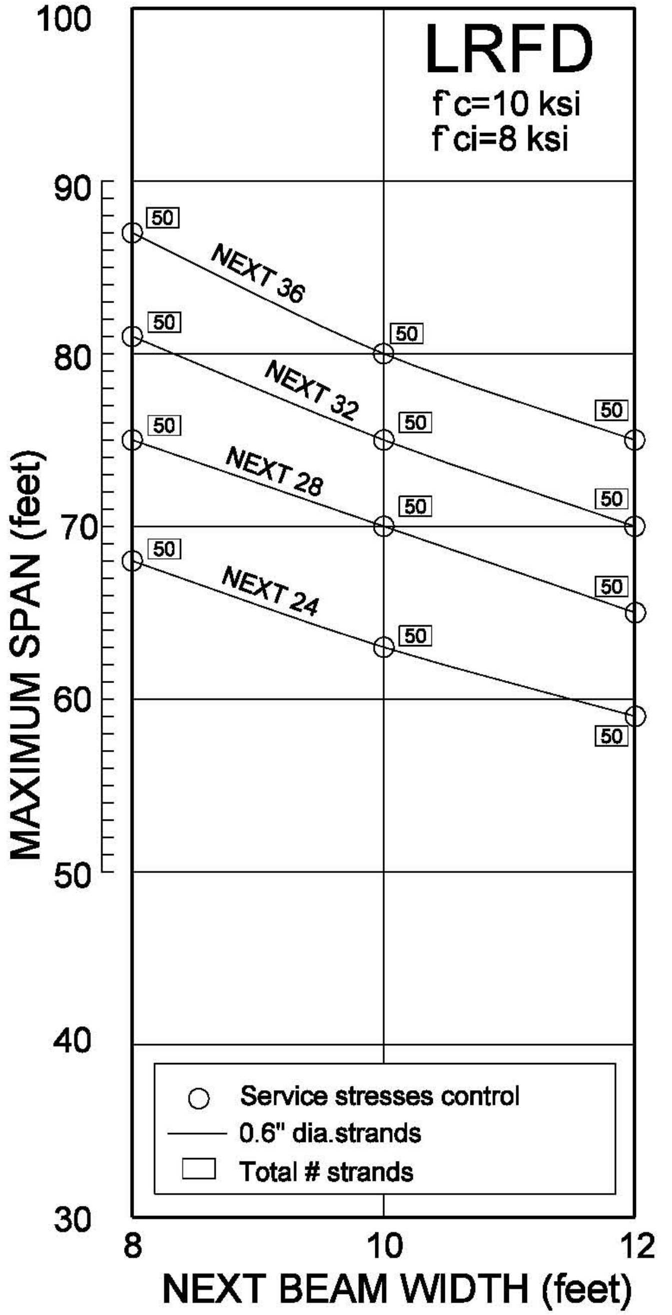
APPENDIX A – SPAN CHARTS FOR THE NEXT BEAM

These Span Charts and the Approved Beam Standards are available at
www.pcine.org





DESIGN PARAMETERS

1. Two lane 4 beam bridge section
2. 18 inch wide concrete curbs with steel rail
3. 8 inch thick RC deck: f'c = 4000 psi
4. 3 inch thick bituminous concrete overlay
5. Beam f'c = 10000 psi
6. Beam f'ci = 8000 psi
7. Debond up to 25% of strand
8. AASHTO LRFD design with allowable tensile stresses for extreme exposure
9. Straight strand only
10. No utility loads
11. Design for interior beam
12. Live load distribution factor based on composite deck stringer bridge, AASHTO cross section Type K

NOTES: 1. MAX 5 ROWS OF STRAND (PLUS TOP ROW)
2. EACH BEAM HAS 4 FULLY TENSIONED STRAND LOCATED 2.5 INCHES FROM THE TOP OF THE BEAM

REVISIONS		
NO.	DATE	DESCRIPTION

NORTHEAST EXTREME BRIDGE TEE
"NEXT" BEAMS

SPAN CHART (f'c=10 KSI)

ISSUE DATE: 02-07-08 SHEET: NEXT- 07

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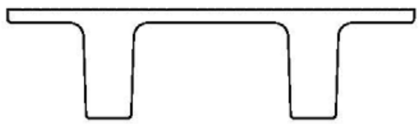

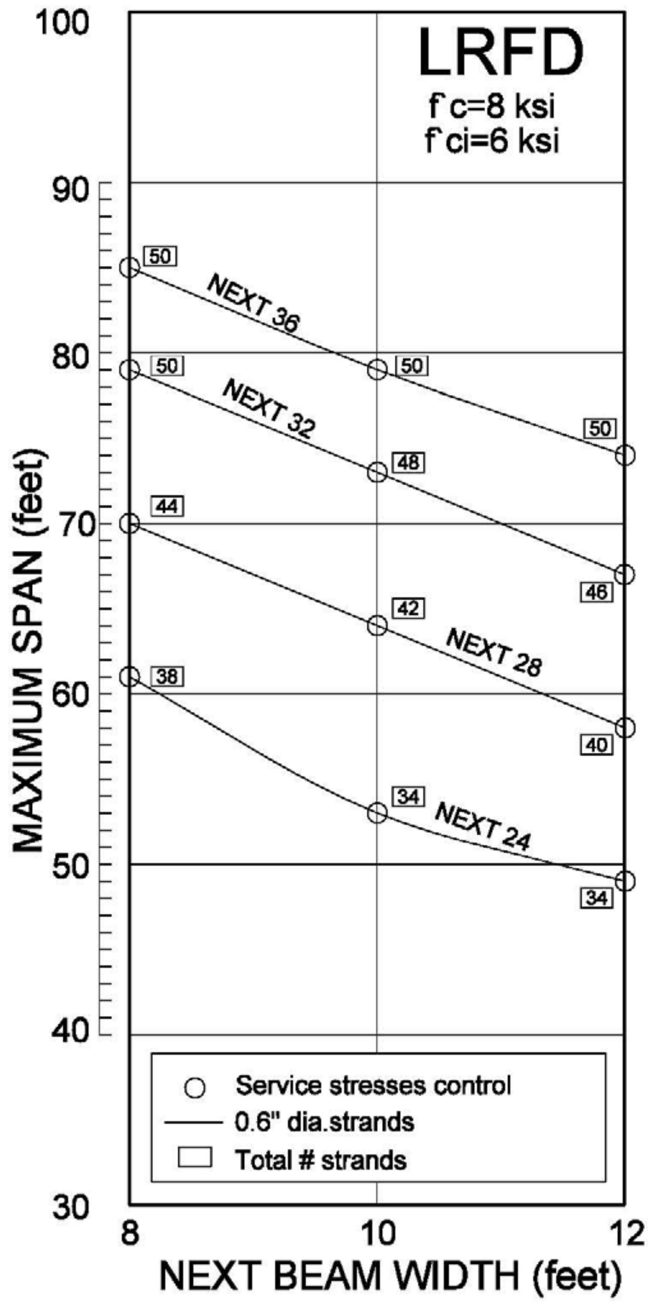

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REVISIONS		
NO.	DATE	DESCRIPTION

NORTHEAST EXTREME BRIDGE TEE
"NEXT" BEAMS

SPAN CHART (f'c=8 KSI)

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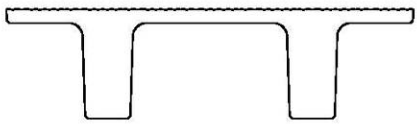

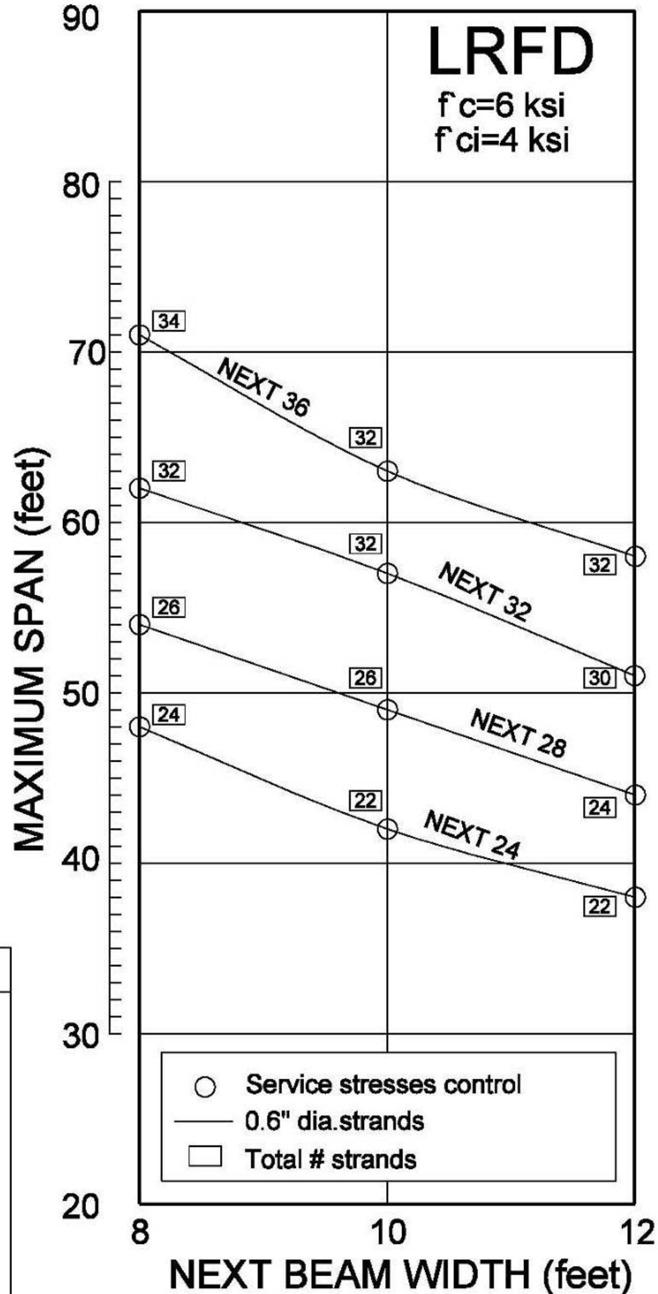

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REVISIONS		
NO.	DATE	DESCRIPTION

NORTHEAST EXTREME BRIDGE TEE
"NEXT" BEAMS

SPAN CHART (f'c=6 KSI)

ISSUE DATE: 02-07-08 SHEET: NEXT-09

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