Chapter 6: Bridge Construction Practices for Cast-In-Place Bridges

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6-1 Introduction

Cast-in-place (CIP) concrete bridges are the most common type of bridges constructed by the Department. This chapter primarily reviews typical construction practices for various components and elements of a CIP concrete bridge.

The major components of CIP concrete bridges are the substructure and superstructure. These bridge components are made of several elements. Concrete for each element of the bridge must be placed continuously. Do not allow the contractor to begin a concrete pour unless the falsework, forms, rebar, and all embedded items (if applicable) are completely installed and have been inspected by both the Contractor and Structure Construction (SC) staff. The Contractor must have sufficient labor, equipment, and material on hand to complete the planned work without interruption.

As suggested in Chapter 2, *Preconstruction Planning*, although not contractually required, consider holding a pre-operation meeting with the Contractor before starting field activities, including concrete placement-related activities. A list of items that SC staff should consider discussing with the Contractor include the following:

1. Safe access and a controlled access zone (if needed), particularly for the girder stem and soffit concrete placement.
2. Concrete mix design to be used. Contractors may utilize multiple mix designs for various uses on the same project.
3. Anticipated rate of concrete placement.
4. Direction and sequence of concrete placement.
5. Equipment and labor force on site.
6. Traffic control.
7. Contingency plans for unforeseen events.
8. Proper storm water pollution prevention plan (SWPPP) measures that need to be in place for the concrete pour, including concrete washout stations.
9. Special consideration to protect epoxy coating when epoxy-coated reinforcement is exposed beyond a construction joint (for example, barrier rail reinforcement above a bridge deck).

6-2 Substructure

The bridge substructure supports the bridge superstructure, transferring bridge and traffic loads to the ground. Substructure elements include piles, footings, columns, caps (or bent caps), abutments, and wingwalls. Piles and footings are considered foundations. A bridge bent is comprised of a column, or set of columns, and bent cap.

Bridge foundations set the location, position, and alignment of a bridge and must be verified as consistent with the project plans. The primary means of establishing the line and grade for bridges is through the “control stakes” provided by District surveyors for the bridge foundations. Since bridge foundations control the bridge lines and grades, SC staff should verify the survey stakes for the bridge foundations are correct before construction begins. Refer to Chapter 2 for additional discussion regarding line and grade control. In addition to the ensuing sections in this chapter, refer to the *Foundation Manual* for further discussion about bridge foundation construction.

6-2.01 Concrete Piles

Two types of concrete piles are commonly used in bridge construction projects: precast concrete piles and CIP concrete piles. CIP concrete piles include cast-in-drilled-hole (CIDH) and cast-in-steel-shell (CISS).

CIP concrete piles are further classified by whether the concrete is placed in a dry or dewatered hole, or if it is placed in a wet hole.

For piles cast in dry or dewatered holes, the concrete placing, consolidation, and finishing requirements are similar to those of any other structural concrete, with some special requirements unique to this type of pile. Per *Contract Specifications*, Section 49-3.01C, *Piling – Cast-In-Place Concrete Piling – General – Construction*, only the top 15 feet of concrete for CIP piles is to be vibrated. The exception to this is for piles placed under slurry, as vibration is not required for piles placed in this condition per *Contract Specifications*, Section 49-3.02C(9)(a), *Piling – Cast-In-Place Concrete Piling – Cast-In-Drilled-Hole Concrete Piling – Construction – Placing Concrete Under Slurry – General*. For dry or dewatered holes, concrete may be allowed to fall greater than 8 feet during concrete placement, provided that the concrete falls without hitting reinforcement, reinforcement bracing, or other objects in the hole on the way to the bottom, which can potentially cause the concrete to segregate. Otherwise, the Contractor must control concrete placement into the drilled hole using a delivery system such as a tremie tube or tubes. Rebar cages for piles are usually fabricated horizontally and require internal bracing (usually crossed diagonal rebar) to prevent the cages from collapsing. Unless a tremie is used for concrete placement, when the cages are lowered into position vertically, the bracing must be removed to prevent the falling concrete from striking the bracing.

For dry hole piles, concrete may be placed directly from concrete truck mixers using the truck-mounted chute. The use of a small hopper with a drop chute, or “elephant trunk”, at the top of the pile shaft will reduce segregation since it will recombine the concrete as it leaves the chute and provide a vertical fall through the reinforcing cage (see Figure 6-1). The advantage of using a chute was explained previously in Chapter 5, *Concrete.* This may be particularly important if a more fluid mixture is being used.

Figure 6-1. Hopper Placed at Top of Drilled Hole

To minimize the formation of voids and rock pockets in the lower, un-vibrated length of the pile, consider allowing water content to be increased to achieve a more fluid mixture. In no case, however, should the water content exceed the specified maximum amount.

For wet hole piles, the Contractor must be especially careful during concrete placement because of the higher likelihood of concrete defects. Because of the high risk associated with concrete placed under wet hole conditions, the *Contract Specifications* include requirements for acceptance testing, which is to be performed by the Department.

6-2.02 Footings

As discussed in Chapter 5, immediately before placing concrete, the ground surface on which the footing concrete will be deposited must be thoroughly dampened with water (in addition to the forms, if used), per *Contract Specifications*, Section 51-1.03D(1), *Concrete Structures – General – Construction – Placing Concrete – General*. This reduces the amount of water absorbed from the concrete by the ground, thus allowing concrete to cure more evenly. Although the ground should be thoroughly moistened during concrete placement, there should not be any puddles of standing water.

Footing concrete is usually deposited by tailgating from the mixers of concrete trucks. In cases where the distance between the truck mixer and the footing is too great to be reached with truck-mounted equipment, the Contractor may employ special chutes or pumps. Figure 6-2 shows a concrete pump being utilized for placing concrete for a footing. Water should not be added to facilitate the use of chutes. In the event that the bottom of the footing excavation is on a slope, the concrete should be placed first at the low end and then proceed up the slope. In all cases, concrete should be deposited near its final location. Do not permit vibrators to be used to extensively shift concrete.

Figure 6-2. Footing Concrete Placement

For contractors, building forms for footings or pile caps is not always worth the additional time, effort, and expense. Instead, contractors typically install the reinforcement in the proper location within the excavation, with the walls of the excavation functioning as formwork for the concrete. This is commonly called “pouring neat”. Depending on the skill of the excavation crew and the stability of the ground, the excavation may either be close to the dimensions of a constructed formwork system or irregular and significantly oversized.

SC staff should discuss with the Contractor whether to allow the footing to be poured neat or require forms to be installed to adhere to the dimensions shown in the project plans. In either case, any dimensional variance from the plans should be carefully measured and documented in the as-built plans. The top and bottom dimensions of the footing are important since variation will affect the stiffness of columns or piling incorporated into the footing.

If the footing is significantly over-excavated, do not allow it to be poured to that depth without consulting the Bridge Design (BD) Project Engineer. The over-excavated depth may have to be made up by placing structural backfill or filling with an incompressible material such as pea gravel or rock base. A layer of non-structural concrete, or “rat slab”, below the footing, with a bond breaker between the slab and footing, can be another option to fill the over-excavation. Curing compound can be used as a bond breaker if authorized. Confirm that the planned top of footing elevation is marked on the forms or excavation before the pour, and that the footing is poured to the proper elevation. If the footing was not constructed to the planned elevation, discuss options with the BD Project Engineer. If a variance is permitted, it must be documented in the as-builts.

Contract Specifications, Section 51-1.03D(1), *Concrete Structures – General – Construction – Placing Concrete – General,* requires concrete reconsolidation or re-vibration for footings that are more than 2-1/2 feet thick and have a top layer of reinforcing steel. The purpose of this re-vibration is to minimize the presence of voids below the top layer of reinforcing bars. Such voids, which may occur because of bleed water collecting below the bars, will reduce the bond between the concrete and the reinforcing bars. Contractors must re-vibrate concrete as late as the concrete will respond to further vibration, but no sooner than 15 minutes after initial screeding. To hasten final finishing, most contractors prefer to perform the required re-vibration sooner, rather than later. When determining the optimum delay period, keep in mind that for maximum effectiveness, re-vibration should be delayed as long as possible.

Following the usual striking-off of concrete to the planned grade and after re-vibrating the concrete, the concrete should be hand-floated to obtain an even-textured surface, free of voids, water, and air pockets. As the concrete sets, the top of the footing should be re-floated to seal the surface.

6-2.03 Columns, Abutments, and Walls

Concrete for columns (or piers), abutments, and walls is usually placed using a concrete pump or by crane and bucket. In Figure 6-3, the Contractor is using a concrete pump to place concrete for a column.

Figure 6-3. Column Concrete Placement

As mentioned in Chapter 5, when the form height exceeds 8 feet, *Contract Specifications*, Section 51-1.03D(1), *Concrete Structures – General – Construction – Placing Concrete – General,* requires concrete delivery using pipes or tubes. As mentioned earlier, a hopper with a drop chute helps to prevent segregation and aid in directing the concrete so that it does not strike the bar reinforcing steel or the sides of the forms above the level of placement. Adjustable-length metal or plastic tubes are commonly used for this purpose. When pumps are used, the pump discharge hose may be used to satisfy this requirement, in which case a hopper will not be needed.

Concrete should be placed in successive lifts and in a manner that the horizontal level of the concrete rises at a uniform rate over the entire area being placed. The lifts should be limited to those stated in the forming system design for walls and columns. The pressure exerted against the side form is directly related to the height of the plastic concrete in the form. If the placement rate is greater than assumed in the form design, the resulting higher pressure may produce excessive deflection or failure. To achieve uniform consolidation between lifts, the Contractor should penetrate vibrators into the previously placed lift. In any case, no more concrete should be deposited into the forms than can be vibrated conveniently and effectively. Be aware that, because vibration makes concrete more fluid, form pressures are greater in areas being vibrated. An otherwise stable pour could experience form failure while undergoing vibration.

Contractors typically pour an extra 1 to 2 inches of concrete on top of the theoretical top of column elevation. This additional height provides a solid vertical surface for the bent cap soffit forms to butt against, providing a good seal and hiding the construction joint above the plane of the soffit. It also acts as a concrete spacer for the bent cap bar reinforcement, helping to achieve the required cover. However, a column poured too high may result in bar reinforcement placed too high, potentially leading to additional issues such as reduced bar reinforcement clearance at the top. If project plans require polystyrene placed at the top of column, the top of concrete pour elevation must account for this polystyrene.

6-2.04 Drop Bent Caps

Bent caps are the topmost portion of a bridge bent. For bridges with steel or precast concrete girders, the end or ends of the bridge girders are seated on the bent caps. This type of bent cap is known as a drop bent cap. Figure 6-4 is an elevation view for a detail of a two-column bent with a drop bent cap for a precast girder bridge.

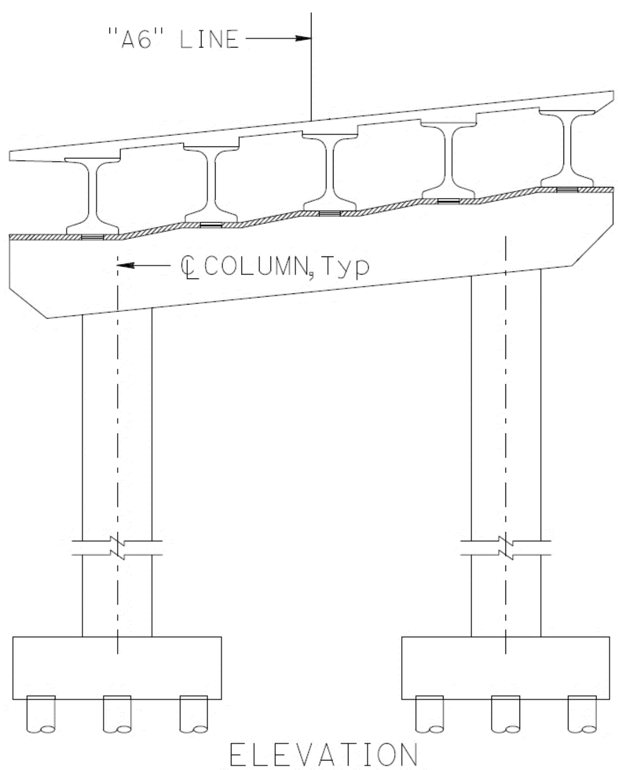

Figure 6-4. Two-Column Bent with a Drop Bent Cap

The construction sequence for a drop bent cap will occasionally require a column and bent cap to be cast in the same pour. In such cases, it is essential to delay the placing of the cap concrete until the column concrete has started setting. This allows the settlement and shrinkage of the column concrete to occur before the cap concrete is placed, thus substantially reducing shrinkage stresses at the joint between the column and cap.

6-3 Superstructure

The superstructure is the component of the bridge that supports the bridge deck loads, as well as other loads, and transfers them onto the substructure. The bridge deck, girder stems (or stems), and soffit (or bottom slab) are the primary elements of the superstructure for CIP concrete box girder bridges. Although the design of bridges considers bent caps as substructure elements, the concrete placement of bent caps for CIP concrete box girder bridges is integrally tied to the concrete placement of the superstructure.

The bridge deck provides the traveling surface for vehicles, pedestrians, and cyclists. It carries the traffic loads and distributes them to the girder stems and other portions of the superstructure. *Contract Specifications*, Section 51-1.03D, *Concrete Structures – General – Construction –Placing Concrete,* requires that the deck comprise a final and separate pour from other elements of the girder span. This prevents incorporating construction stresses into the deck due to shrinkage and falsework settlement, which can cause deck cracks. Chapter 7, *Bridge Deck Construction*, discusses bridge deck construction in detail.

6-3.01 Integral Bent Caps

The ends of concrete girder stems and soffit for CIP concrete bridges are embedded into the bent caps. For this reason, this type of bent cap is known as an integral bent cap, and its concrete placement is performed in the same concrete placing operation as the girder stems and soffit. Figure 6-5 is an elevation view for a detail of a two-column bent with an integral bent cap for a CIP box girder bridge, and Figure 6-6 shows bar reinforcement installation of an integral bent cap.

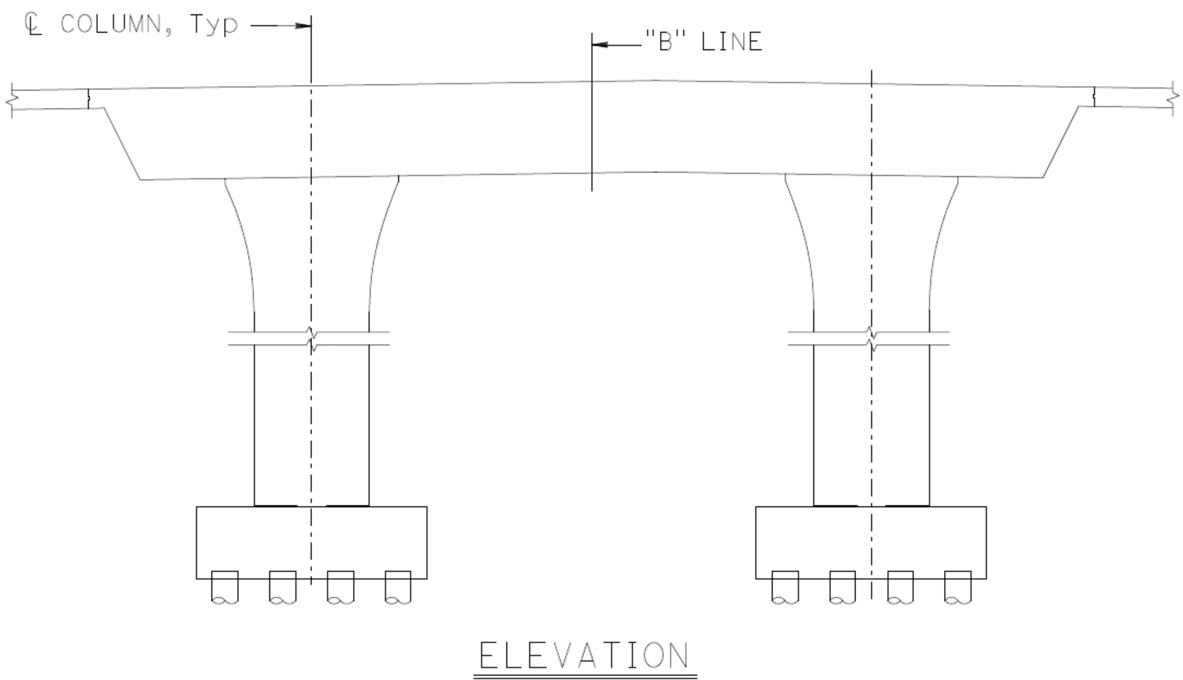

Figure 6-5. Two-Column Bent with an Integral Bent Cap

Figure 6-6. Bent Cap Bar Reinforcement Installation with Blockouts

The project plans may show openings through bent caps and other portions of the bridge to accommodate bridge access, utilities, and drainage. During reinforcement installation, confirm that the Contractor installs appropriate formwork or blockouts so that openings will be in place after the bent cap is cast. A blockout for a bent cap opening has been installed within the reinforcement, as shown in Figure 6-6.

Concrete placement for integral bent caps is comparable to placement for columns and similar elements, in that concrete should be placed in lifts at a uniform rate. The space inside the formwork tends to be congested due to the amount of reinforcement and the possible installation of prestressing ducts and deck drainage system or other utilities. Check that concrete fills all voids and is well consolidated during concrete placement.

6-3.02 Stem and Soffit

In conventional CIP concrete box girder bridge construction, the concrete for the soffit is placed with the concrete for the girder stems (and bent cap) in one concrete placement operation. Although there is no specified construction sequence, when the soffit and girder stems are placed in a single operation, most contractors place soffit concrete first and follow with the girder stems. For this placing sequence, the Contractor must decide how far ahead the soffit concrete should be placed before placing concrete in the stems. Several factors influence this decision, including the length and width of the superstructure, the expected rate of concrete placement, and probably most importantly, the size and experience of the construction crew. Ideally, the soffit concrete should be allowed to set until it is stiff enough to retain concrete placed in the stem, but not so long that it cannot be reworked.

From a construction standpoint, there is no harm if stem concrete is placed before the soffit begins to stiffen, except that additional work will be required in placing the concrete. However, if too much time elapses, a cold joint may occur between the fresh girder stem concrete and the older concrete in the soffit. This would reduce the bond at the cold joint interface. The major drawback to placing the soffit first is the need for additional finishing after the stems are poured. In the typical operation, the soffit will have been struck off and initial hand floating completed before concrete is placed in the adjacent girder stems. Vibrating the girder stems will force some concrete out of the stem below the bottom of the stem form, which will require additional cleanup and floating of the soffit.

Placing the girder stem concrete first may be advantageous because this reduces the soffit finishing effort, but this savings may be illusory when all factors are considered. When the girder stems are placed first, the vibrating of the soffit slab adjacent to the stem tends to draw concrete from the lower part of the stem into the soffit slab area. This creates voids around the longitudinal reinforcing at the bottom of the stem and, for CIP prestressed construction, below the prestressing ducts near mid-span. Unless the stem concrete is thoroughly re-vibrated after the soffit concrete is placed and vibrated, rock pockets will likely result as illustrated in Figure 6-7.

Figure 6-7. Rock Pockets Below Prestressing Ducts

For long bridge frames, and for longer spans having relatively deep girders, the stem and soffit may be cast in separate segments by utilizing transverse construction joints. Authorize construction joint locations proposed by the Contractor that are not shown in the project plans per *Contract Specifications,* Section 51-1.03D(4), *Concrete Structures – General – Construction – Placing Concrete – Construction Joints.* Per *Contract Specifications*, Section 48-2.01C(2), *Temporary Structures – Falsework – General – Submittals – General,* proposed construction joint locations must be shown on the Contractor's falsework shop drawings (see Figure 6-8).

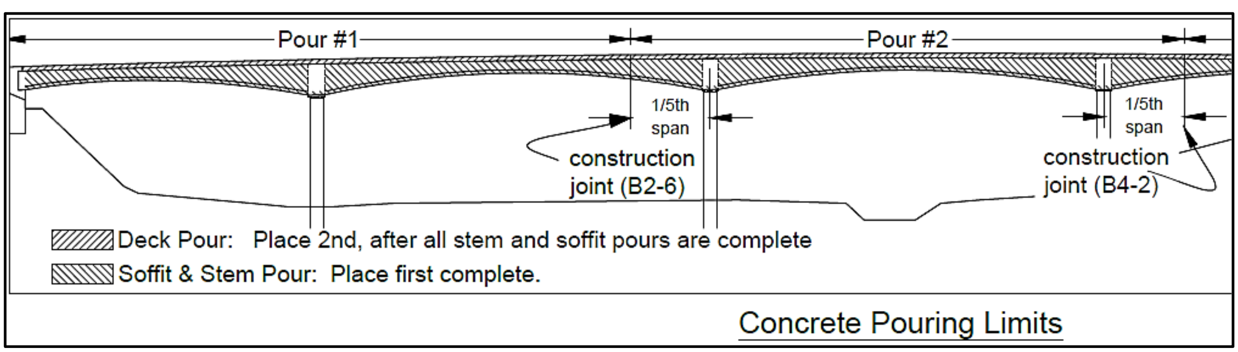

Figure 6-8. Stem and Soffit Construction Joints

Consult with the BD Project Engineer before authorizing proposed construction joint locations. Standard Plan B7-1, *Box Girder Details*, provides the details for construction joints. An example of a construction joint for a girder stem, constructed per the *Standard Plans*, is shown in Figure 6-9.

Figure 6-9. Girder Stem Construction Joint

Regardless of the placing sequence followed, as the soffit is cast, the top surface should be struck off to grade and hand-floated with a float. While the concrete sets, the Contractor should re-float the soffit as necessary to seal the surface. Girder stem concrete should be placed in lifts, and each lift must be thoroughly vibrated. To ensure the bond between successive lifts, the vibrator must penetrate through the fresh concrete and into the previously placed lift. As previously noted, if the first lift of the stems is placed prior to the soffit, the Contractor should thoroughly re-vibrate to the bottom of the stem after the soffit slab is poured to reduce the potential for voids and rock pockets near the bottom of the stem. Figure 6-10 shows a soffit and partially poured stem, as the stem is being placed in lifts.

Figure 6-10. Stem and Soffit Concrete Placement

The project plans oftentimes call for openings or items to be cast into the concrete. These may include the following:

1. Soffit access openings
2. Soffit vents
3. Utility openings
4. Ladder rungs

Make sure that these are addressed before the girder stem and soffit concrete placement. The project plans typically reference details in the *Standard Plans* for these items.

Since the bridge girder stems and bridge deck are not placed in one single operation, the construction joint between these two bridge elements is critical in making the box girder function as a monolithic structural member, as intended by its design. The horizontal shear capacity across the stem-to-deck joint increases significantly when the construction joint is intentionally roughened to a minimum amplitude of 1/4 inch, as required by *Contract Specifications*, Section 51-1.03D(4), *Concrete Structures – General – Construction – Placing Concrete – Construction Joints*. In theory, roughening the surface at the construction joint interface allows for the joint surfaces to ride up on each other as they attempt to slip. This action places the reinforcing steel across the joint (stirrups) in tension and provides a strong clamping force. Design codes allow for significantly more horizontal shear capacity when the construction joint is intentionally roughened to a minimum of 1/4 inch amplitude. Figure 6-11 illustrates the type of roughening required for the top of girder stems.

Figure 6-11. Construction Joint 1/4 Inch Roughening

Roughening the top of the stems can be accomplished by many different methods. The intent is to obtain a rough concrete surface that is not floated or troweled and provides an uneven surface with a minimum of 1/4 inch amplitude across the entire top surface of the girder stem, partially exposing, but not loosening, the coarse aggregate.

During the roughening activity, the Contractor should avoid the following:

1. Excessively dislodging coarse aggregates when using the roughening tool.
2. Floating or trowelling the top surface of the stem. Doing so forces coarse aggregate into the paste and makes the surface smooth.
3. Excessively vibrating concrete, which causes the cement paste to rise and cover coarse aggregates and potentially making the surface smooth.

In addition to roughening the stem concrete, the Contractor is required to clean the surface of the construction joints by abrasive means before deck concrete placement. This helps to remove laitance, curing compound, loose concrete, and other deleterious materials.

6-3.03 Diaphragms

Diaphragms are superstructure elements constructed transverse to the bridge. Their primary purpose is to connect girder stems together and provide stability to the bridge, while also helping with load distribution. CIP concrete bridges may incorporate various types of diaphragms. End diaphragms are located at the ends of the bridge frames at the bridge supports. Abutment diaphragms are a type of end diaphragm that connects the bridge girder stems at abutment ends, while hinge diaphragms serve a similar purpose at hinge ends. Interior diaphragms are located at intermediate locations within the bridge span, adding additional stability and stiffness.

Concrete for diaphragms is typically placed in the same concrete placement operation as the girder stems, soffit, and bent caps. For this reason, construction practices for diaphragm concrete placement are similar to girder stems and bent caps. As with bent caps, abutment and hinge diaphragms may be congested with the inclusion of hardware and additional bar reinforcement for prestressing or hinge tie-downs. Ensure that the Contractor uniformly places concrete in lifts and adequately vibrates concrete, as discussed previously in this chapter.

6-4 Other Bridge Elements

Although the substructure and superstructure are essential components of CIP concrete bridges, other bridge elements serve their own purpose and should be considered just as important. Faulty construction of any of these elements could result in a poorly constructed bridge. This section addresses the construction of various miscellaneous bridge elements.

6-4.01 Barrier Rails

Barriers are an important safety feature of bridges and roadways. They help reduce the risk of vehicles driving off the traveled way or may act as a physical separation between opposing lanes. Barriers can also reduce the severity of accidents by absorbing some of the impact energy during collisions. Various types of concrete barriers may be used on projects. Factors such as structure type, regulatory speed limit, and aesthetics govern the type chosen. This section will mostly focus on the construction of CIP concrete barriers on bridges. Bridge Construction Memo (BCM) 83-3, *Railings and Barriers - Concrete Barriers* is another resource related to concrete barrier and rail construction.

The surface of the deck where the concrete barrier is to be constructed is considered a construction joint. The Contractor must prepare the surface as described in *Contract Specifications*, Section 51-1.03D(4), *Concrete Structures – General – Construction – Placing Concrete – Construction Joints.* To prevent damage to the coating of epoxy-coated bar reinforcement cast into the deck, non-abrasive means of cleaning the deck surface may be required where these type of bars are used for concrete barriers, as discussed in Chapter 4, *Reinforcement* and Chapter 5, *Concrete*.

After they release the falsework, contractors may begin concrete barrier construction. In addition to deck surface preparation, below is a list of items to verify before or during formwork installation:

1. Bar reinforcement is properly installed, including those that should have been previously cast into the deck. Be especially attentive to additional reinforcement details at special locations, such as electroliers, pedestals, pull boxes, end of walls or deck joints, as well as barriers that are to support sound walls.
2. Concrete dobies are not installed at the side of the barrier facing traffic.
3. Embedded items such as conduits, pull boxes, and electrical mounting hardware are acceptable materials and are placed correctly.
4. Blockouts or formwork for openings such as for Midwest guardrail connections, scuppers, expansion joints, wildlife passageways, and post pockets are properly located and sized.

Projects may include architectural features, such as surface textures or colored concrete, on concrete barriers. Chapter 3, *Forms*, and Chapter 5 discuss these items in more detail.

Contract Specifications, Section 83-3.03A(3), *Railings and Barriers – Concrete Barriers – Construction – General – Adjusting Barrier Height,* requires the Contractor to adjust the height of concrete barriers for newly constructed bridges if necessary. This is to provide a smooth, finished profile along the top of the barrier. Adjusting barrier heights compensates for possible irregularities to the deck profile of newly constructed bridges, such as camber and dead load deflection. Projects that involve bridge and roadway overlay may also require barrier height adjustments so that the minimum required barrier height will result after the roadway overlay. Concrete barriers constructed on asphalt concrete (AC) or existing pavement have similar height adjustment requirements.

Adjusting the height of CIP concrete barrier forms is the typical means for adjusting the barrier height. SC staff establishes how much the forms are to be adjusted. One practice is to give the Contractor fills, or the calculations to increase heights, for barrier forms. Below is a common method for determining fills:

1. At 10 feet intervals, place marks on the deck near the inside edge of where barrier forms will be placed. Discuss with the Contractor the best place to start making marks. They should be at a close and consistent distance from the forms, strategically located so that they will not be covered, and ideally coincident with the location of joints between adjacent form panels. Three feet offset from the edge of deck is generally adequate.
2. Survey the existing deck elevations at the placed marks.

3. Generate a profile of the surveyed deck elevations.
4. Generate a smooth, best-fit profile. The newly generated profile should be at or above the existing deck elevations.
5. Calculate the elevation differences between the new profile and deck at the marked points. These differences are the fills to provide the Contractor.

Contractors may use the stringline method to check the profile smoothness when placing barrier forms initially. This method is particularly effective where the planned deck profile does not include a vertical curve. It involves setting a taut string with the ends set equidistant from the top of forms and then measuring the distance between the string and form at intervals along the string. The measured distances should be nearly consistent throughout. This same method can be used for checking the alignment of barrier forms, with the string placed along the side; note that this applies to sections of the bridge which do not contain a horizontal curve.

After all the barrier forms are in place and the Contractor has made initial adjustments, verify the smoothness of the forms by eyeballing, or viewing, along the top edge of forms. Require the Contractor to adjust the forms as needed, to achieve the desired profile.

Figure 6-12 shows a contractor using a hopper and drop chute to help with the barrier concrete placement. During concrete placement, insert copper nails into the top surface at locations referenced in BCM C-13, *Permanent Reference Elevations.*

Figure 6-12. Concrete Barrier Pour

Unless otherwise stated in the *Contract Specifications*, CIP concrete barriers must be cured using the forms-in-place method. Applying curing compound after form removal is not required. The time for forms to stay in place varies and is dependent on the type of barrier. Most CIP concrete barriers forms must stay in place for a minimum of 12 hours, with the following exceptions:

1. Sound wall supporting concrete barriers are to be cured for the timeframe specified in *Contract Specifications*, Section 90-1.03B(5), *Concrete – General – Construction – Curing Concrete – Forms-In-Place Method*.
2. Type 80 (Figure 6-13) and 85 series barriers are to be cured for at least 36 hours.

Figure 6-13. Type 80 Series Barrier

After forms are removed, test the smoothness of the top and exposed faces of barriers using a 10-foot straightedge. Both surfaces should not vary more than 0.02 feet from the straightedge. Obtain and record the elevations of permanent elevation reference points on the as-built plans. Additionally, install expansion joint scribes at each deck joint per Attachment 1, *Guidance for Verifying Contract Compliance for Sealed Joints*, of BCM 51-2, as shown in Figure 6-14. If required, the Contractor must paint the bridge name, number, and other bridge identification information at locations identified in the project plans. These locations are usually at the approach side of the structure and near the paving notch, if applicable. Text must be colored black and 2-1/2 inches high. Modify the text size and paint color if the text is not clearly visible to approaching traffic.

Figure 6-14. Expansion Joint Scribe

6-4.02 Structure Approach Slabs

Structure approach slabs, or approach slabs, are reinforced concrete slabs that connect the roadway pavement to the bridge deck. Over time, roadways may settle while bridge abutments experience little to no settlement. This is known as differential settlement. Approach slabs serve as a transition for vehicles between the two in case of differential settlement. Concrete placement of a structure approach slab is shown in Figure 6-15.

Figure 6-15. Approach Slab Concrete Placement

As suggested in Chapter 2, review the structure and roadway sections of the project plans, specifically the roadway profile and section, deck contours, and adjacent top of retaining wall elevations, to verify that elevations agree and a smooth profile will result. Bridge decks are typically constructed before Type N approach slabs. Check the as-built profile of the bridge deck to verify that the future approach slabs will provide an acceptable transition. Typically, profiling the last 100 feet of the bridge deck is sufficient to make any adjustments between the as-built deck profile, the new approach slab, and the new roadway profile. If any grade discrepancies are found before or during construction, collaborate with the Bridge Design (BD) and District Project Engineers, Resident Engineer, and the Contractor to develop a solution. Changing the bridge profile may not be possible due to minimum vertical clearance requirements or if bridge elements have already been constructed, such as the permanent installation of precast girders. In these cases, adjusting the roadway profile from the planned location may be the best solution, since the roadway is typically constructed after the bridge. Performing these checks early on can save potential rework, costs, and delays.

There are two standard approach slab designs that the Department commonly uses, found in the *Standard Plans*:

1. **Type N (30)** – typically for construction of new approach slabs (Standard Plan B9-1, *Structure Approach – Type N (30)*)
2. **Type R (30)** – typically for replacement or rehabilitation of existing approach slabs (Standard Plan B9-2, *Structure Approach – Type R (30)*).

The minimum length of the above standard approach slabs is typically 30 feet, However, their shapes can vary. The approach slab edge adjacent to the bridge is always parallel to the bridge skew. The orientation of the edge adjacent to the roadway, on the other hand, may not match the bridge skew. In some cases, this edge may be staggered. Its configuration depends on the bridge skew angle and the type of roadway pavement material it abuts, whether Hot Mix Asphalt (HMA) or Portland Cement Concrete (PCC). Figure 6-16 and 6-17 display approach slabs with roadway edges at different configurations. Verify the steel bar reinforcement will fit the actual required shape of the approach slabs.

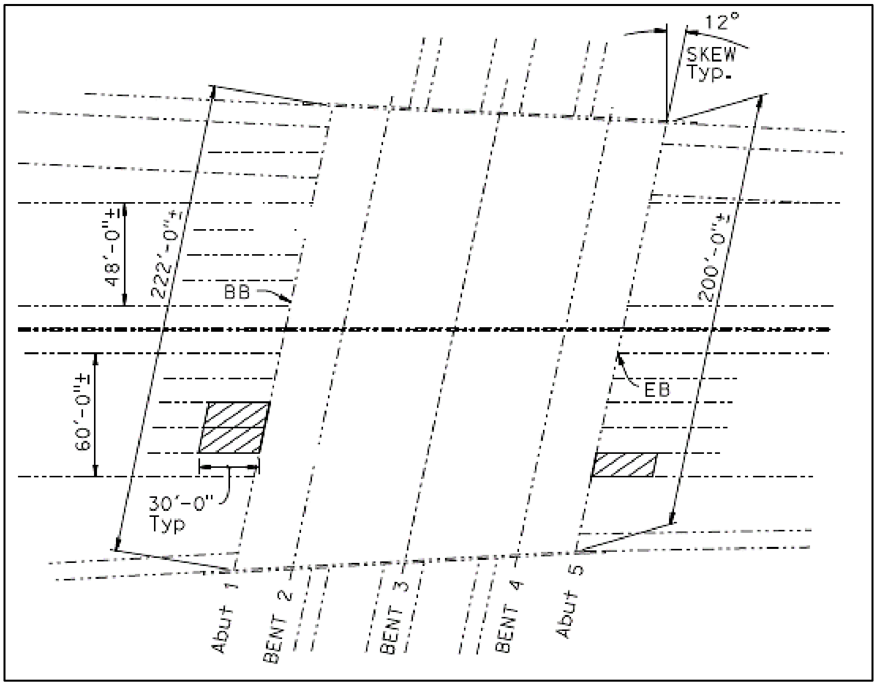

Figure 6-16. Approach Slabs with Roadway Edges Parallel to Skew

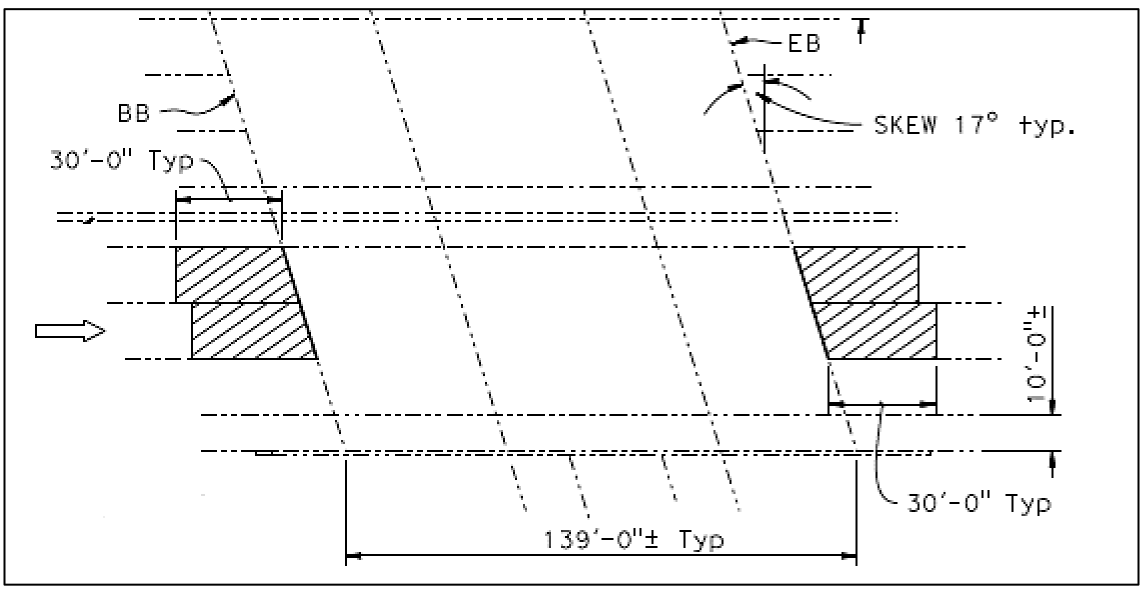

Figure 6-17. Approach Slabs with Staggered Roadway Edges

One key difference between Type N and Type R approach slabs is that Type N slabs include the placement of a 6-inch treated permeable base (TPB) with slotted pipe drains. The time afforded for Type N approach slab construction allows its design to incorporate a drainage system. Verify that filter fabric is installed per both the manufacturer's instructions and *Contract Specifications*, Section 51-5.03B(2), *Concrete*

Structures – Approach Slabs – Construction – Type N Approach Slabs – Filter Fabric, and the TPB is uniformly mixed and properly compacted, as shown in Figure 6-18. *Contract Specifications*, Section 51-5.03B(3), *Concrete Structures – Approach Slabs – Construction – Type N Approach Slabs – Treated Permeable Base*, provides direction for compacting TPB. Observe the consistency of cement treated permeable base (CTPB) during placement. Cement paste from CTPB must not plug the drain openings.

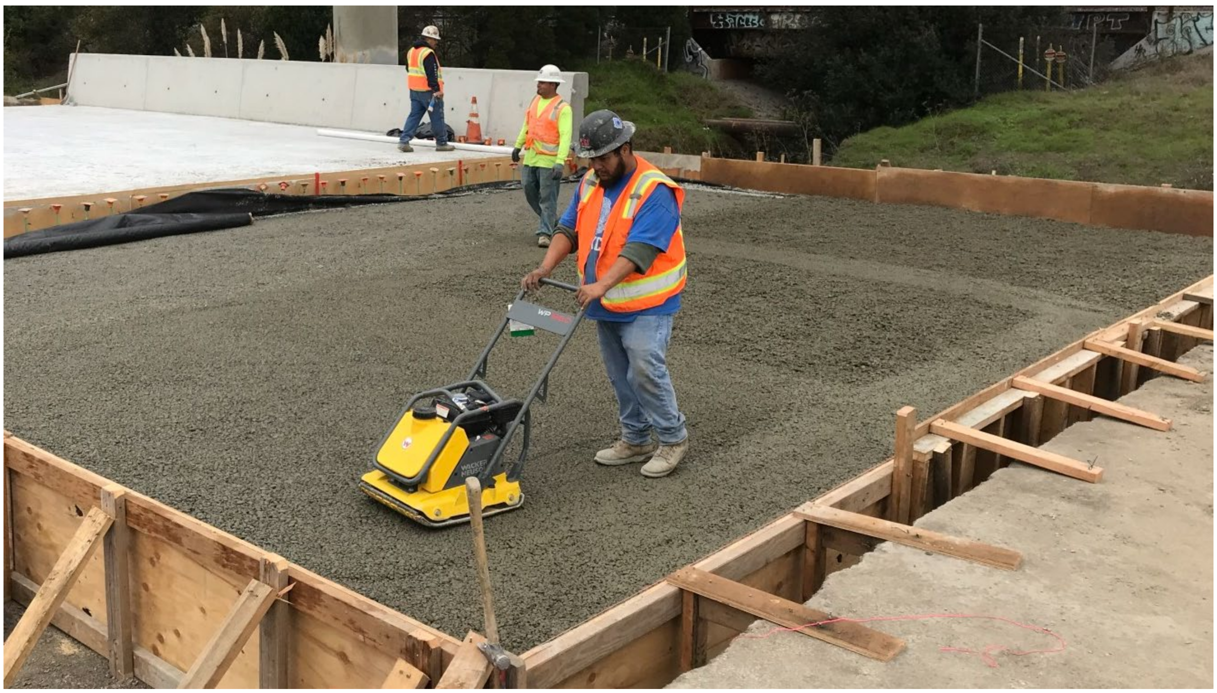

Figure 6-18. Cement Treated Permeable Base for Approach Slab

The Contractor has the option to cast approach slabs with either structural concrete or rapid strength concrete (RSC). The choice is usually dependent on whether construction staging is needed or when the approach slab needs to be open to traffic. Type N approach slabs are usually constructed at locations isolated from traffic, such as for newly constructed bridges or behind temporary railing. In these instances, the time for the approach slab to set and cure is not critical, so contractors usually elect to use structural concrete.

For all types of approach slabs, the Contractor must accommodate the type of joint seal to be installed, including blockout installation, if a joint seal assembly is called for. If the joint seal requires sawcutting grooves, make sure that approach slab rebar is not placed too close to the joint. Otherwise, rebar may encroach into intended clear cover. Additionally, confirm the installation of miscellaneous items, as they can be easily overlooked. These items include paving notches, waterstops, diaphragm abutment ties, edge angles, snowplow deflectors and barrier guards, as well as provisions for longitudinal construction joints of adjacent slabs. These items may need to be installed before, or with, the approach slab concrete placement.

The roadway surfaces of all bridge approach slabs have the same smoothness criteria and coefficient of friction requirements as bridge decks. Refer to Chapter 7 of this manual for guidance. The Begin Bridge (BB) and End Bridge (EB) are locations on approach slabs that typically require grinding. This should be considered when setting top of slab grades and installing rebar.