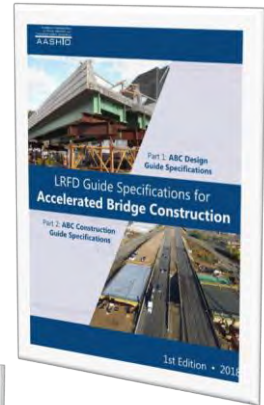


ABC-UTC 2023 In-Depth Web Training Module 1

Available Precast Substructure Specifications and Resources

Presented by:
Michael P. Culmo, PE
Chief Bridge Engineer
CHA Consulting, Inc.

September 12, 2023



1

Project Design Development Needs

- In order to execute a project, the designer needs three major items



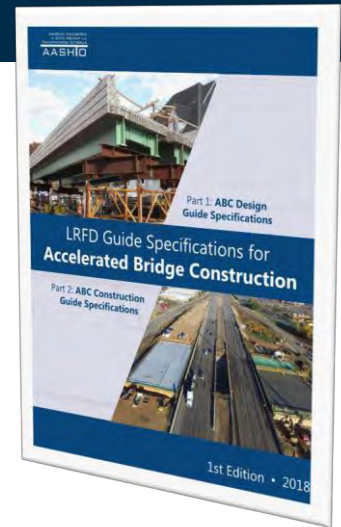
Resources exist to cover all three of these items for substructure design

2

2018

AASHTO LRFD Guide Specifications for Accelerated Bridge Construction

- Many substructure connection details are included
 - UHPC
 - Pocket & Socket Connections
 - Lapped bar reinforced connections
- Includes Seismic Provisions
- For more information:
 - Refer to previous **FIU ABC UTC Webinars**
 - Search NCHRP Projects
 - Locate Project 12-102A Website
 - **Detailed training modules are available**



CHA 3

3

Specification Overview

• Guide Specification Contents

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Design Introduction 2. General Design Provisions 3. Design of Prefabricated Elements 4. Detailing Requirements 5. Durability of ABC Technologies | <ol style="list-style-type: none"> 6. Construction Introduction 7. Temporary Works 8. Fabrication and Assembly Planning 9. Layout and Tolerances 10. Concrete Structures 11. Steel Structures 12. Geosynthetic Reinforced Soil / Integrated Bridge System |
|---|--|

Design
Specifications



Construction
Specifications



CHA 4

4

Emulation Design Theory

Design precast substructures to “Emulate” Cast-in-place concrete

- This is the basis for virtually all of the AASHTO LRFD Guide Specifications for ABC
- The only differences are the connections
 - Construction Joints → Precast Connections
- If an emulation approach is used:
 - **The design of the substructure is the same as cast-in-place construction**

2022 PCI NE Substructure Guide

- Includes detailing for all substructure types
- Based on the AASHTO LRFD Guide Specifications for ABC
- Includes Seismic Details
- Published May 13, 2022
- Available at: WWW.PCINE.ORG
- Let's take a look



Construction
Details



Guidelines for Precast Substructures used in ABC

Introduction

This guide is a replacement for the previously published *Guidelines for Accelerated Bridge Construction* developed by the PCI Northeast Bridge Technical Committee (2014). Previous editions of that document included general information on Accelerated Bridge Construction (ABC) including the use of full-depth precast concrete deck panels. In recent years, there has been a significant amount of publication of ABC related information including the 2018 AASHTO LRFD Guide Specifications for ABC. Based on this, a significant reduction in information in this document was in order to avoid conflicting information. This document focuses on recommended guide details for precast substructure elements. These guideline drawings represent typical details for the design and detailing of precast concrete substructures. The details presented provide an example of the drafting layout of typical precast concrete substructures. Several different substructure types are shown. The details cover a majority of the substructures used in the Northeast. Details and reinforcement shown are schematic. The designer should design and detail each substructure according to the specific requirements of each bridge.

Pertinent information from the previous PCI Northeast *Guidelines for Accelerated Bridge Construction (2014)* are included below.

The use of precast elements such as abutments, pier caps, pier columns, and precast footings can effectively minimize construction time, traffic disruption, and the impact of construction activities on the environment. Details have been revised and developed for the various substructure elements that represent the technologies that are covered in 2018 AASHTO LRFD Guide Specifications for ABC. This guide is not intended as a stand-alone document and does not supersede the AASHTO specifications.

Designer Responsibilities

It is the designer's responsibility to:

- Design and detail all substructure elements, including but not limited to, components such as piers, abutments, footings and foundations.
- Design precast concrete substructure elements in accordance with the latest edition of the AASHTO LRFD Bridge Design Specifications and the AASHTO LRFD Guide Specifications for Accelerated Bridge Construction.
- Design and check the substructure elements for all anticipated loads.
- Detail dimensions of all elements including internal reinforcing.
- Specify and detail tolerances for both fabrication and installation of all elements. See tolerance notes and details.
- Calculate elevations of top of all precast elements. Elevations to be included on all details.
- Determine the geotechnical requirements of the site and place the applicable information on the plans.
- Place applicable general notes on the plan set.
- Show the estimated weight of each element on the plans.

Special Notes to Designers

This document depicts schematic reinforcement details. These details have been simplified for clarity by representing reinforcing as a single line. When developing specific project design details, it is important for the designer to detail all embedded items and reinforcing using actual bar diameters (including deformations), actual bend diameters, and tails used in development hooks. This will help identify conflicts during the design process. The reinforcement depicted is not guaranteed. The final design of each element may require additional reinforcing bars and different bar layouts.

Geometric Configurations

It is preferable to have angles between abutment and wingwalls that are in-line or 90 degrees, although odd angles can be accommodated. Designers should detail abutment sizes to promote repetition of forming with consideration given to transportation, fabrication, and construction. Footing widths may be detailed such that there are common dimensions on each bridge project. For instance, on a particular bridge, all footings for wingwalls that are of approximately equal height could be kept identical (dimensions and reinforcing). The economies of repetition may outweigh the perceived benefits of individually sized elements.

Battered elements should be avoided. Batters on abutment and wing stems should be eliminated and the overall thickness of the stems should be minimized to reduce the overall weight of the element. Wall type elements typically are cast horizontally as slabs.

Tolerances

Designers should specify and account for tolerances in layout of elements and in the width of joints. Designers should specify tolerances for precast elements including fabrication tolerances, erection tolerances (both horizontal and vertical), pile driving tolerances (if applicable), and joint width tolerances. The specified width of joints should be based on the specified tolerances. A recommended guideline for specifying tolerances is *Proposed Guidelines for Prefabricated Bridge Elements and Systems Tolerances*, published under NCHRP Project 12-58. This guideline is available at the PCI Northeast website (www.pcne.org). These guide details include examples of tolerance detailing based on this document.

Recommended element fabrication tolerances are shown on Sheets SUB 15 and SUB 16. These are based on industry practice and should only be reduced after consultation with fabricators. If precast elements are to be connected to cast-in-place concrete, coordinate tolerances between shop and field personnel.

Recommended element erection tolerances are shown on various details within these guide details. Horizontal erection tolerances are always based on measurements from a common working point or line. Erection of elements based on center to center spacing should not be used as this could lead to build up of tolerances.

Recommended joint width tolerances are shown on various details within these guide details. The width of joints between elements are a function of element tolerances, erection tolerances, and placement of fill materials. The width of joints shown in these guide details should not be reduced without careful consideration of tolerances. If narrower joints are desired, smaller tolerances would need to be specified for element tolerances and erection tolerances (Refer to *Proposed Guidelines for Prefabricated Bridge Elements and Systems Tolerances* listed in the reference section of this document for guidance on specifying joint width tolerances based on specified tolerances). Note that smaller tolerances will lead to higher costs.

Vertical erection tolerances should be measured during erection at the top of each element as shown on the guide details. Horizontal joints are provided to accommodate element height tolerances during erection.

Shipping and Handling

The size of precast elements should be determined with consideration of shipping restrictions, equipment availability, and site constraints. In general, the maximum weight of precast substructure elements weighing on the order of 30 tons should be anticipated. In special cases, very large pieces can be detailed; however, the shipping, handling, and installation costs should be considered. It is possible to ship pieces in excess of 30 tons; however, the equipment required, and the limitation of local bridge load postings may restrict this. Off-loading of pieces can also be problematic. Larger pieces may be feasible if the pieces can be fabricated in close proximity to the bridge and shipped a short distance.

The designer should consider each state's requirement for allowable shipping widths and lengths. The following are general recommendations for maximum sizes of elements (including any projecting reinforcing):

- Width: 12 feet
- Height: 10 feet
- Length: 120 feet

The maximum dimensions noted are chosen to avoid cost premiums typically associated with shipping of large elements over the road. Precast elements shall be checked for stresses induced during handling and shipping. The design for handling is the responsibility of the fabricator (or contractor). The AASHTO LRFD Guide Specifications for Accelerated Bridge Construction contains recommended provisions for shipping and handling calculations.

Guidelines for Precast Substructures used in ABC

Special Materials and Devices

The details contained herein show common precast concrete elements. Some of the details show materials and products that may not be typically found in precast bridge elements. The following is a list of special materials and devices that are shown in these guide details:

- Corrugated Metal Pipe (CMP) Voids: Research has shown that standard galvanized CMP drainage pipes can be used to form voids within precast elements. These voids can be used to make connections between elements and to reduce the weight of the elements.
- Grouted Splice Couplers: These devices can be used to connect reinforcing steel bars. They are mechanical devices that meet the requirements of mechanical connectors as defined in the AASHTO LRFD Guide Specifications for Accelerated Bridge Construction. These devices are proprietary; however, they are available from multiple manufacturers.
- Leveling Devices: These are devices that are fabricated to allow for fast and accurate adjustment of the vertical elevation of elements. They are typically designed by the fabricator as part of the element lifting and placement hardware. The details depict one type of device. Alternate devices should also be allowed in the project specifications.
- Non-Compressible Shim: Several details depict the use of non-compressible shims between precast elements. The Contractor should be given leeway to select an appropriate material, however, steel shims should be avoided as there is potential for the shims to concentrate forces under the shims due to the relative stiffness of the shim versus the adjacent grout. There are specialty multipolymer shim products in the precast industry that are formulated for this purpose and are acceptable and recommended for this application.

Construction on Bedrock

A more extensive soils boring program should precede construction of precast footings so that the degree of variation of top of rock elevations can be assessed prior to construction. The uneven nature of construction of footings on bedrock may require preparation of the site prior to installation of precast footings. Over-blasting of rock by approximately 12" to provide room to prepare for a level work area is recommended. This will facilitate the installation of flowable fill or lean concrete under the footings. Designers should consider the use of cast-in-place concrete footings for footings founded on bedrock.

Construction on Soil

Prior to construction on soil, the area must be excavated and prepared as in conventional cast-in-place construction. Once the area is prepared, there are two recommended methods for preparing the area for installation of precast footings. The first is to pour a low-strength concrete sub-footing to a level that is just below the proposed bottom of footing elevation. The second method is to provide small level areas under the proposed leveling devices or shims. Temporary load distribution plates will be required under the leveling devices or shims when a sub-footing is not used in order to spread the loads to the soil. This method is more cost effective; therefore, it should be considered for most situations.

Construction on Piles

The use of precast footings (or pile caps) can be difficult. Typical pile driving tolerances lead to oversized voids for pile connections. It is recommended that cast-in-place concrete footings and pile caps be used for footings on pile foundations. These guidelines contain several options for footings on pile foundations.

Precast integral abutment stems are recommended. The typical width of integral abutment stems can often exceed larger voids that can be used for pile connections. The size of the void shall be based on driving tolerances. These guide details include recommended void sizes for different driving tolerances (See Sheet SUB 16).

Grade Control for Precast Footings

Leveling devices are critical in maintaining proper vertical grade control on precast concrete substructures. Embedded leveling devices can be used to allow for adjustment of the footing grade and elevation during installation. A minimum of four leveling devices should be specified for each spread footing element. Each

device should be designed to support half the self-weight of the footing element. Experience has shown that these leveling devices provide fast and easy grade adjustment; however, it comes at a cost. Leveling shims can be used; however, the elevation of the non-adjustable shim packs should be carefully established in order to erect the footings within the specified erection tolerance.

Concrete and Grout Notes

Precast concrete:
In general, designers should specify concrete with a minimum compressive strength of 5000 psi. The mix design of the precast concrete should normally be developed by the precast fabricator and approved by the owner.

Site cast concrete and grout:
The designer shall specify the minimum concrete properties for the final construction (strength, cure time, etc.). The engineer responsible for the assembly plan shall specify the required concrete strengths for various stages of the assembly based on calculations developed for the assembly plan. For example: the assembly plans could specify a concrete strength in a closure pour of 2 ksi for a certain stage of construction, provided that the concrete gains the full design strength prior to opening the bridge to traffic.

Recommendations for site cast concrete mixes:
Most states have standard concrete mixes for bridge construction using conventional construction. Accelerated bridge construction projects often require concrete that can gain strength and cure in a rapid manner. Material performance specifications are recommended in lieu of rigid prescriptive specifications. The following concrete strength parameters are suggested for use on prefabricated bridge projects:

- Very early strength concrete: Concrete that will attain the design strength in less than 12 hours
- Early strength concrete: Concrete that will gain the design strength in less than 24 hours
- Conventional concrete: Concrete that will gain the design strength in 7th to 28 days (* Agencies have found that their standard conventional bridge deck concretes can reach a typical strength of 4 ksi in as little as 7 days.)

Shrinkage of early strength concrete can lead to cracking. For this reason, shrinkage compensating admixtures should be considered. Liquid admixtures should be used in lieu of expansive metallic powders.

It is recommended that the states work with local ready-mix producers to develop acceptable mix designs that can meet the required parameters. Ideally, these mixes should be developed prior to bidding an accelerated bridge construction project.

Controlled density fill (flowable fill):

Controlled density fill can be used to fill voids that are not subjected to high unit stresses and are not reinforced. The strength of controlled density fill is often less than non-shrink grout; however, the required strength under a footing is typically well within the limits of common controlled density fills, as most spread footings and slabs are less than 100 psi. This normally includes areas that are used to seat footings and slabs. Typical areas include voids under footings and approach slabs. Controlled density fills have relatively slow set times. Use grout to fill voids if fast set times are required. Designers should verify the acceptability of the use of flowable fills with the owner.

Grout:

Grout should only be used for small void grouting. The required strength of the grout should be determined and specified by the design engineer. Normally the design strength is the same strength as the surrounding concrete.

Flowable grout should be specified in areas that require significant horizontal flow of the grout in order to fill the void. This would normally include horizontal joints between vertical elements. For complex voids, the

Guidelines for Precast Substructures used in ABC

engineer may specify a test mock-up grout pour prior to the actual construction. The mock-up should be similar to the final configuration. The contractor should be required to demonstrate that the grout can be placed without voids. This can be proven by dismantling of the mock-up after grout curing.

Joints and Connections between Elements

Joints fall under two categories. The first category is structural connections that transmit moment, axial, or shear forces between elements. The second category is non-structural connections that may be used for thermal movements or to separate discrete portions of the structure (e.g. abutment to wingwall joint). This guide contains multiple details for different joints and connections between various precast elements. In most cases, several options are provided.

Surfaces of joints should be specified to have an exposed aggregate finish. This is achieved through the use of retarders applied to the forms and/or water blasting after stripping. A specific profile amplitude need not be specified. If the designer prefers to specify an amplitude, it should be specified as 1/8".

Vertical Joints

A flowable, cementitious grout should be used for vertical joints. It should be introduced at the top of the joint, filling it from bottom to top. Designers should specify the use of rigid formwork for the joints and rodding of grout during installation to minimize voids as a significant hydraulic head will be created due to the typical height of the joints being filled. Backer rods placed at the edges of the enclosed vertical joint as a dam against the fluid grout will not be adequate in restraining the grout due to the fluid pressure. It is recommended that such a joint be restrained with formwork in most cases.

If shear transfer is not required, consider filling this joint with expanding foam sealant or other fillers. This treatment may be considered adequate if the joint is deemed non-structural. The expanding foam keeps the joint free of foreign material. Pre-applied rigid joint filler materials are not recommended. Inserting rigid fillers after assembly is also not recommended. Experience has shown that tolerance between the elements will be compromised with the use of rigid fillers. Installation of rigid fillers after assembly is nearly impossible and results in a poor quality joint. Note that non-structural joints are not shown in the enclosed details.

Design of Connections

The design of connections shall be in accordance with the AASHTO LRFD Guide Specifications for Accelerated Bridge Construction. The design provisions for the connections shown in these guide details are covered in this AASHTO Specification. Seismic connections are included in these guide details. Refer to the AASHTO LRFD Guide Specifications for Accelerated Bridge Construction for special design requirements for seismic applications. Several of these connections require additional reinforcement within the precast element to achieve the proper seismic performance. It is acceptable to use seismic details in non-seismic regions.

Construction Specifications

The previous versions of these guide details included significant construction specifications and recommendations. The AASHTO LRFD Guide Specifications for Accelerated Bridge Construction now contains similar provisions and more, therefore, they should be used for the development of construction specifications for precast elements.

Repair of Non-conformances and Damage during Fabrication and Shipping

As with any manufacturing process, non-conformances and damage can occur in precast concrete bridge products. Examples may include voids, cracks, as well as missing, improperly located, or damaged reinforcement and hardware. The repairs of non-conformances and damage should be in accordance with the document entitled *Guidelines for Resolution of Non-Conformances in Precast Concrete Bridge Elements* (Report No. PCINE-18-RNPCBE) and can be found at www.pcine.org.

References:

The following references should be used for the development of designs, details, and construction specifications for precast bridge elements. Edition numbers are not included in this list. Designers should use the latest edition of these documents unless the owner places specific limitations on usage of editions.

- AASHTO LRFD Bridge Design Specifications, American Association of State Highway and Transportation Officials.
- AASHTO LRFD Guide Specifications for Accelerated Bridge Construction, American Association of State Highway and Transportation Officials.
- PCI Documents (located at www.pci.org)
 - PCI Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products, PCI MNL-116, Precast/Prestressed Concrete Institute, Chicago, IL.
 - Bridge Design Manual, PCI MNL-153, Precast/Prestressed Concrete Institute, Chicago, IL.
 - PCI Design Handbook Precast and Prestressed Concrete, The Precast/Prestressed Concrete Institute, Chicago, IL.
 - Erection Safety for Precast and Prestressed Concrete, PCI MNL-132, Precast/Prestressed Concrete Institute, Chicago, IL.
 - Erectors Manual—Standard and Guidelines for the Erection of Precast Concrete Products, PCI MNL-127, Precast/Prestressed Concrete Institute, Chicago, IL.
- PCI Northeast Documents (located at www.pcine.org)
 - Guidelines for Resolution of Non-Conformances in Precast Concrete Bridge Elements, (Report No. PCINE-18-RNPCBE)
- FHWA Manuals and Guidelines
 - Accelerated Bridge Construction - Experience in Design, Fabrication and Erection of Prefabricated Bridge Elements and Systems, (FHWA-HIF-12-013), U.S. Department of Transportation, Federal Highway Administration, November 2011.
 - Engineering Design, Fabrication and Erection of Prefabricated Bridge Elements and Systems, (FHWA-HIF-17-019), U.S. Department of Transportation, Federal Highway Administration, November 2013.
 - Contracting and Construction of ABC Projects with Prefabricated Bridge Elements and Systems, (FHWA-HIF-17-020), U.S. Department of Transportation, Federal Highway Administration, November 2013.
- NCHRP Project 12-98, Proposed Guidelines for Prefabricated Bridge Elements and Systems Tolerances, (available at www.pcine.org), National Cooperative Highway Research Program, Washington, D.C.

Usage of this Document:

The following page contains a usage table for each detail contained herein. The table includes the following:

- The connection detail title and sheet location where connection details reside
- Sheet reference where the connection details are recommended for use
- Advantages of each connection detail
- Design/Construction Considerations for each connection detail

The table contains hyperlinks that will bring users to the referenced sheet. Each detail sheet also contains a hyperlink that will return the users back to the table.



Guidelines for Precast Substructures used in ABC

There are options for each connection depicted in these guide details. The designer should choose connection details that are appropriate for the bridge being designed and approved by the owner. It is recommended that the number of different connections in a project be minimized in order to simplify the fabrication and construction. The following table outlines the advantages and disadvantages of each connection to aid in the selection of details.

Detail Title (Sheet #)	Detail Usage Reference (sheet #)	Advantages	Design/Construction Considerations
G1 Grouted Coupler Connection Precast Column to Wall Panel to Footing (08)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Placement of coupler is outside the potential plastic hinge zone Coupler can be pre-grouted just prior to placement of the upper element Upper element bars can be placed closer to the column face 	<ul style="list-style-type: none"> Potential for debris to get into coupler during construction (will require covers and cleaning prior to placement of upper element) Upper element will have projecting bars that may get damaged during handling
G2 Grouted Coupler Connection Column to Bent Cap (09)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Less chance of debris getting into the coupler during construction Upper element is easier to handle without projecting bars 	<ul style="list-style-type: none"> Grout must be pumped into coupler after placement of upper element Upper element bars need to be placed deeper into the section to provide cover over the couplers
G3 Grouted Coupler Connection Column to Bent Cap (09)	(01) (02) (03) (04) (05)	<ul style="list-style-type: none"> Same as G2 	<ul style="list-style-type: none"> Same as G2
P1 Pocket Connection Column to Bent Cap (10)	(01) (02) (03) (04) (05)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Placement of concrete is easy Can accommodate significant tolerances Can be used in seismic regions 	<ul style="list-style-type: none"> Layout of bars in cap and column need to be carefully coordinated to avoid conflicts during erection Temporary support of cap may require temporary supports and braces
P2 Pocket Connection Wall Panel to Cap (11)	(03) (05)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can accommodate significant tolerances 	<ul style="list-style-type: none"> Piers required to place concrete
P3 Pocket Connection Column to Bent Cap Connection Using Post-Tensioning (PT) Over Pockets (11)	(01) (02) (03) (04) (05)	<ul style="list-style-type: none"> Simple connection made with either conventional concrete or grout Placement of FR concrete is easy Can accommodate larger tolerances when compared to grouted coupler connections Can be used in seismic regions 	<ul style="list-style-type: none"> Requires smaller tolerance when compared to connection P2 PT ducts may interfere with layout of cap reinforcement. Special detailing may be required.
P4 Pocket Connection Cap In-Place Footing Precast Column or Wall Panel (12)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can accommodate significant tolerances Good for pile-supported footings Can be used in seismic regions Bottom mats of reinforcement can be placed prior to erection of upper element 	<ul style="list-style-type: none"> Requires temporary support and bracing Top mats of footing reinforcement cannot be placed until after the upper element is erected
P5 Pocket Connection Footing to Wall Panel (12)	(03) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Can accommodate significant tolerances Can be less expensive than grouted coupler connections 	<ul style="list-style-type: none"> Layout of projecting footing bars needs to be coordinated with wall panels Requires temporary bracing of wall panel Size of voids may require wider wall panels Choices of projecting bars from footing are not as efficient as grouted coupler bars, which may limit height of wall
S1 Socket Connection Cap-In-Place Footing to Column (13)	(01) (02)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Can accommodate significant tolerances Good for pile-supported footings All footing reinforcement can be pre-tied and placed before erection of the column 	<ul style="list-style-type: none"> Requires temporary bracing of column Requires special surface treatment of embedded portion of column
S2 Socket Connection Footing to Wall Panel (13)	(04) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Check wall can be integral or a separate element 	<ul style="list-style-type: none"> Requires tighter pile installation tolerances in order to keep pile size and term width reasonable
K1 Key Connection Abutment and Wall Plate Sums Shim Key (14)	(03) (04) (05)	<ul style="list-style-type: none"> Simple connection made with conventional concrete 	<ul style="list-style-type: none"> Forming required to retain concrete
K2 Key Connection Footing Key (14)	(03) (05)	<ul style="list-style-type: none"> Same as K1 	<ul style="list-style-type: none"> Same as K1
K3 Key Connection Wall Key (14)	(04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with non-shrink grout 	<ul style="list-style-type: none"> Forming required to retain grout
RC1 Reinforced Concrete Joint (07)	(02) (03) (04) (05)	<ul style="list-style-type: none"> Can be used to create a flexurally continuous footing or other element 	<ul style="list-style-type: none"> Footing can be designed as individual footings for dead loads and continuous for live loads

Note: Blue text represents hyperlinks to detail sheets.



Guidelines for Precast Substructures used in ABC

There are options for each connection depicted in these guide details. The designer should choose connection details that are appropriate for the bridge being designed and approved by the owner. It is recommended that the number of different connections in a project be minimized in order to simplify the fabrication and construction. The following table outlines the advantages and disadvantages of each connection to aid in the selection of details.

Detail Title (sheet #)	Detail Usage Reference (sheet #)	Advantages	Design/Construction Considerations
G1 Grouted Coupler Connection Precast Column or Wall Panel to Footing (08)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Placement of couplers is outside the potential plastic hinge zone Coupler can be pre-grouted just prior to placement of the upper element Upper element bars can be placed closer to the column face 	<ul style="list-style-type: none"> Potential for debris to get into coupler during construction (will require covers and cleaning prior to placement of upper element) Upper element will have projecting bars that may get damaged during handling
G2 Grouted Coupler Connection Precast Column or Wall Panel to Footing (08)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Less chance of debris getting into the coupler during construction Upper element is easier to handle without projecting bars 	<ul style="list-style-type: none"> Grout must be pumped into coupler after placement of upper element Upper element bars need to be placed deeper into the section to provide cover over the couplers
G3 Grouted Coupler Connection Column to Beam Cap (09)	(01) (02) (03) (04) (05) (06)		
P1 Pocket Connection Column to Beam Cap (09)	(01) (02) (03) (04) (05) (06)		
P2 Pocket Connection Wall Panel to Cap (11)	(01) (02) (03) (04) (05) (06)		
P3 Pocket Connection Column to Beam Cap Connection Using Post-Tensioning (PT) Ducts (11)	(01) (02) (03) (04) (05) (06)		
P4 Pocket Connection Cap-In-Place Footing Precast Column or Wall Panel (12)	(01) (02) (03) (04) (05) (06)		
P5 Pocket Connection Footing to Wall Panel (12)	(01) (02) (03) (04) (05) (06)		
S1 Socket Connection Cap-In-Place Footing Column (13)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete 	<ul style="list-style-type: none"> Requires temporary bracing of column
S2 Socket Connection Pile to Wall Panel (13)	(01) (02) (03) (04) (05) (06)		
K1 Key Connection Abutment and Wall Pier Stem Shim Key (14)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Backwall can be integral or a separate element Simple connection made with conventional concrete 	<ul style="list-style-type: none"> Forming required to retain concrete
K2 Key Connection Footing Key (14)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Same as K1 	<ul style="list-style-type: none"> Same as K1
K3 Key Connection Wall Key (14)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with non-shrink grout 	<ul style="list-style-type: none"> Forming required to retain grout
RCI Reinforced Concrete Joint (07)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Can be used to create a flexurally continuous footing or other element 	<ul style="list-style-type: none"> Footing can be designed as individual footings for dead loads and continuous for live loads

Note: Blue text represents hyperlinks to detail sheets

Page vi



Guidelines for Precast Substructures used in ABC

There are options for each connection depicted in these guide details. The designer should choose connection details that are appropriate for the bridge being designed and approved by the owner. It is recommended that the number of different connections in a project be minimized in order to simplify the fabrication and construction. The following table outlines the advantages and disadvantages of each connection to aid in the selection of details.

Detail Title (sheet #)	Detail Usage Reference (sheet #)	Advantages	Design/Construction Considerations
G1 Grouted Coupler Connection Precast Column or Wall Panel to Footing (08)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Placement of couplers is outside the potential plastic hinge zone Coupler can be pre-grouted just prior to placement of the upper element Upper element bars can be placed closer to the column face 	<ul style="list-style-type: none"> Potential for debris to get into coupler during construction (will require covers and cleaning prior to placement of upper element) Upper element will have projecting bars that may get damaged during handling
G2 Grouted Coupler Connection Precast Column or Wall Panel to Footing (08)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Less chance of debris getting into the coupler during construction Upper element is easier to handle without projecting bars 	<ul style="list-style-type: none"> Grout must be pumped into coupler after placement of upper element Upper element bars need to be placed deeper into the section to provide cover over the couplers
G3 Grouted Coupler Connection Column to Beam Cap (09)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Same as G2 	<ul style="list-style-type: none"> Same as G2
P1 Pocket Connection Column to Beam Cap (10)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Placement of concrete is easy Can accommodate significant tolerances Can be used in seismic regions 	<ul style="list-style-type: none"> Layout of bars in cap and column need to be carefully coordinated to avoid conflicts during erection Temporary support of cap may require temporary supports and braces
P2 Pocket Connection Wall Panel to Cap (11)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can accommodate significant tolerances 	<ul style="list-style-type: none"> Piers required to place concrete
P3 Pocket Connection Column to Beam Cap Connection Using Post-Tensioning (PT) Ducts/Pockets (11)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with either conventional concrete or grout Placement of fill concrete is easy Can accommodate larger tolerances when compared to grouted coupler connections Can be used in seismic regions 	<ul style="list-style-type: none"> Requires smaller tolerance when compared to connection P2 PT ducts may interfere with layout of cap reinforcement. Special detailing may be required.
P4 Pocket Connection Cap-In-Place Footing at Precast Column or Wall Panel (12)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can accommodate significant tolerances Good for pile-supported footings Can be used in seismic regions 	<ul style="list-style-type: none"> Requires temporary support and bracing Top mats of footing reinforcement cannot be placed until after the upper element is erected
P5 Pocket Connection Footing to Wall Panel (12)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Can accommodate significant tolerances Bottom mats of reinforcement can be placed prior to erection of upper element 	<ul style="list-style-type: none"> Layout of projecting footing bars needs to be coordinated with wall panels Requires temporary bracing of wall panel Size of voids may require wider wall panels Choice of projecting bars from footing are not as efficient as grouted coupler bars, which may limit height of wall
S1 Socket Connection Cap-In-Place Footing in Column (13)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Can accommodate significant tolerances Good for pile-supported footings All footing reinforcement can be pre-tied and placed before erection of the column 	<ul style="list-style-type: none"> Requires temporary bracing of column Requires special surface treatment of embedded portion of column
S2 Socket Connection Pile to Wall Panel (13)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Backwall can be integral or a separate element 	<ul style="list-style-type: none"> Requires tighter pile installation tolerances in order to keep pile size and stem width reasonable
K1 Key Connection Abutment and Wall Pier Stem Shim Key (14)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete 	<ul style="list-style-type: none"> Forming required to retain concrete
K2 Key Connection Footing Key (14)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Same as K1 	<ul style="list-style-type: none"> Same as K1
K3 Key Connection Wall Key (14)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with non-shrink grout 	<ul style="list-style-type: none"> Forming required to retain grout
RCI Reinforced Concrete Joint (07)	(01) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Can be used to create a flexurally continuous footing or other element 	<ul style="list-style-type: none"> Footing can be designed as individual footings for dead loads and continuous for live loads

Note: Blue text represents hyperlinks to detail sheets

Page vi

Detail Usage Table

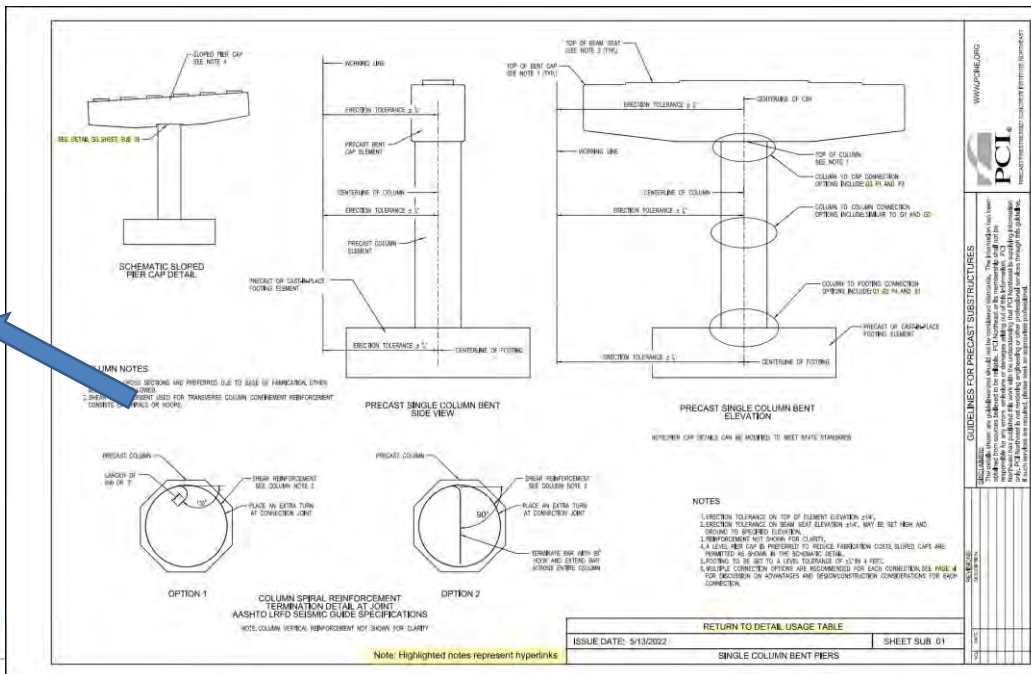
Guidelines for Precast Substructures used in ABC			
There are options for each connection depicted in these guide details. The designer should choose connection details that are appropriate for the bridge being designed and approved by the owner. It is recommended that the number of different connections in a project be minimized in order to simplify the fabrication and construction. The following table outlines the advantages and disadvantages of each connection to aid in the selection of details.			
Detail Title (Sheet #)	Reference Object	Advantages	Design/Construction Considerations
G1 Grouted Coupler Connection Precast Column or Wall Panel (in Footing) (05)	(07) (02) (03) (04) (05) (06)	<ul style="list-style-type: none"> Placement of couplers is outside the potential plastic hinge zone Coupler can be pre-grouted just prior to placement of the upper element Upper element bars can be placed closer to the column face 	<ul style="list-style-type: none"> Potential for debris to get into coupler during construction (will require covers and cleaning prior to placement of upper element) Upper element will have projecting bars that may get damaged during handling
Advantages		Design/Construction Considerations	
<ul style="list-style-type: none"> Placement of couplers is outside the potential plastic hinge zone Coupler can be pre-grouted just prior to placement of the upper element Upper element bars can be placed closer to the column face 		<ul style="list-style-type: none"> Potential for debris to get into coupler during construction (will require covers and cleaning prior to placement of upper element) Upper element will have projecting bars that may get damaged during handling 	
P2 Pocket Connection Wall Panel or Cap (11)	(01) (05)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can accommodate significant tolerances 	<ul style="list-style-type: none"> Ports required to place concrete
P3 Pocket Connection Column to Bent Cap Connection Using Post-Tensioning (PT) Dead Pockets (11)	(01) (02) (03) (05)	<ul style="list-style-type: none"> Simple connection made with either conventional concrete or grout Placement of fill concrete is easy Can accommodate larger tolerances when compared to grouted coupler connections Can be used in seismic regions 	<ul style="list-style-type: none"> Requires smaller tolerances when compared to connection P2 PT ducts may interfere with layout of cap reinforcement. Special detailing may be required.
P4 Pocket Connection Cap-to-Place Footing to Precast Column or Wall Panel (12)	(01) (02) (03) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can accommodate significant tolerances Good for pile-supported footings Can be used in seismic regions Bottom mats of reinforcement can be placed prior to erection of upper element 	<ul style="list-style-type: none"> Requires temporary support and bracing Top mats of footing reinforcement cannot be placed until after the upper element is erected
P5 Pocket Connection Footing to Wall Panel (12)	(03) (05) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Can accommodate significant tolerances Can be less expensive than grouted coupler connections 	<ul style="list-style-type: none"> Layout of projecting footing bars needs to be coordinated with wall panels Requires temporary bracing of wall panel Size of voids may require wider wall panels Clusters of projecting bars from footing are not as efficient as grouted coupler bars, which may limit height of wall
S1 Socket Connection Cap-to-Place Footing to Column (17)	(01) (02)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Can accommodate significant tolerances Good for pile-supported footings All footing reinforcement can be pre-tied and placed before erection of the column 	<ul style="list-style-type: none"> Requires temporary bracing of column Requires special surface treatment of embedded portion of column
S2 Socket Connection Pile to Wall Panel (17)	(04) (06)	<ul style="list-style-type: none"> Simple connection made with conventional concrete Can be used in seismic regions Blockwall can be integral or a separate element 	<ul style="list-style-type: none"> Requires tighter pile installation tolerances in order to keep pipe size and stem width reasonable
K1 Key Connection Abutment and Wall Pier Stem Shear Key (14)	(03) (04) (05)	<ul style="list-style-type: none"> Simple connection made with conventional concrete 	<ul style="list-style-type: none"> Forming required to retain concrete
K2 Key Connection Footing Key (14)	(03) (07)	<ul style="list-style-type: none"> Same as K1 	<ul style="list-style-type: none"> Same as K1
K3 Key Connection Wall Key (14)	(04) (05) (06)	<ul style="list-style-type: none"> Simple connection made with non-shrink grout 	<ul style="list-style-type: none"> Forming required to retain grout
RC1 Reinforced Closing Joint (07)	(02) (03) (04) (05)	<ul style="list-style-type: none"> Can be used to create a flexurally continuous footing or other element 	<ul style="list-style-type: none"> Footing can be designed as individual footings for dead loads and continuous for live loads

Note: Blue text represents hyperlinks to detail sheets

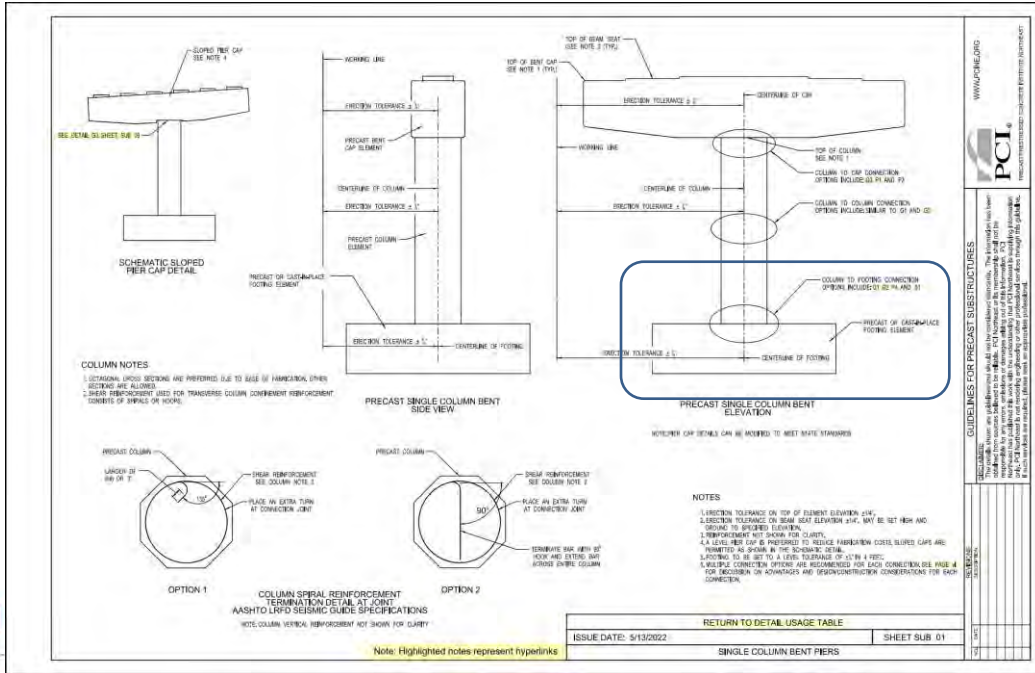
Page vi



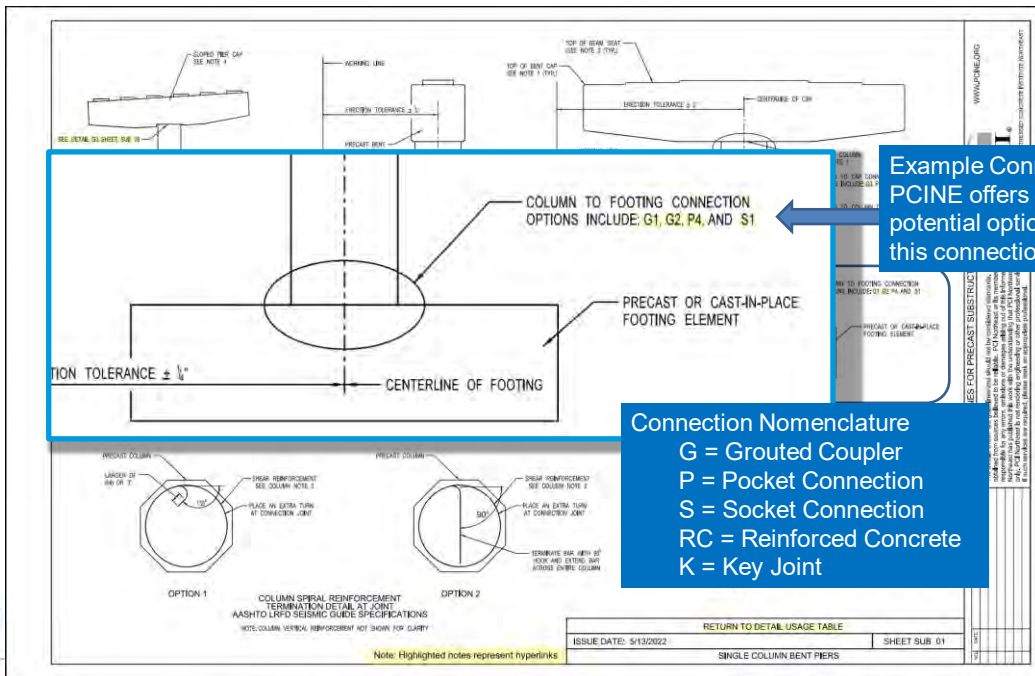
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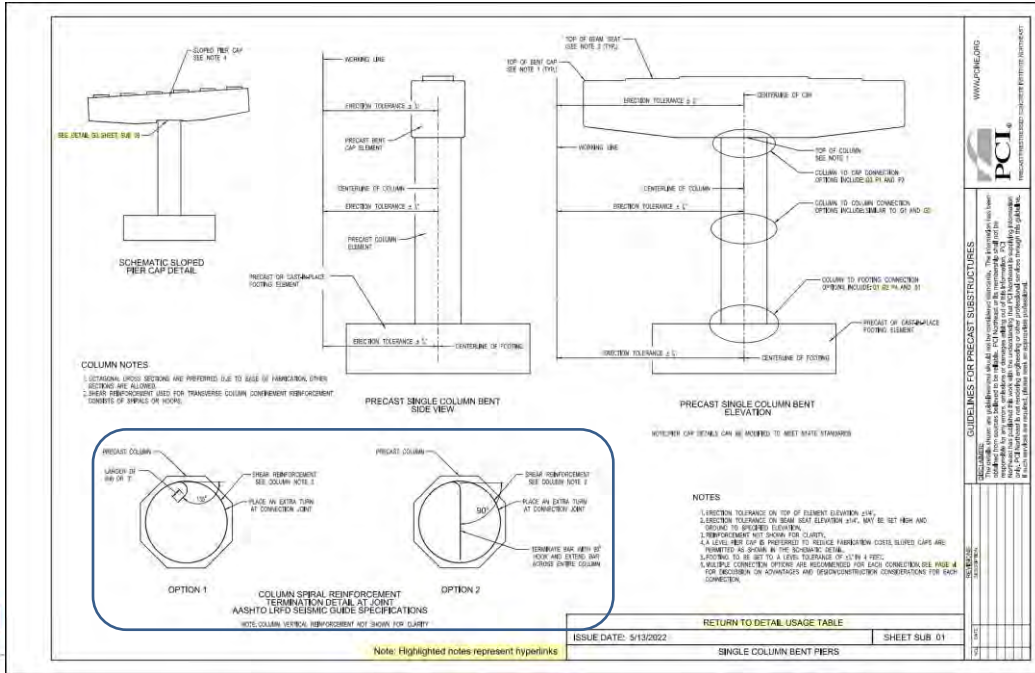
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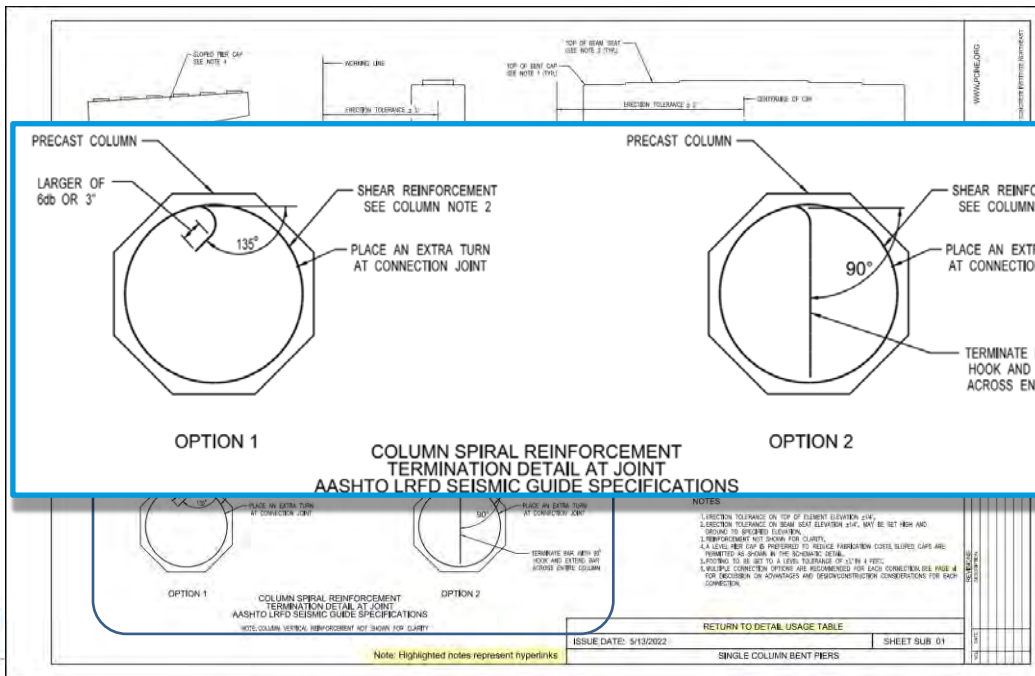
Single Column Pier



Single Column Pier



Single Column Pier



Single Column Pier



SCHEMATIC SLOPED PIER CAP DETAIL

PRECAST SINGLE COLUMN BENT SIDE VIEW

PRECAST SINGLE COLUMN BENT ELEVATION

COLUMN NOTES

OPTION 1

OPTION 2

COLUMN SPIRAL REINFORCEMENT TERMINATION DETAIL AT JOINT

NOTES

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 01

SINGLE COLUMN BENT PIERS

Note: Highlighted notes represent hyperlinks

Single Column Pier



SCHEMATIC SLOPED PIER CAP DETAIL

PRECAST SINGLE COLUMN BENT SIDE VIEW

PRECAST SINGLE COLUMN BENT ELEVATION

COLUMN NOTES

OPTION 1

OPTION 2

COLUMN SPIRAL REINFORCEMENT TERMINATION DETAIL AT JOINT

NOTES

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

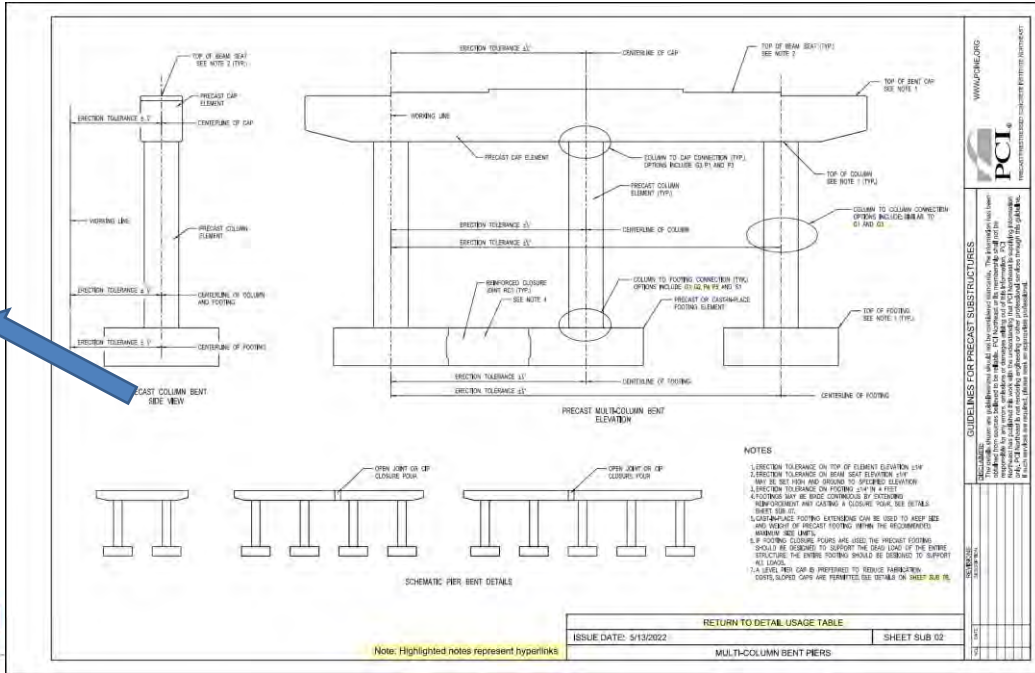
SHEET SUB 01

SINGLE COLUMN BENT PIERS

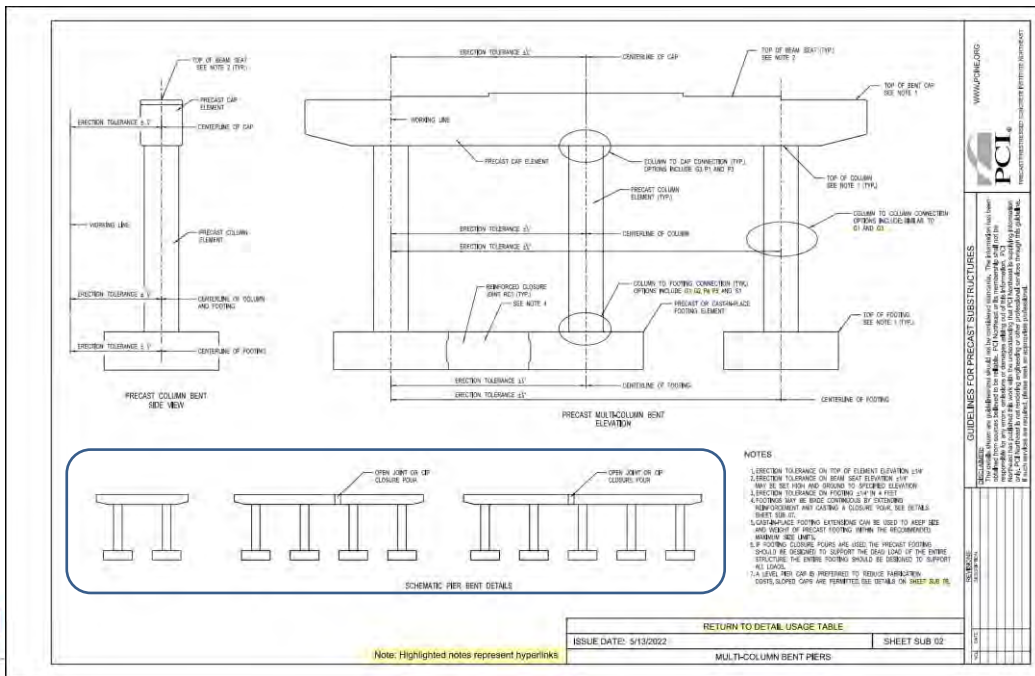
Note: Highlighted notes represent hyperlinks

SHOWN FOR CLARITY

Pier Bents



Pier Bents



Pier Bents

SCHMATIC PIER BENT DETAILS

NOTES

1. ERUCTION TOLERANCE ON TOP OF ELEMENT ELEVATION ±1/4"
2. ERUCTION TOLERANCE ON BEAM SEAT ELEVATION ±1/4"
3. MAX. BEAM SEAT TOLERANCE TO REFERRED ELEVATION SHALL BE ±1/4" AND SHALL BE CONTINGENT TO REFERRED ELEVATION
4. CLOSING JOINTS MAY BE BRIDGE CONNECTIONS BY EXTENDING REINFORCEMENT INTO CASTING IN TOUSING TOUSING SEE DETAILS SHEET SUB 02
5. CORROSION-RESISTANT EXTENDING CAN BE USED TO ACHIEVE AND MAINTAIN PRECAST FOOTING WITHIN THE RECOMMENDED MINIMUM SEE LIMITS
6. IF FOOTING CLOSURE JOINTS ARE USED THE PRECAST FOOTING SHOULD BE DESIGNED TO SUPPORT THE DEAD LOAD OF THE FRAME STRUCTURE THE ENTIRE FOOTING SHOULD BE DESIGNED TO SUPPORT ALL LOADS
7. A LEVEL REEL CAP IS RECOMMENDED TO REDUCE FRICTION. CORROSION-RESISTANT CAPS ARE PERMITTED SEE DETAILS ON SHEET SUB 02

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

WALL PIERS

SHEET SUB 02

Note: Highlighted notes represent hyperlinks



Wall Piers

PRECAST WALL PIER ELEVATION

PRECAST WALL PIER PLAN

PRECAST WALL PIER SIDE VIEW

NOTES

1. ERUCTION TOLERANCE ON ELEVATION ±1/4" MEASURED AT THE CENTERLINE OF THE WALL PANEL
2. ERUCTION TOLERANCE ON BEAM SEAT ELEVATION ±1/4"
3. CAP AND WALL SHALL BE CAST WITH REINFORCEMENT SEE DETAILS FOR CLARITY
4. CLOSING JOINTS MAY BE BRIDGE CONNECTIONS BY EXTENDING REINFORCEMENT INTO CASTING IN TOUSING TOUSING SEE DETAILS SHEET SUB 02
5. CORROSION-RESISTANT EXTENDING CAN BE USED TO ACHIEVE AND MAINTAIN PRECAST FOOTING WITHIN THE RECOMMENDED MINIMUM SEE LIMITS
6. IF FOOTING CLOSURE JOINTS ARE USED THE PRECAST FOOTING SHOULD BE DESIGNED TO SUPPORT THE DEAD LOAD OF THE FRAME STRUCTURE THE ENTIRE FOOTING SHOULD BE DESIGNED TO SUPPORT ALL LOADS

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

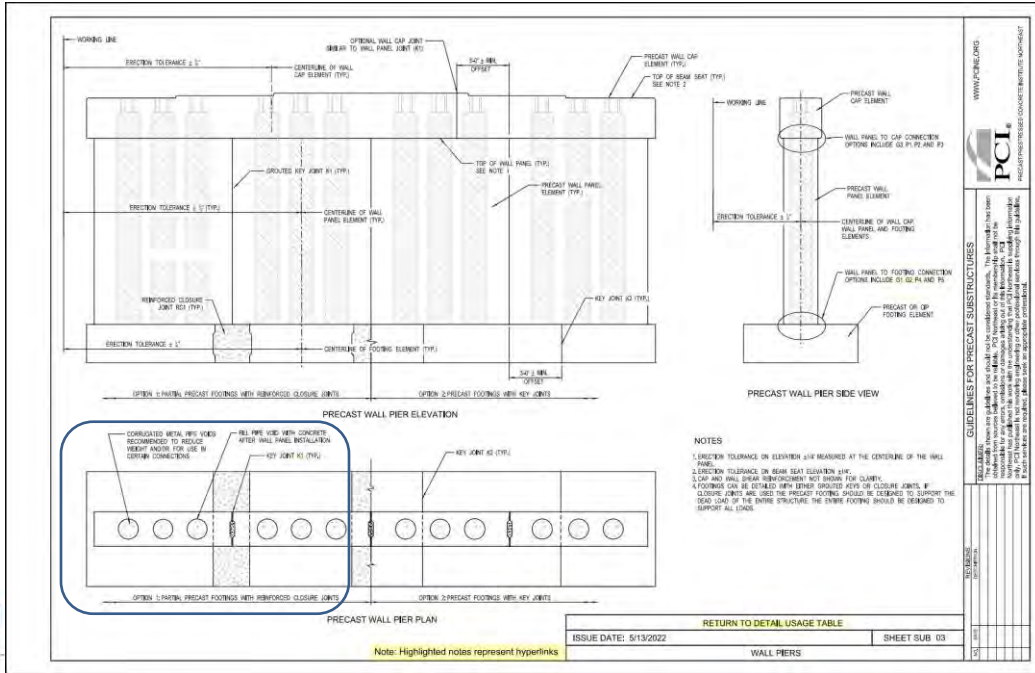
WALL PIERS

SHEET SUB 03

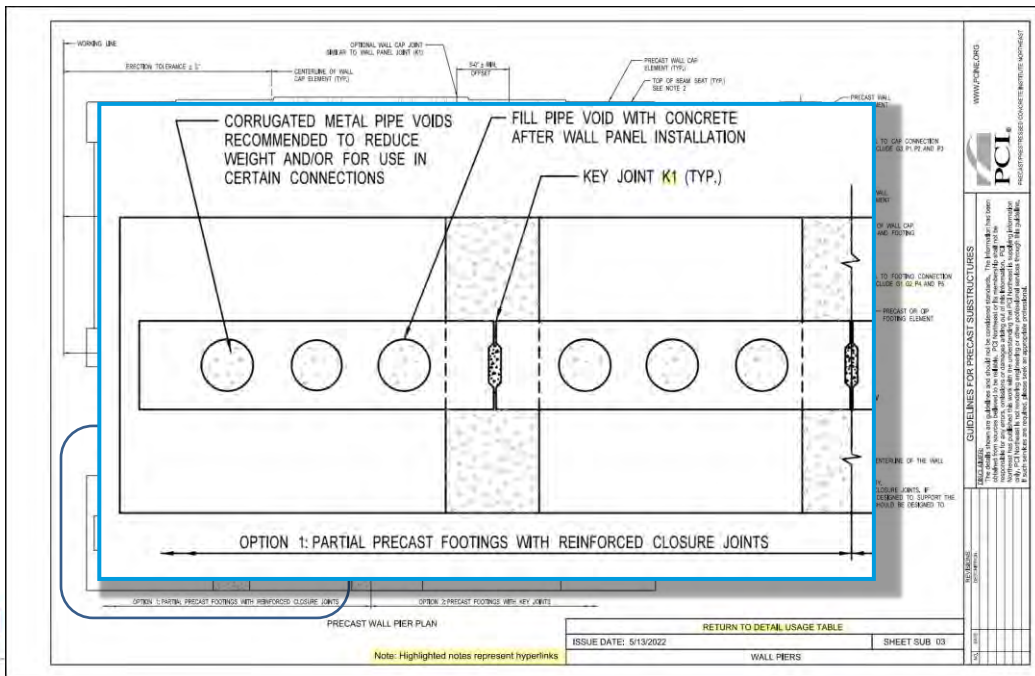
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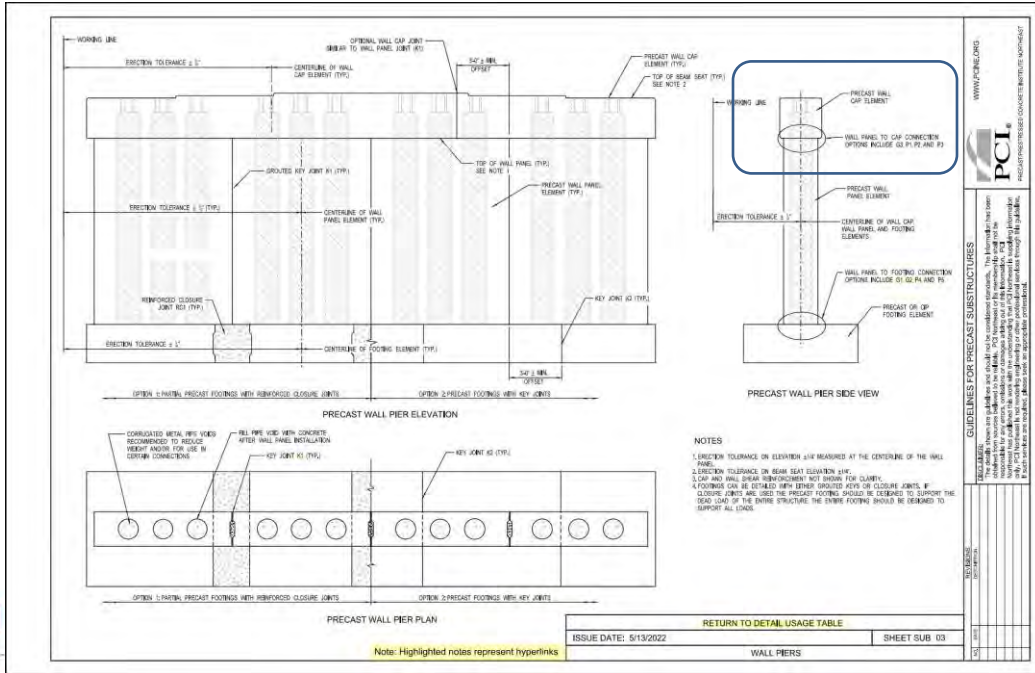
Wall Piers



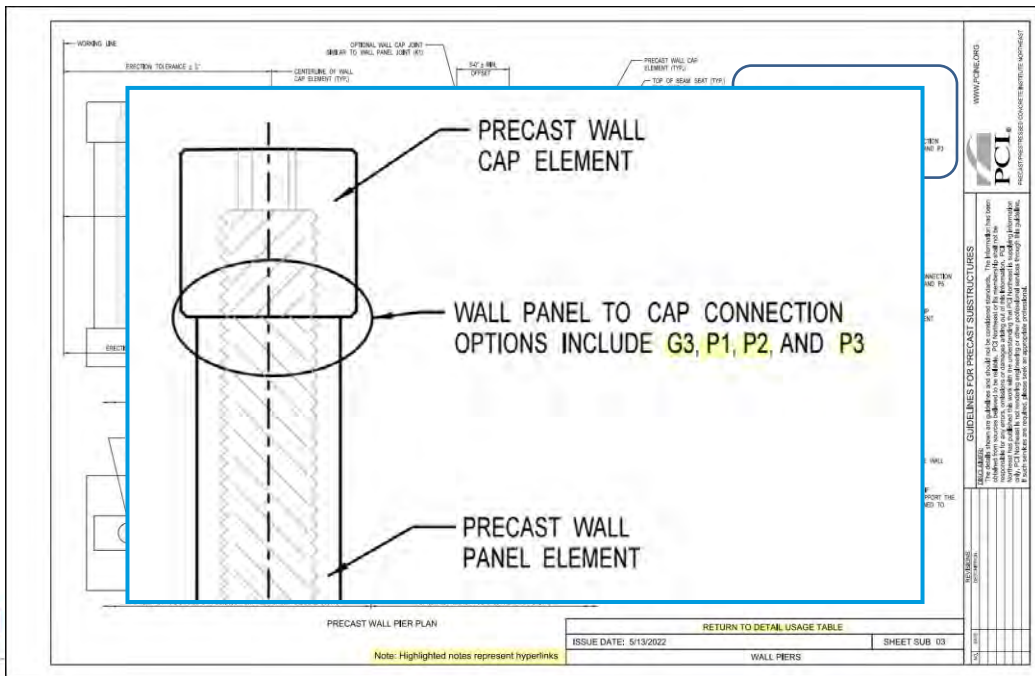
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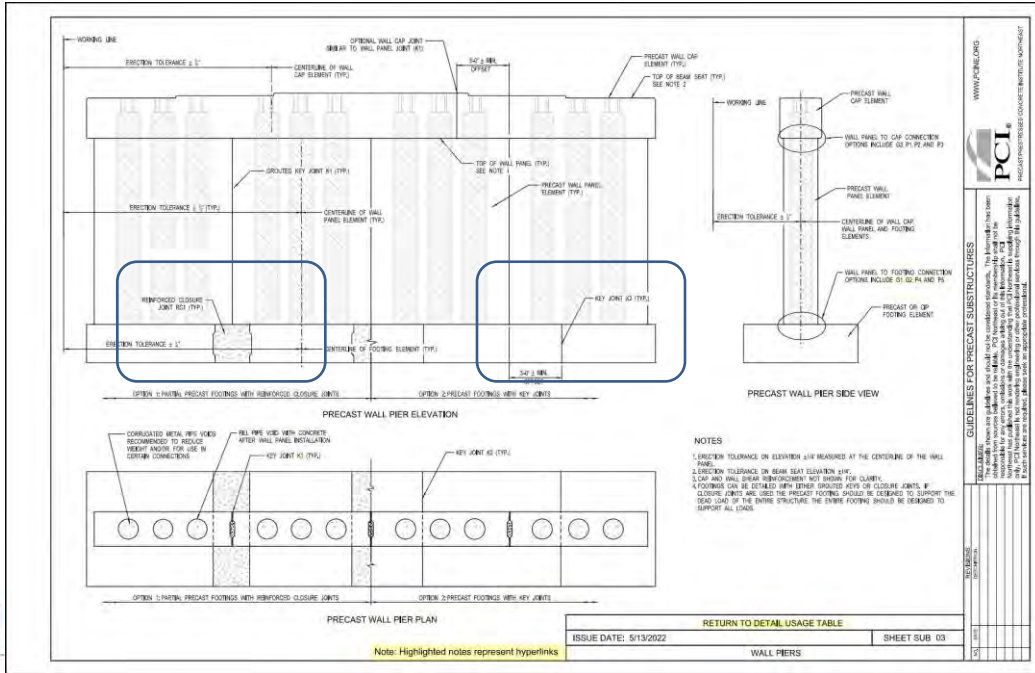
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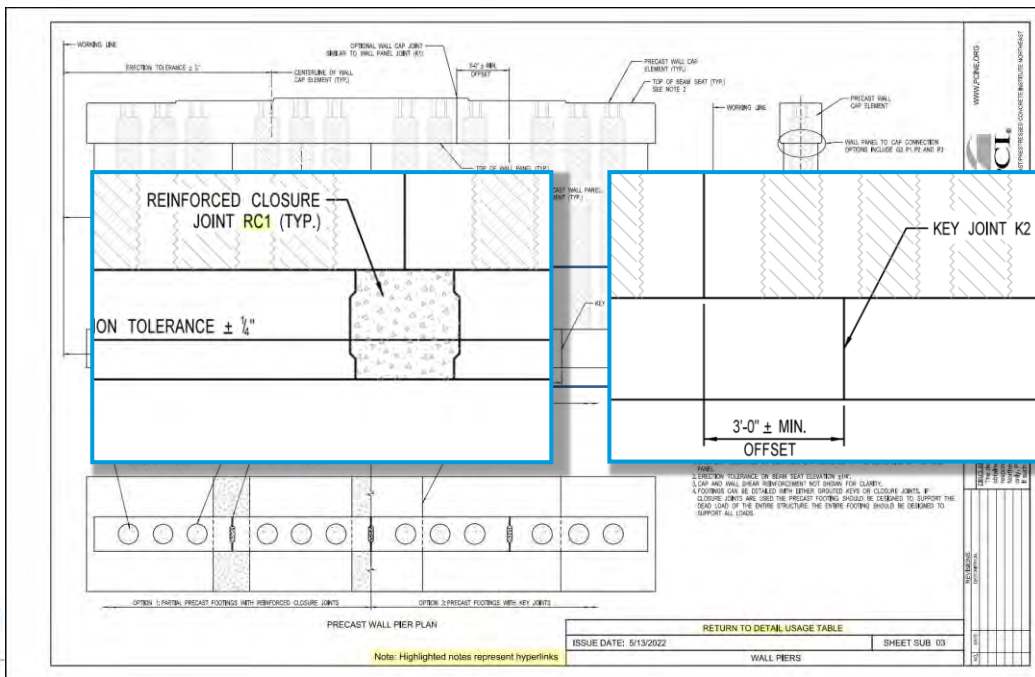
Wall Piers



Wall Piers



Wall Piers



Integral abutments



PRECAST INTEGRAL ABUTMENT PLAN

PRECAST INTEGRAL ABUTMENT ELEVATION

SECTION 1: INTEGRAL ABUTMENT

SECTION 2: SEMI-INTTEGRAL ABUTMENT

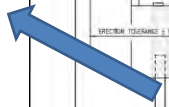
INTEGRAL ABUTMENT NOTES

1. LOCATION TOLERANCE ON ELEVATION ±1/4" MEASURED AT THE CENTRELINE OF THE WALL PANEL.
2. LOCATION TOLERANCE ON BEAM SEAT ELEVATION ±1/4".
3. TEMPORARY ABUTMENT BRACKETS NOT SHOWN FOR CLAMPING BACKWALL MAY BE USED AS THE END BRACKETS FOR DIMENSIONAL ADJUSTMENTS.
4. LATERAL-PLACED SHOWN STEEL REIN. TYPE AND SCHEDULE SHAPES MAY BE USED, SEE 407' COVERING DIFFERENT FOUNDATIONS ON ANY ONE STRUCTURAL ELEMENT UNLESS INDICATED BY DESIGN.
5. INTERMEDIATE JOISTS BETWEEN WALLS MAY BE USED TO REDUCE WEIGHT OF STEEL ELEMENTS.
6. REIN. NOT REQUIRED UNDER EACH BEAM.
7. USE THIS FILL PER ABUTMENT CAP ELEMENT IF THIS IS NOT POSSIBLE CONSIDER CLOSING FOUR SIDING CONNECTION NOT BETWEEN BRACKETS FULL CAP ELEMENT AND ADJACENT WALLS CAP ELEMENT.
8. IF JOISTS ARE PLACED WITH CONCRETE THE DESIGN OF THE JOIST CAN BE KEPT IN THE SCOPE OF THE REINFORCING FOR THE STEEL DECK. HORIZONTAL REINFORCING IN STEEL ASSUMING A BEAM JOINT AT THE STEEL DECK WITH REIN. BARS SHOULD BE USED IN THE REIN. REINFORCING AND SHOULD BE CONTINUED TO BRIDGE THE JOIST. PROVISIONS REGARDING THE ABUTMENT STEEL ASSUMING BEYOND AT THE STRUCTURE CONNECTION.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022 SHEET SUB: 04

INTEGRAL/SEMI-INTTEGRAL ABUTMENTS



Note: Highlighted notes represent hyperlinks.

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PCI

GUIDELINES FOR PRECAST SUBSTRUCTURES

REVISIONS:

NO.	DATE	DESCRIPTION
1		
2		
3		

Integral abutments



PRECAST INTEGRAL ABUTMENT PLAN

PRECAST INTEGRAL ABUTMENT ELEVATION

SECTION 1: INTEGRAL ABUTMENT

SECTION 2: SEMI-INTTEGRAL ABUTMENT

INTEGRAL ABUTMENT NOTES

1. LOCATION TOLERANCE ON ELEVATION ±1/4" MEASURED AT THE CENTRELINE OF THE WALL PANEL.
2. LOCATION TOLERANCE ON BEAM SEAT ELEVATION ±1/4".
3. TEMPORARY ABUTMENT BRACKETS NOT SHOWN FOR CLAMPING BACKWALL MAY BE USED AS THE END BRACKETS FOR DIMENSIONAL ADJUSTMENTS.
4. LATERAL-PLACED SHOWN STEEL REIN. TYPE AND SCHEDULE SHAPES MAY BE USED, SEE 407' COVERING DIFFERENT FOUNDATIONS ON ANY ONE STRUCTURAL ELEMENT UNLESS INDICATED BY DESIGN.
5. INTERMEDIATE JOISTS BETWEEN WALLS MAY BE USED TO REDUCE WEIGHT OF STEEL ELEMENTS.
6. REIN. NOT REQUIRED UNDER EACH BEAM.
7. USE THIS FILL PER ABUTMENT CAP ELEMENT IF THIS IS NOT POSSIBLE CONSIDER CLOSING FOUR SIDING CONNECTION NOT BETWEEN BRACKETS FULL CAP ELEMENT AND ADJACENT WALLS CAP ELEMENT.
8. IF JOISTS ARE PLACED WITH CONCRETE THE DESIGN OF THE JOIST CAN BE KEPT IN THE SCOPE OF THE REINFORCING FOR THE STEEL DECK. HORIZONTAL REINFORCING IN STEEL ASSUMING A BEAM JOINT AT THE STEEL DECK WITH REIN. BARS SHOULD BE USED IN THE REIN. REINFORCING AND SHOULD BE CONTINUED TO BRIDGE THE JOIST. PROVISIONS REGARDING THE ABUTMENT STEEL ASSUMING BEYOND AT THE STRUCTURE CONNECTION.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022 SHEET SUB: 04

INTEGRAL/SEMI-INTTEGRAL ABUTMENTS

Note: Highlighted notes represent hyperlinks.

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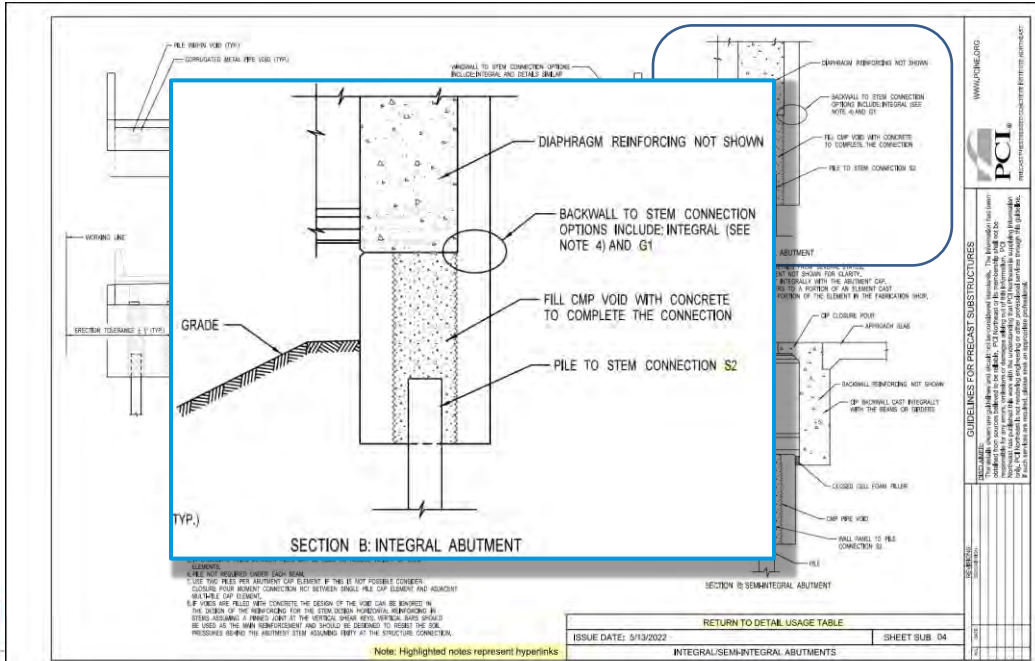
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GUIDELINES FOR PRECAST SUBSTRUCTURES

REVISIONS:

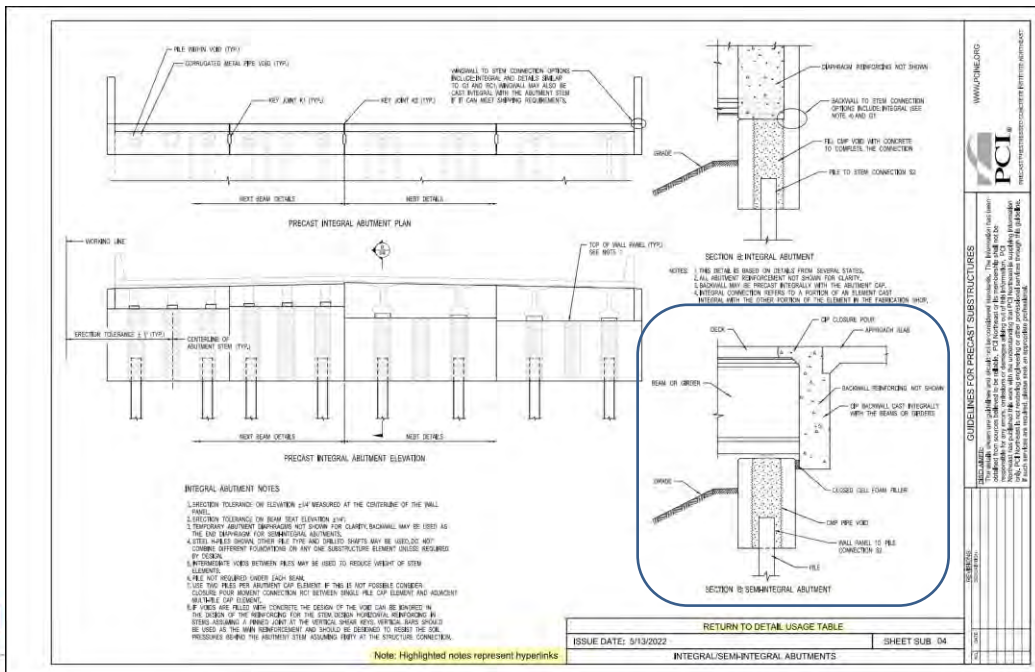
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Integral abutments



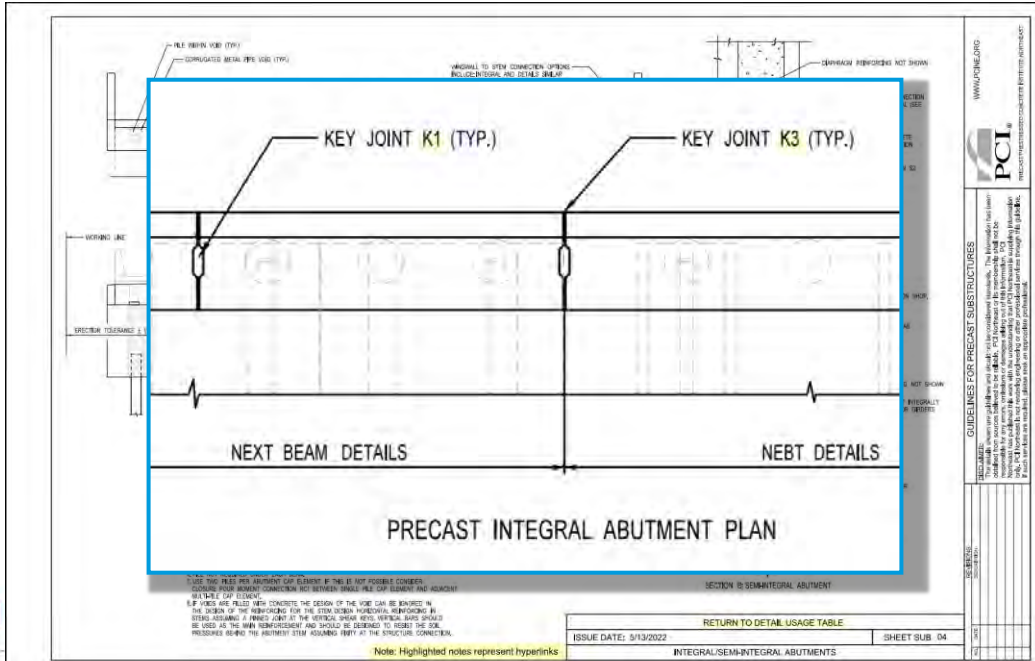
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Integral abutments

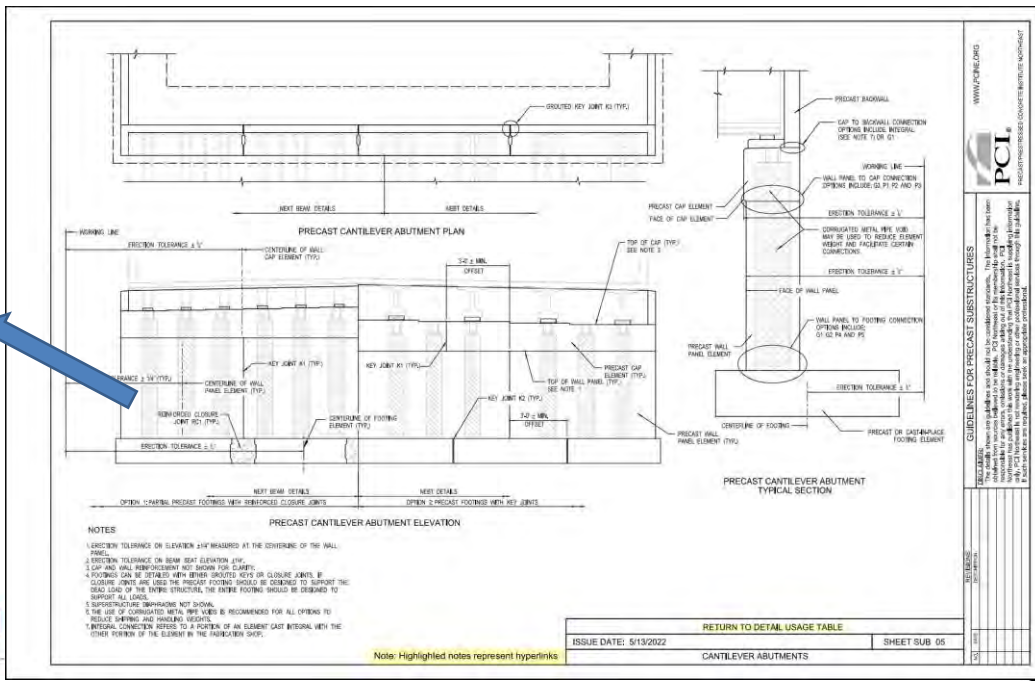


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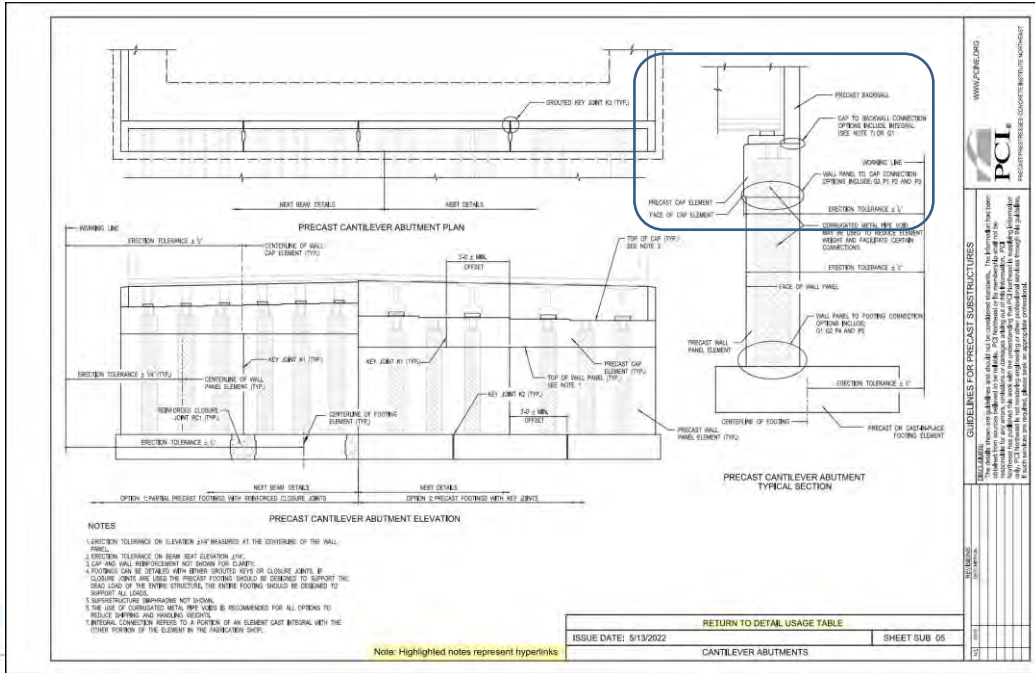
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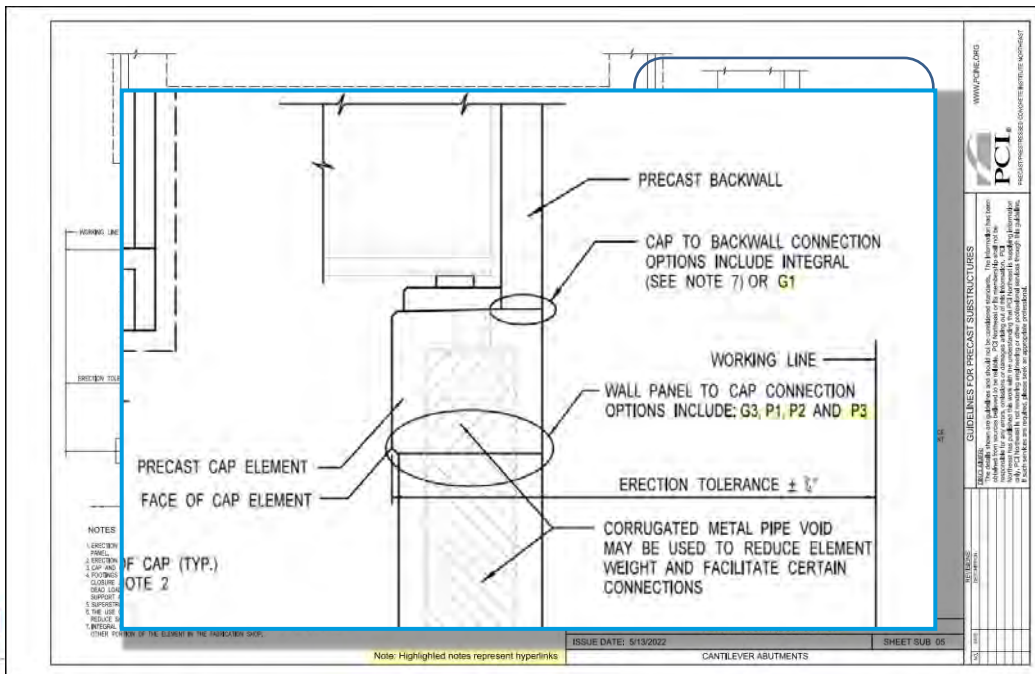
Cantilever abutments



Cantilever abutments



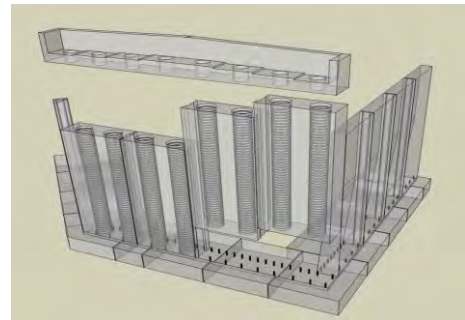
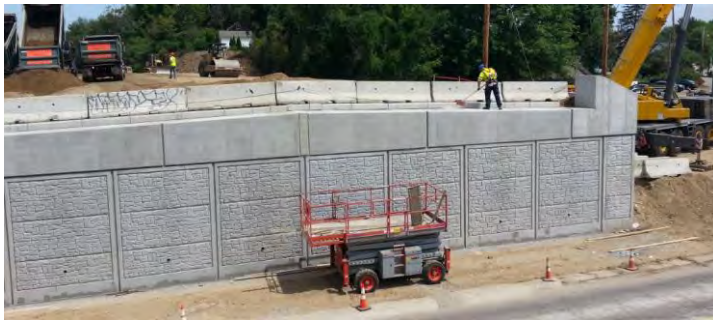
Cantilever abutments



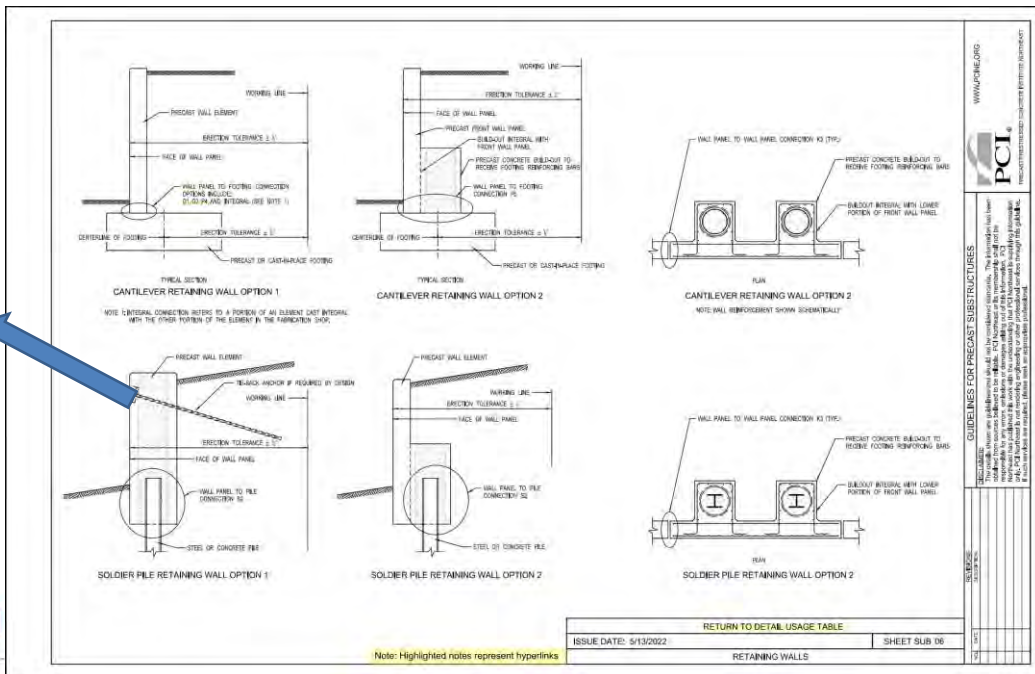
Cantilever Abutments



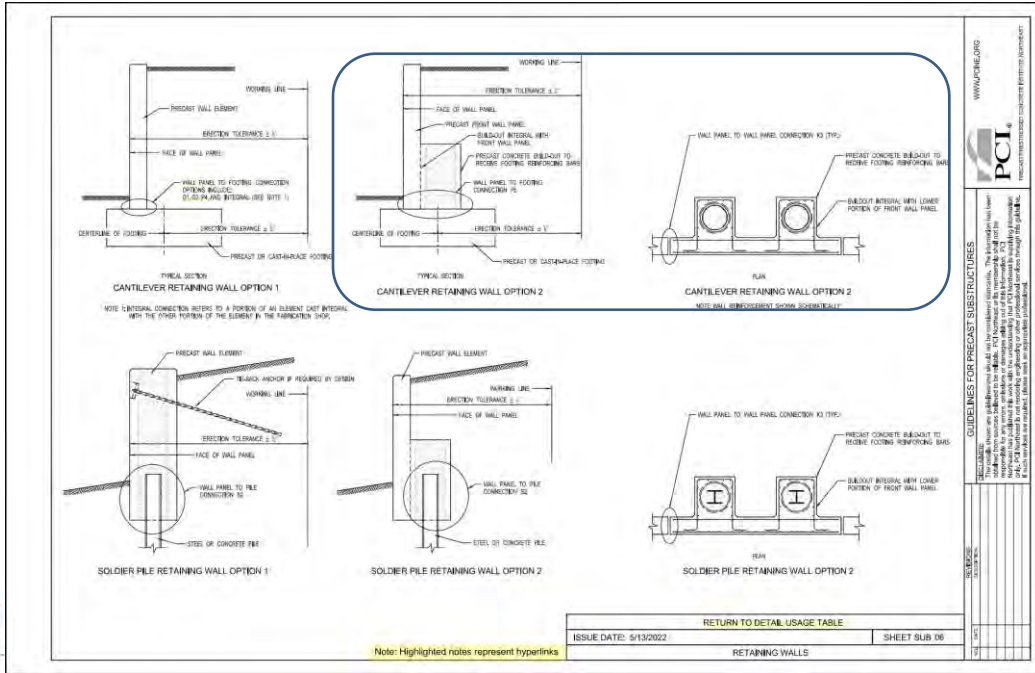
Route 1 Bridge over Route 236
Kittery, Maine
Courtesy of Maine DOT
Precast Wall Cap Concept



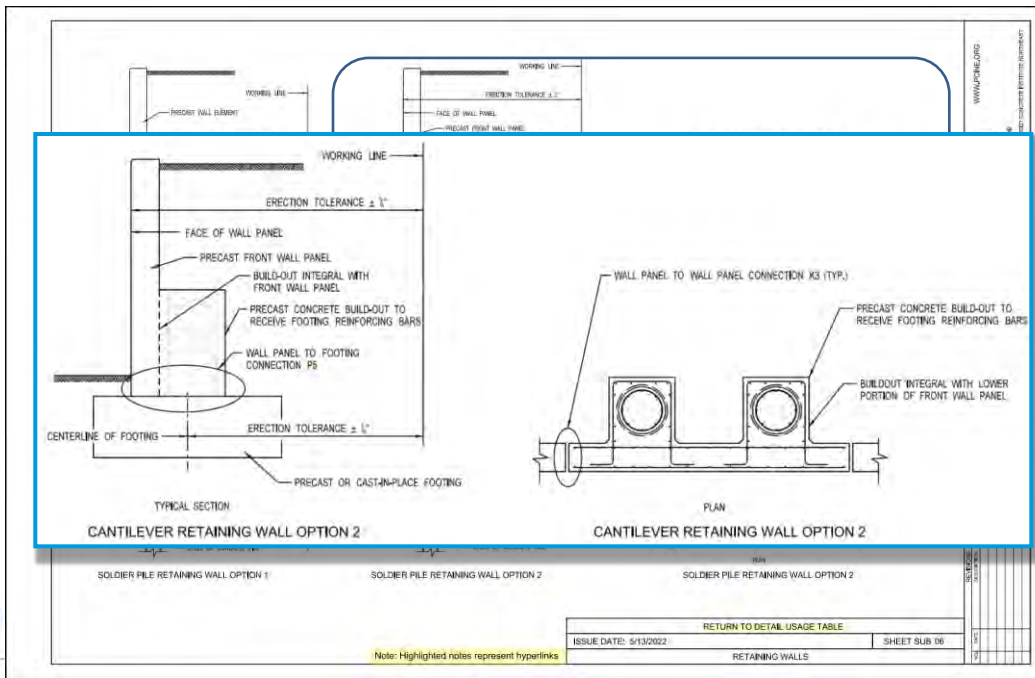
Retaining Walls



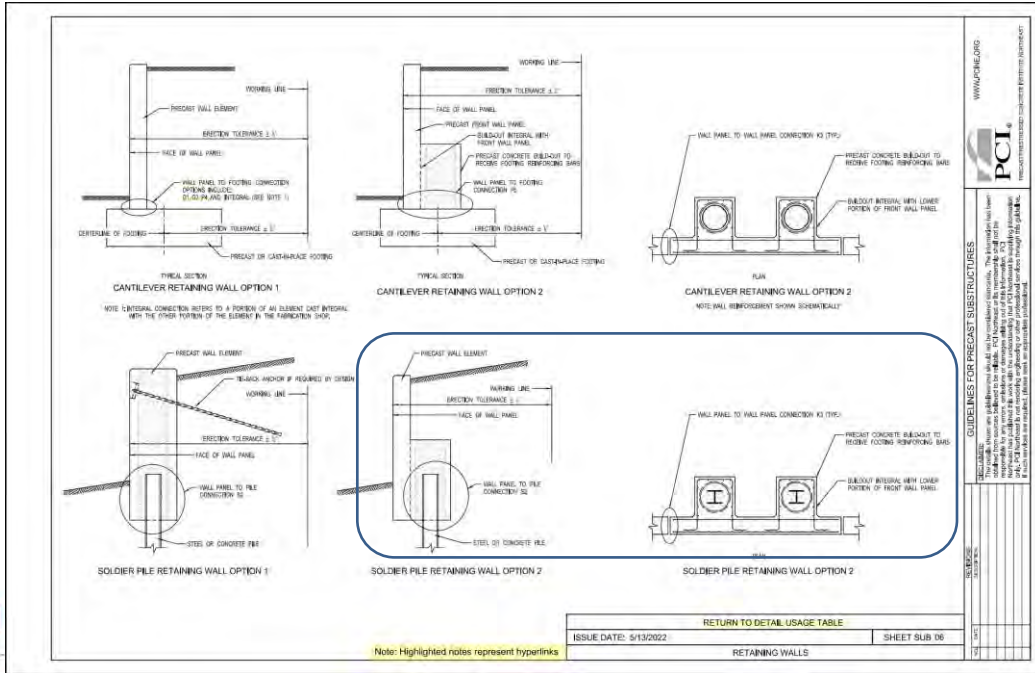
Retaining Walls



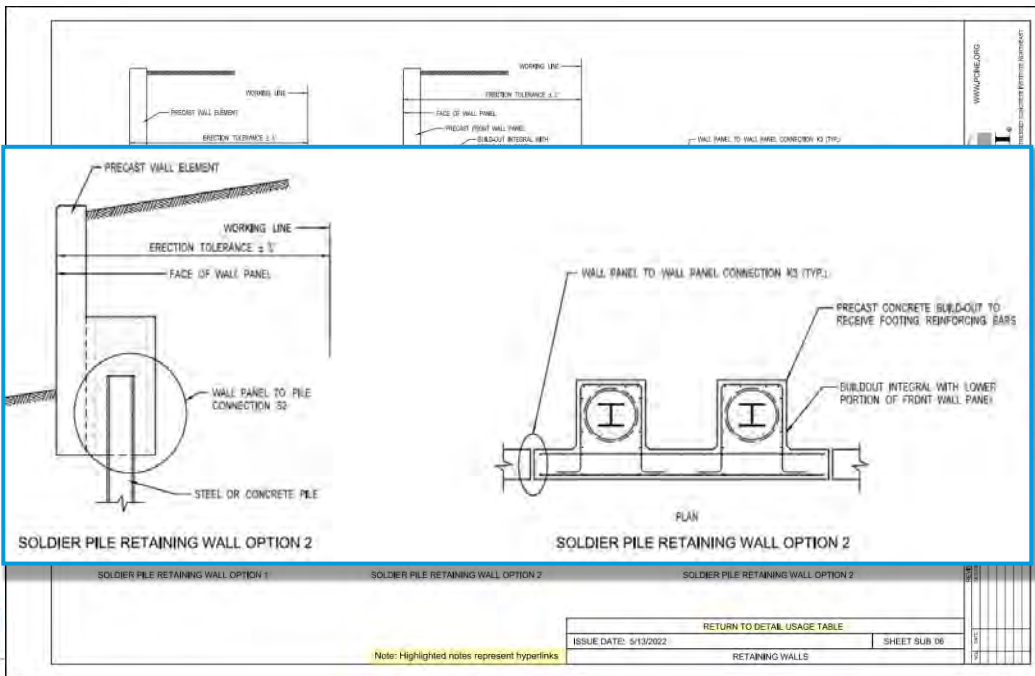
Retaining Walls



Retaining Walls



Retaining Walls



Spread Footings



PRECAST FOOTING NOTES

- CONTRACTOR TO DETERMINE SIZE AND SPACING OF PORTS BASED ON WIND DESIGN AND FOOTING SIZE.
- VERTICAL TOLERANCE ON ELEVATION SHALL BE OBSERVED AND SPACING OF PORTS SHALL BE OBSERVED ON THE CONTRACTOR'S ASSEMBLY PLAN.
- STEEL BAR EXTENDING TO THE LIMITS OF THE FOOTING IF POSSIBLE IF TOTAL WIDTH OF FOOTING AND BAR EXTENDING EXCEEDS SHIPPING LIMITS. THIS DETAIL IS LAY SPACES IN REINFORCEMENT OR AID MECHANICAL BAR SPECIALS.
- PROVIDE A CLEAR COVER FOR BOTTOM BARS OF REINFORCEMENT.
- THE CENTERLINE SHOULD DETAIL ALL PRECAST FOOTING REINFORCEMENT AND REINFORCING CONNECTIONS WITH THE FIELD.
- USE CAST-IN-PLACE EXTENSIONS TO MEET SIZE AND WEIGHT OF PRECAST FOOTING WHEN THE RECOMMENDED NUMBER ARE MET.
- WARNING PRECAST FOOTINGS MAY BE USED WITH PAIRS OR CHILLED DIMPTS.
- WARNING PRECAST FOOTINGS MAY BE USED TO CONNECT ADJACENT FOOTINGS TO CREATE A CONTINUOUS FOOTING.
- IN GENERAL, A BOLT SHOULD NOT BE PLACED DIRECTLY BELOW THE COLUMN ABOVE UNLESS ALL REINFORCING CONNECTIONS CAN BE MET.
- IN MOST CASES FLOWABLE FILL SHALL BE ACCEPTABLE FOR SEATING SPREAD FOOTINGS. MONITORING GREAT SHOULD ONLY BE USED WHERE FOOTING PRESURES ARE EXCESSIVE OF WEIGHT FACT SET THERE ARE REQUIRED.
- DESIGN OF THE COLUMN FORM AND AVAILABLE TO THE USE OF CROCKET SHEET COLLAPSE CONNECTIONS, OTHER CONNECTIONS CAN BE USED WITH MEANS DETAIL.

LEVELING DEVICE NOTES

- ALTERNATE LEVELING DEVICES MAY BE SUBMITTED BY THE CONTRACTOR WITH THE APPROVAL FROM THE ENGINEER.
- STEEL PLATES ARE WITH ANCHORS ARE WITH STEEL BRACE PLATES TO BE CALIBRATED ACCORDING TO ASTM A308 AND BOLTS TO BE CALIBRATED ACCORDING TO ASTM A307.
- REINFORCEMENT BARS ARE HELD AS SET WITH.
- ANCHORS OR BOLT ARE A BOLT THROUGH TO ACHIEVE LEVELING AND REMOVAL.
- BOLT MAY BE REMOVED AFTER THE FLOWABLE FILL HAS SET.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022	SHEET SUB: 07
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SPREAD FOOTINGS

Note: Highlighted notes represent hyperlinks

Spread Footings



PRECAST FOOTING NOTES

- CONTRACTOR TO DETERMINE SIZE AND SPACING OF PORTS BASED ON WIND DESIGN AND FOOTING SIZE.
- VERTICAL TOLERANCE ON ELEVATION SHALL BE OBSERVED AND SPACING OF PORTS SHALL BE OBSERVED ON THE CONTRACTOR'S ASSEMBLY PLAN.
- STEEL BAR EXTENDING TO THE LIMITS OF THE FOOTING IF POSSIBLE IF TOTAL WIDTH OF FOOTING AND BAR EXTENDING EXCEEDS SHIPPING LIMITS. THIS DETAIL IS LAY SPACES IN REINFORCEMENT OR AID MECHANICAL BAR SPECIALS.
- PROVIDE A CLEAR COVER FOR BOTTOM BARS OF REINFORCEMENT.
- THE CENTERLINE SHOULD DETAIL ALL PRECAST FOOTING REINFORCEMENT AND REINFORCING CONNECTIONS WITH THE FIELD.
- USE CAST-IN-PLACE EXTENSIONS TO MEET SIZE AND WEIGHT OF PRECAST FOOTING WHEN THE RECOMMENDED NUMBER ARE MET.
- WARNING PRECAST FOOTINGS MAY BE USED WITH PAIRS OR CHILLED DIMPTS.
- WARNING PRECAST FOOTINGS MAY BE USED TO CONNECT ADJACENT FOOTINGS TO CREATE A CONTINUOUS FOOTING.
- IN GENERAL, A BOLT SHOULD NOT BE PLACED DIRECTLY BELOW THE COLUMN ABOVE UNLESS ALL REINFORCING CONNECTIONS CAN BE MET.
- IN MOST CASES FLOWABLE FILL SHALL BE ACCEPTABLE FOR SEATING SPREAD FOOTINGS. MONITORING GREAT SHOULD ONLY BE USED WHERE FOOTING PRESURES ARE EXCESSIVE OF WEIGHT FACT SET THERE ARE REQUIRED.
- DESIGN OF THE COLUMN FORM AND AVAILABLE TO THE USE OF CROCKET SHEET COLLAPSE CONNECTIONS, OTHER CONNECTIONS CAN BE USED WITH MEANS DETAIL.

LEVELING DEVICE NOTES

- ALTERNATE LEVELING DEVICES MAY BE SUBMITTED BY THE CONTRACTOR WITH THE APPROVAL FROM THE ENGINEER.
- STEEL PLATES ARE WITH ANCHORS ARE WITH STEEL BRACE PLATES TO BE CALIBRATED ACCORDING TO ASTM A308 AND BOLTS TO BE CALIBRATED ACCORDING TO ASTM A307.
- REINFORCEMENT BARS ARE HELD AS SET WITH.
- ANCHORS OR BOLT ARE A BOLT THROUGH TO ACHIEVE LEVELING AND REMOVAL.
- BOLT MAY BE REMOVED AFTER THE FLOWABLE FILL HAS SET.

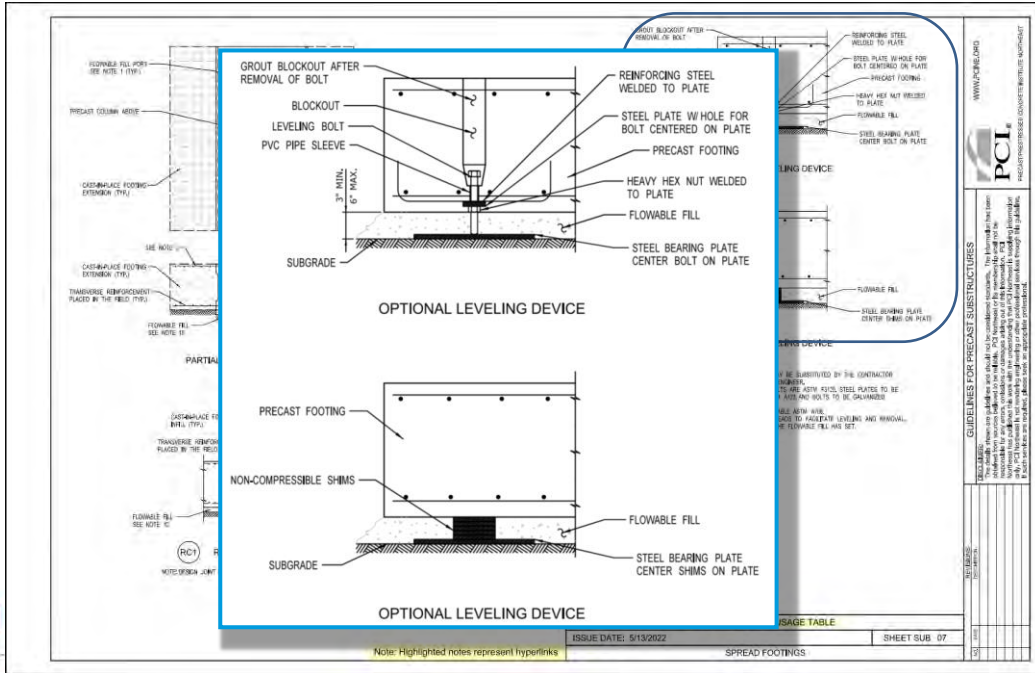
RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022	SHEET SUB: 07
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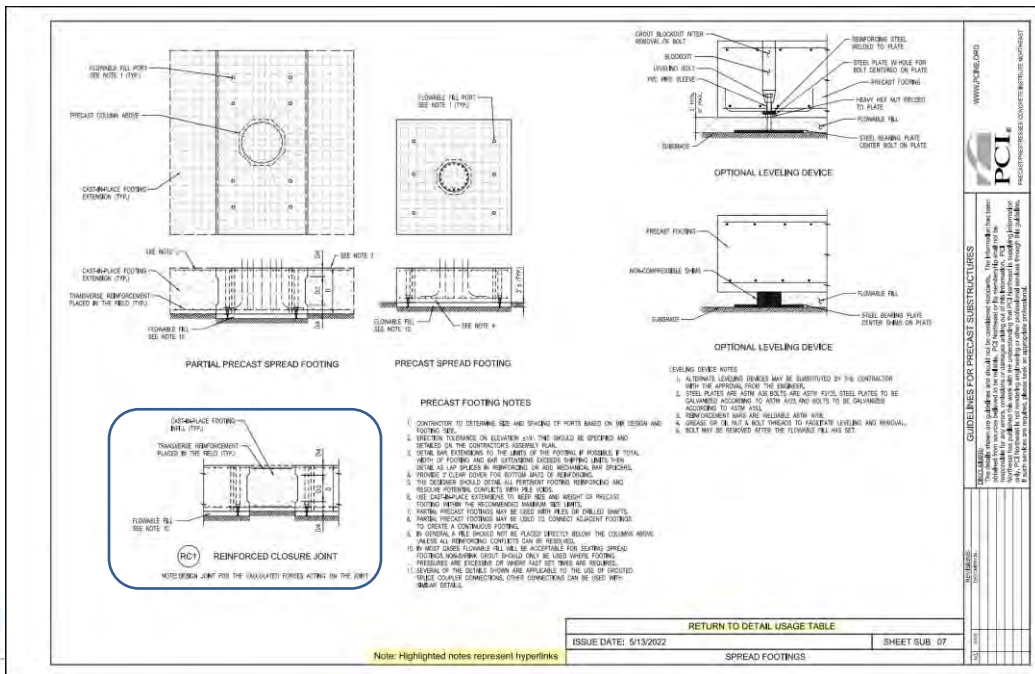
SPREAD FOOTINGS

Note: Highlighted notes represent hyperlinks

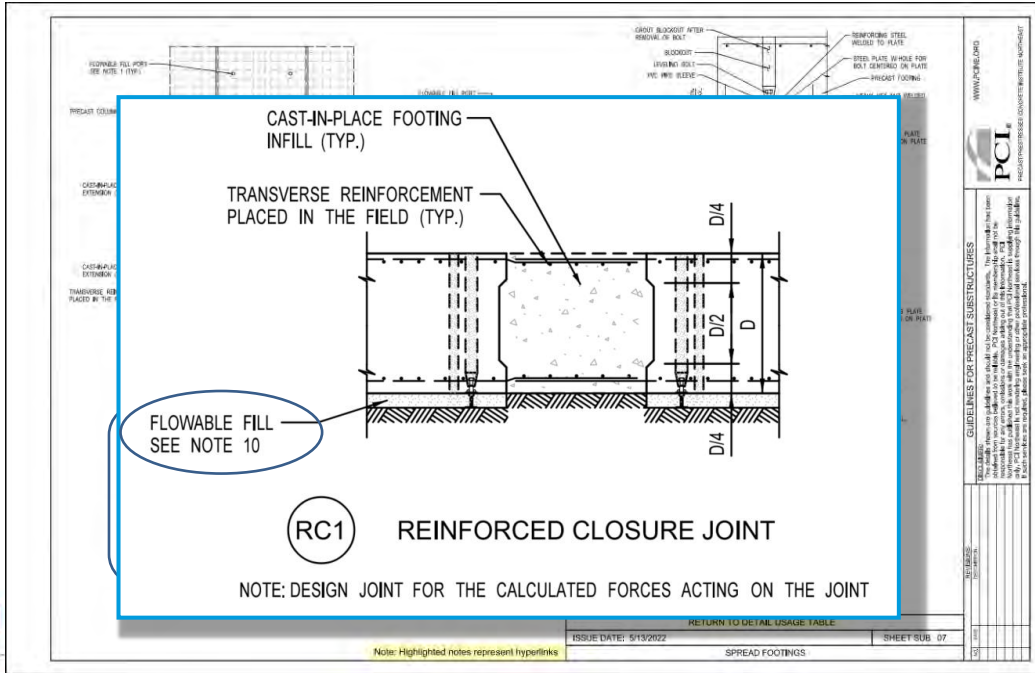
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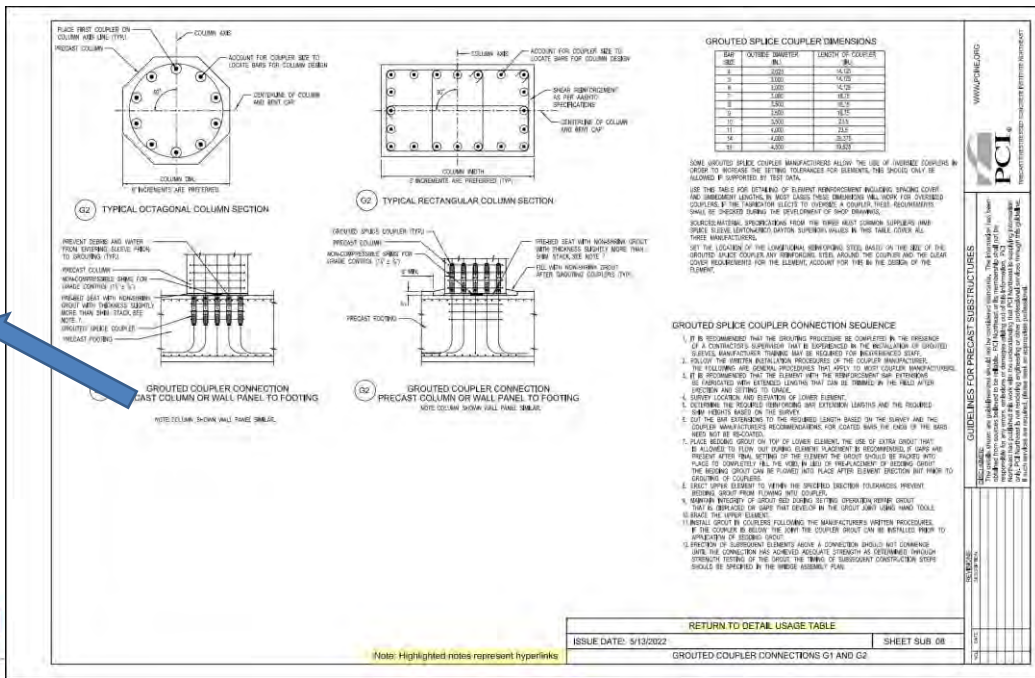
Spread Footings



Spread Footings



Grouted Coupler Connections





GRouted SPlice CouPLer DIMENSIONS

BAR SIZE	NUMBER OF COUPLERS	LENGTH OF COUPLER
3	3	14.00
4	3	14.00
5	3	14.00
6	3	14.00
7	3	14.00
8	3	14.00
9	3	14.00
10	3	14.00
11	3	14.00
12	3	14.00
13	3	14.00
14	3	14.00
15	3	14.00
16	3	14.00
17	3	14.00
18	3	14.00
19	3	14.00
20	3	14.00
21	3	14.00
22	3	14.00
23	3	14.00
24	3	14.00
25	3	14.00
26	3	14.00
27	3	14.00
28	3	14.00
29	3	14.00
30	3	14.00
31	3	14.00
32	3	14.00
33	3	14.00
34	3	14.00
35	3	14.00
36	3	14.00
37	3	14.00
38	3	14.00
39	3	14.00
40	3	14.00
41	3	14.00
42	3	14.00
43	3	14.00
44	3	14.00
45	3	14.00
46	3	14.00
47	3	14.00
48	3	14.00
49	3	14.00
50	3	14.00
51	3	14.00
52	3	14.00
53	3	14.00
54	3	14.00
55	3	14.00
56	3	14.00
57	3	14.00
58	3	14.00
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65	3	14.00
66	3	14.00
67	3	14.00
68	3	14.00
69	3	14.00
70	3	14.00
71	3	14.00
72	3	14.00
73	3	14.00
74	3	14.00
75	3	14.00
76	3	14.00
77	3	14.00
78	3	14.00
79	3	14.00
80	3	14.00
81	3	14.00
82	3	14.00
83	3	14.00
84	3	14.00
85	3	14.00
86	3	14.00
87	3	14.00
88	3	14.00
89	3	14.00
90	3	14.00
91	3	14.00
92	3	14.00
93	3	14.00
94	3	14.00
95	3	14.00
96	3	14.00
97	3	14.00
98	3	14.00
99	3	14.00
100	3	14.00

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022 SHEET SUB 08

GRouted COUPLer CONNECTIONS G1 AND G2



GRouted SPlice CouPLer DIMENSIONS

BAR SIZE	NUMBER OF COUPLERS	LENGTH OF COUPLER
3	3	14.00
4	3	14.00
5	3	14.00
6	3	14.00
7	3	14.00
8	3	14.00
9	3	14.00
10	3	14.00
11	3	14.00
12	3	14.00
13	3	14.00
14	3	14.00
15	3	14.00
16	3	14.00
17	3	14.00
18	3	14.00
19	3	14.00
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27	3	14.00
28	3	14.00
29	3	14.00
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46	3	14.00
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86	3	14.00
87	3	14.00
88	3	14.00
89	3	14.00
90	3	14.00
91	3	14.00
92	3	14.00
93	3	14.00
94	3	14.00
95	3	14.00
96	3	14.00
97	3	14.00
98	3	14.00
99	3	14.00
100	3	14.00

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022 SHEET SUB 08

GRouted COUPLer CONNECTIONS G1 AND G2



GRouted SPlice COUPLER DIMENSIONS

BAR SIZE	OUTSIDE DIAMETER (IN.)	LENGTH OF COUPLER (IN.)
4	2.625	14.125
5	3.000	14.125
6	3.000	14.125
7	3.000	18.75
8	3.500	18.75
9	3.500	18.75
10	3.500	23.5
11	4.000	23.5
14	4.000	28.375
18	4.500	39.625

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022 SHEET SUB 08

GRouted COUPLER CONNECTIONS G1 AND G2



GRouted SPlice COUPLER DIMENSIONS

BAR SIZE	OUTSIDE DIAMETER (IN.)	LENGTH OF COUPLER (IN.)
4	2.625	14.125
5	3.000	14.125
6	3.000	14.125
7	3.000	18.75
8	3.500	18.75
9	3.500	18.75
10	3.500	23.5
11	4.000	23.5
14	4.000	28.375
18	4.500	39.625

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022 SHEET SUB 08

GRouted COUPLER CONNECTIONS G1 AND G2

Grouted Coupler Connections



NOTES

1. ADJUST SPIKE BRACK HEIGHT TO CONTROL EXCESSIVE SLAB/BEAM DEFLECTION. USE MULTIPLE SPIKES TO PROVIDE STABILITY OF CAP ELEMENT.
2. END COUPLERS MUST EXCEED TRANS RESISTANCE AND G3 TO PROVIDE HEAVY AFTER INSTALLATION OF LOWER ELEMENTS.
3. COLUMN TO CAP CONNECTION SHOULD A SIMILAR DETAIL MAY BE USED TO SPIKE COUPLERS.
4. SPIKE REINFORCEMENT TO BE SIMILAR OR HIGHER WITH RESISTANCE BUT NOT HIGHER.
5. SEE SHEET SUB 08 FOR GROUTED SPIKE COUPLER CONNECTION SEQUENCE.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 09

GRADED COUPLER CONNECTION G3

Note: Highlighted notes represent hyperlinks

Grouted Coupler Connections



NOTES

1. ADJUST SPIKE BRACK HEIGHT TO CONTROL EXCESSIVE SLAB/BEAM DEFLECTION. USE MULTIPLE SPIKES TO PROVIDE STABILITY OF CAP ELEMENT.
2. END COUPLERS MUST EXCEED TRANS RESISTANCE AND G3 TO PROVIDE HEAVY AFTER INSTALLATION OF LOWER ELEMENTS.
3. COLUMN TO CAP CONNECTION SHOULD A SIMILAR DETAIL MAY BE USED TO SPIKE COUPLERS.
4. SPIKE REINFORCEMENT TO BE SIMILAR OR HIGHER WITH RESISTANCE BUT NOT HIGHER.
5. SEE SHEET SUB 08 FOR GROUTED SPIKE COUPLER CONNECTION SEQUENCE.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 09

GRADED COUPLER CONNECTION G3

Note: Highlighted notes represent hyperlinks

SECTION A BENT CAP SECTION

SPLICE BAR WITH HOOK (TYP.)

CAP STIRRUP SHOWN WITH TWO LEGS OF REINFORCING. DETAIL ADDITIONAL LEGS IF REQUIRED BY DESIGN. DETAIL ACCORDING TO AASHTO LRFD REQUIREMENTS.

VENT TUBE (TYP.)

GROUT TUBE (TYP.)

ADJUST BAR SPACING TO CLEAR COUPLERS

GROUTED SPLICE COUPLER (TYP.)

NOTE: IT IS IMPORTANT TO LAYOUT THE COUPLER PATTERN WITH CONSIDERATION OF THE REINFORCEMENT IN THE CONNECTED ELEMENT. THIS IS ESPECIALLY IMPORTANT FOR ROUND COLUMNS AND SKEWED BRIDGES.

NOTES

1. ADJUST BAR STACK HEIGHT TO CONTROL EXCESSIVE SLABING. USE WAFFLE SLABS TO PROVIDE STABILITY OF CAP ELEMENT.
2. END STAIRS AND CORNERS: THIS REQUIRES THE GUT TO PROVIDE HEIGHT AFTER.

Route 202NB over B&M Railroad
Holyoke, MA
MassDOT Project 603735

PCI NORTHEAST

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 09

GROUTED COUPLER CONNECTION G3

Note: Highlighted notes represent hyperlinks

Design of Grouted Bar Coupler Connections

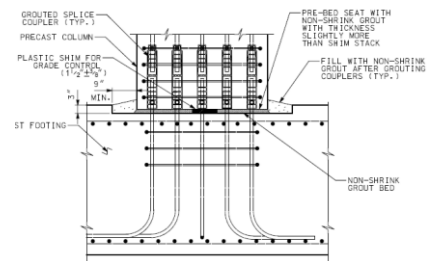
Couplers have a minor impact on the design

– Coupler Designs

- The diameter of the coupler is larger than the bar
- In order to maintain cover over the coupler, the designer needs to move the rebar cage for design
- This has a minor impact on the section capacity
- May require larger bars

– This is covered in the ABC Guide Spec

– See NCHRP Project 12-102A Training Module 2 for sample calculations



3.6.4.4—Type 2 Mechanical Connectors in Plastic Hinge (ED) Regions for SDCs C and D (Seismic Zones 3 and 4)

Where Type 2 mechanical connectors are used in plastic hinge regions to connect a precast column to a footing or pier cap, the following requirements shall be satisfied.



MINIMUM CMP PIPE SIZE
 RECOMMENDED MIN PIPE SIZE = $Sw = 2t_{mh} d + db + 2\frac{1}{2} + S$
 WHERE:
 t_{mh} = MINIMUM ALLOWABLE SPACE BETWEEN BAR AND PIPE FOR MATERIAL PLACEMENT
 d = DIAMETER OF REINFORCING BAR
 db = MAXIMUM CENTER-TO-CENTER DISTANCE BETWEEN BAR EXTREMES
 $2\frac{1}{2}$ = DIMENSION IN EQUATION IS TO ACCOUNT FOR TOLERANCES

NOTES

- THE DESIGN OF THIS TYPE OF POCKET CONNECTION SHALL BE IN ACCORDANCE WITH THE AASHTO AND AISC SPECIFICATIONS FOR ACCELERATED BRIDGE CONSTRUCTION.
- THE SUPPLEMENTAL HOOPS ON THE OUTSIDE OF THE CAP POCKET MAY NOT BE REQUIRED FOR ALL BEAMS; SEE THE PROVISIONS IN THE AASHTO SPEC CODE REQUIREMENTS.
- THE POCKET MAY BE DETAIL AS PARTIAL-HEIGHT WEB PILES FOR CASTING THE POCKET CONCRETE.
- IF A FULL HEIGHT POCKET IS DETAIL THE DESIGNER MAY ELECT TO REINFORCE THE TOP OF THE POCKET TO BE REMOVED TO EXHIBIT EXPOSED STEEL AT THE TOP SURFACE OF THE CONNECTION; THE REMOVAL PORTION OF THE FORM CAN BE MADE OF WOOD OR OTHER STIFF MATERIAL.
- THE CONCRETE FOR THE POCKET CAN BE NORMAL CONCRETE THAT IS SPECIFIED FOR BRIDGE DECK; HIGH EARLY STRENGTH CONCRETE CAN ALSO BE USED.
- THE TEMPORARY SUPPORT OF THE CAP PRIOR TO THE POCKET POUR IS THE RESPONSIBILITY OF THE CONTRACTOR.
- IF THE CAP BETWEEN THE COLUMN TOP AND THE BOTTOM OF THE CAP IS WEATHER PROOF OR SUPERELEVATION HOOP SHALL BE PLACED BETWEEN THE CAP.
- THE DESIGNER SHOULD CAREFULLY REVIEW THE LOCATION OF ALL REINFORCING BARS TO AVOID CONFLICTS DURING INSTALLATION AND ASSEMBLY; THIS IS ESPECIALLY TRUE FOR CONNECTIONS CAP BARS AND THE COLUMN VERTICAL BARS.
- THE COLUMN VERTICAL BARS SHALL BE DEVELOPED IN THE CAP POCKET; STRAIGHT BARS AND/OR HOOKED BARS MAY BE USED PROVIDED THEY CAN PASS THROUGH THE CAP (CAPTIONAL BARS SUPPLEMENTED WITH DEVELOPMENT LENGTH SPECIFICATIONS ARE INCLUDED IN THE AASHTO LRP) (SEE SPECIFICATIONS FOR ACCELERATED BRIDGE CONSTRUCTION).

RETURN TO DETAIL USAGE TABLE
 ISSUE DATE: 5/13/2022 SHEET SUB 10
 POCKET CONNECTION P1



MINIMUM CMP PIPE SIZE
 RECOMMENDED MIN PIPE SIZE = $Sw = 2t_{mh} d + db + 2\frac{1}{2} + S$
 WHERE:
 t_{mh} = MINIMUM ALLOWABLE SPACE BETWEEN BAR AND PIPE FOR MATERIAL PLACEMENT
 d = DIAMETER OF REINFORCING BAR
 db = MAXIMUM CENTER-TO-CENTER DISTANCE BETWEEN BAR EXTREMES
 $2\frac{1}{2}$ = DIMENSION IN EQUATION IS TO ACCOUNT FOR TOLERANCES

NOTES

- THE DESIGN OF THIS TYPE OF POCKET CONNECTION SHALL BE IN ACCORDANCE WITH THE AASHTO AND AISC SPECIFICATIONS FOR ACCELERATED BRIDGE CONSTRUCTION.
- THE SUPPLEMENTAL HOOPS ON THE OUTSIDE OF THE CAP POCKET MAY NOT BE REQUIRED FOR ALL BEAMS; SEE THE PROVISIONS IN THE AASHTO SPEC CODE REQUIREMENTS.
- THE POCKET MAY BE DETAIL AS PARTIAL-HEIGHT WEB PILES FOR CASTING THE POCKET CONCRETE.
- IF A FULL HEIGHT POCKET IS DETAIL THE DESIGNER MAY ELECT TO REINFORCE THE TOP OF THE POCKET TO BE REMOVED TO EXHIBIT EXPOSED STEEL AT THE TOP SURFACE OF THE CONNECTION; THE REMOVAL PORTION OF THE FORM CAN BE MADE OF WOOD OR OTHER STIFF MATERIAL.
- THE CONCRETE FOR THE POCKET CAN BE NORMAL CONCRETE THAT IS SPECIFIED FOR BRIDGE DECK; HIGH EARLY STRENGTH CONCRETE CAN ALSO BE USED.
- THE TEMPORARY SUPPORT OF THE CAP PRIOR TO THE POCKET POUR IS THE RESPONSIBILITY OF THE CONTRACTOR.
- IF THE CAP BETWEEN THE COLUMN TOP AND THE BOTTOM OF THE CAP IS WEATHER PROOF OR SUPERELEVATION HOOP SHALL BE PLACED BETWEEN THE CAP.
- THE DESIGNER SHOULD CAREFULLY REVIEW THE LOCATION OF ALL REINFORCING BARS TO AVOID CONFLICTS DURING INSTALLATION AND ASSEMBLY; THIS IS ESPECIALLY TRUE FOR CONNECTIONS CAP BARS AND THE COLUMN VERTICAL BARS.
- THE COLUMN VERTICAL BARS SHALL BE DEVELOPED IN THE CAP POCKET; STRAIGHT BARS AND/OR HOOKED BARS MAY BE USED PROVIDED THEY CAN PASS THROUGH THE CAP (CAPTIONAL BARS SUPPLEMENTED WITH DEVELOPMENT LENGTH SPECIFICATIONS ARE INCLUDED IN THE AASHTO LRP) (SEE SPECIFICATIONS FOR ACCELERATED BRIDGE CONSTRUCTION).

RETURN TO DETAIL USAGE TABLE
 ISSUE DATE: 5/13/2022 SHEET SUB 10
 POCKET CONNECTION P1

Design of Pocket Connections

- This connection requires a detailed design procedure.
- The 2018 AASHTO LRFD Guide Specifications have detailed provisions.
- See NCHRP Project 12-102A Training Module 2 for sample calculations

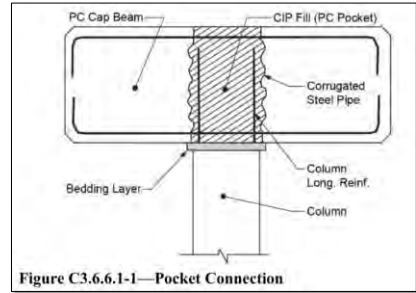


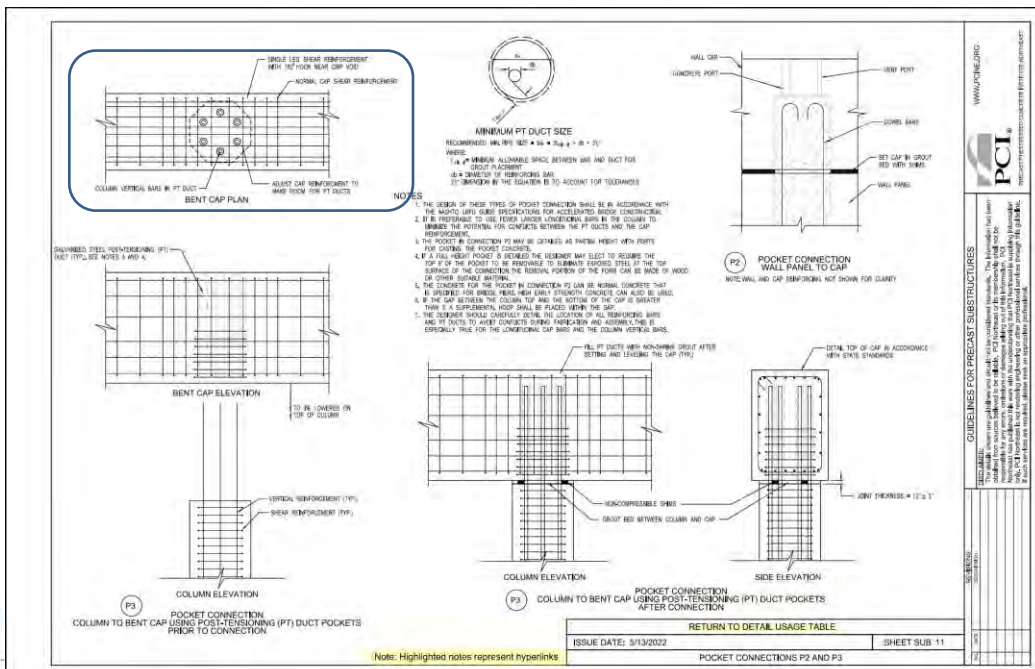
Figure C3.6.6.1-1—Pocket Connection

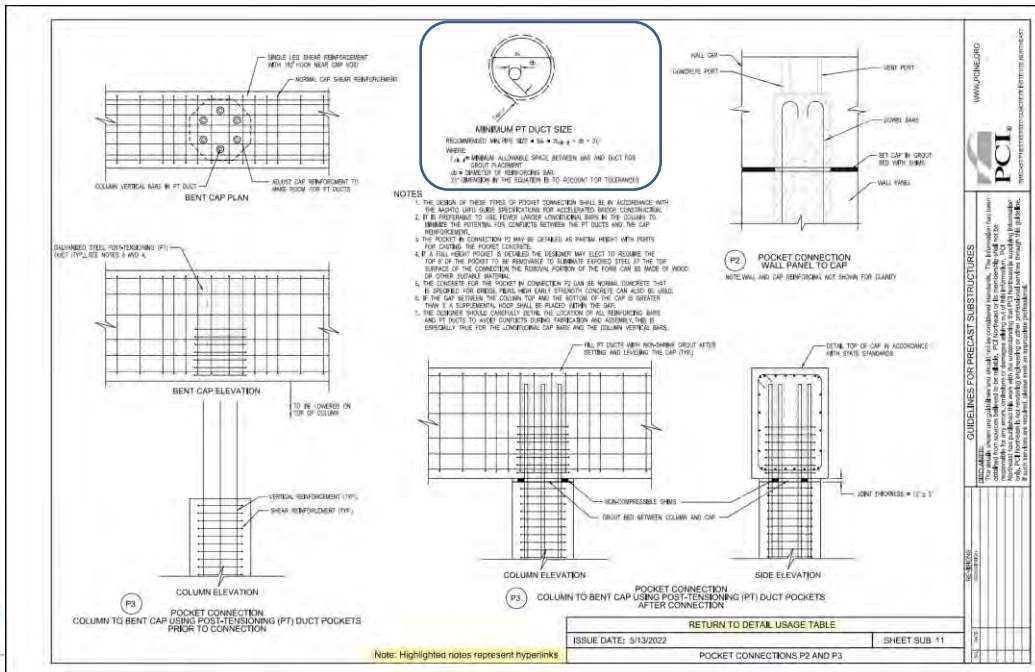
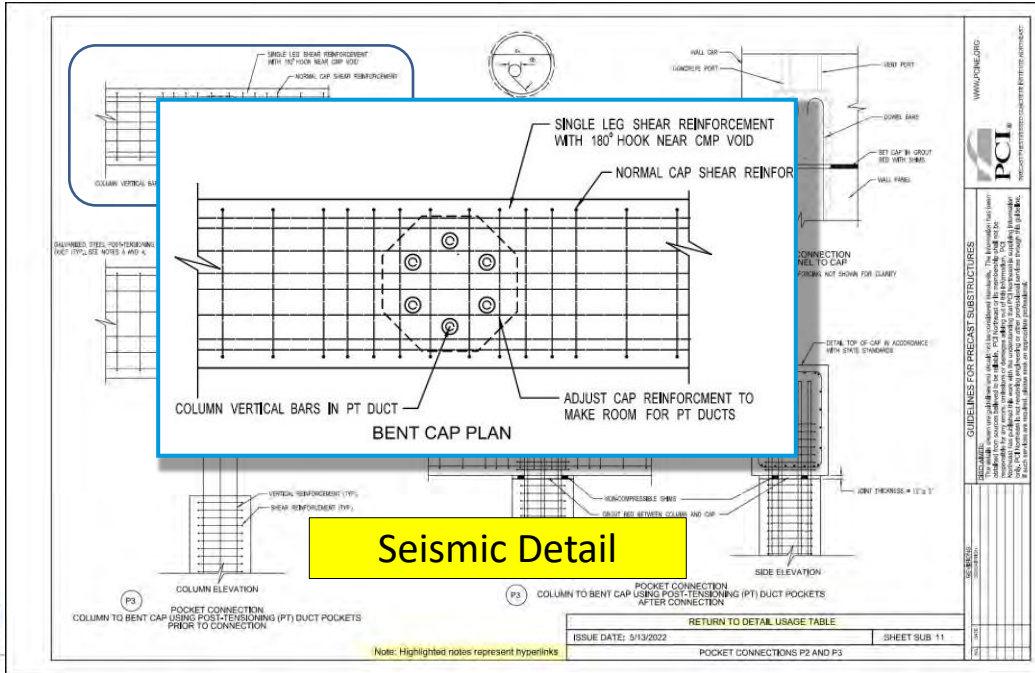
3.6.6.1—Column-to-Pier Cap or Column-to-Footing Pocket Connections

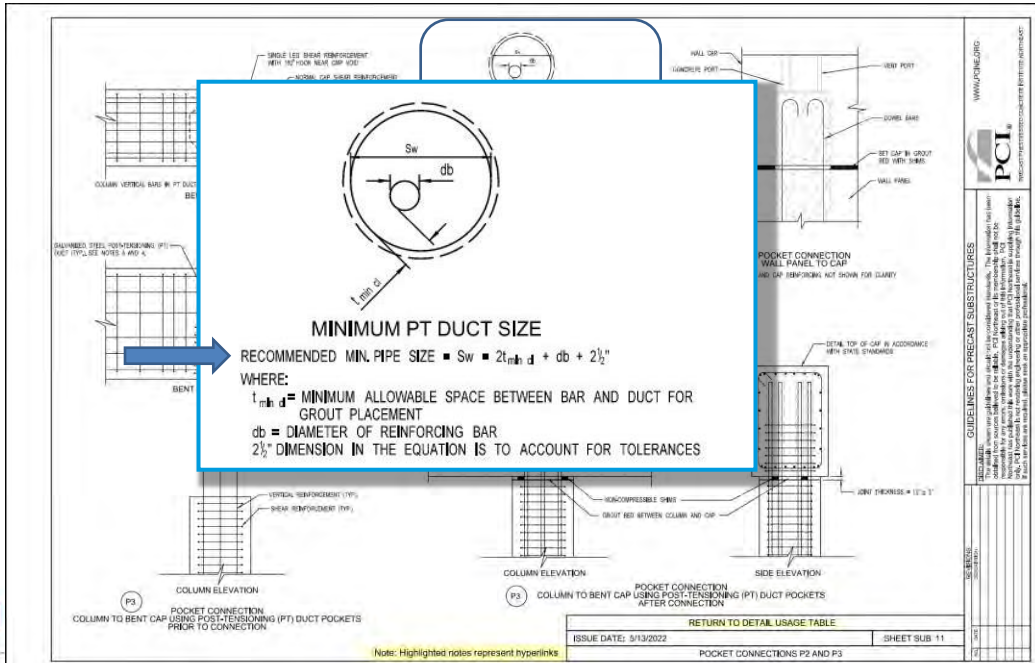
Pocket connections involve a column with projecting reinforcement and a receiving precast pier cap or footing containing a pocket. The column is placed such that the projecting reinforcement falls inside of the precast pocket and the connection is completed by filling the void with cast-in-place concrete or grout. A bedding layer between the end of the column and the pier cap soffit or footing top is used to accommodate fabrication and placement tolerances.



Pocket Connections







Design of PT Duct Pocket Connection

- This connection requires a detailed design procedure.
- The 2018 AASHTO LRFD Guide Specifications have provisions.

3.6.5—GROUTED DUCT CONNECTIONS

Grouted duct connections are used to connect individual reinforcing bars in tension by grouting the reinforcing bar that projects from one member into a corrugated steel duct embedded in a receiving member. Tensile force transfer occurs from the bar into the grout, from the grout into the duct, and then from the

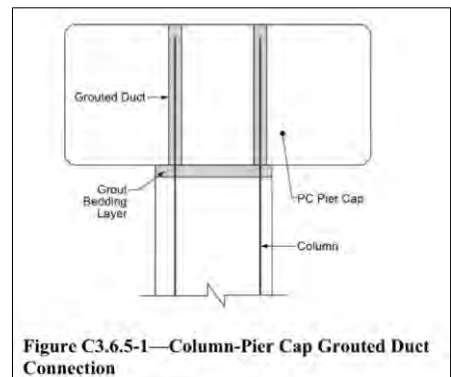
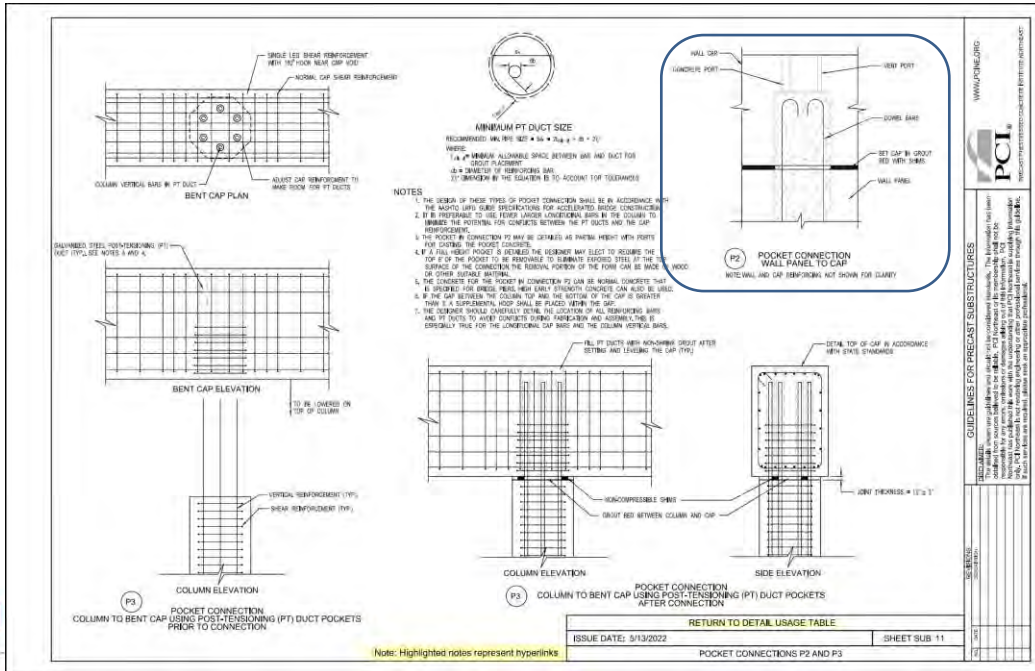


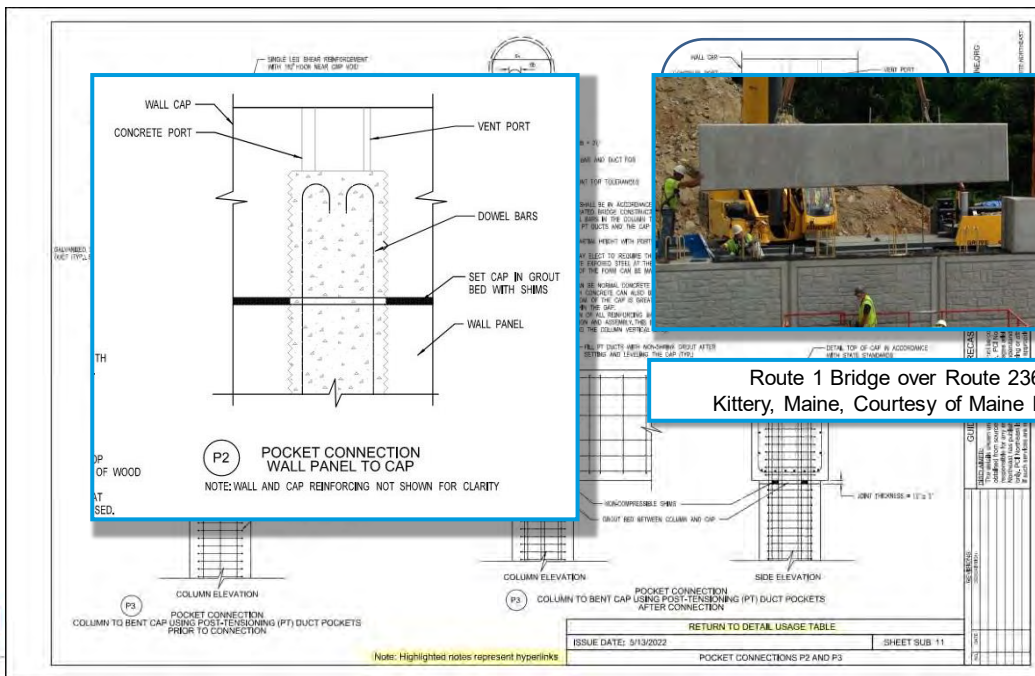
Figure C3.6.5-1—Column-Pier Cap Grouted Duct Connection



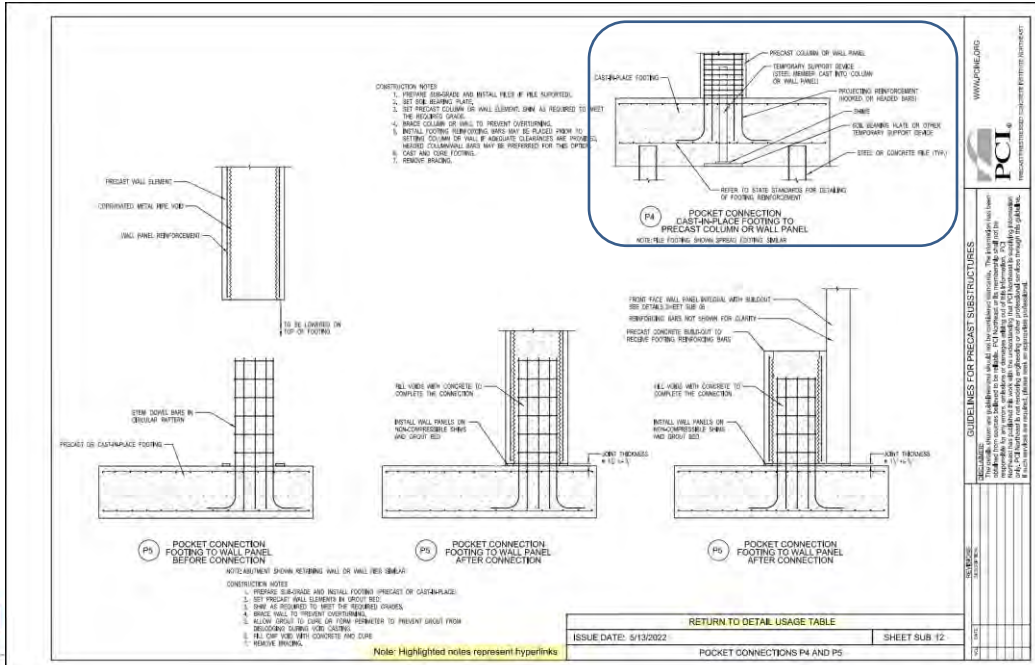
Pocket Connections



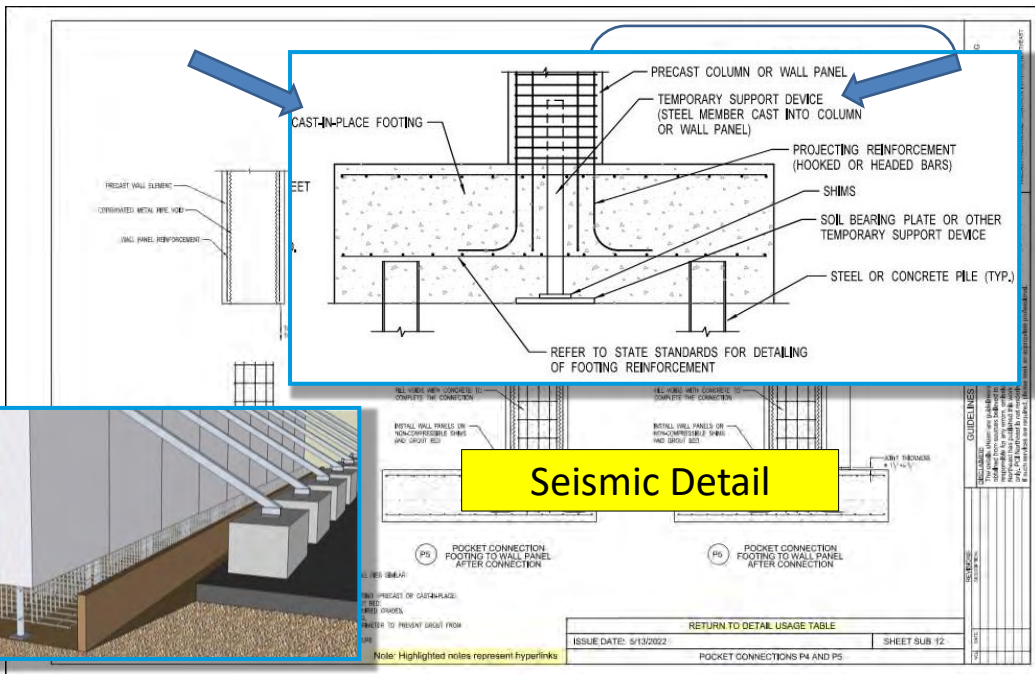
Pocket Connections



Pocket Connections



Pocket Connections



Pocket Connections



CONSTRUCTION NOTES

1. PREPARE SUBGRADE AND INSTALL REEF IF FILE SUPPORTED.
2. SET FOR BRACING PLATE.
3. SET PRECAST COLUMN OR WALL ELEMENT DOWN AS REQUIRED TO MEET THE REQUIRED CLEARANCE.
4. BRACE COLUMN OR WALL TO PREVENT OVERTURNING.
5. INITIAL FOOTING REINFORCING BARS MAY BE PLACED DOWN TO SETTING COLUMN OR WALL IF ADEQUATE CLEARANCES ARE PROVIDED.
6. REEFED COLUMNS SHALL NOT BE PREPARED FOR THE OPTION.
7. REMOVE BRACING.

CONSTRUCTION NOTES

1. PREPARE SUBGRADE AND INSTALL FOOTING (PRECAST OR CAST-IN-PLACE).
2. SET PRECAST WALL ELEMENTS IN SPECIFIC ORDER.
3. BRACE WALL TO PREVENT OVERTURNING.
4. ALLOW GROUT TO CURE OR FORM PERIMETER TO PREVENT GROUT FROM RECEIVING SURFACE VOID COVERING.
5. FILL GROUT WITH CONCRETE AND CURE.
6. REMOVE BRACING.

CONSTRUCTION NOTES

1. PREPARE SUBGRADE AND INSTALL FOOTING (PRECAST OR CAST-IN-PLACE).
2. SET PRECAST WALL ELEMENTS IN SPECIFIC ORDER.
3. BRACE WALL TO PREVENT OVERTURNING.
4. ALLOW GROUT TO CURE OR FORM PERIMETER TO PREVENT GROUT FROM RECEIVING SURFACE VOID COVERING.
5. FILL GROUT WITH CONCRETE AND CURE.
6. REMOVE BRACING.

POCKET CONNECTION FOOTING TO WALL PANEL BEFORE CONNECTION (P4)

POCKET CONNECTION FOOTING TO WALL PANEL AFTER CONNECTION (P5)

POCKET CONNECTION FOOTING TO WALL PANEL AFTER CONNECTION (P6)

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 12

POCKET CONNECTIONS P4 AND P5

Note: Highlighted notes represent hyperlinks

Pocket Connections



CONSTRUCTION NOTES

1. AND INITIAL REEF IF FILE SUPPORTED.
2. SET FOR BRACING PLATE.
3. SET PRECAST COLUMN OR WALL ELEMENT DOWN AS REQUIRED TO MEET THE REQUIRED CLEARANCE.
4. BRACE COLUMN OR WALL TO PREVENT OVERTURNING.
5. INITIAL FOOTING REINFORCING BARS MAY BE PLACED DOWN TO SETTING COLUMN OR WALL IF ADEQUATE CLEARANCES ARE PROVIDED.
6. REEFED COLUMNS SHALL NOT BE PREPARED FOR THE OPTION.
7. REMOVE BRACING.

CONSTRUCTION NOTES

1. PREPARE SUBGRADE AND INSTALL FOOTING (PRECAST OR CAST-IN-PLACE).
2. SET PRECAST WALL ELEMENTS IN SPECIFIC ORDER.
3. BRACE WALL TO PREVENT OVERTURNING.
4. ALLOW GROUT TO CURE OR FORM PERIMETER TO PREVENT GROUT FROM RECEIVING SURFACE VOID COVERING.
5. FILL GROUT WITH CONCRETE AND CURE.
6. REMOVE BRACING.

CONSTRUCTION NOTES

1. PREPARE SUBGRADE AND INSTALL FOOTING (PRECAST OR CAST-IN-PLACE).
2. SET PRECAST WALL ELEMENTS IN SPECIFIC ORDER.
3. BRACE WALL TO PREVENT OVERTURNING.
4. ALLOW GROUT TO CURE OR FORM PERIMETER TO PREVENT GROUT FROM RECEIVING SURFACE VOID COVERING.
5. FILL GROUT WITH CONCRETE AND CURE.
6. REMOVE BRACING.

POCKET CONNECTION FOOTING TO WALL PANEL AFTER CONNECTION

POCKET CONNECTION FOOTING TO WALL PANEL AFTER CONNECTION

POCKET CONNECTION FOOTING TO WALL PANEL AFTER CONNECTION

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 12

POCKET CONNECTIONS P4 AND P5

Note: Highlighted notes represent hyperlinks

**Route 1 Bridge over Route 236
Kittery, Maine, Courtesy of Maine DOT**

Socket Connections



SOCKET CONNECTION CAST-IN-PLACE FOOTING TO COLUMN BEFORE CONNECTION (S1)

SOCKET CONNECTION PILE TO WALL PANEL (S2)

RETURN TO DETAIL USAGE TABLE
 ISSUE DATE: 5/13/2022
 SHEET SUB 13
 SOCKET CONNECTIONS S1 AND S2

Notes:

1. THE SOULING SURFACE MAY BE FORMED FINISHED WITH AN EXPOSED AGGREGATE SURFACE OR CAST WITH A CORRUGATED PIPE IF THE PIPE OPTION IS USED THE TOP OF THE PIPE SHOULD BE RECESSED BELOW THE TOP OF THE CAST-IN-PLACE CONCRETE TO PREVENT CORROSION PROTECTION.
2. THE SOULING SURFACE OF COLUMN SHOULDER AND AN EFFECT ON THE DESIGN OF THE CONNECTION, SEE PRECEDING IN THE AASHTO LRFD GUIDE SPECIFICATIONS FOR ACCEPTABLE RANGE OF CONNECTION.
3. THE BOTTOM OF THE COLUMN MAY BE SET BELOW THE BOTTOM OF THE FOOTING TO MEET THE REQUIREMENTS OF THE OTHER PRECEDING NOTES ABOVE IF PROBING THE BOTTOM OF THE COLUMN SHOULD BE AT THE SAME ELEVATION AS THE BOTTOM OF FOOTING.

CONSTRUCTION SEQUENCE:

1. EXCAVATE FOR FOOTING AND FORM FOOTING.
2. INSTALL REINFORCING AND STEEL PLATE ON CONCRETE (SEE PLAN).
3. INSTALL FOOTING REINFORCEMENT.
4. INSTALL COLUMN FORMS, BRACE COLUMN IN PLACE.
5. CAST FOOTING CONCRETE.

CONSTRUCTION SEQUENCE:

1. INTALL PILES
2. COMPACT SOIL AROUND PILE TO PROVIDE SUPPORT FOR CAP ERECTION
3. INSTALL ABUTMENT STEM
4. FILL CMP VOID WITH CONCRETE

Notes:

1. PIPE SIZE SHOULD ACCOMMODATE PILE DRIVING TOLERANCES.
2. DESIGN THE CONNECTION IN ACCORDANCE WITH THE AASHTO LRFD GUIDE SPECIFICATION FOR ABC.
3. DESIGN AND DETAILING OF CAP REINFORCEMENT IS THE SAME AS A CAST-IN-PLACE ABUTMENT CAP.

CONSTRUCTION SEQUENCE:

1. INTALL PILES
2. COMPACT SOIL AROUND PILE TO PROVIDE SUPPORT FOR CAP ERECTION
3. INSTALL ABUTMENT STEM
4. FILL CMP VOID WITH CONCRETE

Pocket Connections



SOCKET CONNECTION CAST-IN-PLACE FOOTING TO COLUMN BEFORE CONNECTION (S1)

SOCKET CONNECTION PILE TO WALL PANEL (S2)

RETURN TO DETAIL USAGE TABLE
 ISSUE DATE: 5/13/2022
 SHEET SUB 13
 SOCKET CONNECTIONS S1 AND S2

Notes:

1. THE SOULING SURFACE MAY BE FORMED FINISHED WITH AN EXPOSED AGGREGATE SURFACE OR CAST WITH A CORRUGATED PIPE IF THE PIPE OPTION IS USED THE TOP OF THE PIPE SHOULD BE RECESSED BELOW THE TOP OF THE CAST-IN-PLACE CONCRETE TO PREVENT CORROSION PROTECTION.
2. THE SOULING SURFACE OF COLUMN SHOULDER AND AN EFFECT ON THE DESIGN OF THE CONNECTION, SEE PRECEDING IN THE AASHTO LRFD GUIDE SPECIFICATIONS FOR ACCEPTABLE RANGE OF CONNECTION.
3. THE BOTTOM OF THE COLUMN MAY BE SET BELOW THE BOTTOM OF THE FOOTING TO MEET THE REQUIREMENTS OF THE OTHER PRECEDING NOTES ABOVE IF PROBING THE BOTTOM OF THE COLUMN SHOULD BE AT THE SAME ELEVATION AS THE BOTTOM OF FOOTING.

CONSTRUCTION SEQUENCE:

1. EXCAVATE FOR FOOTING AND FORM FOOTING.
2. INSTALL REINFORCING AND STEEL PLATE ON CONCRETE (SEE PLAN).
3. INSTALL FOOTING REINFORCEMENT.
4. INSTALL COLUMN FORMS, BRACE COLUMN IN PLACE.
5. CAST FOOTING CONCRETE.

CONSTRUCTION SEQUENCE:

1. INTALL PILES
2. COMPACT SOIL AROUND PILE TO PROVIDE SUPPORT FOR CAP ERECTION
3. INSTALL ABUTMENT STEM
4. FILL CMP VOID WITH CONCRETE

Notes:

1. PIPE SIZE SHOULD ACCOMMODATE PILE DRIVING TOLERANCES.
2. DESIGN THE CONNECTION IN ACCORDANCE WITH THE AASHTO LRFD GUIDE SPECIFICATION FOR ABC.
3. DESIGN AND DETAILING OF CAP REINFORCEMENT IS THE SAME AS A CAST-IN-PLACE ABUTMENT CAP.

CONSTRUCTION SEQUENCE:

1. INTALL PILES
2. COMPACT SOIL AROUND PILE TO PROVIDE SUPPORT FOR CAP ERECTION
3. INSTALL ABUTMENT STEM
4. FILL CMP VOID WITH CONCRETE

**Mountain Road over Hartwell Brook
 Charlemont, MA
 MassDOT Project 603704**

Pocket Connections



PRECAST COLUMN ELEMENT

COLUMN REINFORCEMENT
NOTE: HOOP STIRRUPS SHOWN. SPIRALS ARE ALSO ACCEPTABLE.

ROUGHEN PORTION OF COLUMN END EMBEDDED IN CONCRETE. SEE NOTE 1.

NOTES:

1. THE ROUGHEN SURFACE MAY BE FORMED FIMBRICATED WITH AN EXPOSED AGGREGATE SURFACE OR CAST WITH A CONCRETE PIPE IF THE PIPE OPTION IS USED. THE TOP OF THE PIPE SHOULD BE RECESSED BELOW THE TOP OF THE CAST-IN-PLACE CONCRETE TO PROVIDE CORNER PROTECTION.
2. THE SURFACE OF THE ROUGHENED COLUMN END HAS AN EFFECT ON THE DESIGN OF THE CONNECTION. SEE PROVISIONS IN THE AASHTO LRFD CODE SPECIFICATIONS FOR CONNECTIONS OF CONCRETE.
3. THE BOTTOM OF THE COLUMN MAY BE SET BELOW THE BOTTOM OF THE FOOTING TO MEET THE REQUIREMENTS OF THE DESIGN PROCEEDING NOTES. HOWEVER, THE BOTTOM OF THE COLUMN SHOULD BE AT THE SAME ELEVATION AS THE BOTTOM OF FOOTING.

CONSTRUCTION SEQUENCE:

1. EXCAVATE FOR FOOTING AND FORM FOOTING.
2. INSTALL LEVELING AND STEEL PLATE OR CONCRETE (SEE PLAN).
3. INSTALL FOOTING REINFORCEMENT.
4. INSTALL COLUMN FORMS, BRACE COLUMN IN PLACE.
5. CAST FOOTING CONCRETE.

CONSTRUCTION SEQUENCE:

1. PIPE END SHOULD ACCOMMODATE PIPE DRAINING TOLERANCES.
2. DESIGN THE CONNECTION IN ACCORDANCE WITH THE AASHTO LRFD GUIDE SPECIFICATION FOR P.C.
3. DESIGN AND DETAILING OF CAP REINFORCEMENT BE THE SAME AS A CAST-IN-PLACE ARCHITECTURE CAP.

CONSTRUCTION SEQUENCE:

1. INSTALL PIPE.
2. CONDUCT SOIL AROUND PIPE TO PROVIDE SUPPORT FOR CAP ELECTION.
3. INSTALL ARCHITECTURE STEEL.
4. FILL CAP VOID WITH CONCRETE.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 13

SOCKET CONNECTIONS S1 AND S2

Note: Highlighted notes represent hyperlinks

WAWA/CORPORATION

PCI

GUIDELINES FOR PRECAST SUBSTRUCTURES

Minimum 1/4" thick steel plate or equivalent reinforcement shall be used for all connections. The following have been used in the design of this connection: PCI 318, PCI 308, PCI 309, PCI 310, PCI 311, PCI 312, PCI 313, PCI 314, PCI 315, PCI 316, PCI 317, PCI 318, PCI 319, PCI 320, PCI 321, PCI 322, PCI 323, PCI 324, PCI 325, PCI 326, PCI 327, PCI 328, PCI 329, PCI 330, PCI 331, PCI 332, PCI 333, PCI 334, PCI 335, PCI 336, PCI 337, PCI 338, PCI 339, PCI 340, PCI 341, PCI 342, PCI 343, PCI 344, PCI 345, PCI 346, PCI 347, PCI 348, PCI 349, PCI 350, PCI 351, PCI 352, PCI 353, PCI 354, PCI 355, PCI 356, PCI 357, PCI 358, PCI 359, PCI 360, PCI 361, PCI 362, PCI 363, PCI 364, PCI 365, PCI 366, PCI 367, PCI 368, PCI 369, PCI 370, PCI 371, PCI 372, PCI 373, PCI 374, PCI 375, PCI 376, PCI 377, PCI 378, PCI 379, PCI 380, PCI 381, PCI 382, PCI 383, PCI 384, PCI 385, PCI 386, PCI 387, PCI 388, PCI 389, PCI 390, PCI 391, PCI 392, PCI 393, PCI 394, PCI 395, PCI 396, PCI 397, PCI 398, PCI 399, PCI 400, PCI 401, PCI 402, PCI 403, PCI 404, PCI 405, PCI 406, PCI 407, PCI 408, PCI 409, PCI 410, PCI 411, PCI 412, PCI 413, PCI 414, PCI 415, PCI 416, PCI 417, PCI 418, PCI 419, PCI 420, PCI 421, PCI 422, PCI 423, PCI 424, PCI 425, PCI 426, PCI 427, PCI 428, PCI 429, PCI 430, PCI 431, PCI 432, PCI 433, PCI 434, PCI 435, PCI 436, PCI 437, PCI 438, PCI 439, PCI 440, PCI 441, PCI 442, PCI 443, PCI 444, PCI 445, PCI 446, PCI 447, PCI 448, PCI 449, PCI 450, PCI 451, PCI 452, PCI 453, PCI 454, PCI 455, PCI 456, PCI 457, PCI 458, PCI 459, PCI 460, PCI 461, PCI 462, PCI 463, PCI 464, PCI 465, PCI 466, PCI 467, PCI 468, PCI 469, PCI 470, PCI 471, PCI 472, PCI 473, PCI 474, PCI 475, PCI 476, PCI 477, PCI 478, PCI 479, PCI 480, PCI 481, PCI 482, PCI 483, PCI 484, PCI 485, PCI 486, PCI 487, PCI 488, PCI 489, PCI 490, PCI 491, PCI 492, PCI 493, PCI 494, PCI 495, PCI 496, PCI 497, PCI 498, PCI 499, PCI 500, PCI 501, PCI 502, PCI 503, PCI 504, PCI 505, PCI 506, PCI 507, PCI 508, PCI 509, PCI 510, PCI 511, PCI 512, PCI 513, PCI 514, PCI 515, PCI 516, PCI 517, PCI 518, PCI 519, PCI 520, PCI 521, 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PCI 855, PCI 856, PCI 857, PCI 858, PCI 859, PCI 860, PCI 861, PCI 862, PCI 863, PCI 864, PCI 865, PCI 866, PCI 867, PCI 868, PCI 869, PCI 870, PCI 871, PCI 872, PCI 873, PCI 874, PCI 875, PCI 876, PCI 877, PCI 878, PCI 879, PCI 880, PCI 881, PCI 882, PCI 883, PCI 884, PCI 885, PCI 886, PCI 887, PCI 888, PCI 889, PCI 890, PCI 891, PCI 892, PCI 893, PCI 894, PCI 895, PCI 896, PCI 897, PCI 898, PCI 899, PCI 900, PCI 901, PCI 902, PCI 903, PCI 904, PCI 905, PCI 906, PCI 907, PCI 908, PCI 909, PCI 910, PCI 911, PCI 912, PCI 913, PCI 914, PCI 915, PCI 916, PCI 917, PCI 918, PCI 919, PCI 920, PCI 921, PCI 922, PCI 923, PCI 924, PCI 925, PCI 926, PCI 927, PCI 928, PCI 929, PCI 930, PCI 931, PCI 932, PCI 933, PCI 934, PCI 935, PCI 936, PCI 937, PCI 938, PCI 939, PCI 940, PCI 941, PCI 942, PCI 943, PCI 944, PCI 945, PCI 946, PCI 947, PCI 948, PCI 949, PCI 950, PCI 951, PCI 952, PCI 953, PCI 954, PCI 955, PCI 956, PCI 957, PCI 958, PCI 959, PCI 960, PCI 961, PCI 962, PCI 963, PCI 964, PCI 965, PCI 966, PCI 967, PCI 968, PCI 969, PCI 970, PCI 971, PCI 972, PCI 973, PCI 974, PCI 975, PCI 976, PCI 977, PCI 978, PCI 979, PCI 980, PCI 981, PCI 982, PCI 983, PCI 984, PCI 985, PCI 986, PCI 987, PCI 988, PCI 989, PCI 990, PCI 991, PCI 992, PCI 993, PCI 994, PCI 995, PCI 996, PCI 997, PCI 998, PCI 999, PCI 1000.

Pocket Connections



PRECAST COLUMN ELEMENT

COLUMN REINFORCEMENT
NOTE: HOOP STIRRUPS SHOWN. SPIRALS ARE ALSO ACCEPTABLE.

ROUGHEN PORTION OF COLUMN END EMBEDDED IN CONCRETE. SEE NOTE 1.

NOTES:

1. THE ROUGHEN SURFACE OR CORNER OF THE PIPE SHOULD PROVIDE CORNER PROTECTION.
2. THE SURFACE OF THE CONNECTION SHOULD BE ACCELERATED.
3. THE BOTTOM OF THE COLUMN SHOULD MEET THE REQUIREMENTS OF THE DESIGN AT THE BOTTOM OF THE FOOTING.

CONSTRUCTION SEQUENCE:

1. EXCAVATE FOR FOOTING AND FORM FOOTING.
2. INSTALL LEVELING AND STEEL PLATE OR CONCRETE (SEE PLAN FOR LAYOUT).
3. INSTALL FOOTING REINFORCEMENT.
4. INSTALL COLUMN FORMS, BRACE COLUMN IN PLACE.
5. CAST FOOTING CONCRETE.

CONSTRUCTION SEQUENCE:

1. PIPE END SHOULD ACCOMMODATE PIPE DRAINING TOLERANCES.
2. DESIGN THE CONNECTION IN ACCORDANCE WITH THE AASHTO LRFD GUIDE SPECIFICATION FOR P.C.
3. DESIGN AND DETAILING OF CAP REINFORCEMENT BE THE SAME AS A CAST-IN-PLACE ARCHITECTURE CAP.

CONSTRUCTION SEQUENCE:

1. INSTALL PIPE.
2. CONDUCT SOIL AROUND PIPE TO PROVIDE SUPPORT FOR CAP ELECTION.
3. INSTALL ARCHITECTURE STEEL.
4. FILL CAP VOID WITH CONCRETE.

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022

SHEET SUB 13

SOCKET CONNECTIONS S1 AND S2

Note: Highlighted notes represent hyperlinks



FHWA Highways for LIFE Washington State DOT

Seismic Detail

Design of Socket Connections

- This connection requires a detailed design procedure.
- The 2018 AASHTO LRFD Guide Specifications have detailed provisions.
- See NCHRP Project 12-102A Training Module 2 for sample calculations

3.6.7.2—Precast Concrete Column in Spread Footing or Pile Cap Socket Connection

Where socket connections are used to connect precast columns to spread footings or pile caps, the following requirements shall apply.

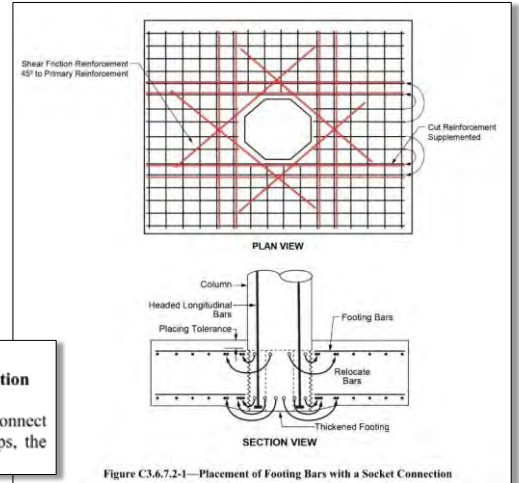


Figure C3.6.7.2-1—Placement of Footing Bars with a Socket Connection



Key Connections

KEY CONNECTION NOTES:

1. NOT ALL ELEMENT REINFORCING SPECIAL ELEMENT REINFORCING SHOWN AS NOT THROUGH THE JOINTS SHOULD OCCUR FOR THE ACTION.
2. REINFORCEMENT REQUIRED TO SATISFY THE DESIGN REQUIREMENTS.
3. CONTRACTOR TO CHECK FORMS TO SECURE KEY CONNECTIONS ON BOTH SIDES OF THE JOINT.
4. THE WIDTH OF THE KEY SHALL VARY BASED ON THE MATERIAL AT THE JOINT. THE ELEMENT TOLERANCES AND THE DESIGN TOLERANCES SET TABLE FOR THE CONNECTIONS CALL-OUT FOR JOINT WIDTHS.
5. THE FORMS ARE SHOWN FOR REFERENCE ONLY. NOT BE NECESSARY FOR DETAILER'S ANALYSIS.
6. THE SPACING OF THE KEYS SHOULD BE SUFFICIENT TO HAVE AN ADEQUATE AVERAGE FINISH. SEE PAGE 4 OF THESE GUIDELINES.

MATERIAL IN JOINT	MINIMUM CALL-OUT
REINFORCING CURVED WITH FINE AGGREGATE OR FIBERLESS	17" x 3"
CONCRETE WITH 3/8" MAXIMUM SIZE AGGREGATE	17" x 3"
CONCRETE WITH 1/2" MAXIMUM SIZE AGGREGATE	22" x 3"

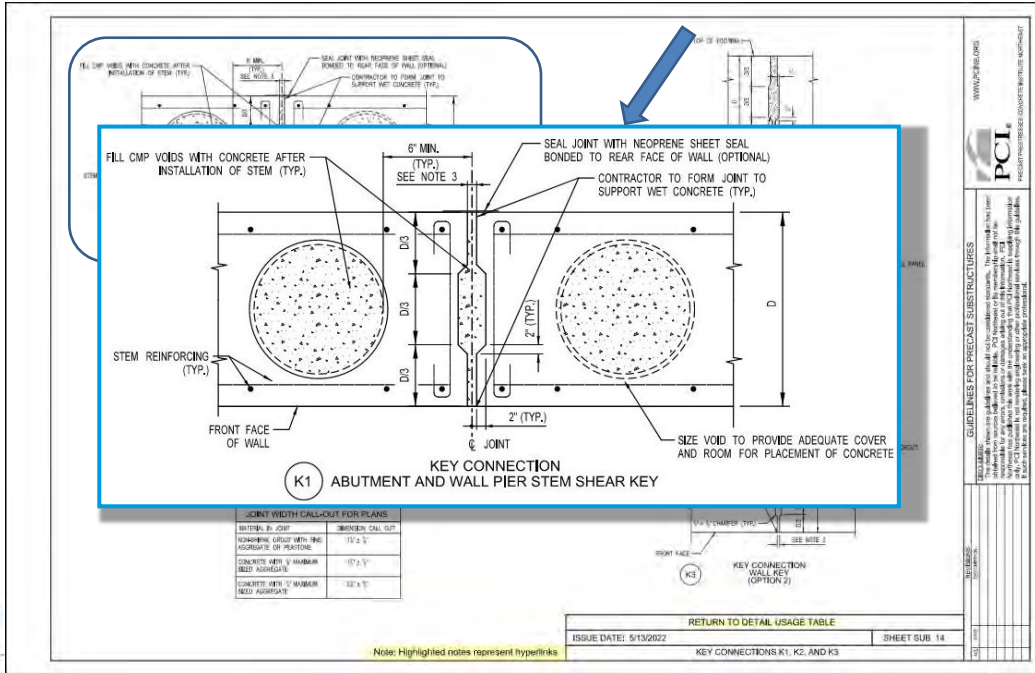
RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022	SHEET SUB 14
KEY CONNECTIONS K1, K2, AND K3	

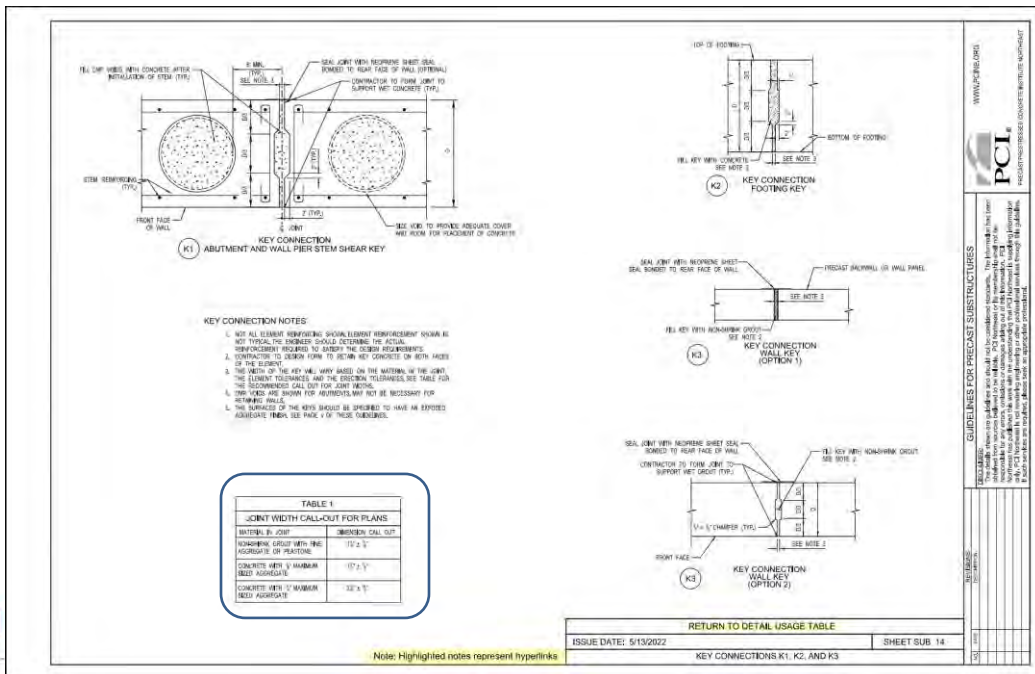
Note: Highlighted notes represent hyperlinks



Pocket Connections



Pocket Connections



Pocket Connections



TABLE 1
JOINT WIDTH CALL-OUT FOR PLANS

MATERIAL IN JOINT	DIMENSION CALL OUT
NON-SHRINK GROUT WITH FINE AGGREGATE OR PEASTONE	$1\frac{1}{2}'' \pm \frac{1}{8}''$
CONCRETE WITH $\frac{3}{8}''$ MAXIMUM SIZED AGGREGATE	$1\frac{1}{2}'' \pm \frac{1}{4}''$
CONCRETE WITH $\frac{1}{2}''$ MAXIMUM SIZED AGGREGATE	$2\frac{1}{2}'' \pm \frac{1}{4}''$

TABLE 1
JOINT WIDTH CALL-OUT FOR PLANS

MATERIAL IN JOINT	DIMENSION CALL OUT
NONSHRINK GROUT WITH FINE AGGREGATE OR PEASTONE	$1\frac{1}{2}'' \pm \frac{1}{8}''$
CONCRETE WITH $\frac{3}{8}''$ MAXIMUM SIZED AGGREGATE	$1\frac{1}{2}'' \pm \frac{1}{4}''$
CONCRETE WITH $\frac{1}{2}''$ MAXIMUM SIZED AGGREGATE	$2\frac{1}{2}'' \pm \frac{1}{4}''$

RETURN TO DETAIL USAGE TABLE
ISSUE DATE: 5/13/2022
KEY CONNECTIONS K1, K2, AND K3
SHEET SUB 14

Note: Highlighted notes represent hyperlinks

Pier Element Tolerances



TABLE 1
COLUMN FABRICATION TOLERANCES

DESCRIPTION	TOLERANCE
A. LENGTH	$\pm 1/4''$
B. WIDTH (OVERALL)	$\pm 1/4''$
C. DEPTH (OVERALL)	$\pm 1/4''$
D. VARIATION FROM SUPPLIED END SQUARENESS OR PERPENDICULARITY	$\pm 1/16''$ PER 12 INCH MEASUREMENT
E. TOLERANCE FOR MEMBER LENGTH	$\pm 1/4''$ MAXIMUM
F. LOCATION OF GROUDED SPICE COUPLER (MEASURED FROM A COMMON REFERENCE POINT)	$\pm 1/4''$
G. LOCAL SMOOTHNESS OF ANY SURFACE	$\pm 1/16''$ IN 10 FEET

TABLE 2
COLUMN ERECTION TOLERANCES

DESCRIPTION	TOLERANCE
A. TOP ELEVATION FROM NOMINAL TOP ELEVATION	MAXIMUM LOW MAXIMUM HIGH
B. MAXIMUM PLUMB VARIATION OVER HEIGHT OF COLUMN	$1/4''$
C. PLUMB IN ANY 10 FEET OF COLUMN HEIGHT	$1/4''$

TABLE 3
BENT CAP FABRICATION TOLERANCES

DESCRIPTION	TOLERANCE
A. LENGTH	$\pm 1/4''$
B. WIDTH (OVERALL)	$\pm 1/4''$
C. DEPTH (OVERALL)	$\pm 1/4''$
D. VARIATION FROM SUPPLIED PLAN END SQUARENESS OR PERPENDICULARITY	$\pm 1/16''$ PER 12 INCH MEASUREMENT
E. LOCATION OF GROUDED SPICE COUPLER (MEASURED FROM A COMMON REFERENCE POINT)	$\pm 1/4''$ PER 12 INCH MEASUREMENT
F. SLOPE FOR MEMBER LENGTH	$\pm 1/16''$ PER 10 FEET
G. LOCATION OF GROUDED SPICE COUPLER (MEASURED FROM A COMMON REFERENCE POINT)	$\pm 1/4''$ PER 10 FEET
H. LOCAL SMOOTHNESS OF ANY SURFACE	$\pm 1/16''$ IN 10 FEET
I. VARIATION FROM SQUARE CORNER (IF PRESTRESSED)	$\pm 1/16''$ MAXIMUM
J. ERECTION ELEVATION TOLERANCE	$\pm 1/4''$
K. SLOPE OF BENT PRESENTED FROM TOP SURFACE	$\pm 1/4''$

RETURN TO DETAIL USAGE TABLE
ISSUE DATE: 5/13/2022
PIER BENT ELEMENT TOLERANCES
SHEET SUB 15

Note: Highlighted notes represent hyperlinks

GROUTED SPICE COUPLER DETAILS

NOTES:

- USE FACTORY TOLERANCES AND USE FOR THE LOCATION OF REINFORCEMENT AND GROUTED SPICE COUPLER PLACEMENT UNLESS THE DRAWING TO CONTRARY INDICATES.
- CONSULT MANUFACTURER OF THE GROUTED SPICE COUPLER FOR PROPER DIMENSIONS TO ALLOW FOR TOLERANCE ON THESE DIMENSIONS.
- BEFORE GROUTING GROUTED SPICE COUPLER ASSEMBLY ALWAYS SEAL BEARING SURFACE FROM THE MANUFACTURER OF THE GROUTED SPICE COUPLER.

GROUTED SPICE COUPLER TOLERANCES

1. BORE HOLE VARIATION	±0.015"
2. BORE HEIGHT	CONSULT MANUFACTURER
3. LOCATION OF COLUMN REINFORCING GROUTED SPICE COUPLER AND HOLES (GENERAL)	±1"
4. GAP BETWEEN COUPLER AND COLUMN REINFORCING	CONSULT MANUFACTURER

WALL PANEL FABRICATION TOLERANCES

1. LENGTH	±1/2"
2. WIDTH (OVERALL)	±1/2"
3. THICKNESS (OVERALL)	±1/2"
4. VARIATION FROM SPECIFIED PLAN AND SQUARENESS OF JOINT	1/4" PER 10' EACH WIDTH ±1/4" MAXIMUM
5. VARIATION FROM SPECIFIED ELEVATION AND SQUARENESS OF JOINT	1/4" PER 10' EACH HEIGHT ±1/4" MAXIMUM
6. LOCATION OF GROUTED SPICE COUPLER MEASURED FROM A COMMON REFERENCE POINT	±1/2"
7. LOCAL SMOOTHNESS OF AIR SURFACE	±1/16" TO 3/32"
8. LOCATION OF BLOODOUT FOR REES OR JOBS	±1/2"

WALL PANEL ERECTION TOLERANCES

1. TOP ELEVATION FROM FINISH TOP ELEVATION	±1/2"
2. MAXIMUM PLUMB VARIATION OVER HEIGHT OF COLUMN	±1/2"
3. PLUMB BY ANY 10 FEET OF COLUMN HEIGHT	±1/2"

RETURN TO DETAIL USAGE TABLE

ISSUE DATE: 5/13/2022	SHEET SUB 16
ABUTMENT AND WALL ELEMENT TOLERANCES	



Conclusions

- Designers have all the tools required to execute an ABC Substructure design
 - AASHTO LRFD Guide Specifications for ABC
 - Design Specifications
 - Construction Specifications
 - PCI Northeast Guidelines for Precast Substructures used in ABC
 - Design Details
- With these resources, you can develop a design for all common substructure types

