BDA 409-02 | SEPTEMBER 2024

SEMI-INTEGRAL CONSIDERATIONS FOR REHABILITION PROJECTS

Reference: IDM 409-03 Semi-Integral End Bent

Introduction

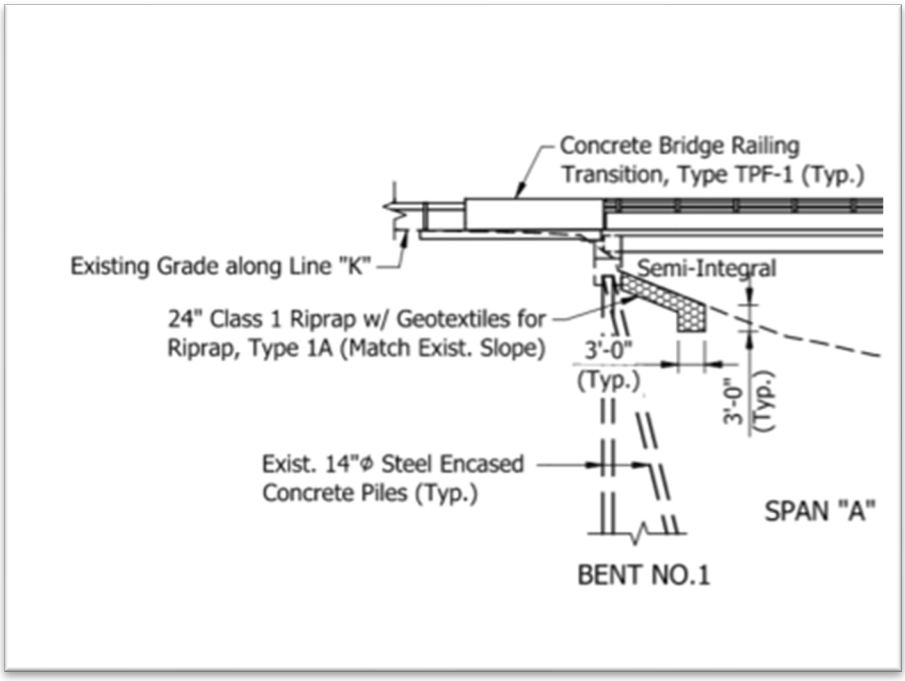
The intent of this design aid is to share best practices and common challenges associated with converting existing supports to semi-integral end bents. Modifying an existing structure can often create challenges not accounted for in the semi-integral end bent details shown in the Indiana Design Manual (IDM) that are intended for new construction. The following guidance is based on historical in-service performance, constructability, and inspection findings.

This document does not relieve the designer of any responsibility associated with designing and detailing semi-integral end bent conversions. Designs will always need to be specific to the existing conditions.

General Guidance and Preferences

Label bent as semi-Integral on elevation view on the General Plan sheet.

Example Callout:



BDA 409-02 | SEPTEMBER 2024

Thermal Movement

When existing expansion bents are being converted to semi-integral, thermal movements of the bridge need to be accounted for at the interface between the approach slab and the approach roadway pavement. Terminal joints are the most common way to account to this movement. Thermal movement can also cause issues at other interfaces such as keyways, MSE walls, moment slabs, sidewalks and barrier railings.

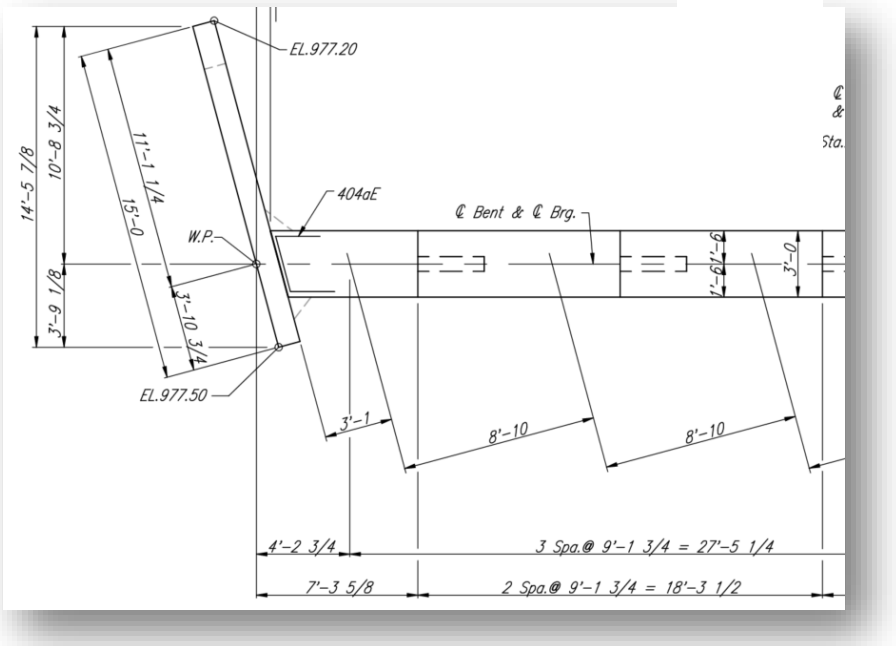
Keyways are typically not warranted. Fixed or semi-fixed interior supports may provide adequate restraint. If no supports are fixed, keyways should be utilized at one end only. If one end has an existing fixed bearing that should be the end with the keyway in the final condition. Keyways need to be aligned with and sized for specific thermal movements of that structure. The thickness of preformed expansion joint filler (PEJF) should be at least 1.5 times the factored thermal movement to allow movement without excessive resistance. Even when calculations indicate a smaller amount of movement, a minimum thickness of ½ inches of PEJF should be used.

Additional width of PEJF may be used to account for movement when existing steps are perpendicular to bent.

If existing steps are not aligned with the longitudinal axis of the beams, the diaphragm (top pour) may not be able to move freely relative to the bent cap. Modifications to the typical diaphragm configuration are necessary to account for this conflict. Even when steps appear to be aligned with movement, PEJF should be placed along the vertical faces to account to any imperfections.

Detail Example:

Note: Steps and keyways are not aligned with the longitudinal axis of the beams. Details must be included to account for this difference to avoid restraint and damage during thermal expansion and contraction.



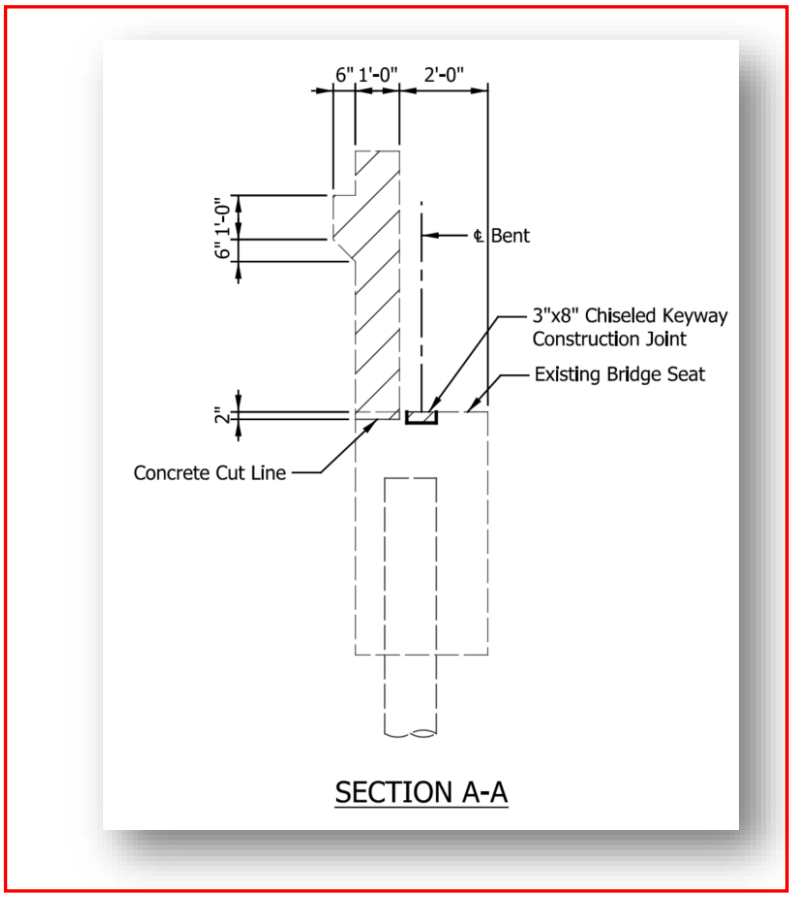
Temporary Supports

Often temporary supports are required when existing superstructures are being converted to semi-integral. The designer is responsible providing specific loads and support locations on the plans. The superstructure should be evaluated for the change in support locations including local effects. INDOT's preference is to prohibit live loads on the portion of bridge being supported by temporary shoring. The designer should clearly delineate service dead and service live load contributions to the overall load to be temporarily supported. The Jacking and Supporting pay item should be included in the contract.

Lack of Fixity

Keyways cut out of existing concrete are difficult to construct per plan and often lead to unintended restraint during thermal movement. Cutting a keyway into existing concrete should be avoided. In situations where a lack of longitudinal restraint is a concern, constructability and full thermal movements of the bridge must be considered. Reconstructing the bridge seat is often the best option.

Detail Example – Chiseled Keyway (AVOID THIS DEAIL)



Example of field issues:

Use of Bent "Candy Cane" Bars

Due to constructability issues, the use of hooked bars in a pvc sleeve shown in past versions of the IDM is discouraged. Such bars are not required for most scenarios. If the bar doesn't remain centered in the pvc sleeve during the end bent diaphragm pour, unintended restraint can develop when the bar comes in contact with the inside of the sleeve. The use of these bars should be warranted by design computations.

When longitudinal restraint is required, reconstruction of the pile cap with new keyways is the preferred method for creating this restraint.

In the rare instance of an uplift condition at the end bent, the use of these hooked bars may be acceptable for providing vertical restraint. Other constructability issues are likely a concern if uplift at the end bent is predicted by design computations. Uplift conditions should be avoided wherever possible.

If used, a square block of compressible PEJF material, sized to accommodate the anticipated thermal movements, should be specified around the bar to insure space for movement.

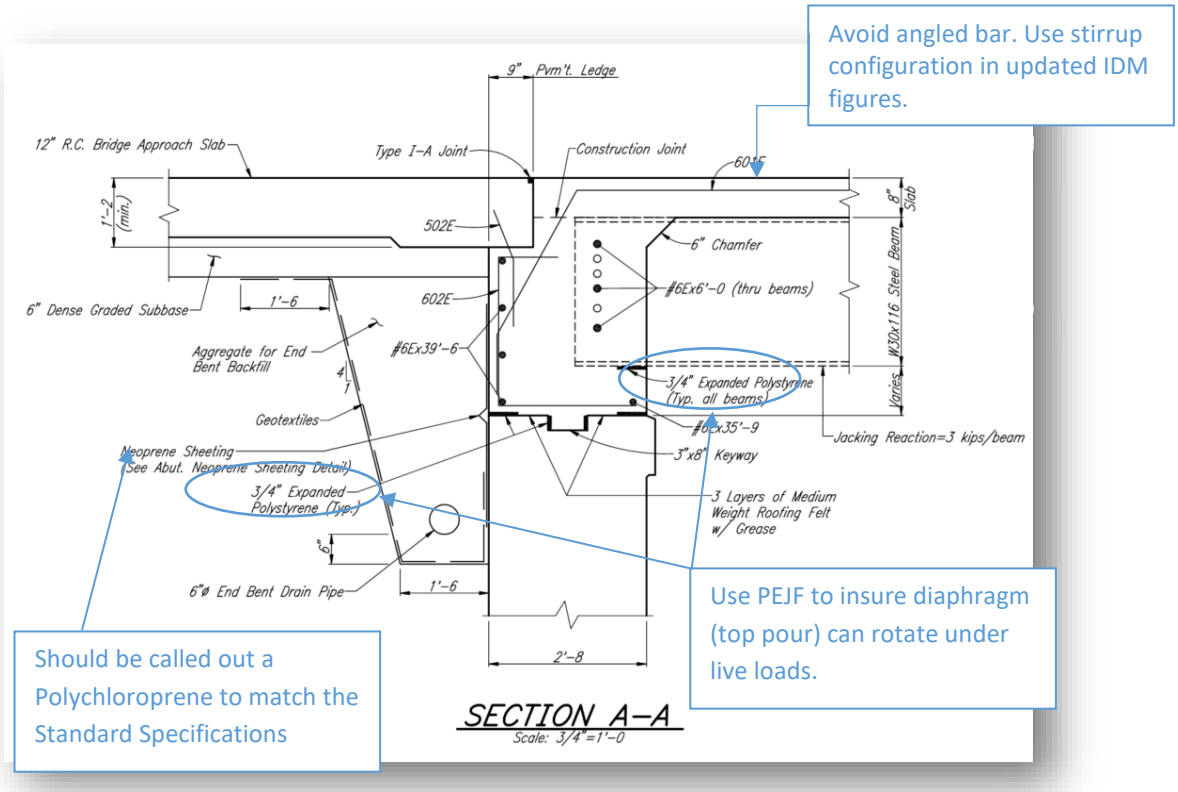
Configuration Shown as Method A in Past Version of the IDM

This method is discouraged. Configurations with bearing pads are preferred.

1. This method without an elastomeric bearing is not preferred. Use should be limited to scenarios where methods which include elastomeric bearings are not feasible.
    a. Field issues have arisen from improper detailing. These detailing errors include failing to provide PEJF under the beams and at the face of the construction joint and improper keyway sizing and configuration along the skew. These issues have included loss of cover concrete on the face of the diaphragm resulting in costly repairs and reduced service life.
    b. This method may be warranted where limited bearing seat width is available on the existing cap.
2. Use updated rebar layouts instead of previous angled bars at the pavement ledge.
    a. The angled bars if not detailed properly can have fit and cover issues at the pavement ledge.
    b. Updated rebar configurations allow for more flexibility in the field.
2. Optional construction joint should be included. See example detail.

Detail Example – Method A (now obsolete)

Note: “PEJF” should be used instead of “Expanded Polystyrene”

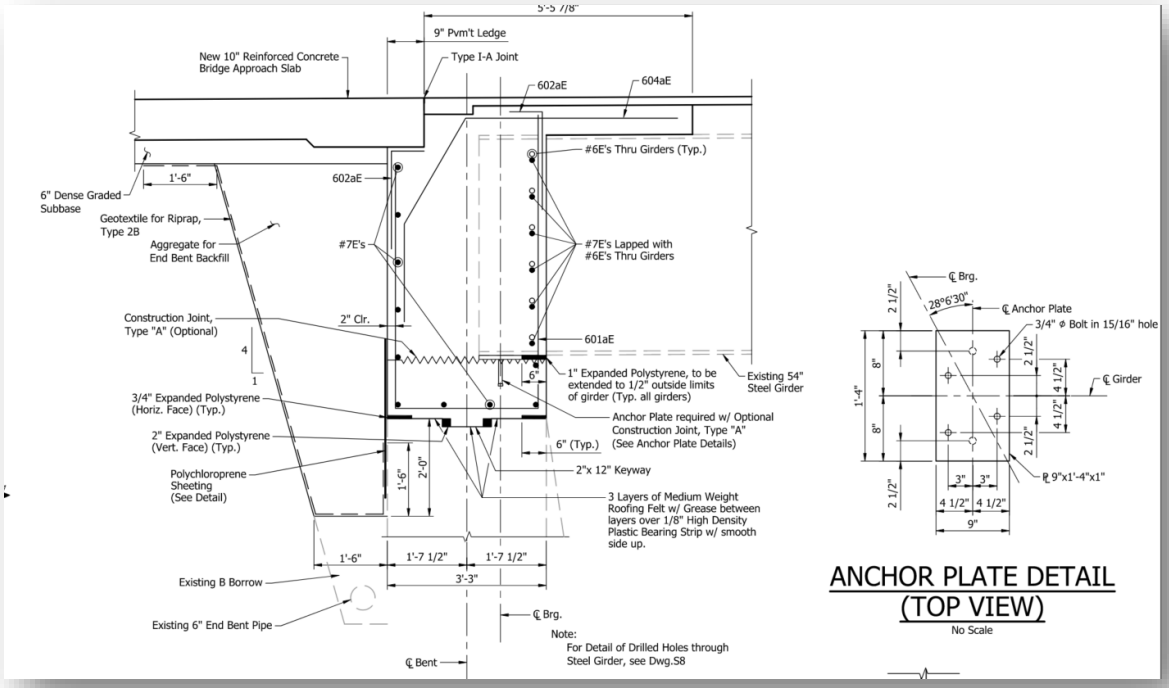


Method A (now obsolete) with Anchor Plate (steel girder)

PEJF should be detailed under the flange to reduce the point loading at the face of the diaphragm under live loads. Increasing the PEJF thickness should be considered especially in cases with longer spans.

Detail Example - Accounting for Girder End Rotation:

(Note: "PEJF" should be used instead of "Expanded Polystyrene")



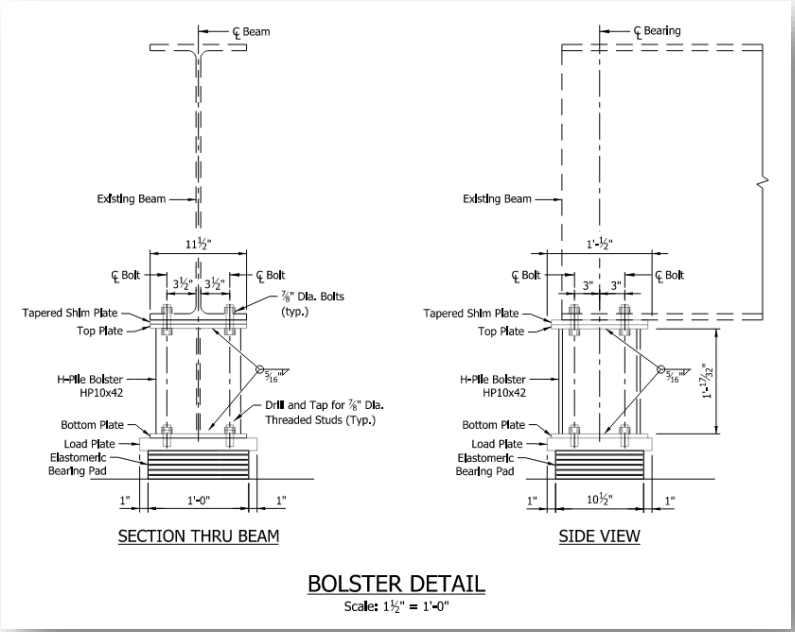
Bearing Pad and Bolster Configuration

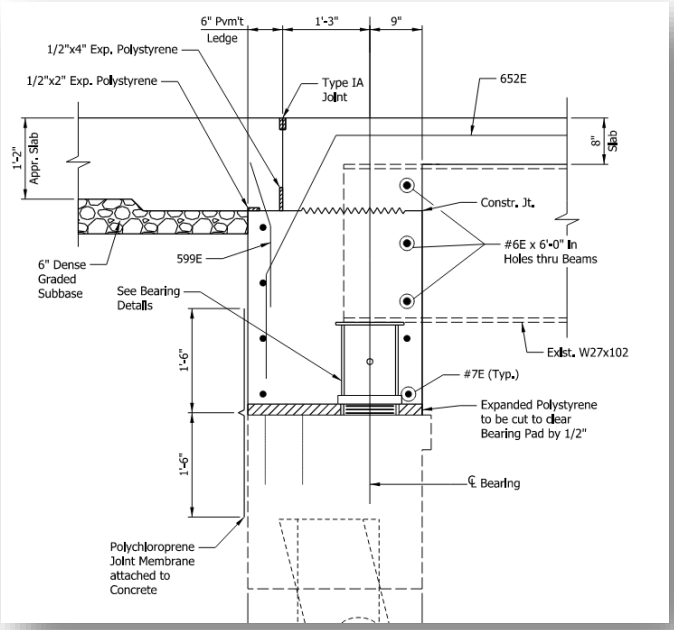
This configuration with a bearing pad is preferred over those without a bearing pad.

1. Bolsters are typically used when existing bearing is steel rockers.
2. Designers should ensure the existing bridge seat condition is acceptable. Deteriorated bridge seats should be reconstructed or built up when necessary for proper bearing pad performance.
3. This method can reduce jacking loads and ease constructability at structures where space for temporary supports is limited.
4. Specifying and detailing shim packs allows for more flexibility in the field. This is especially true on rehabilitation projects.
5. HP sections should be bolted to the bearing after bearing fabrication to minimize testing requirements associated with unique bearing pad configurations.

6. Encasing the HP section in concrete is preferred. Blocking out around the HP section with PEJF is not preferred unless warranted by a unique situation.

Detail Examples – Bearing Pad with Bolster





NOTES

All structural steel shall conform to the requirements of AASHTO M270/AASHTO A709 (Grade 50).

All bolts shall be galvanized high strength ASTM A325, Type 1.

The bridge seats shall be completely level to ensure full contact with the bottom of the bearing device.

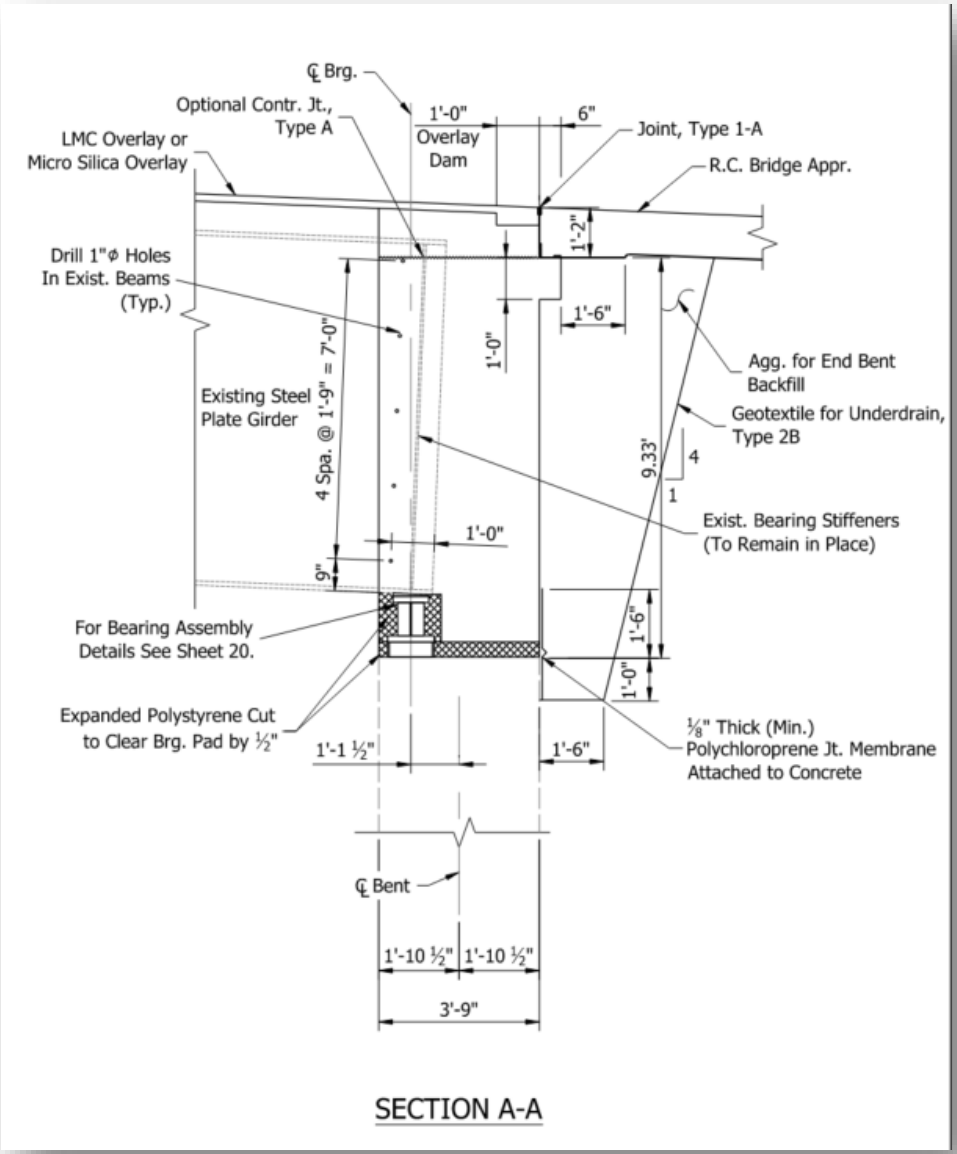
Load plate shall be vulcanized to the elastomeric bearing.

Verify bolt hole locations, existing bolt hole diameters, and assembly height prior to fabricating assemblies.

All bearing plates, bolts, bolster, and washers shall be galvanized in accordance with ISS 910.01(g) and 915.04.

Detail Example - Foam Blockout (not preferred)

Note: Do not include thickness of the polychloroprene in the plans. The required thickness is covered in the standard specifications.



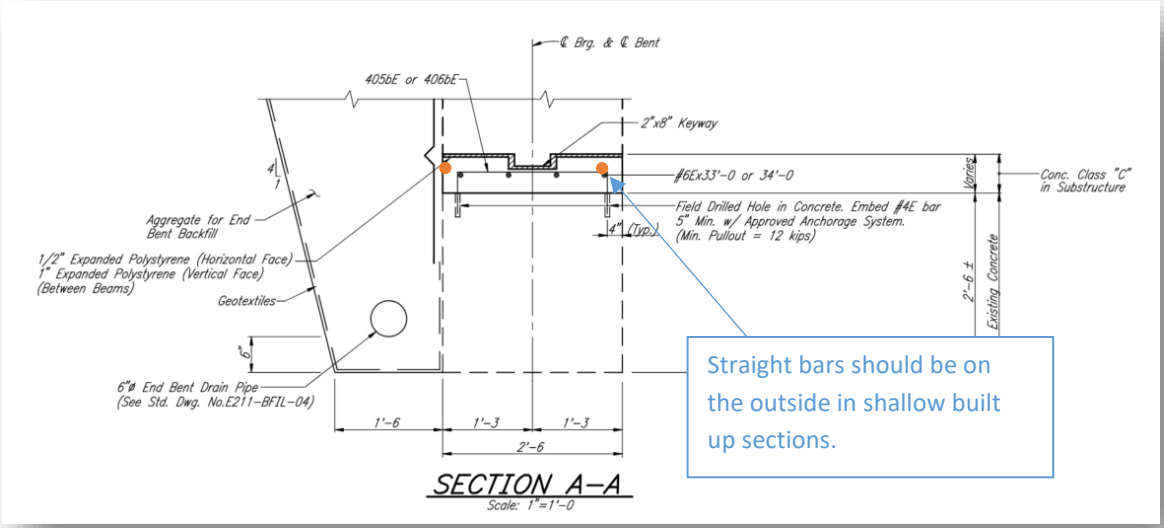
Concrete Pedestal Construction

Constructing concrete pedestals is an alternative to the steel bolster.

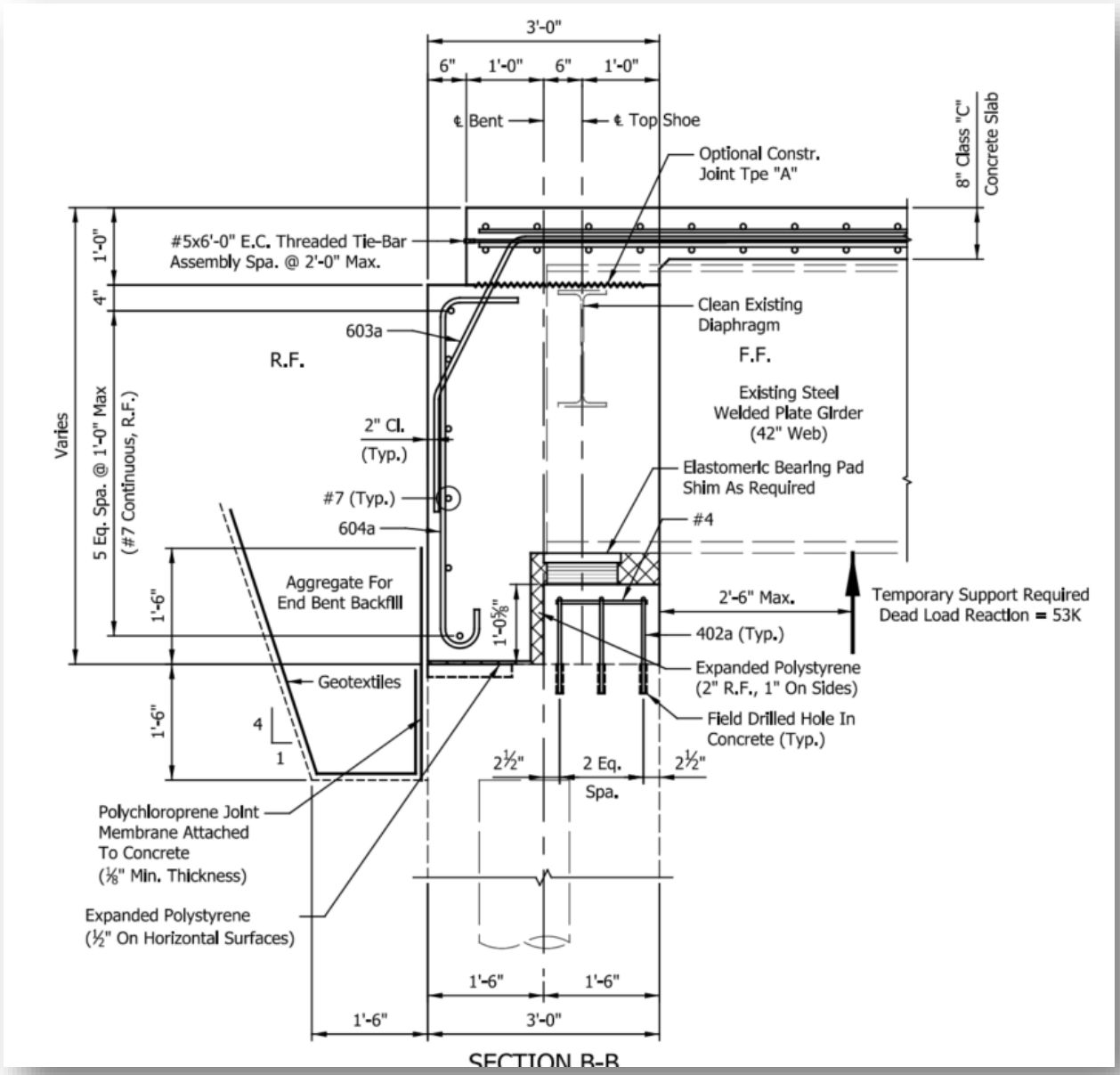
1. Individual pedestals are not preferred. Building up the entire bridge seat with full width pour is easier to construct and avoids potential thermal expansion conflicts.
2. If individual pedestals are utilized, details should include space for thermal movements on each side of the pedestal.
3. When using small U-bars in pedestals, the longitudinal rebar should be placed outside of U bars to reduce thickness of unreinforced concrete. LRFD minimum edge distances apply.
4. When building up on an existing bridge seat, a minimum depth of concrete is required to provides adequate rebar cover. Designer should consider this this when deciding between a steel bolster and a built-up concrete section.

Detail Examples:

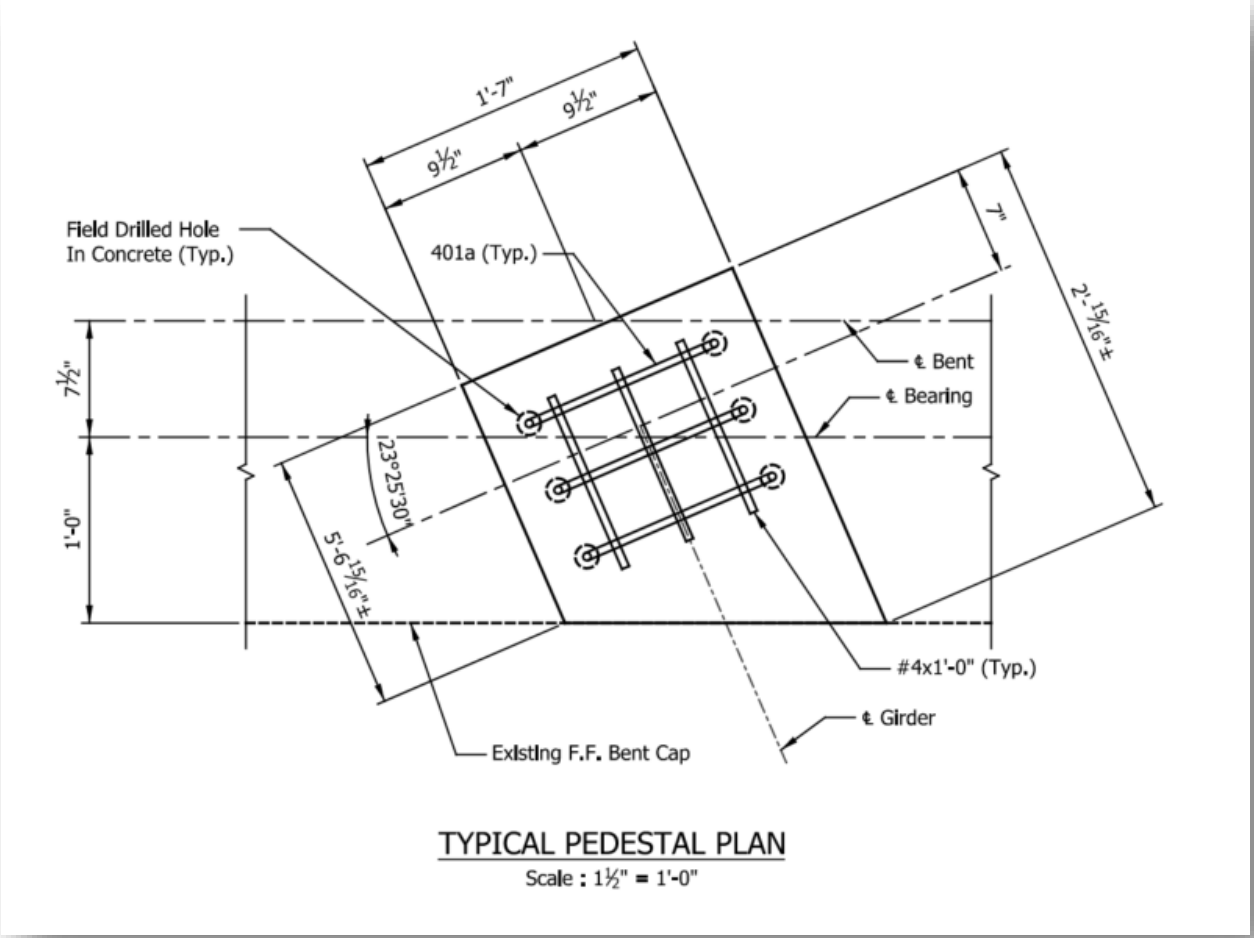
Note: Keyways should typically be avoided.



Note: Existing diaphgrams should only remain in place when in good condition.



Note: Pedestals should be configured to match the movement of the beams as shown here.



TYPICAL PEDESTAL PLAN

Scale : 1½" = 1'-0"

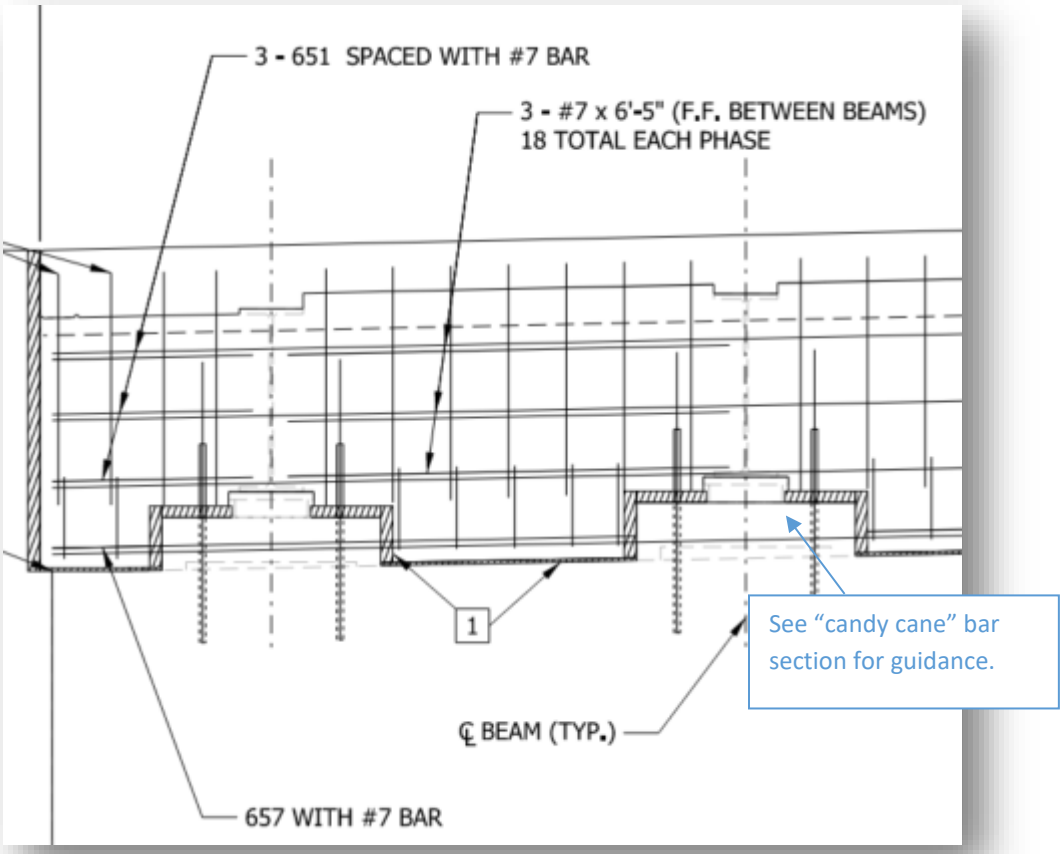
Existing Pedestals

Special detailing accommodations must be made for thermal movement when pedestals are perpendicular to the bent and not parallel to the beam lines.

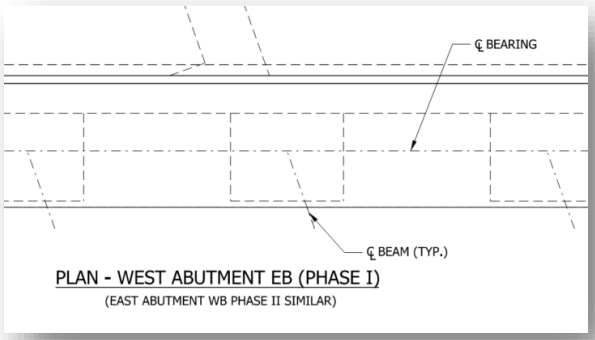
For shorter structures with limited thermal movements, additional thickness of PEJF on vertical surfaces may be enough to avoid conflict.

In most cases, unique detailing will need to be considered to avoid conflict between the existing steps and the concrete diaphragm.

Detail Examples – Existing Pedestal



1 ½" EXPANDED POLYSTYRENE (HORIZONTAL FACE)
2 " EXPANDED POLYSTYRENE (VERTICAL FACE)



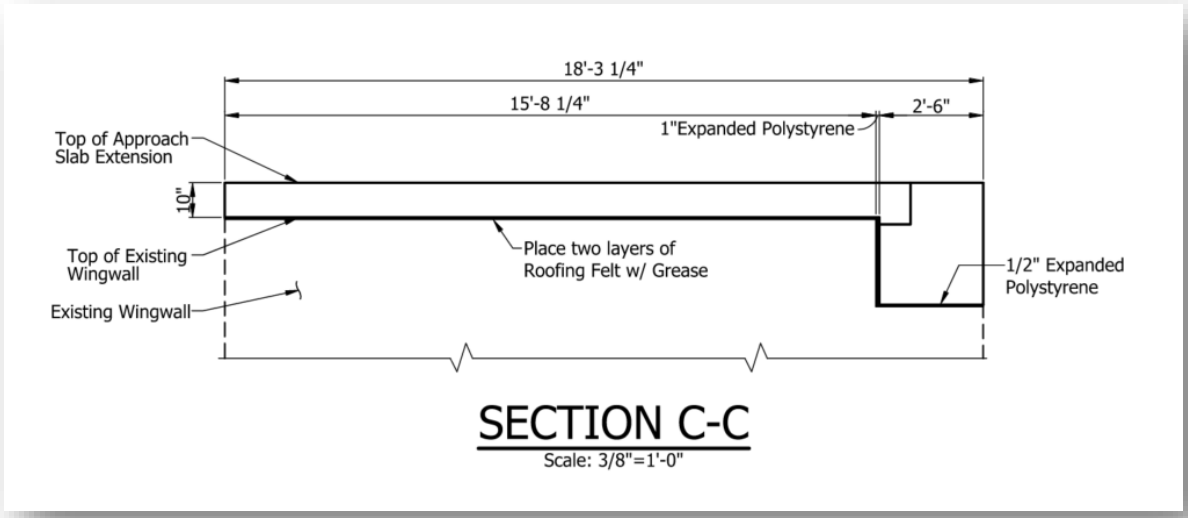
BDA 409-02 | SEPTEMBER 2024

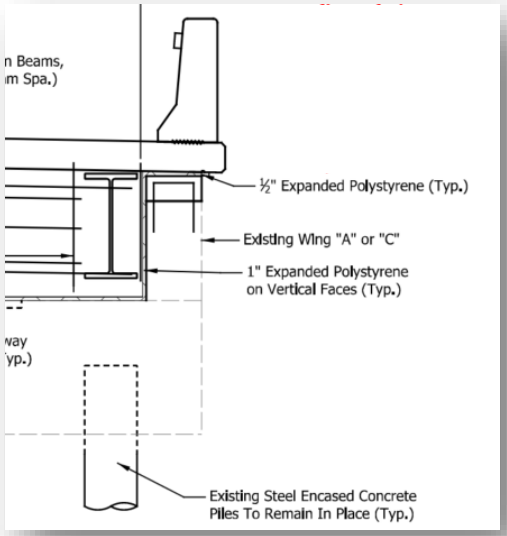
Considering RCBA Movement and Wingwalls

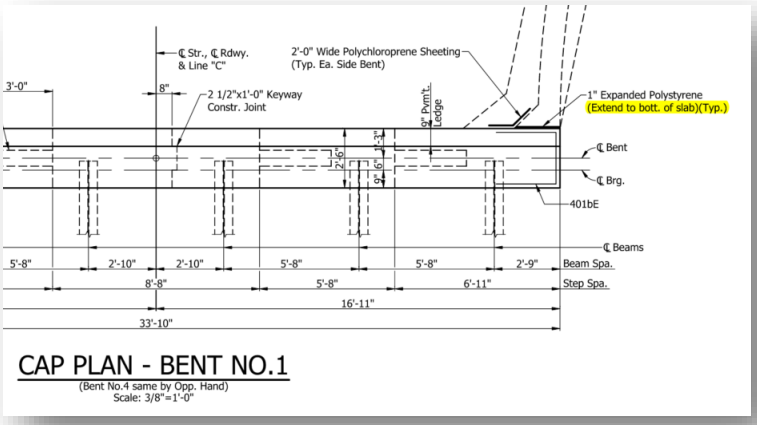
When converting an existing structure to semi-integral, the reinforced concrete bridge approach slab will now slide with thermal movements of the bridge. This new movement must be accounted for in the detailing of the wingwalls.

When placing the RCBA over wingwalls cannot be avoided, PEJF can be used in these situations. Greased roofing felt has been used in this situation in the past, but PEJF is now preferred. The PEJF allows for some settlement of the RBCA subbase prior to the RCBA bearing on the wingwall.

Detail Examples:







Positive Connection between Beam and Diaphgram

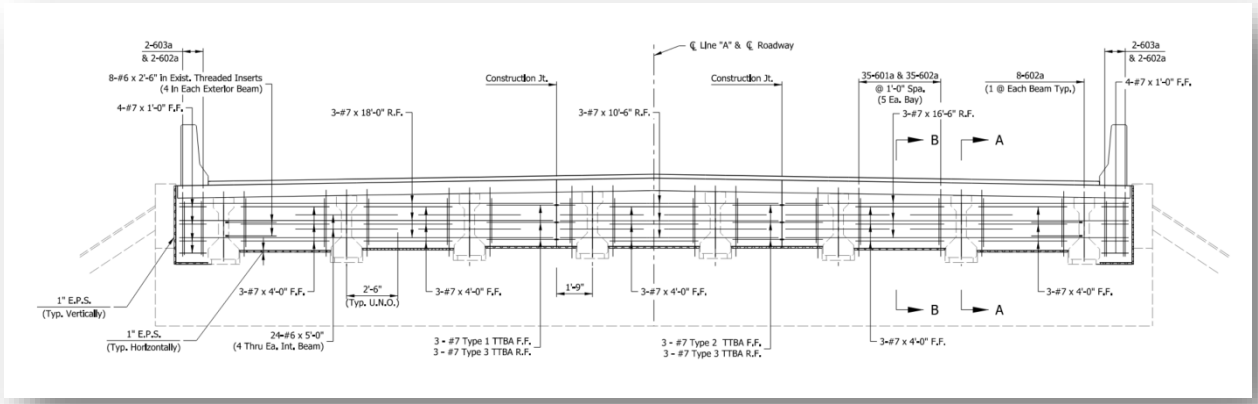
A mechanical connection should be made between the concrete diaphgram and the steel member. This can be accomplished by drilling holes and placing rebar though the existing web, or by installing shear studs on the existing steel member. Alternatively, when existing diaphgram connections angles are in good conditions, such angles could remain in place.

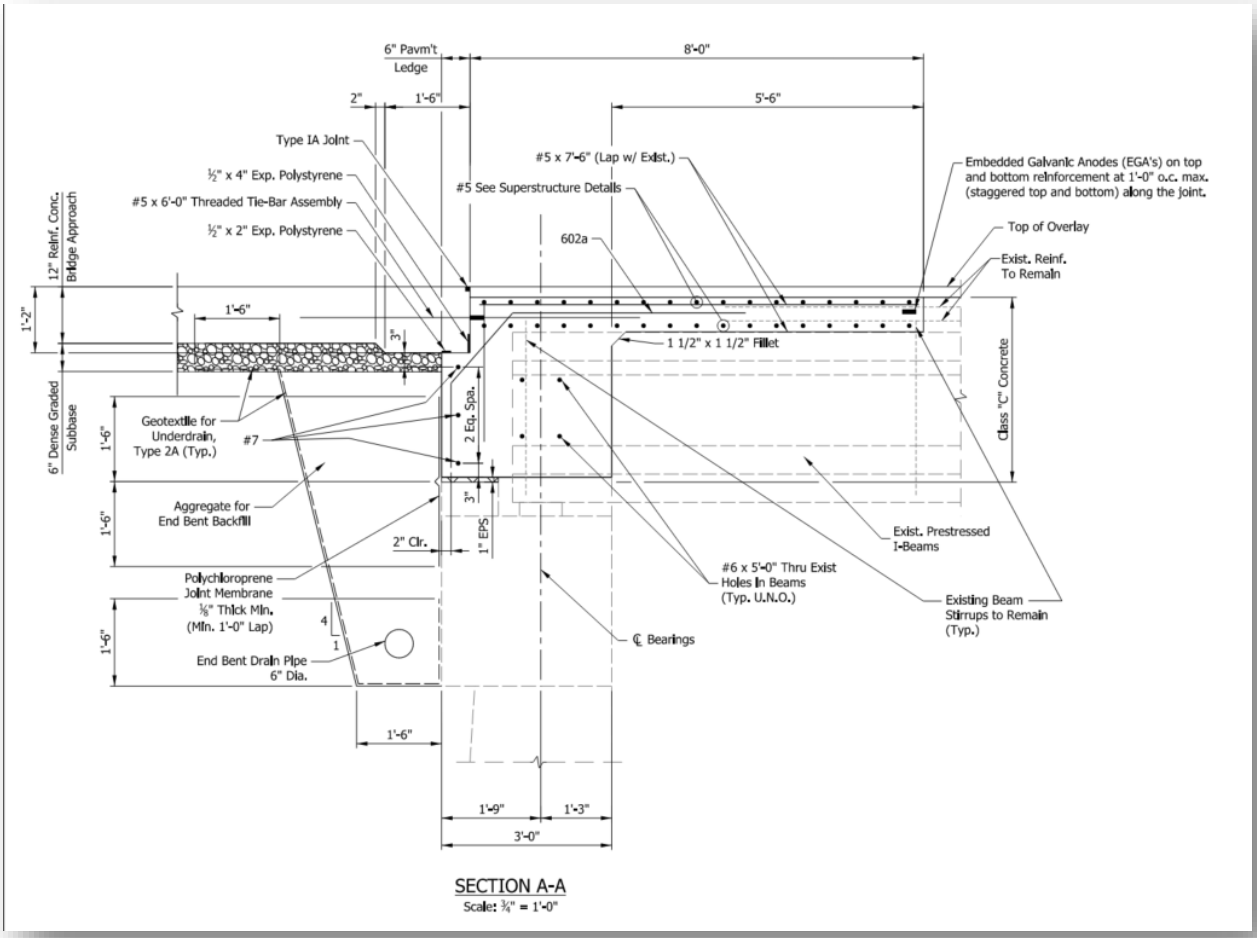
Establishing a mechanical connection between concrete beams and semi-integral diaphragms is typically not warranted due to sufficient adhesion between the new and existing concrete. Additionally, field drilling prestressed beams is not preferred due to the risk of drilling through a prestressing strand.

Existing Beam Pockets

Some existing prestressed structures have pockets built into the bridge seat for the bearing pads. For these types of configurations, providing the additional depth for jacking is likely not possible. The designer should insure adequate typical sections are provided to show contractor all location where concrete should be blocked out during the pour.

Detail Examples:

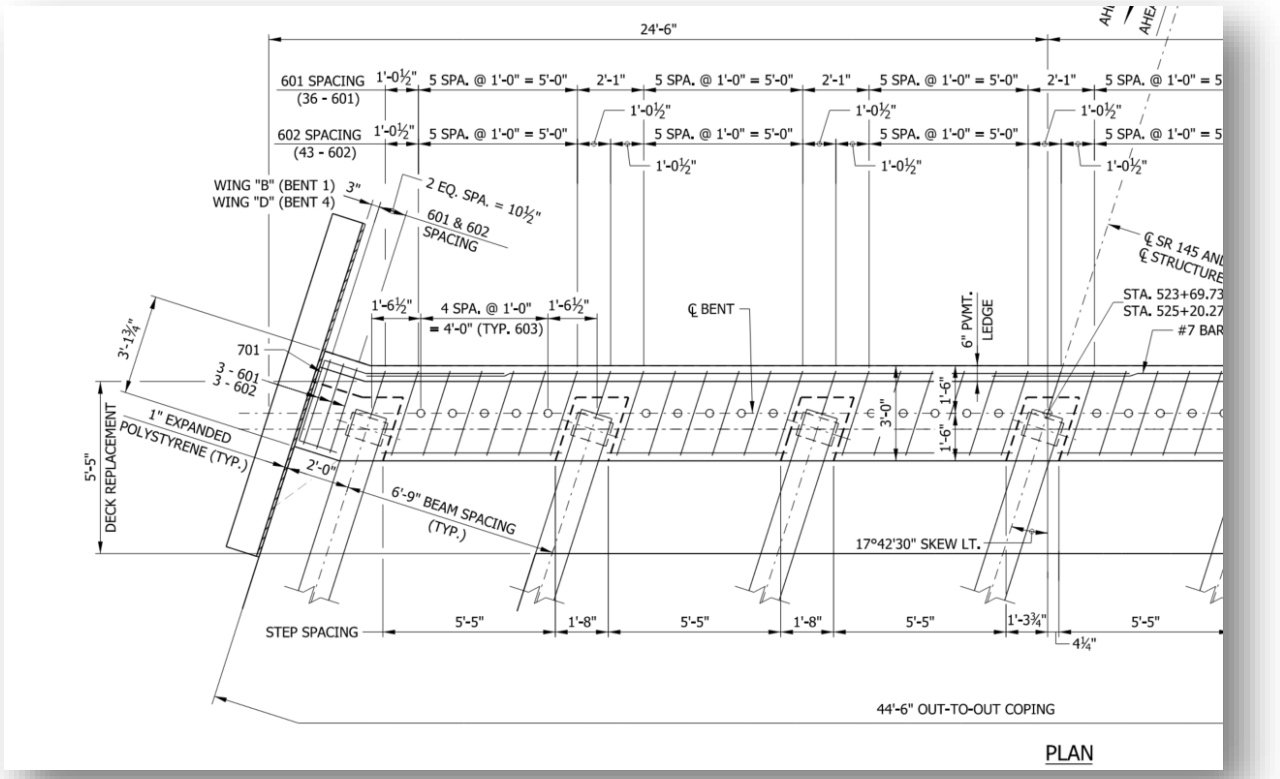




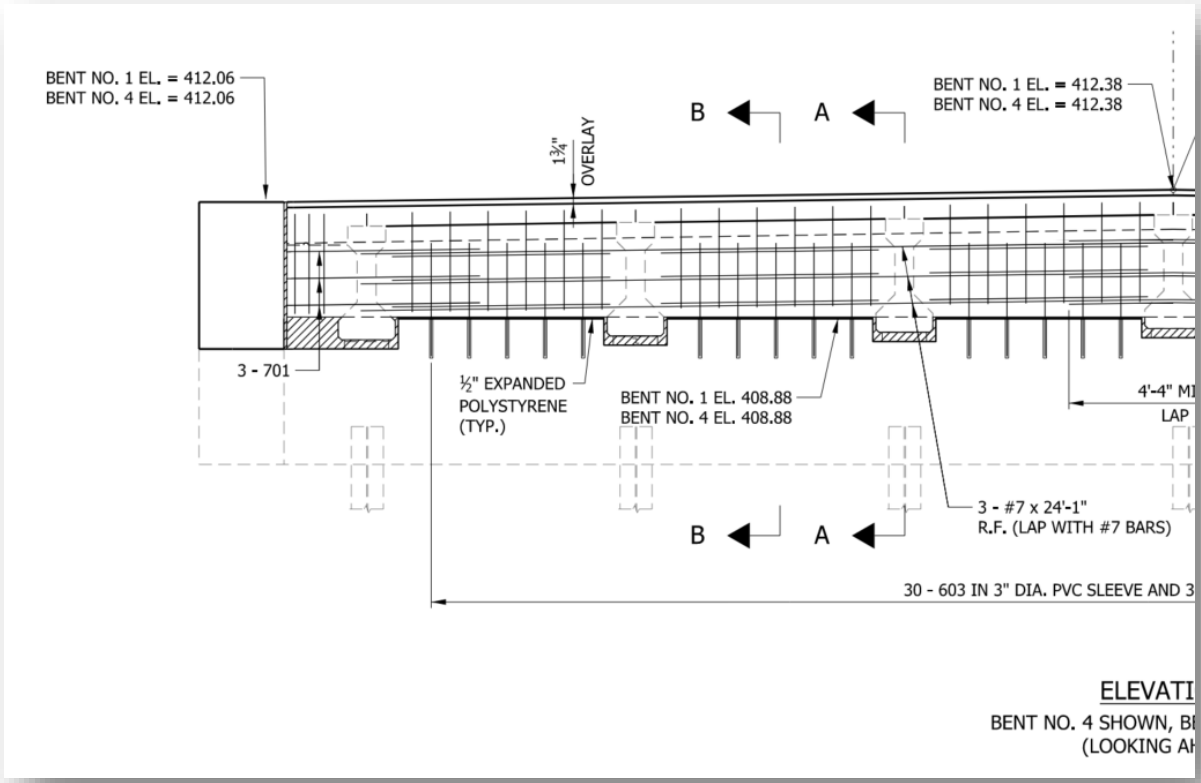
SECTION A-A
Scale: ¾" = 1'-0"

Continued on next page.

Note: As previously stated, the use of “candy cane” bars should be determined by design.



Continued on next page.



Unique Details

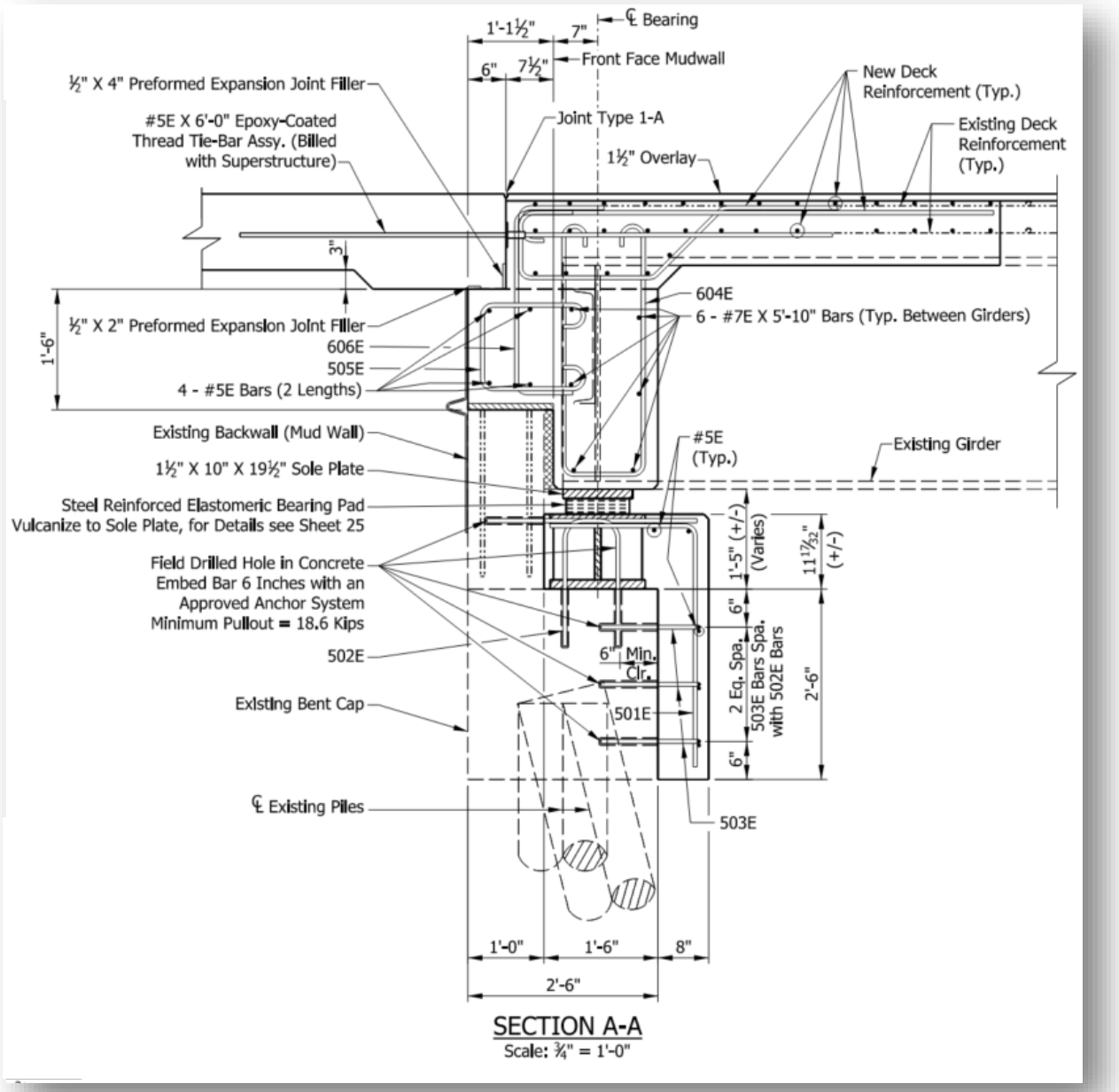
In difficult circumstances, unique solutions may be warranted.

For example, limiting the depth of excavation during phased construction may be desirable. In such cases, retaining some of the existing backwall may be warranted. Where unique details are necessary, adequately accomidating all thermal movements needs to accounted for in the detailing.

Another unique detail is the built out pavement ledge. Exisitng beams may conflict with the pavement ledge. A solution used in the past is the built out pavement ledge shown in the second example. When possible a 9” pavement ledge is preferred.

BDA 409-02 | SEPTEMBER 2024

Detail Examples:



To discuss any project specific questions, please reach out to BridgeDesignOffice@indot.IN.gov.