12-10 RAILROADS

Stray Current Design Details

Bridges can be protected from stray current most effectively by keeping the current out of the bridge. This work must be incorporated in the railroad construction. Details shown here are to be included in the bridge plans as minimum requirements for future LRT installation on the bridge. The actual design plans will be the LRT plans for the railroad construction, which will be submitted for review with the application for an encroachment permit.

Mass Transit

Mass transit (heavy rail) tracks are typically not installed on highway bridges. Stray current control/monitoring may be required at traction power substations next to highway bridge footings. Control measures will depend on the bridges involved and the track/traction power system.

Light Rail Transit

The following guidelines give the basic requirements for stray current control on bridges with light rail transit (LRT) tracks. These guidelines presume the LRT to be a modern system with the running rails well insulated from the soil and the DC traction power system ungrounded.

Running Rails

To isolate a bridge deck from the running rails, the most effective method is tie-on-ballast tracks with standard railroad bridge waterproofing using butyl membrane covered with asphaltic panels. For a fixed abutment extend the waterproofing membrane down the backwall at least 20 inches below any ballast. If an expansion joint is involved provide a detail to carry the waterproofing across the joint, and continue the waterproofing to the end of the approach slab.

For a bare deck, several provisions are required. The primary requirement is insulating track fasteners of the steel-rubber sandwich type, with the best available insulating values both dry and wet. Bridges longer than 100 feet require a drain path for leakage current, consisting of the grade pad reinforcing connected by cable to a ground bed. The reinforcing must be

welded to make it electrically continuous and connected by cable across drainage openings and around expansion joints.

Traction Power

Third rail posts and overhead contact system (OCS) poles and other mounting hardware for the DC positive are required to be grounded for safety. Connect mounting hardware with an insulated copper cable to a ground bed separate from the ground bed for the running rails.

To control stray current, mounting hardware needs to be isolated from the bridge. Use epoxy-coated foundation bolts, epoxy achorages, etc.

Ground Beds

Ground beds must be separated from footings a distance equal to the substructure depth (spread footing or pile tip depth). The OCS and running rail ground beds must be separated from each other by the ground bed depth.

Bridges longer than 1000 feet require two grounds beds. The ground bed must be designed and cable sized such that the resistance to remote soil from any point on the bridge must be kept below 5 ohms.

All bridges longer than 1000 feet require continuous remote monitoring.

Contract Plans

Insert a sheet in the contract plans showing the stray current requirements for future light rail installation if light rail load ratings are shown. On the load ratings sheet, refer to the stray current details sheet to alert the encroachment permit engineer for future installations.

EXAMPLE ALERT: I-105 GUIDELINES FOR LRT STRAY CURRENT PROVISIONS

Discussion

The following guidelines give the basic requirements for stray current control on prestressed or reinforced concrete box girder bridges of the I-105 Project including the Airport Viaduct. Providing electrical interconnection will mitigate internal stray current corrosion, particularly for prestressing elements. These guideline procedures, plus an insulating coating on the

deck, should control LRT stray current. Details 1 through 3, 4A & 4B, 5, 6, 7A & 7B, 8 thru 13, plus Standard Sheets 20-24 (XS-10-33) and 20-25 (XS-10-34) illustrate the following guidelines.

I-105 UNDERCROSSINGS, SEPARATIONS, AND VIADUCT
INTERCONNECTION OF REINFORCING AND PRESTRESS TENDONS

Deck

CIP Prestressed Bridge:

Lap weld all continuous top longitudinal rebar splices within the width of LRT trackway. Designer must designate these bars on a plan sheet. See Detail 1. (Note: The typical section shown on the bridge General Plan should define the limits of LRT trackway. Usually this is from inside face to inside face of the concrete barriers.)

Reinforced Concrete Bridge:

Provide an extra (non-structural) lap-welded continuous top longitudinal #4 rebar in the deck slab at each girder and within one foot of the inside face of the future concrete barriers. Provided only within the width of the LRT trackway. Designer must designate these bars on a plan sheet. See Detail 1.

Both Bridge Types:

Weld connect the above mentioned longitudinal bars to a transverse collector bar (#9 rebar) at each bent cap, hinge diaphragm, abutment diaphragm and abutment backwall. (See Details 1 through 9.)

Superstructure Hinge

Exothermic weld two #2/0 copper cables to collector bars in both diaphragms; pass #2/0 cable through a 2" duct. See Detail 3.

Abutment with Spread Footing

Provide transverse collector bar (#9 rebar) in the top of abutment backwalls in seat type abutments. Weld connect all backwall exterior face vertical rebars to the collector bar within LRT trackway width. See Detail 4A. Provide transverse collector bar (#9 rebar) at the top of the abutment diaphragm as described under “Deck” subject. See Details 4A & 4B.

Exothermic weld one #2/0 copper cable to each collector bar. See Detail 4A & 4B. Bring cables through abutment back wall if it exists (no duct), direct bury in ground to #5 pull box at end of wingwall.

Apply membrane insulation on abutment diaphragm end surface. See Details 4A & 4B.

Use epoxy coated approach slab tie rods in full width of bridge. Permit only high density mortar blocks.

Abutment with Pile Cap Footing

Same provisions as Abutment with Spread Footing plus the following pile provisions: Permit only Alternative “X” and “Y” driven piles. Special details for 16" C.I.D.H. Piles. See Standard Sheets 20-24 (XS-10-33) and 20-25 (XS-10-34). Designer shall eliminate the requirements shown on the standard sheets for epoxy coated reinforcing and epoxy coating insulate at pile tops and pile sides at all abutments.

Prestress Tendons

Weld connect the #9 collector bar to one prestress strand in each prestress anchor plate by using a #6 collector wire. See Detail 5. Place 4 x 4, W4.0 x W4.0 WWR shield over prestress plate area at the abutment blockouts. Weld connect at least one fabric wire to the #6 connector wire. See Detail 5.

Columns

Weld connect one main column bar to the transverse collector bar in the bent cap using a #6 rebar. See Details 6 through 9. Coat column concrete surface below ground and 6" minimum above ground with membrane insulation. Permit only high density mortar blocks to be used. Provide a test box in the column face 3'-0" above finish ground surface. Connect to the one main column bar with a #12 copper wire. See Detail 11.

Columns with Spread Footing

Hinged Column at Footing:

Hinge vertical rebar shall be epoxy coated and no contact to column cage rebar permitted. Provide hinge spiral discontinuity in top of footing. Provide sealant at column hinge joint. See Detail 6.

Fixed Column at Footing:

The one main column bar connected to the deck transverse collector bar shall be electrically continuous (by welding) through the footing. Coat all top of footing surfaces with membrane insulation. Provide 6" deep concrete course beneath footing. Provide depressed keys at top. Permit only high density mortar blocks. See Detail 7B.

Column with Pile Footing

Hinged Column at Footing:

Same details as spread footing. See Detail 6. In addition only Alternative “X” and “Y” driven piles permitted. Special details for 16" C.I.D.H. Piles. See Standard sheets 20-24 (XS-10-33) and 20-25 (XS-10-34) except designer shall eliminate epoxy coated reinforcing and epoxy insulation at pile top and sides.

Fixed Column at Footing:

Same as fixed column spread footing details except neoprene sheet insulation used instead of concrete insulation course. See Detail 7A. Pile requirements same as hinged column except all requirements of Standard Sheets (XS-10-33) and 20-25 (XS-10-34) shall be used.

Column/Pile Shaft Type

Hinged Column:

Details similar to hinged column with footing. See Detail 8.

Fixed Column:

One main column bar connected to the deck transverse collector bar shall be electrically continuous (by welding) through the pile shaft, provide plastic bar end protector epoxy bonded to pile rebar bottom ends. Coat column/pile shaft concrete surfaces in the vicinity of finish ground Line with membrane insulation. Permit only high density mortar blocks to be used. See Detail 9.

Traction Power

Pole Anchor:

Insulate. Epoxy coated anchorage hardware in concrete. Includes anchor plate, bolts, nuts. Where possible, coat after assembly. See Detail 12.

OCS Hanger:

Epoxy-coat the anchorages cast into a bridge soffit or elsewhere to support the overhead contact system (OCS). These hangers will mostly occur at overcrossing soffits.

Deck Drains

Insulate drain systems within LRT trackway. Insulate drain systems outside of LRT trackway if directly connected to the LRT trackway drain system. See Detail 10.

Additional details shall be provided during track rail installation. They will be items such as deck surface insulation coating, direct rail fixation insulators, direct rail fixation elastomeric pads, and epoxy coated anchor bolts for rail attachment.

I-105 OVERCROSSING GUIDELINES FOR LRT STRAY CURRENT PROVISIONS

Discussion

Stray current at overcrossings shall be controlled by insulation within the trackway (ballast type) area. This barrier will prevent stray current entry through the adjacent overcrossing substructure (bent columns and footings) or station platforms. Many overcrossings have already been constructed so it is impractical to coat insulate the footings, etc. In addition, some overcrossings are not sufficiently wide to attract significant stray current.

Provisions Needed

Designer needs only to require the use of high density mortar blocks in all overcrossings as required for the undercrossings, etc. Other provisions required for the overcrossings will be incorporated outside the bridge in the trackway design.

I-105 OTHER MAJOR STRUCTURES

Retaining Walls

Reinforced concrete walls or mechanically stabilized embankment systems (MSE) with metal elements shall be provided with stray current provisions if they are within 30 feet of LRT tracks.

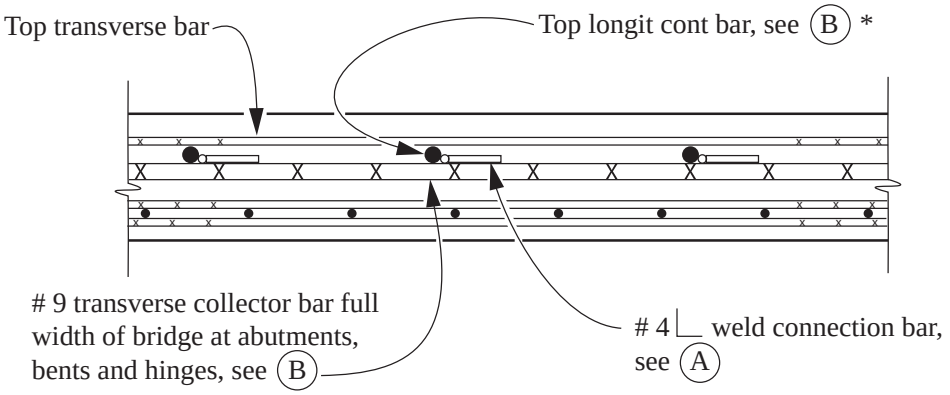
Pumping Plants

Provisions are needed for pump plant storage boxes that are beneath the highway roadways in the vicinity of LRT tracks. The provisions are as follows:

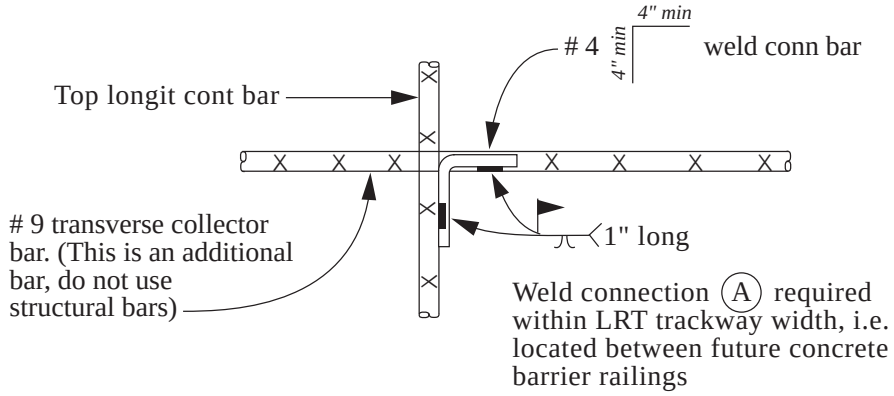
1. Epoxy coated bar reinforcing steel shall be used throughout the entire box structure except in the dry pit shaft when the LRT travelway is 20'-0" or closer to the pumping plant endway. The epoxy coated bar reinforcement shall have all ends coated and any damaged bars shall be recoated with epoxy. When the LRT travelway is greater than 20'-0" from the pumping plant endways, reinforcement shall be as per standard plans. See Detail 13.
2. Increase bottom slab thickness by 1" to provide 3" clearance from bottom of slab to the bar reinforcing steel.
3 Permit only high density mortar blocks.

LRT Stations

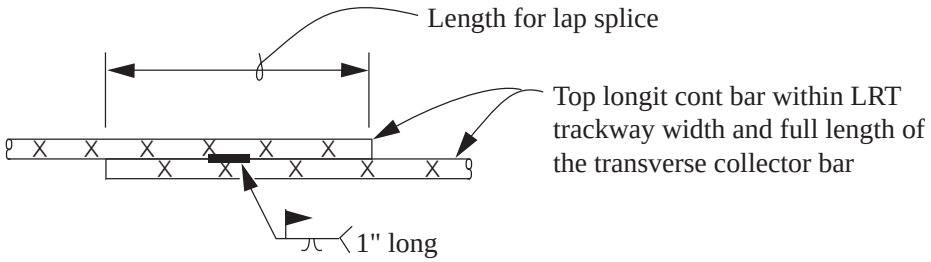
Provisions will be necessary. Specific details will be provided in the future after the station plans have been developed in more detail. The type of structures include platforms, pedestrian overcrossings, stairs, elevators, etc.



DECK SLAB SECTION



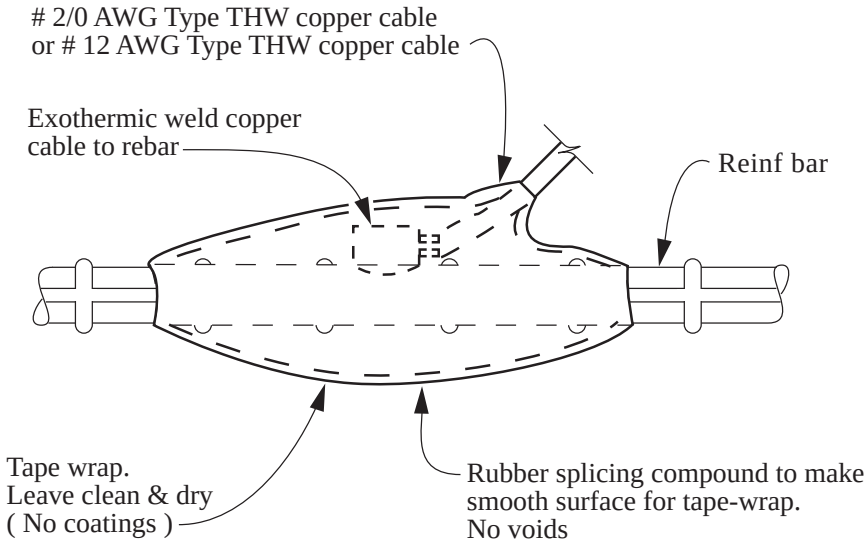
(A) WELD CONNECTION BAR DETAIL



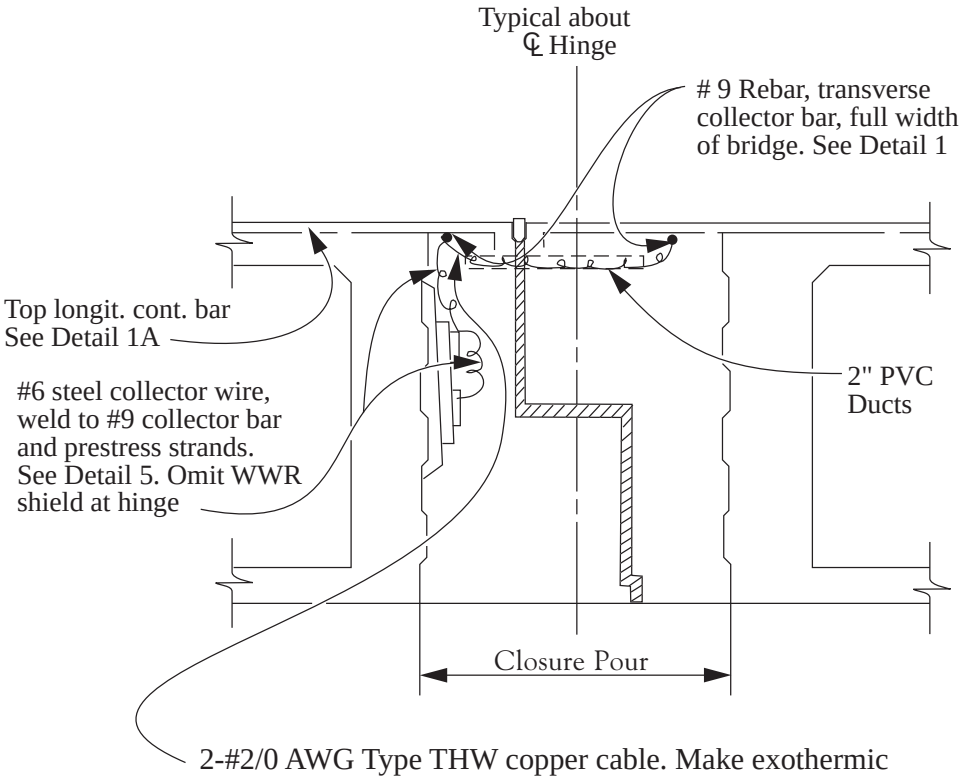
(B) BAR LAP SPLICE WELD DETAIL

* Design must designate these bars on plan sheet per instructions in text, "Deck".

DETAIL 1 - DECK SLAB COLLECTOR BAR

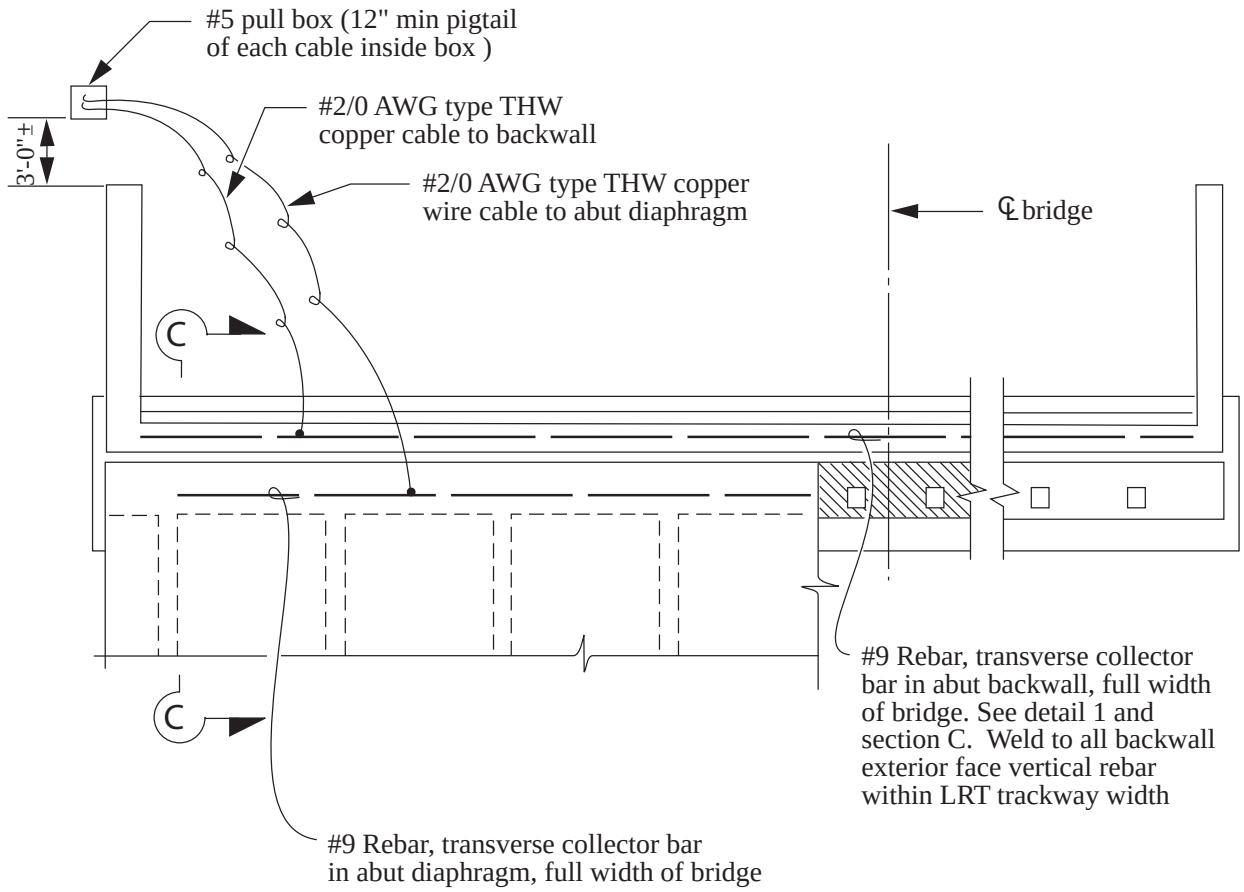


DETAIL 2 - COPPER CABLE TO REBAR CONNECTION



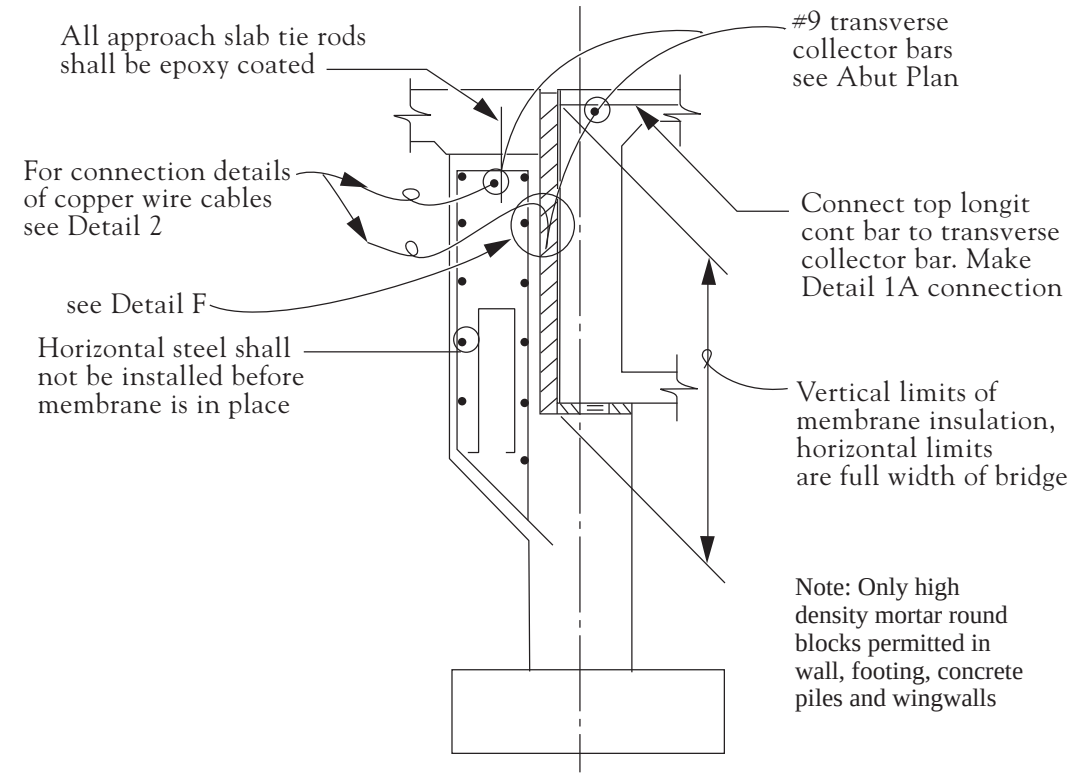
SECTION THRU HINGE

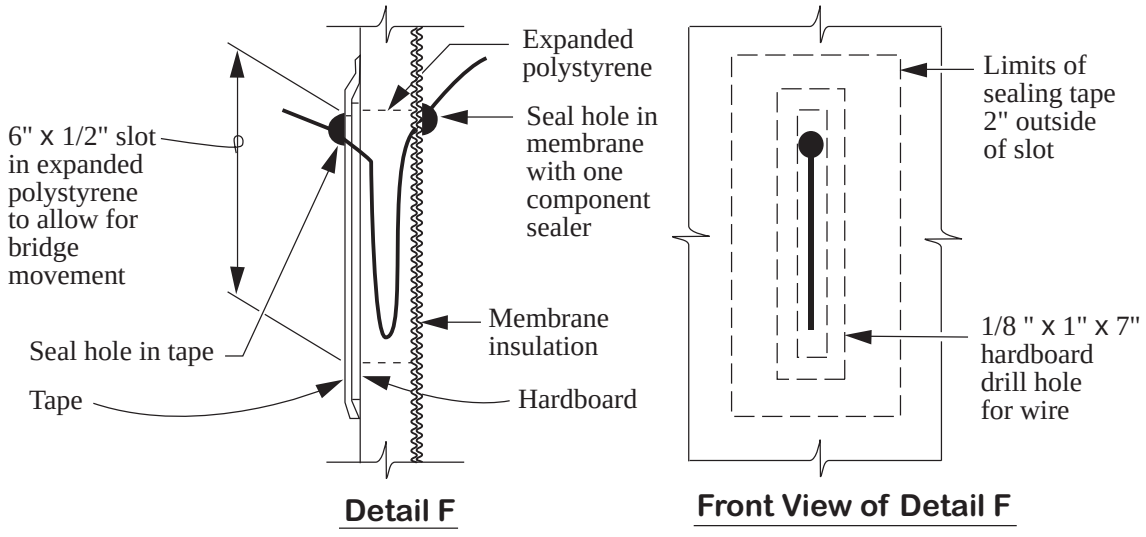
DETAIL 3 - HINGE DETAILS



Seat Abutment Type with Backwall

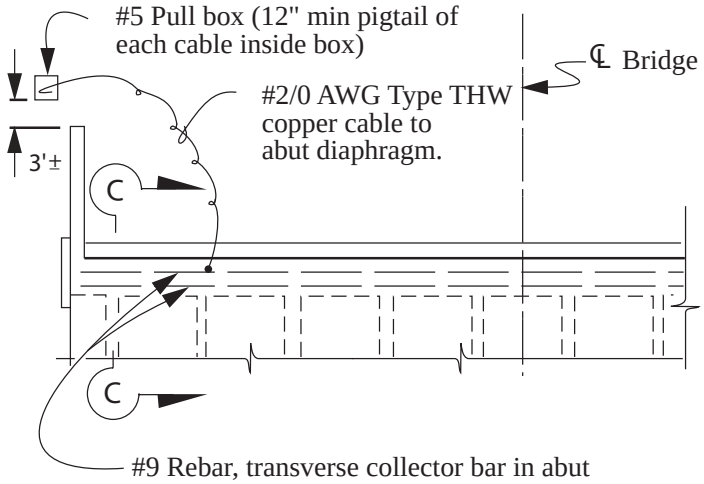
DETAIL 4A1 - TYPICAL ABUTMENT PLAN



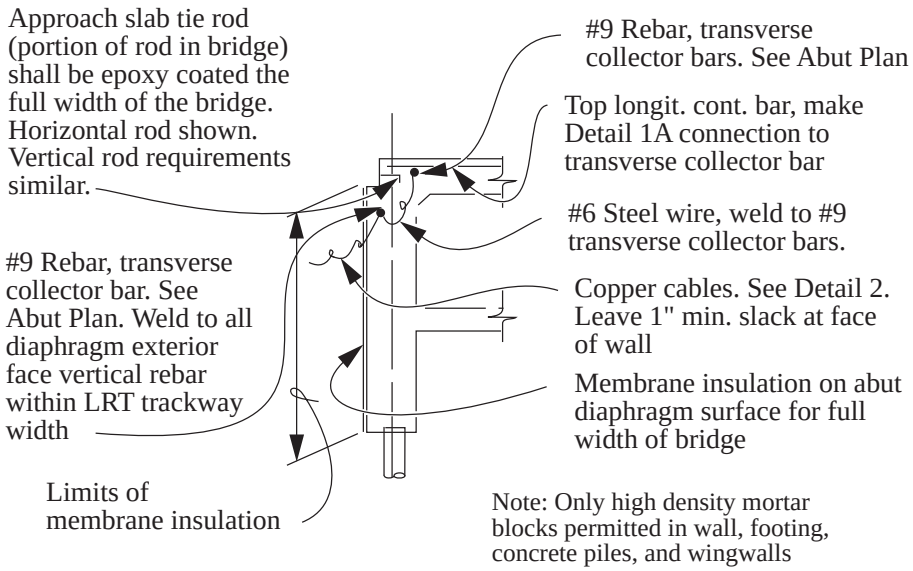


DETAIL 4A2 - ABUTMENT DETAILS

Seat Abutment Type with Backwall
(Offset backwall shown. Flush backwall details similar.
Spread footing shown. Pile cap footing similar.)

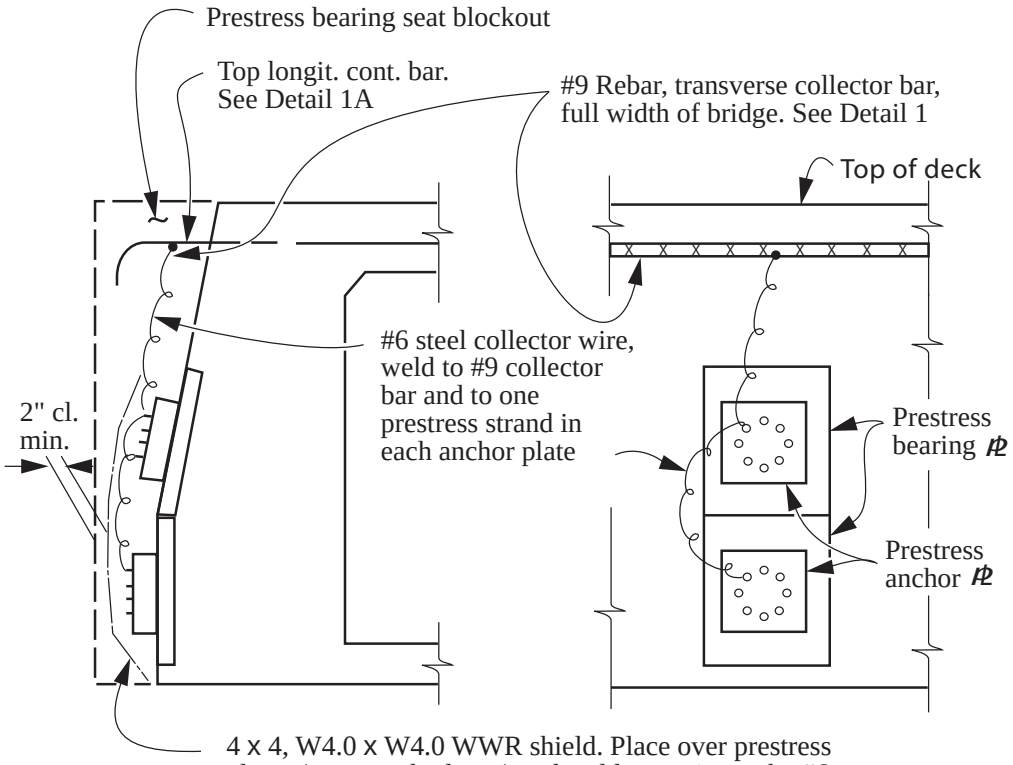


TYPICAL ABUTMENT PLAN



Ⓒ - ABUTMENT SECTION

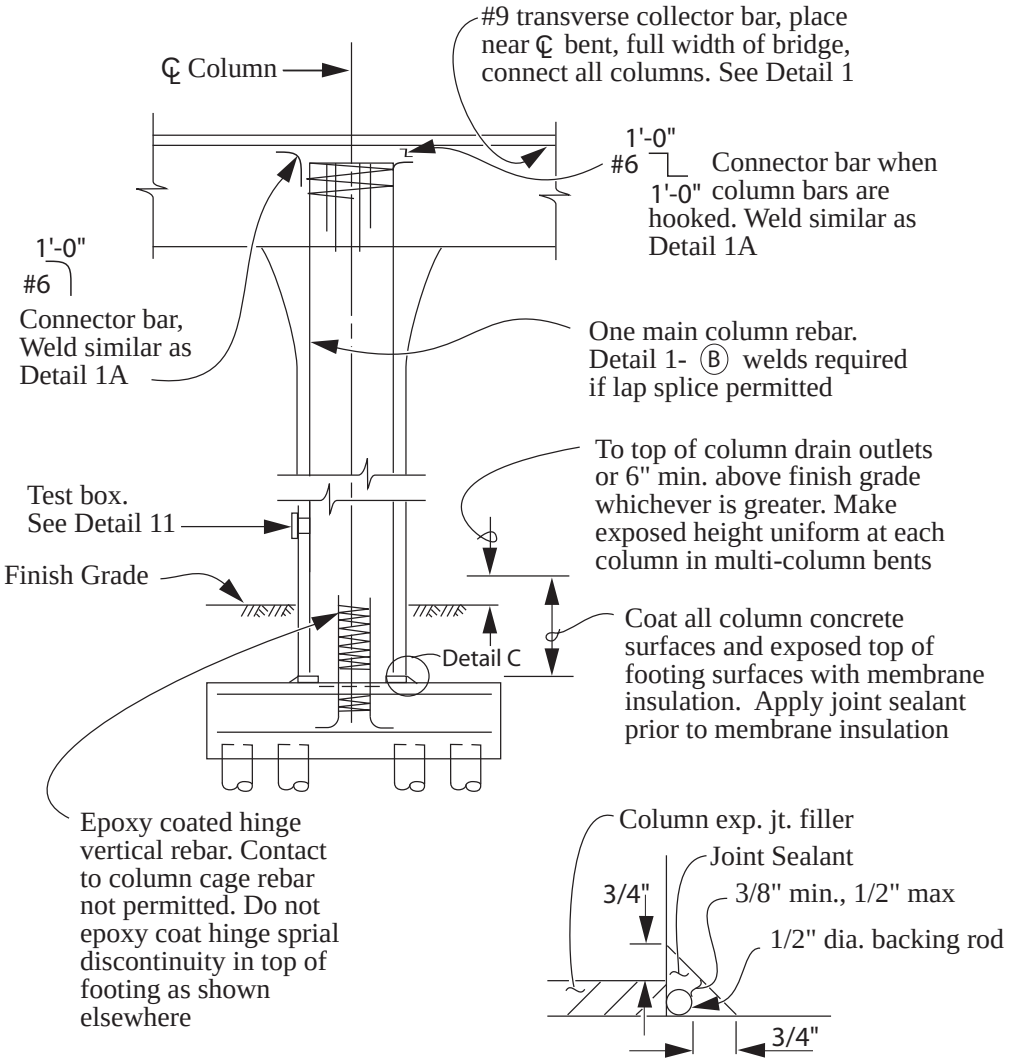
DETAIL 4B - ABUTMENT DETAILS - Diaphragm type Abutment



Note: Detail typical for all girders, full width of bridge.

SIDE SECTION **END SECTION**

DETAIL 5 - PRESTRESS TENDON CONNECTION

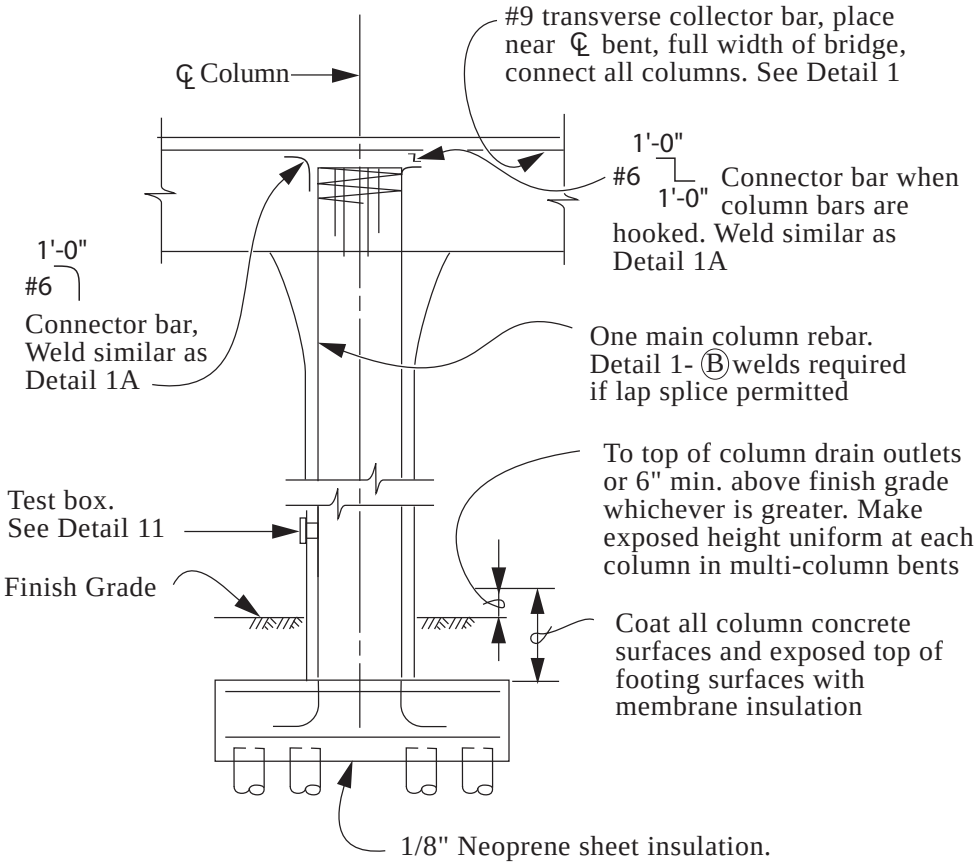


COLUMN ELEVATION

DETAIL C

Notes:
Hinged column w/pile cap footing shown. Hinged column w/spread footing similar.
Only high density mortar blocks permitted in column, footing, or concrete piles.

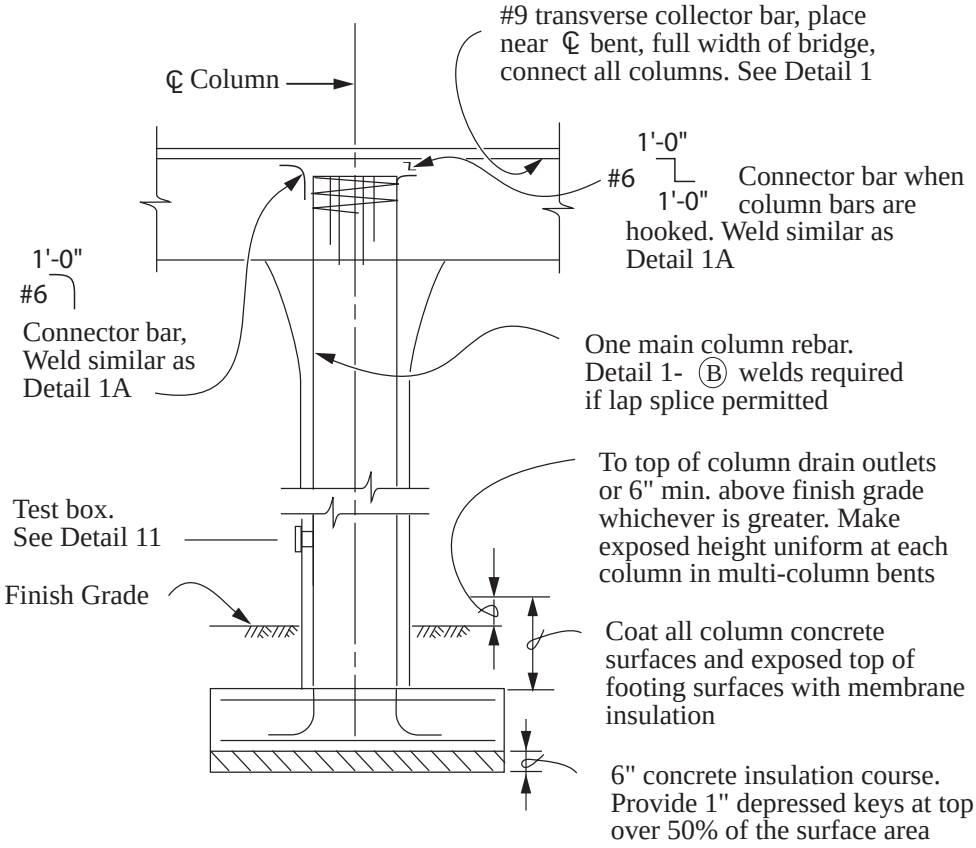
DETAIL 6 - HINGED COLUMN DETAILS W/FOOTING



Note: Only high density mortar blocks permitted in columns, footings, and concrete piles

COLUMN ELEVATION

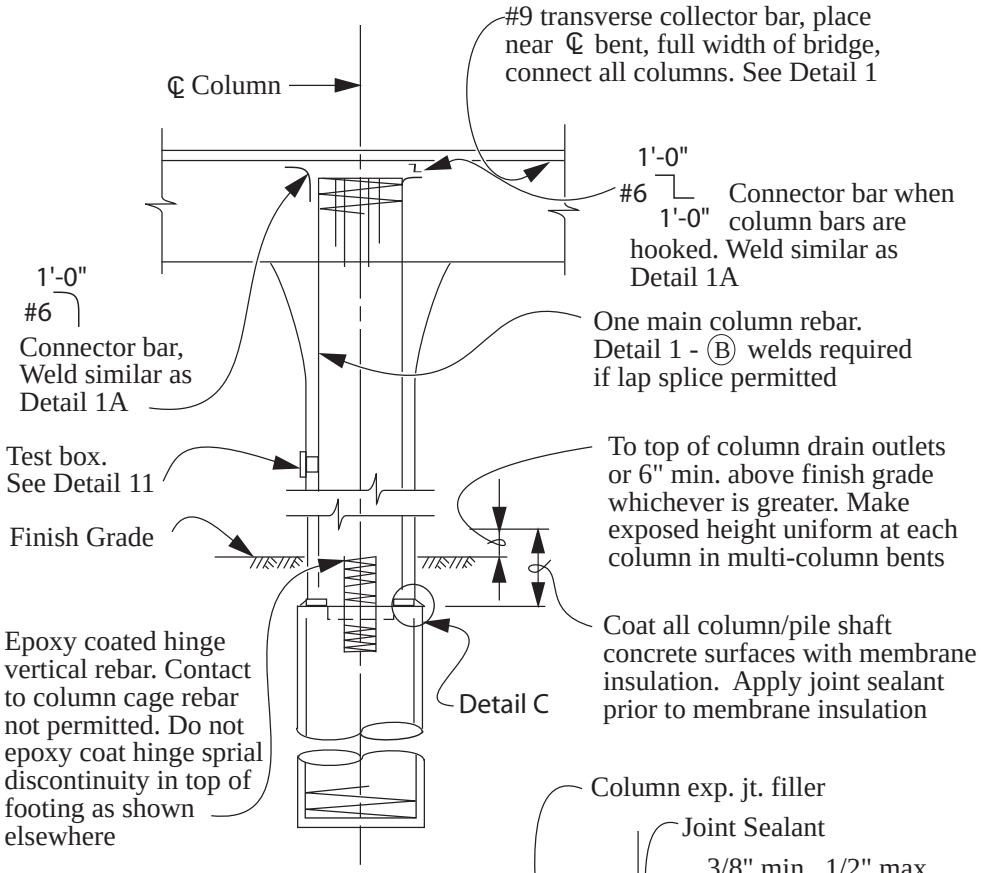
DETAIL 7A - FIXED COLUMN DETAILS W/PILE CAP FOOTING



Note: Only high density mortar blocks permitted in columns, footings, and concrete piles.

COLUMN ELEVATION

DETAIL 7B - FIXED COLUMN DETAILS W/SPREAD FOOTING



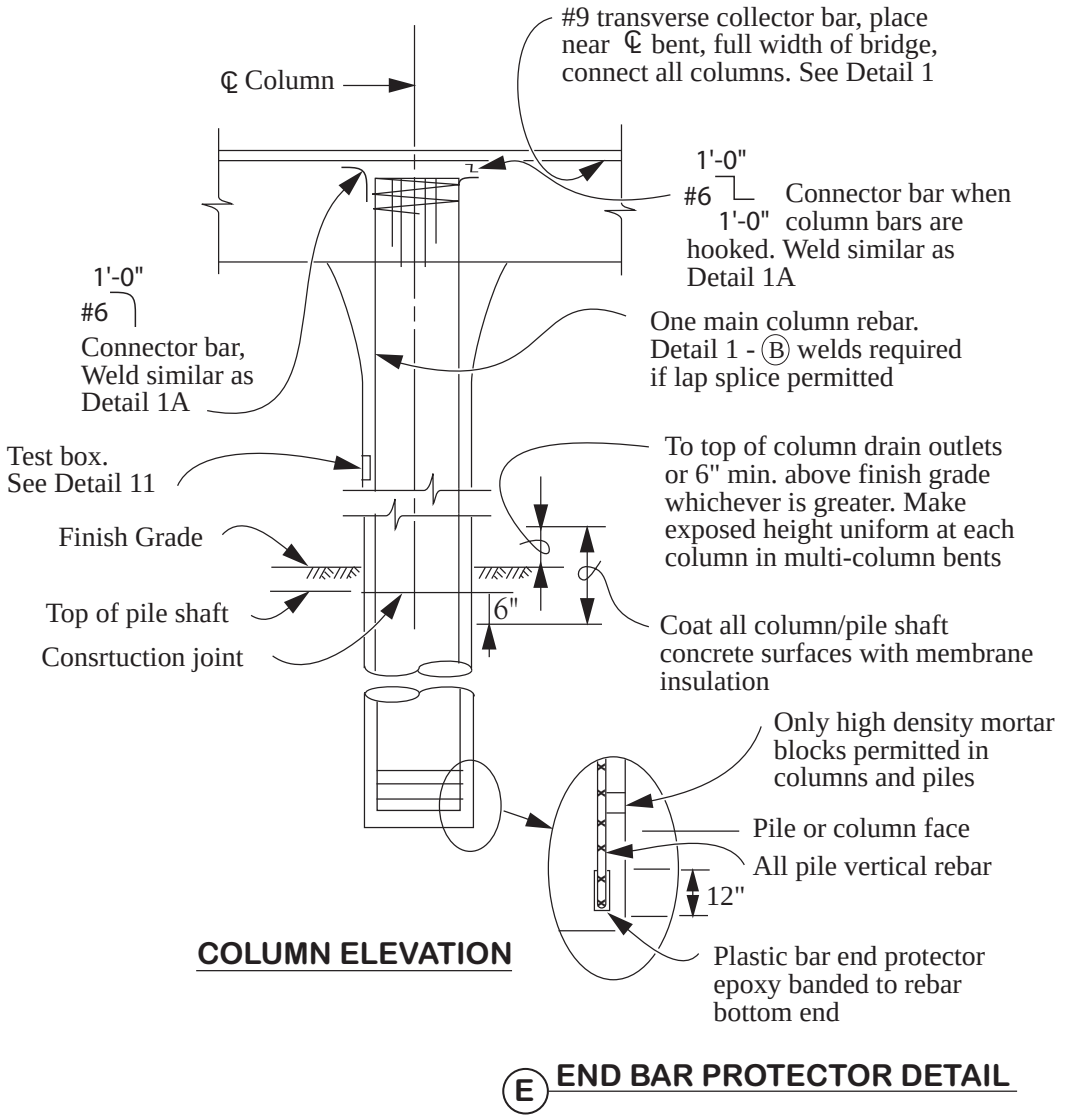
COLUMN ELEVATION

DETAIL C

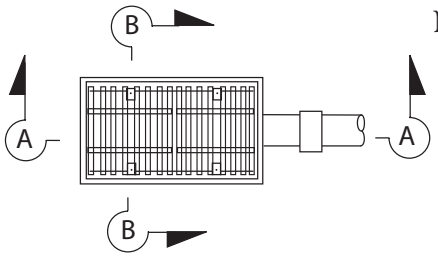
Notes:

Use Detail 9 - (E) for pile shaft rebar. Only high density mortar blocks permitted in columns and pile shafts.

DETAIL 8 - HINGED COLUMN DETAILS, PILE SHAFT TYPE

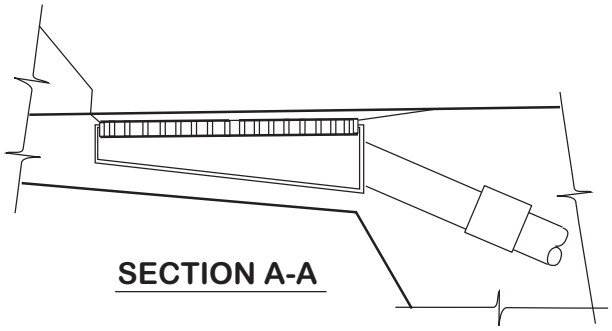


DETAIL 9 - COLUMN DETAILS, PILE SHAFT TYPE

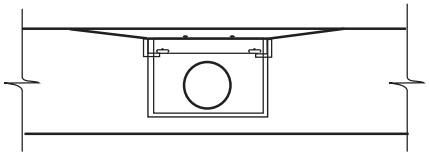


TYPE D-2M PLAN

Note: Within LRT trackway width epoxy insulate all drain box surfaces in contact with concrete including bolt anchors. Tape wrap steel drain pipe where embedded in concrete. If the LRT trackway drainage system is connected to the highway bridge drainage system then the combined system shall require the above provisions

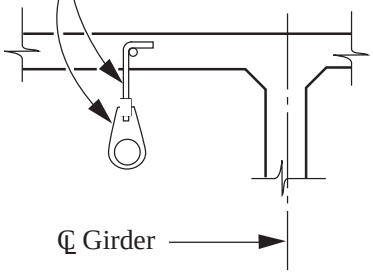


SECTION A-A

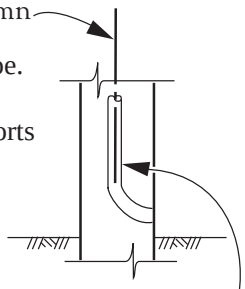


SECTION B-B

DECK DRAIN ASSEMBLY



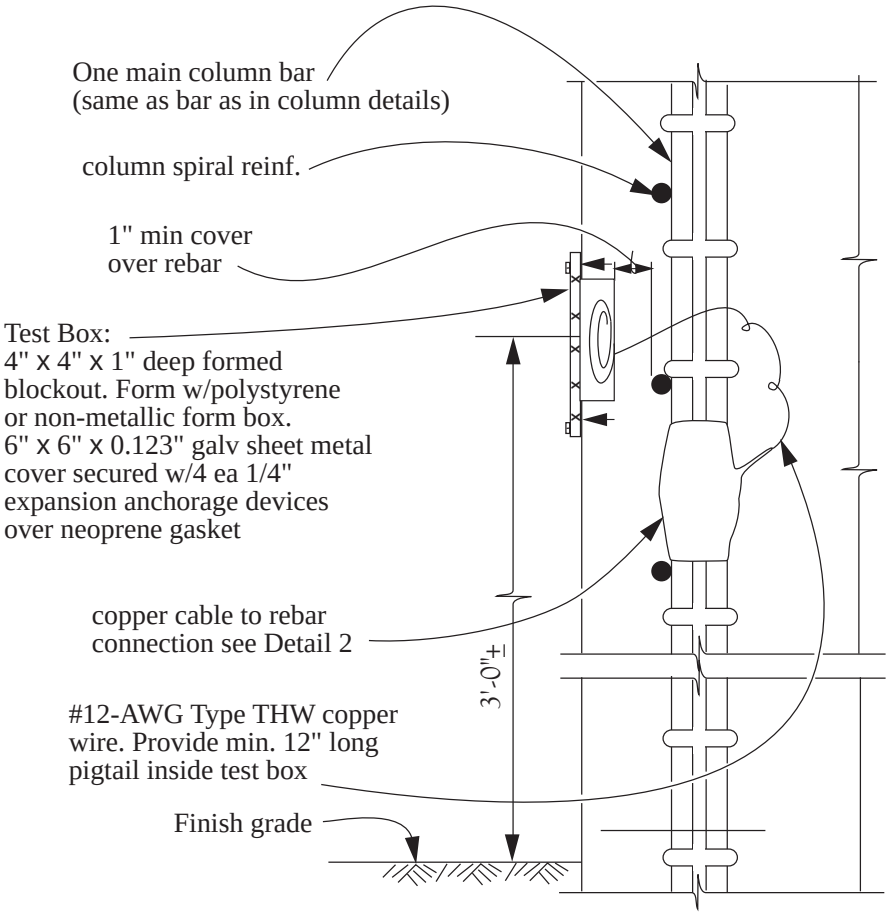
PIPE HANGER DETAIL



Tape wrap the steel drain pipe. In addition, epoxy coat all reinf. steel or metallic supports in contact with the tape wrapped drain pipe for a distance of one foot on each side of the contact point. A 1/8" thick x 6" wide neoprene rubber bushing may be substitued for the epoxy coating at each contact point

COLUMN DRAIN

DETAIL 10 - DECK DRAIN DETAILS

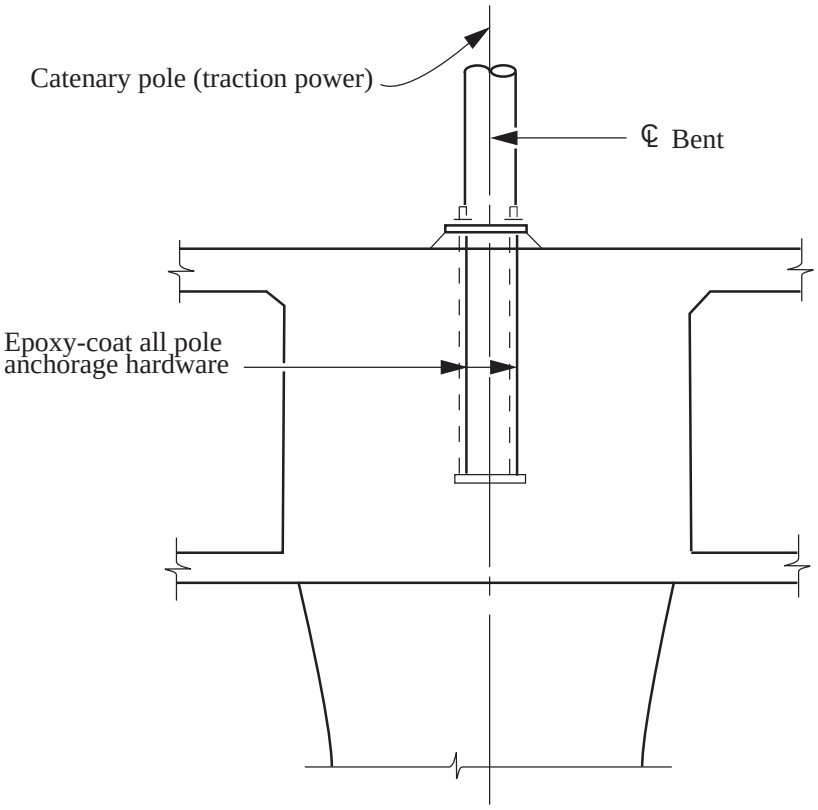


COLUMN ELEVATION

Installation Locations for Test Boxes:

1. At all single column bents.
2. At multi-column bents:
   (a) All columns within trackway width. If no columns within trackway width, install at column nearest trackway location.
   (b) All outside columns of the bridge.

DETAIL 11 - COLUMN TEST BOX

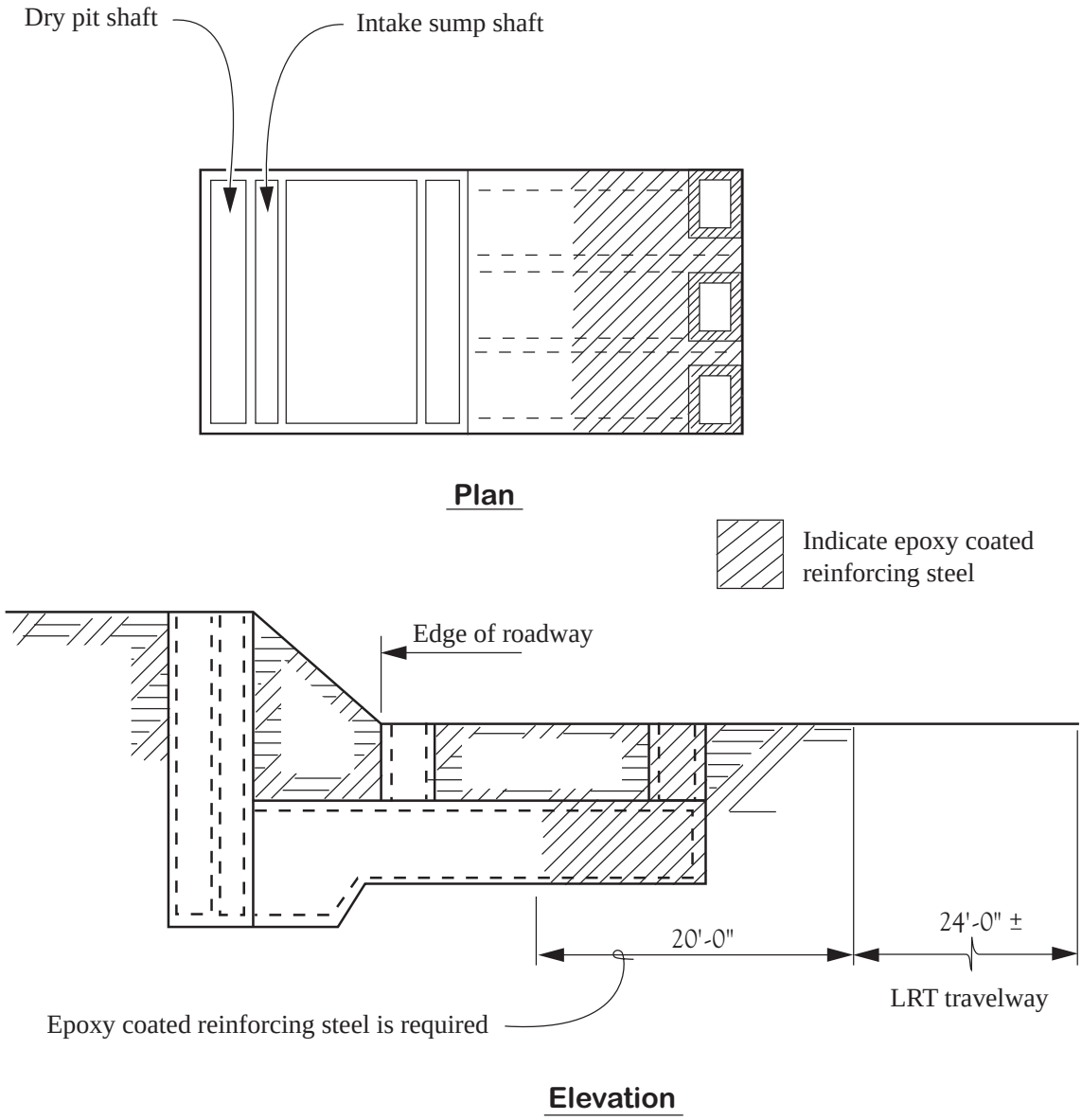


CATENARY POLE DETAIL
(shown at column cap)

Note:
Overhead Catenary System (OCS) anchorages cast into bridge soffits or elsewhere shall be epoxy-coated.

OVERHEAD CONTACT SYSTEM DETAIL

DETAIL 12 - TRACTION POWER SYSTEM DETAIL



DETAIL 13 - PUMPING PLANT PROVISION