Illinois Department of Transportation
Memorandum

To:	ALL BRIDGE DESIGNERS	22.8
From:	Jayme F. Schiff	
Subject:	Modular Expansion Joint Details and Re-Certification	
Date:	December 2, 2022	

Modular and swivel modular expansion joints are theoretically a very useful expansion device for longer structures and currently the only joints readily available to accommodate significant lateral movement. Improvements have been made to the concrete details encasing these joints, intended to prolong the service life and reduce lifecycle costs. This memorandum introduces new bridge details for accommodating modular joint systems and updated policies and Guide Bridge Special Provision No. 18 (GBSP18) applicable for modular joints.

Joint Application

Modular expansion joints are an expansion device option, along with steel finger plate joints, for structures with contributing expansion lengths as shown in the updated Bridge Manual Figure 2.3.6.1.6-1. The joints consist of a series of strip seal glands, held in place by center beams and edge beams studded into deck concrete. Wheel loads are transferred from the center beams to support bars and their bearings. A concrete support ledge or the steel beam and bracing under the support bar bearings is utilized to direct the load into the girder and bearings at the joint.

In addition to allowing for longitudinal expansion, standard modular joints also allow for minimal lateral movement (typically around 3/8" per gland), while swivel modular joints allow for much larger lateral movements. In comparison, steel finger joints allow for 3/8" lateral movement total.

The more complex, multi-directional swivel modular joints have a higher cost and more complex installation procedure. For this reason, swivel modular joints shall only be considered for structures that must remain open to all traffic after seismic events (critical or essential structures), or for other structures as required by the owner. For joints requiring higher lateral movements, consideration shall be given to selecting a larger standard modular joint size in lieu of using a swivel joint. The benefit of reducing any possible normal racking due to temperature movements typically outweighs the small additional cost to increase the joint size.

The joint type (modular, finger plate, or other) shall be specified on the Type, Size, and Location (TSL) plan, but the size of the joint does not need to be shown. The specific joint size and the need for a swivel modular joint will be determined during the design phase.

Additional consideration shall be given to the bearings on structures with lateral movement. In some cases, the expected lateral movement at the expansion bearings is greater than the typical distance between the beam and the side retainer. If this occurs, the retainers should be placed at least the expected lateral movement distance away from the beam flanges.

Contributing Expansion Length and Total Longitudinal Movement
For structures with only one fixed pier, the contributing expansion length for each abutment shall be the length from the joint at the abutment to the centerline of the fixed pier. For structures with multiple fixed piers (typically two) the contributing expansion length shall be the length from the joint at the abutment to the centroid of fixity, typically the middle of the span between the fixed piers. For structures with joints at the piers the expansion length shall be the distance from one joint to the center of fixity.

The total longitudinal movement in inches shall be shown on the contract plans and calculated using the following equation:

$$T = \gamma \alpha L(\Delta t)$$

Where:
T = total longitudinal movement along centerline of roadway (in.)
γ = 1.2 (AASHTO Table 3.4.1-1)
α = 0.0000065/ºF
L = contributing expansion length (in.)
Δt = 140 ºF (-20 ºF to 120 ºF)

The designer shall then choose the joint size based on this calculated movement. The dimension shown for the actual modular joint width is determined by the manufacturer and shall be left as a starred dimension with a note as shown on the figures and base sheets.

The distance between the concrete at right angles, “A” at 50 ºF, shown in Figures 1, 2, 7, and 8 shall be calculated as:

$$A = (T/2)\cos(S) + 3/4"$$

Where:
S = skew angle (degrees), measured from the baseline to a line perpendicular to the centerline of joint

The additional 3/4" is provided to ensure there is no hard contact between the concrete surfaces.

For the purposes of calculating the quantity for the contract plans, the length shall be calculated along the centerline of the joint from out-to-out of the deck.

Structures with larger lateral movement demands requiring swivel modular joints shall also specify the maximum vertical displacements, transverse displacements, and horizontal rotations on the contract plans.

Modular Joint Deck Details
Two types of deck end details have been developed or expanded upon to improve the performance of the modular joints and the deck surrounding them.

Full Depth Deck Blockout: A deck end detail utilizing a full depth deck blockout is shown in Figures 1 thru 6. Full depth deck blockouts allow for easier forming and reinforcement bar placement, greater flexibility to adjust rebar in the field to avoid interferences and provides a larger monolithic cast of concrete around the joint assembly. The joint assembly shall be temporarily supported off of the beam ends until the concrete is placed. If intermittent support is required due to large skews, large beam spacing, or heavy joints

then the joint shall be additionally supported off of the cross frame top chord members. This detail type is applicable for all girder sizes. Longitudinal bar splicers are not required for the full depth blockout detail type.

A blockout and construction joint is preferred according to AASHTO 14.5.5.1. It may be optional if the designer evaluates the pouring sequence and determines that there will be no adverse effects, such as excessive rotations, that will inhibit concrete cover or cause joint misalignment. The blockout and construction joint shall be labeled on the plans as optional, as applicable.

Partial Depth (Ledge) Deck Blockout: A deck end detail utilizing a partial depth blockout and concrete ledge is shown in Figures 7 thru 13. A concrete ledge provides a formed concrete platform to easily place and adjust the joint assembly. While the increased concrete thickness below the support box reduces reinforcement congestion, the ledge requires complicated formwork and reinforcement bar placement in order to prevent modular joint assembly interference. Due to the increased concrete thickness this detail may be more suitable for deeper girder sections but is not recommended for structures with web depths less than 54". The bar splicer/reinforcement detail shown in Figure 13 shall be included on the bar splicer base sheet for plans utilizing this concrete ledge type detail.

Both types of deck end details shall have a minimum clearance of 4¼" above the support box and the full depth blockout shall have a minimum clearance of 6" below the support box.

Modular Joint Beam End Details
Beam ends shall be coped whenever feasible to avoid support box interference and allow the support boxes to have a uniform spacing. Plate girders shall utilize the standard coping details shown in Figures 14 and 15. If the beams are not coped then the modular joint assembly support boxes shall be spaced to miss the beam flanges.

Modular Joint End Cross Frames and Diaphragms
Cross frames are the preferred lateral bracing method for plate girder structures with modular joints. Cross frame details for various skews are shown in Figures 16 thru 20.

The centerline of the diagonal members of the cross frame are not required to intersect the centerline of the top chord, but it should be as close as practical. When the diagonals of the cross frame cannot practically have a minimum angle of 30 degrees (as measured from the bottom chord) due to beam spacing, skew, and/or web/cope depth, an alternate bent plate channel is required as shown in Figure 21. The bent plate channel is not allowed for skews greater than or equal to 45 degrees. Additional analysis is required if the minimum diagonal angle cannot be satisfied for skews over 45 degrees.

For end cross frames and end bent plate diaphragms at stage construction joints, see Figures 22 and 23.

Figures 16 through 23 supersede Figures 14 through 17 from ALL BRIDGE DESIGNERS (ABD) 19.4 memorandum.

Base sheets
Twelve base sheets have been developed that show the minimum amount of information required on the plans for the deck end, beam end, and sliding plate details for the structure. Modular joint details, deck end reinforcement, and beam end/end diaphragm details may be found in the Base Sheets – General, Superstructure – Expansion Steel Beams, and Diaphragms – Expansion Abutment Steel Beams base sheet libraries, respectively.

Guide Bridge Special Provision
GBSP18 (Modular Expansion Joint) has been updated and will be released concurrently with this memorandum. The updates include additional guidance on construction and fabrication requirements, such as:

- Additional weld requirements have been added and tolerances have been developed for various joint dimensions.
- Updated fatigue requirements are clearly specified for different elements of the joint.
- The entire width of the joint shall be designed for the vehicular live load shown on the General Plan & Elevation sheet of the contract plans.
- All non-stainless steel structural elements of the joint assembly shall be hot-dip galvanized.

Recertification
Modular joint suppliers will be required to recertify their joint assemblies within six months of the release of this memorandum and then at least every five years to remain on the List of Prequalified Modular Expansion Joints. Recertification will be required immediately if any changes are made to the materials, or joint details.

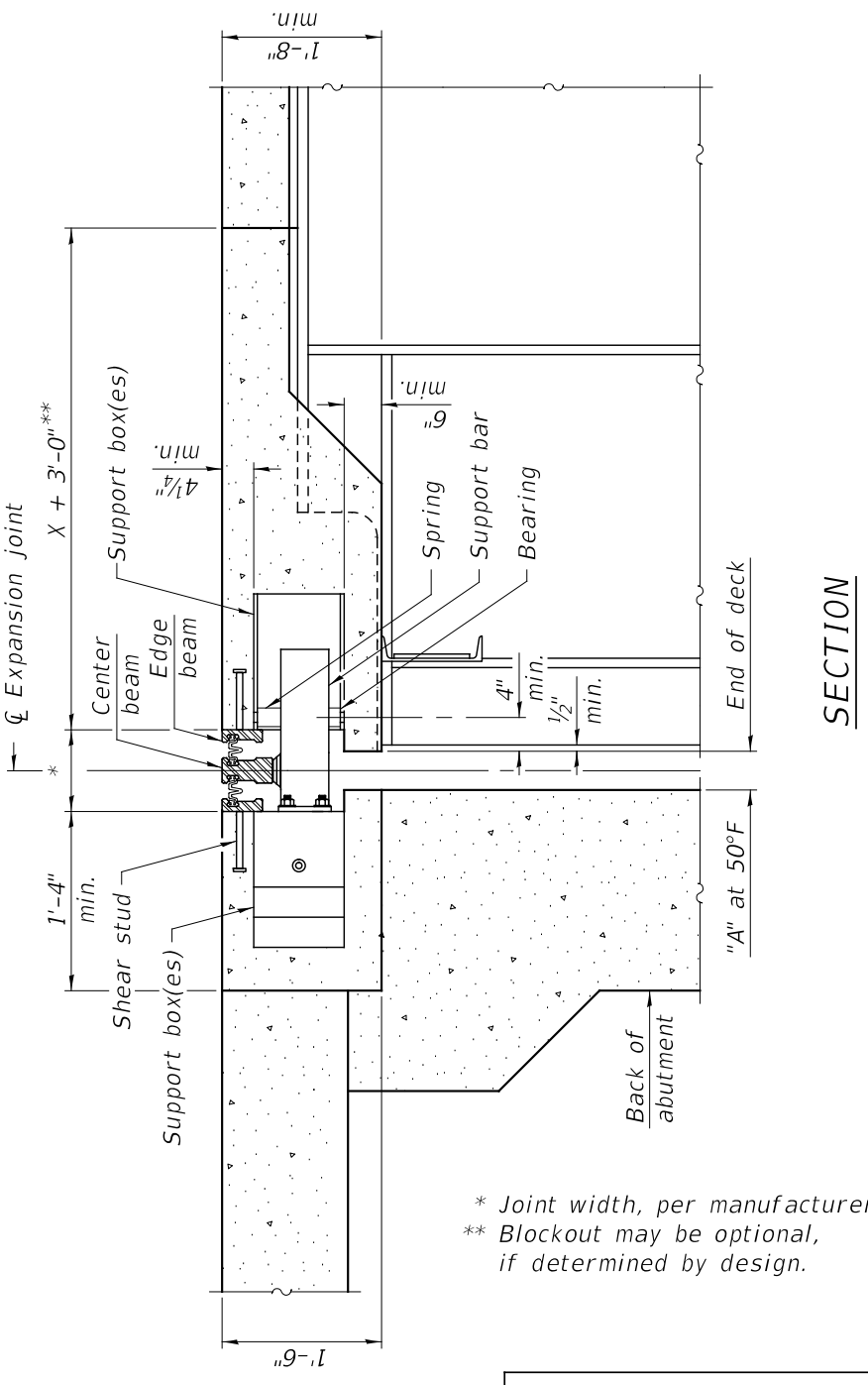
The Recertification section of the Submittal Requirement for Modular Expansion Joints Evaluation and Pre-Qualification has been updated to reflect this new requirement.

Implementation
The revised modular joint base sheets dated 11-1-2022 shall be implemented as soon as practical, on all applicable projects that have not been let. The Modular Expansion Joint Guide Bridge Special Provision No. 18 and the modular expansion joint submittal requirements have been updated. To remain on the prequalified modular expansion joint product list, companies will have six months to submit their re-certification.

The base sheets, updated GBSP18, and certification requirements may be found on IDOT's website at https://idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/index.

Please direct questions to the Policy, Standards, and Specifications Unit by email at dot.bbs.comsuggest@illinois.gov.

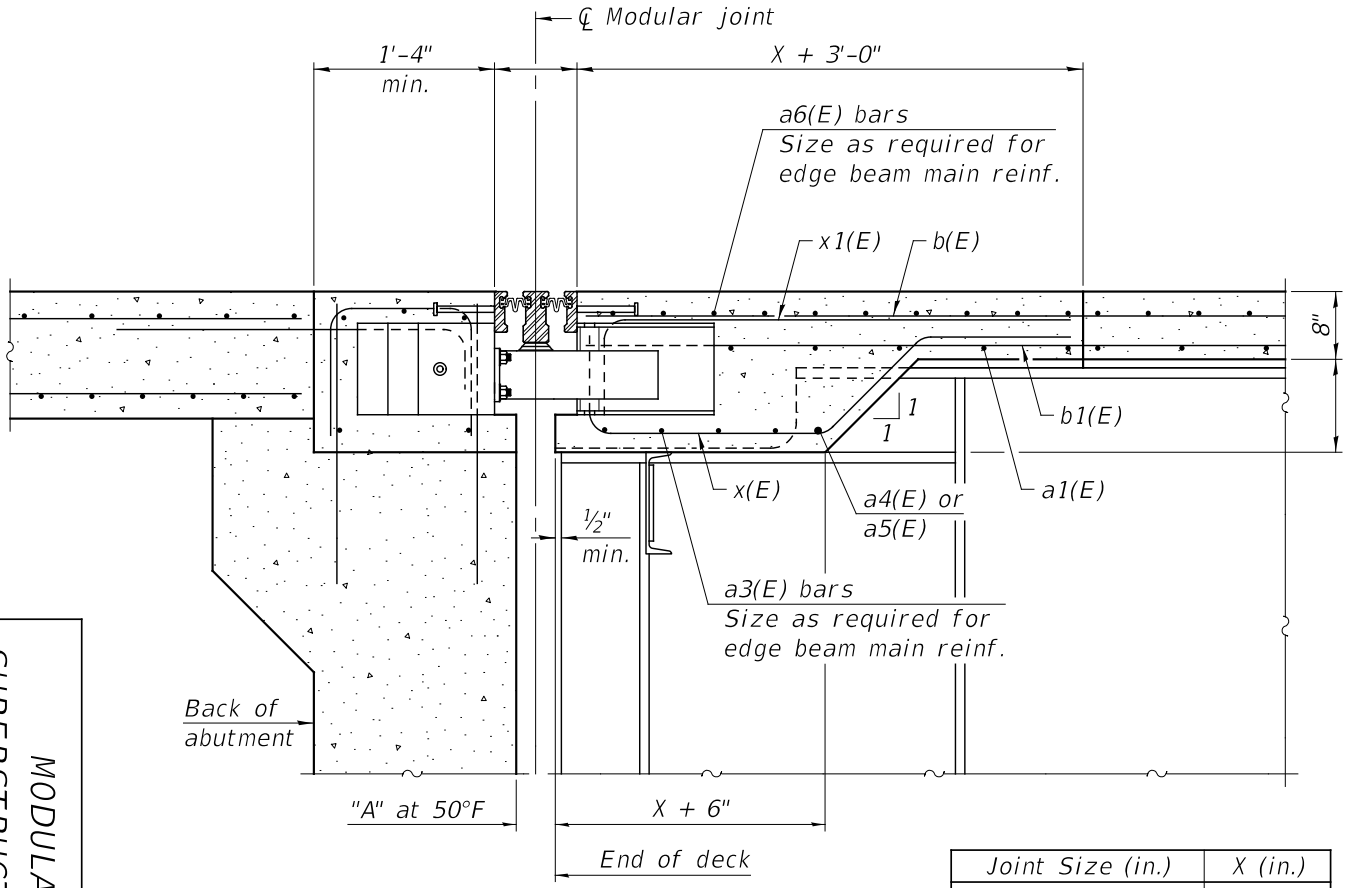
Attachments



Note:
Modular joint shown is a general schematic. See prequalified list of modular joints for all available configurations.

MODULAR JOINT & FULL DEPTH BLOCKOUT DETAILS

Figure 1 ABD 22.8



SECTION

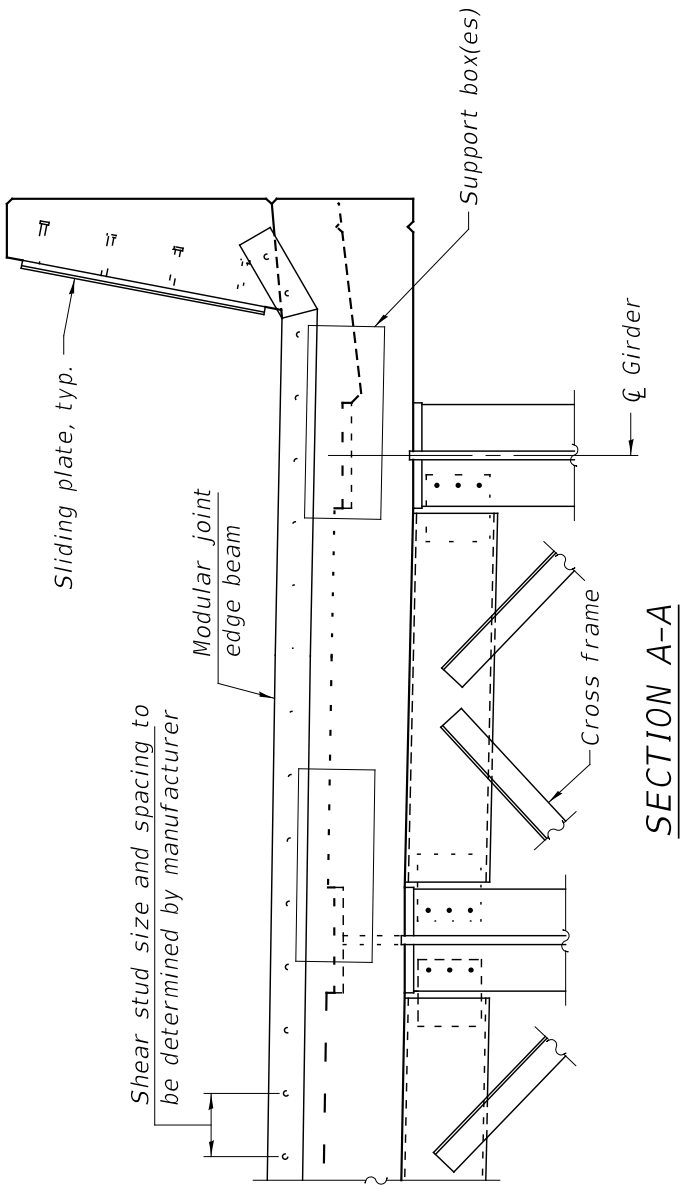
Joint Size (in.)	X (in.)
6	21
9	24
12	27
15	30
18	33
21	36
24	39

Joint Size = 3" x (# of center beams + 1)

MODULAR JOINT
SUPERSTRUCTURE DETAILS
FOR FULL DEPTH BLOCKOUT

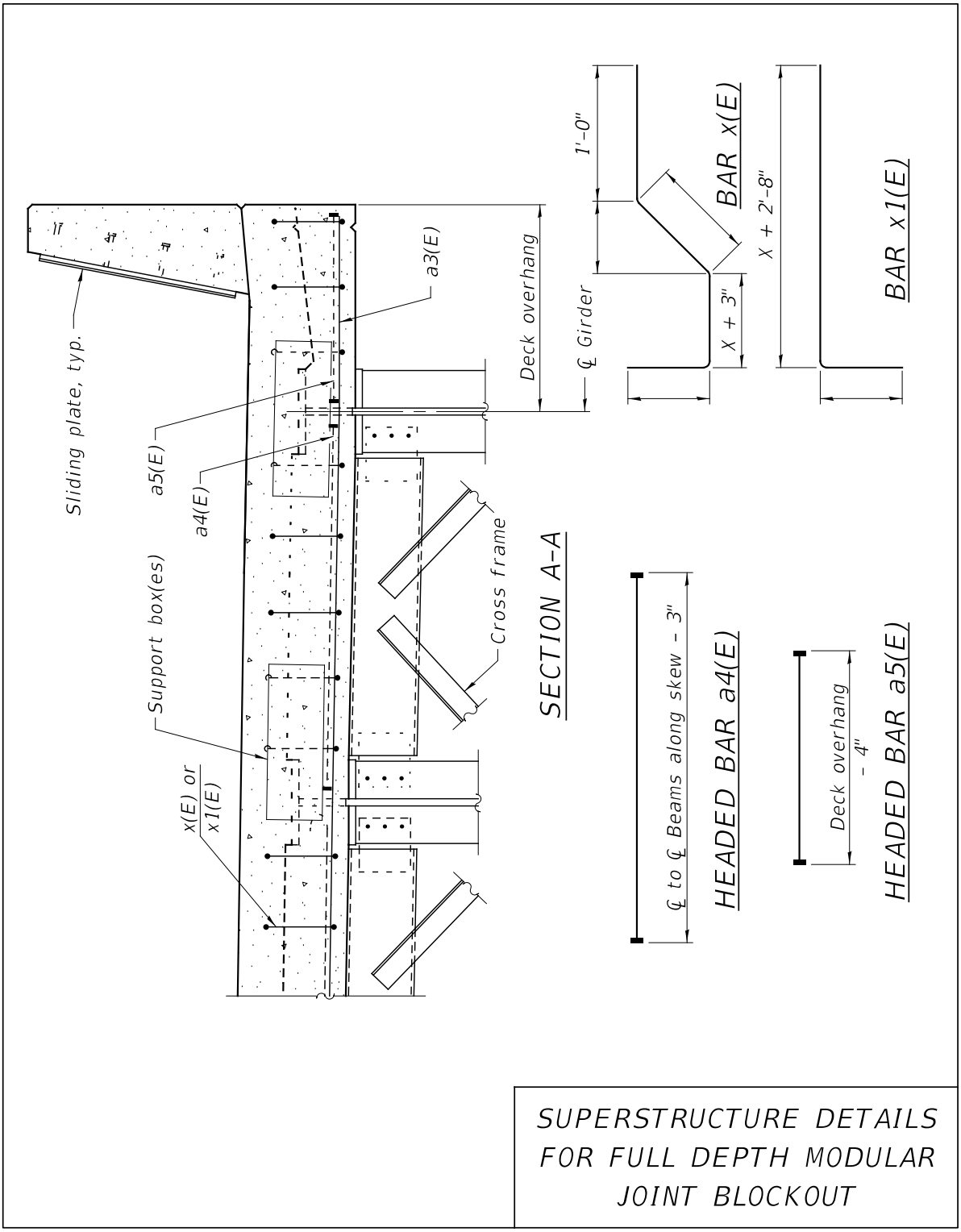
Figure 2

ABD 22.8



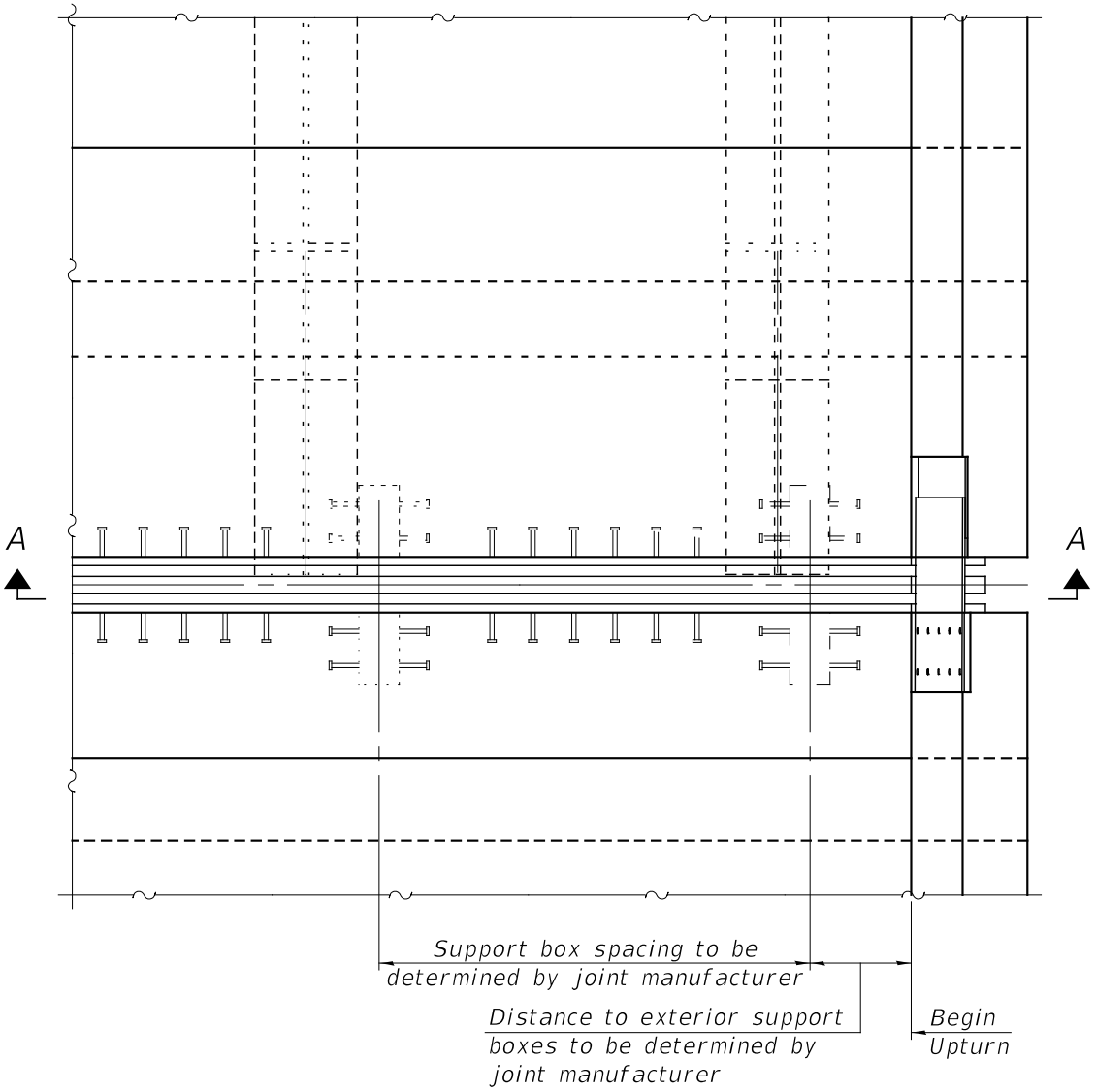
MODULAR JOINT & FULL DEPTH BLOCKOUT DETAILS

Figure 3 *ABD 22.8*



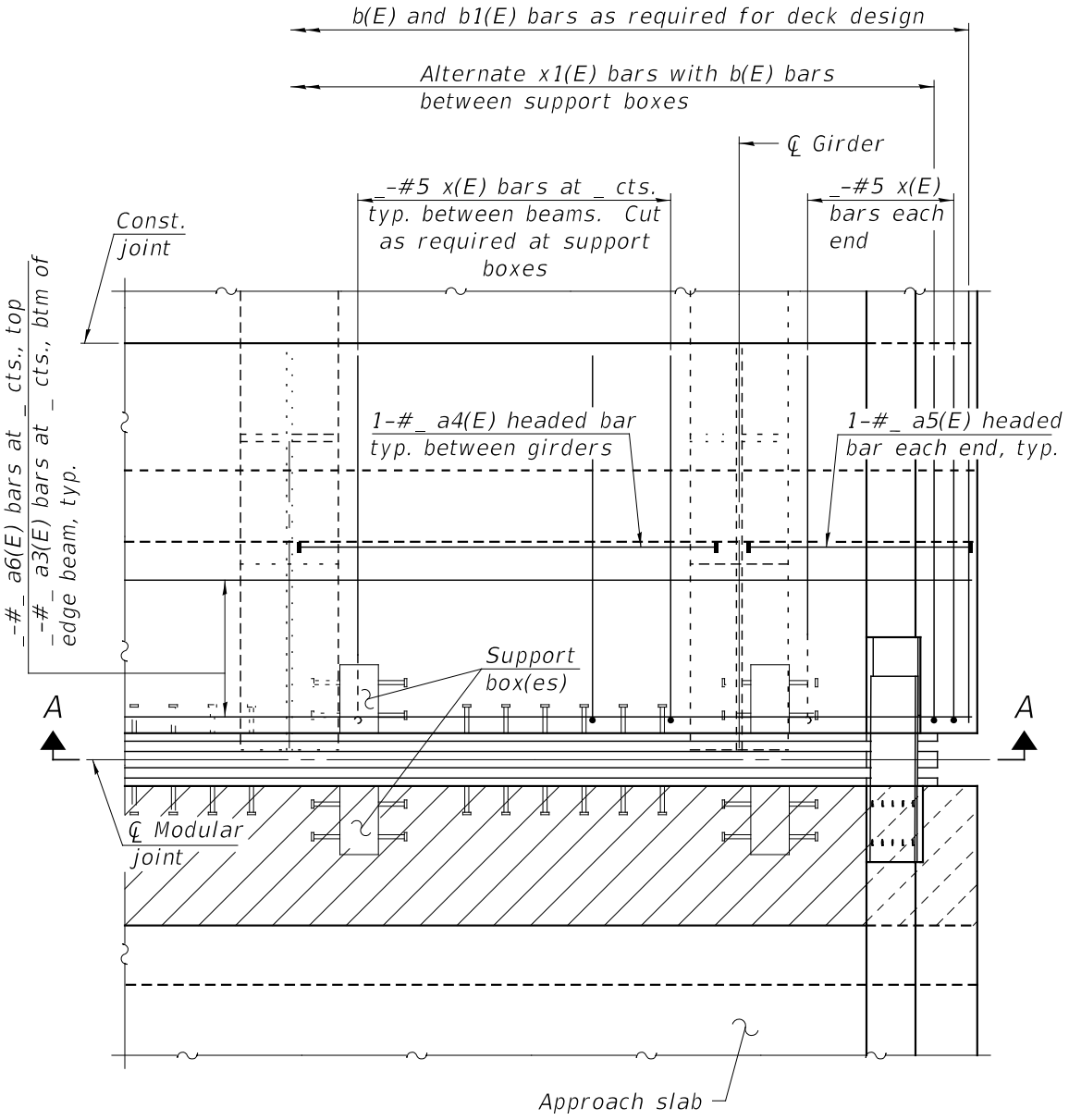
SUPERSTRUCTURE DETAILS FOR FULL DEPTH MODULAR JOINT BLOCKOUT

Figure 4 *ABD 22.8*



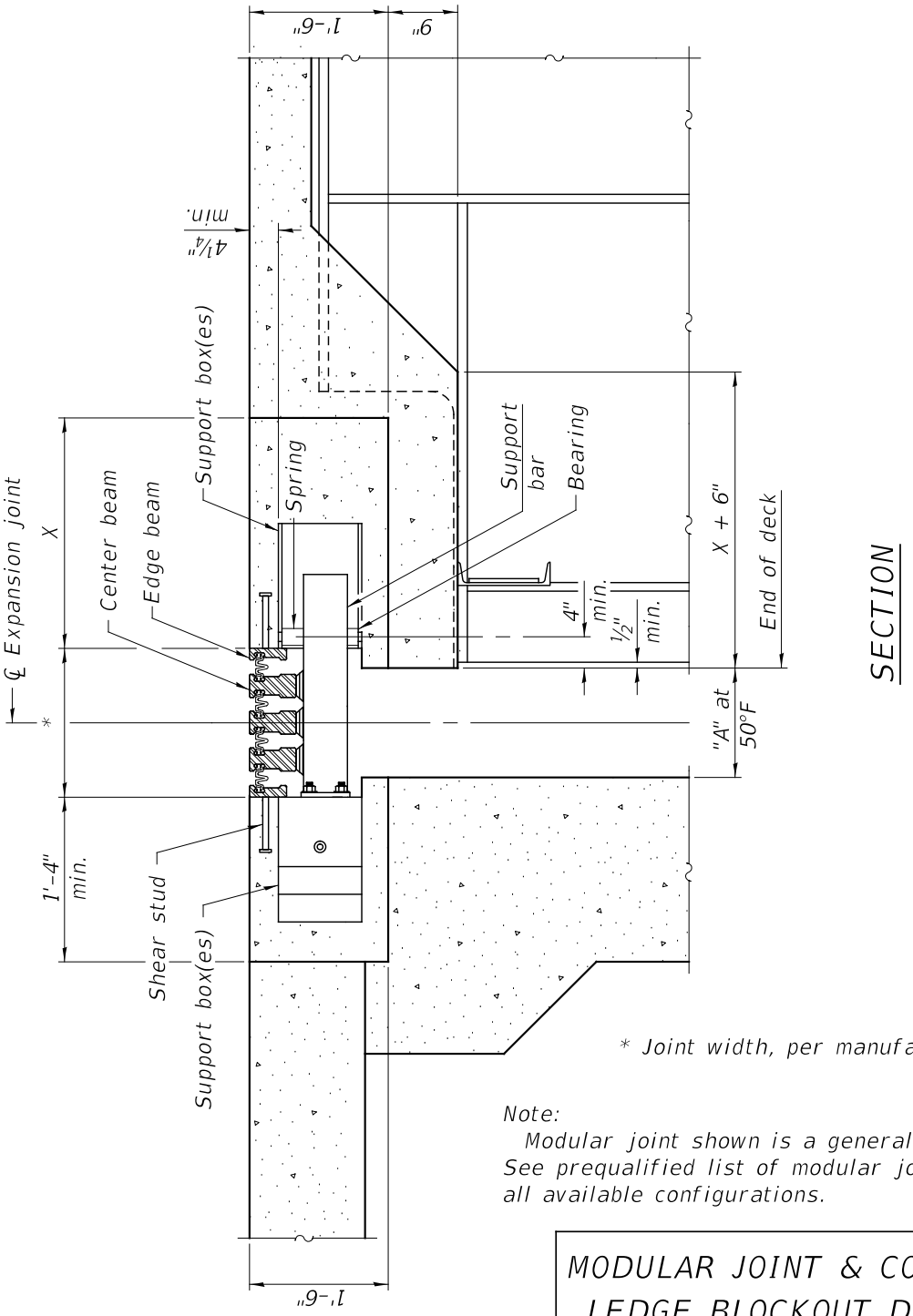
MODULAR JOINT & FULL DEPTH BLOCKOUT DETAILS

Figure 5 ABD 22.8



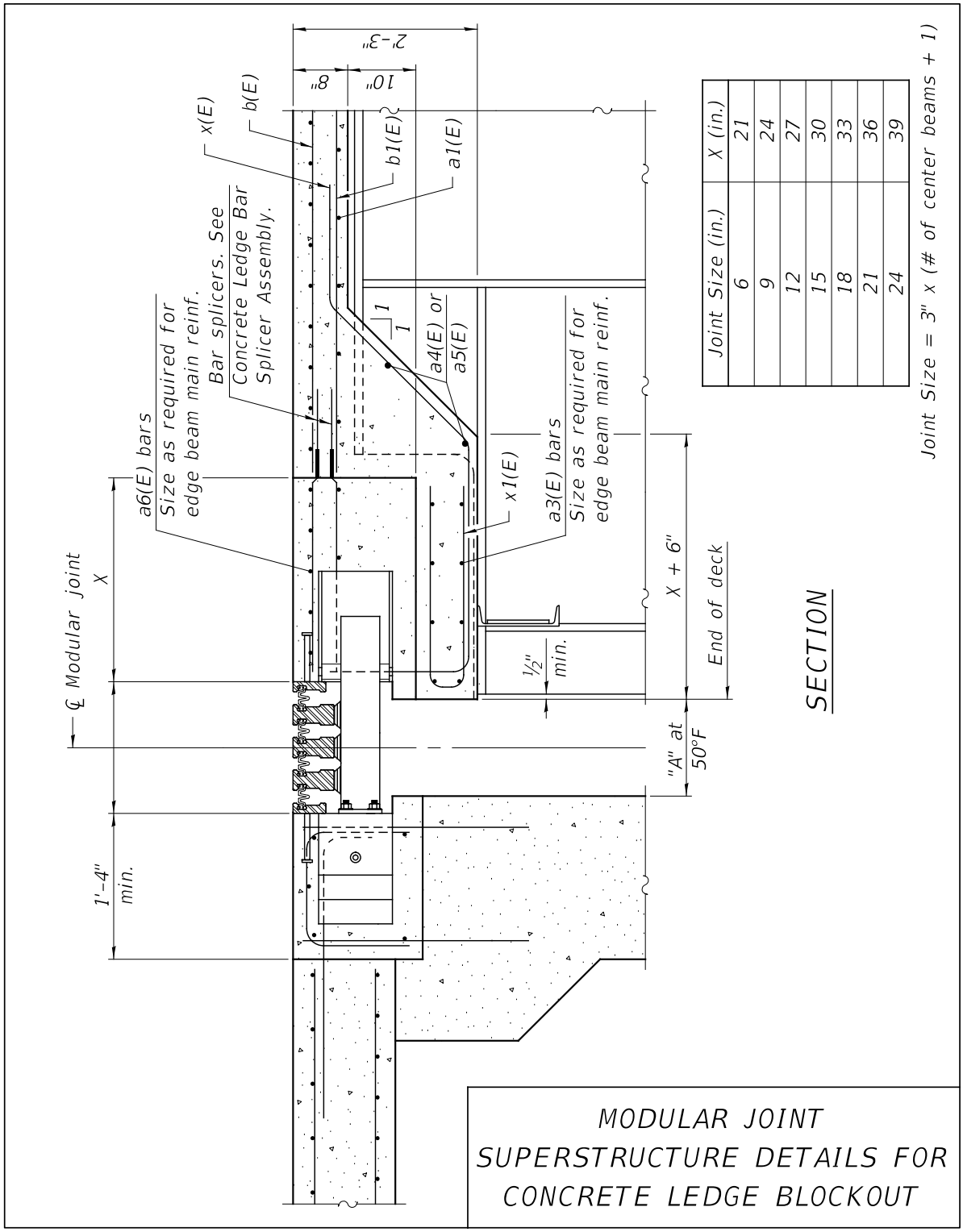
PARTIAL PLAN

SUPERSTRUCTURE DETAILS FOR FULL DEPTH MODULAR JOINT BLOCKOUT



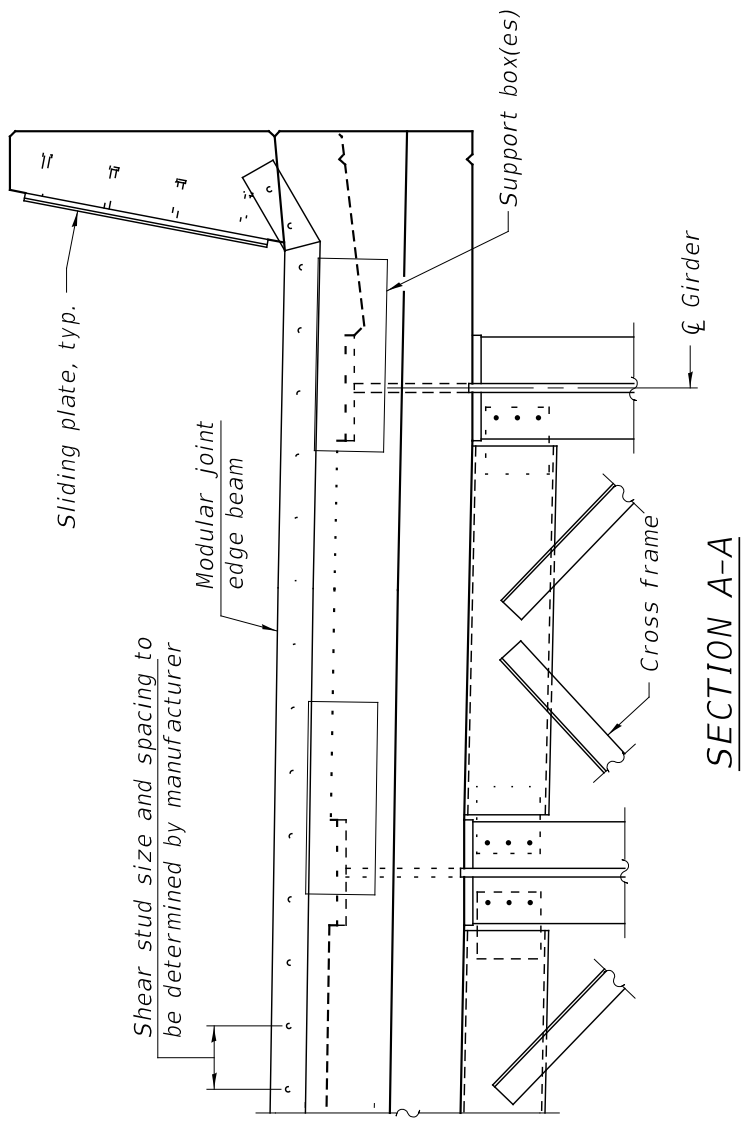
MODULAR JOINT & CONCRETE LEDGE BLOCKOUT DETAILS

Figure 7 ABD 22.8



Joint Size (in.)	X (in.)
6	21
9	24
12	27
15	30
18	33
21	36
24	39

Figure 8 **ABD 22.8**



MODULAR JOINT & CONCRETE LEDGE BLOCKOUT DETAILS

Figure 9 ABD 22.8

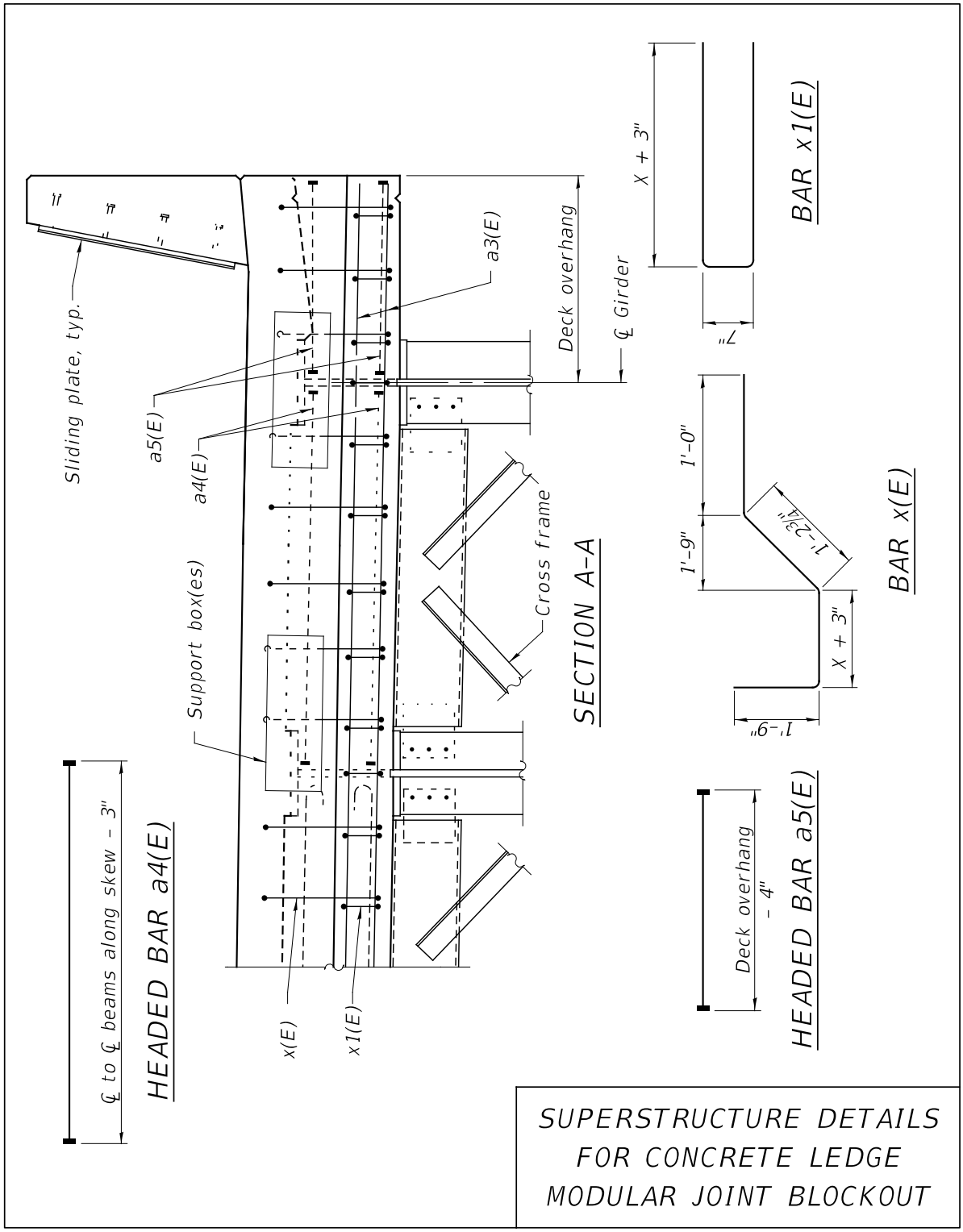
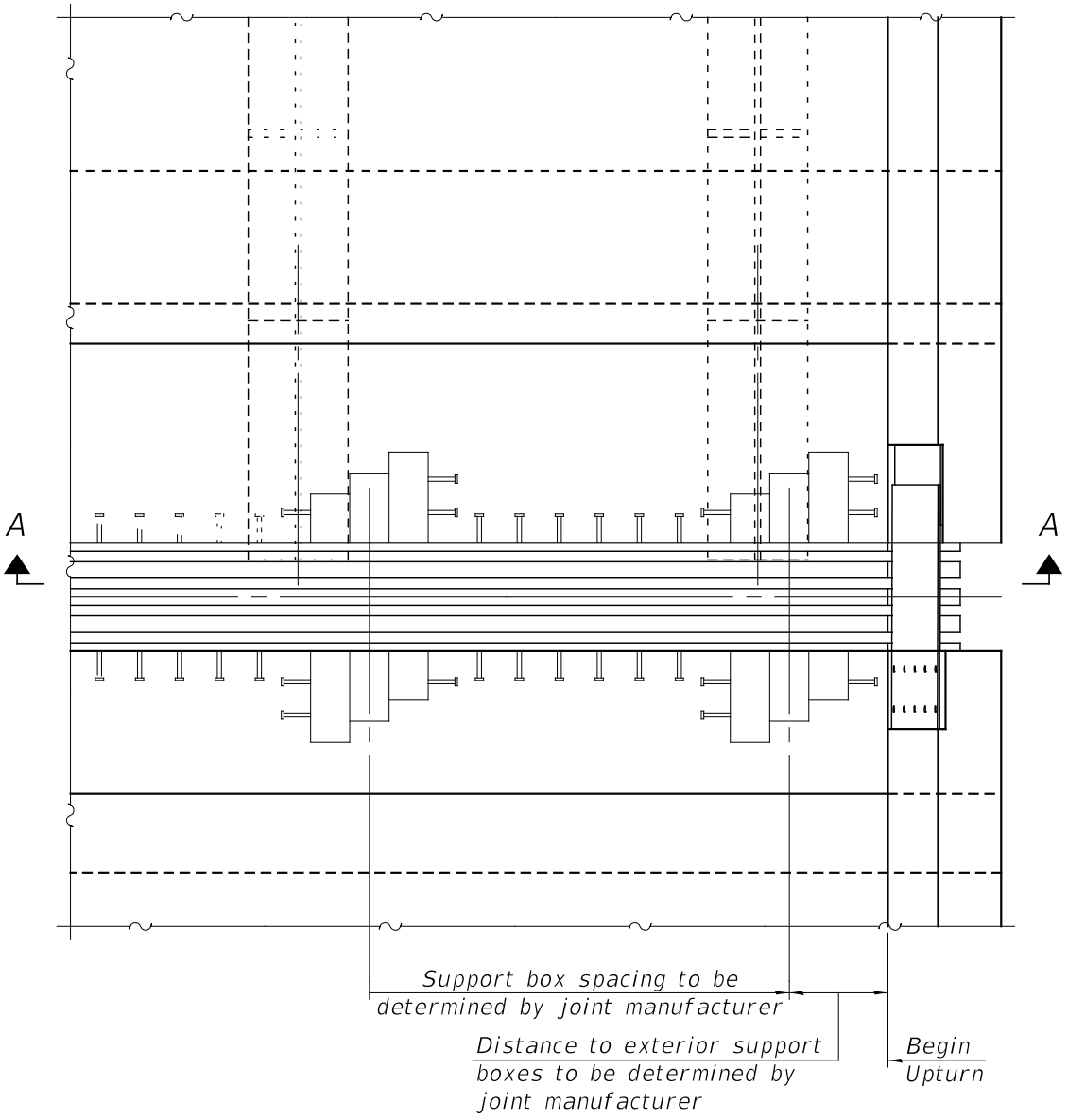
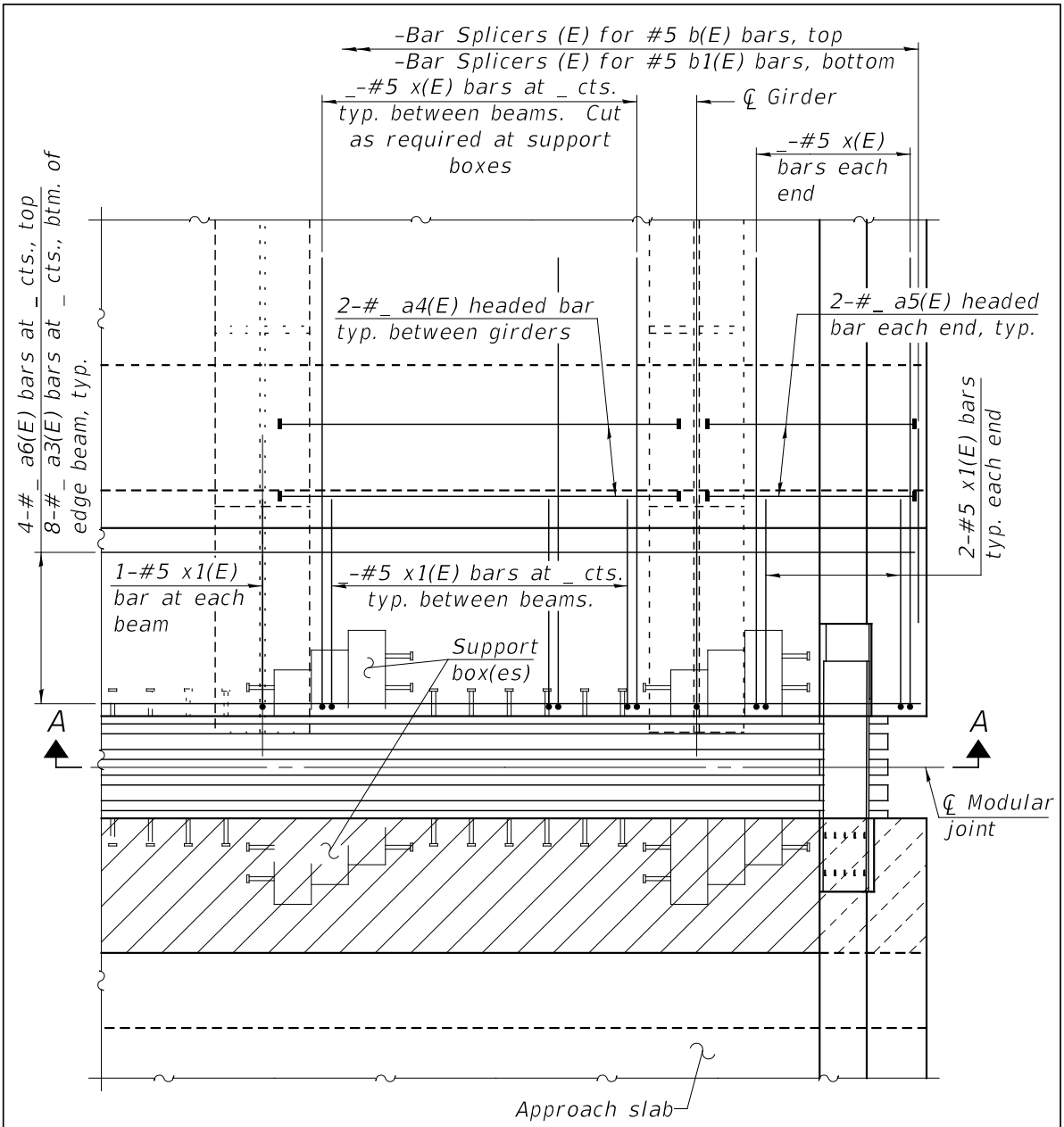


Figure 10 ABD 22.8



MODULAR JOINT & CONCRETE LEDGE BLOCKOUT DETAILS

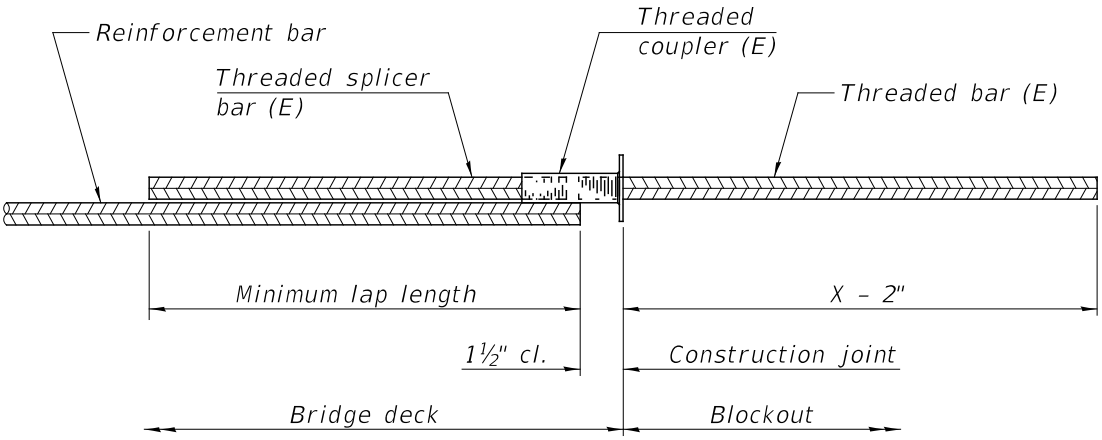
Figure 11 *ABD 22.8*



PARTIAL PLAN

SUPERSTRUCTURE DETAILS FOR CONCRETE LEDGE MODULAR JOINT BLOCKOUT

Figure 12 ABD 22.8



CONCRETE LEDGE BAR SPLICER ASSEMBLY PLAN

(All components shall be provided from one supplier)

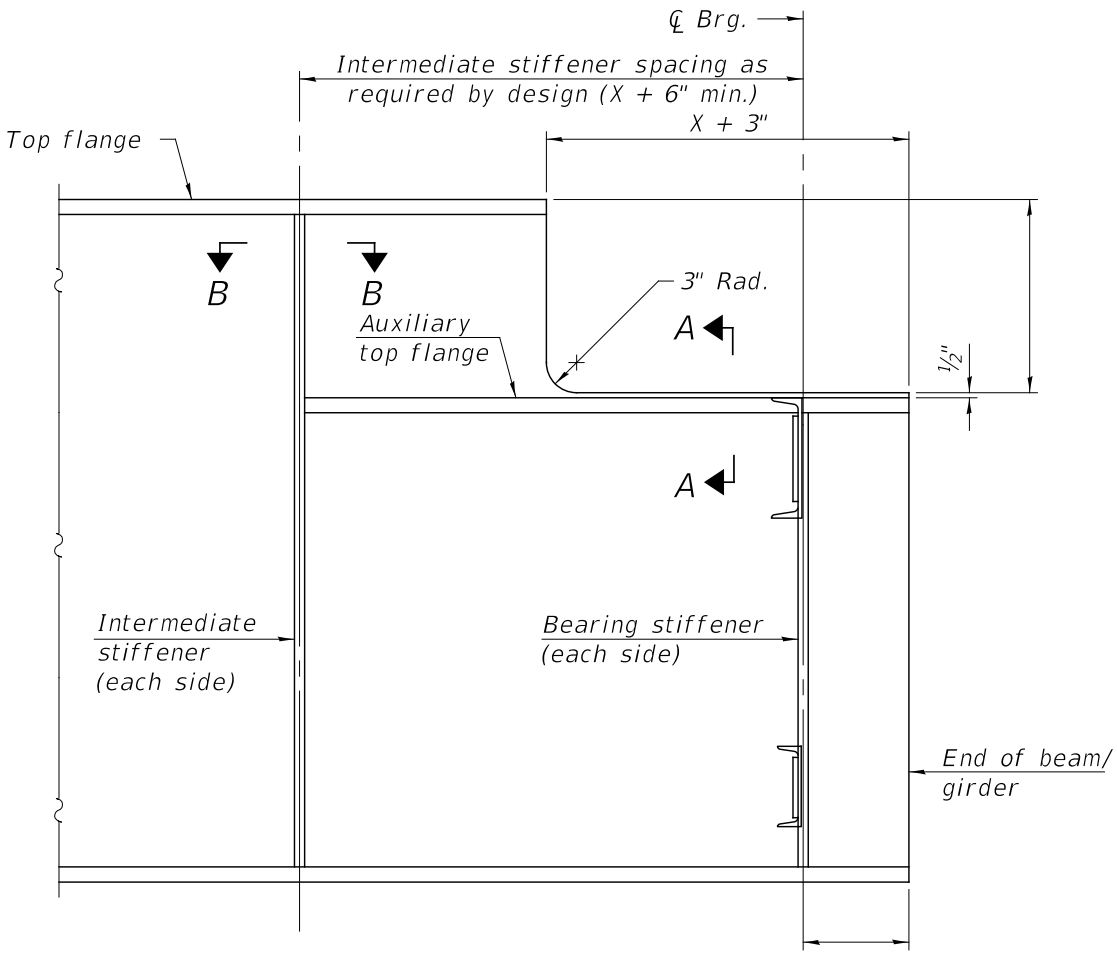
Threaded splicer bar length = min. lap length + 1½" + thread length
Threaded bar length = X – 2" + 1 thread length

Location	Bar size	No. threaded bars req'd	Length
Bridge deck	#5		
Blockout	#5		

Note:
One bar splicer assembly includes a threaded splicer bar, threaded bar, and threaded coupler.

CONCRETE LEDGE BAR SPLICER ASSEMBLY

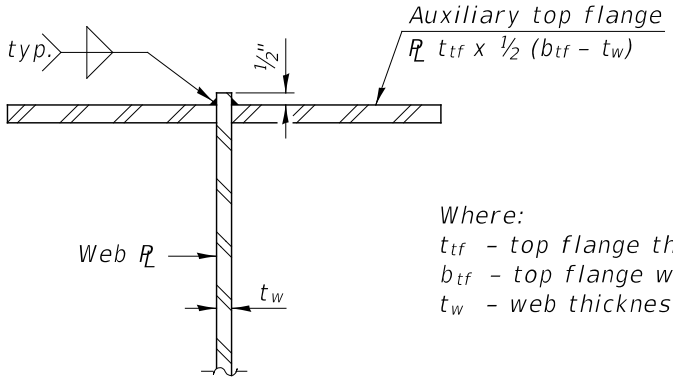
Figure 13 ABD 22.8



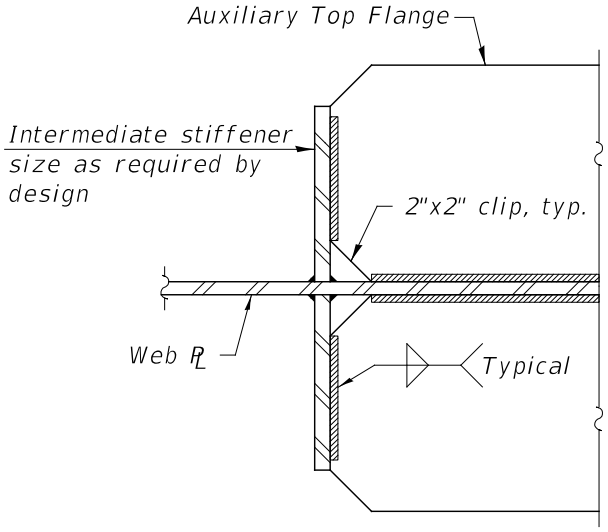
TYPICAL BEAM END

END OF GIRDER DETAILS FOR MODULAR JOINTS

Figure 14 ABD 22.8



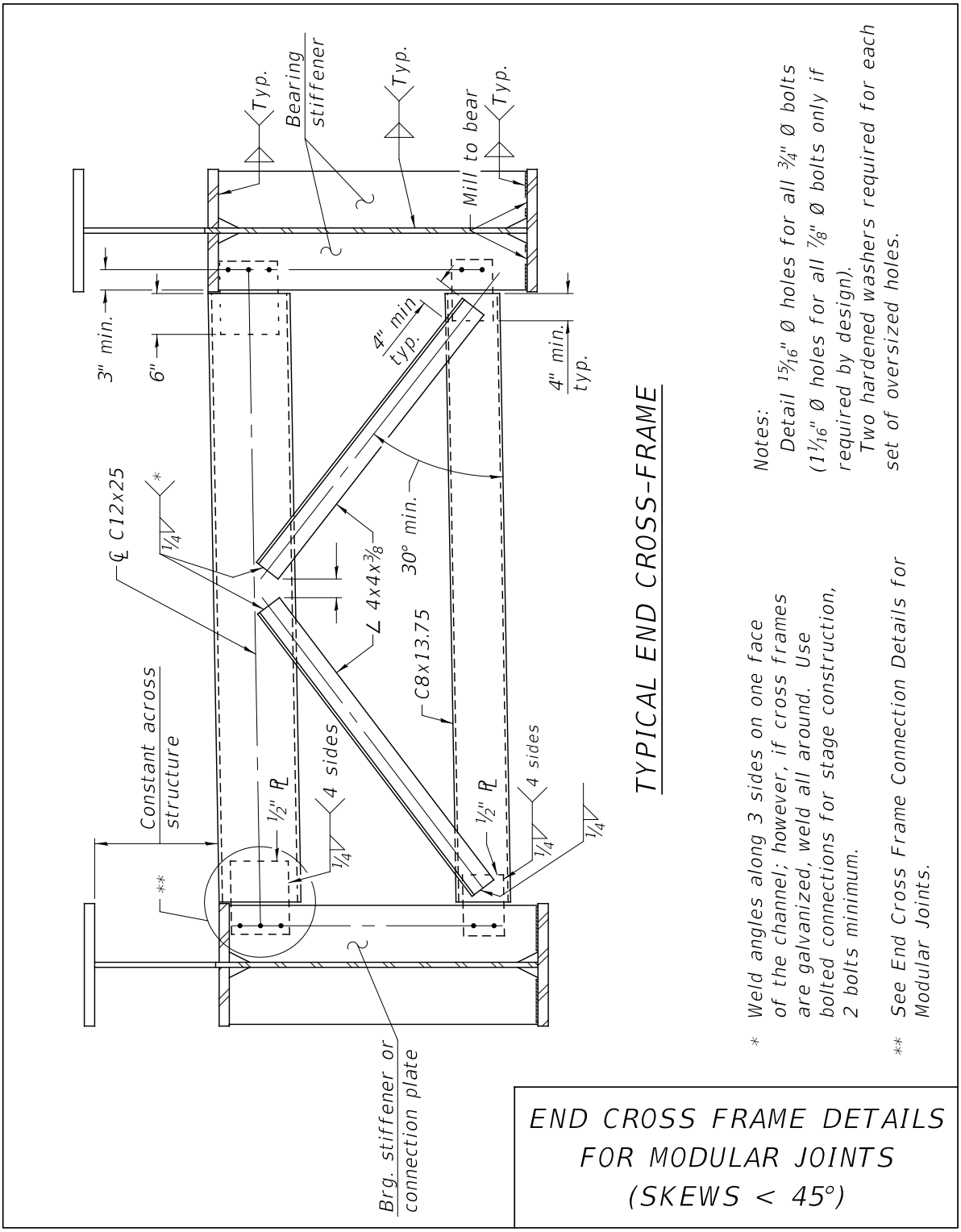
SECTION A-A



SECTION B-B

END OF GIRDER DETAILS FOR MODULAR JOINTS

Figure 15 ABD 22.8



TYPICAL END CROSS-FRAME

Notes:

* Weld angles along 3 sides on one face of the channel; however, if cross frames are galvanized, weld all around. Use bolted connections for stage construction, 2 bolts minimum.

Detail $^{15}/_{16}$" Ø holes for all $^{3}/_{4}$" Ø bolts ($1^{1}/_{16}$" Ø holes for all $^{7}/_{8}$" Ø bolts only if required by design).

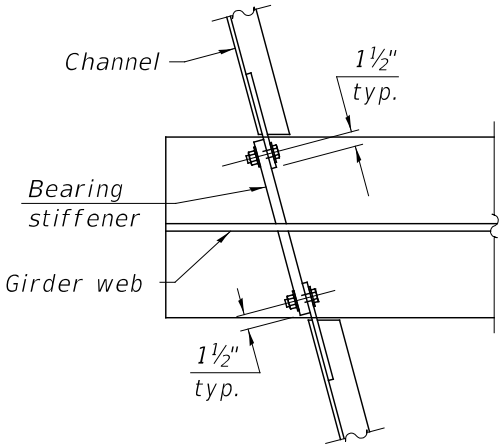
Two hardened washers required for each set of oversized holes.

** See End Cross Frame Connection Details for Modular Joints.

END CROSS FRAME DETAILS FOR MODULAR JOINTS (SKEWS < 45°)

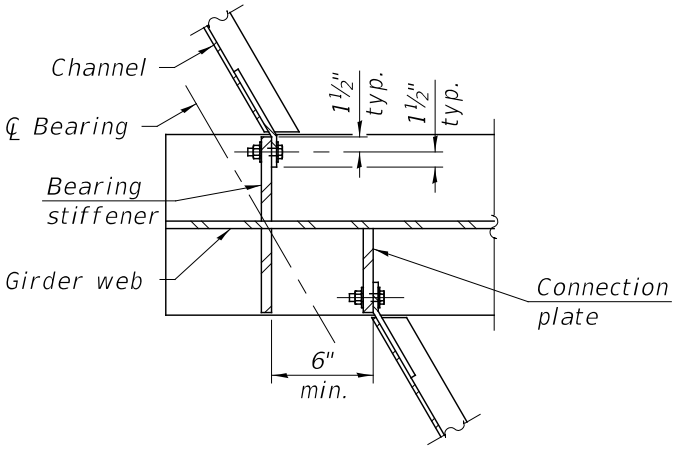
Figure 16

ABD 22.8



CONNECTION DETAIL

(Skews ≤ 20°)

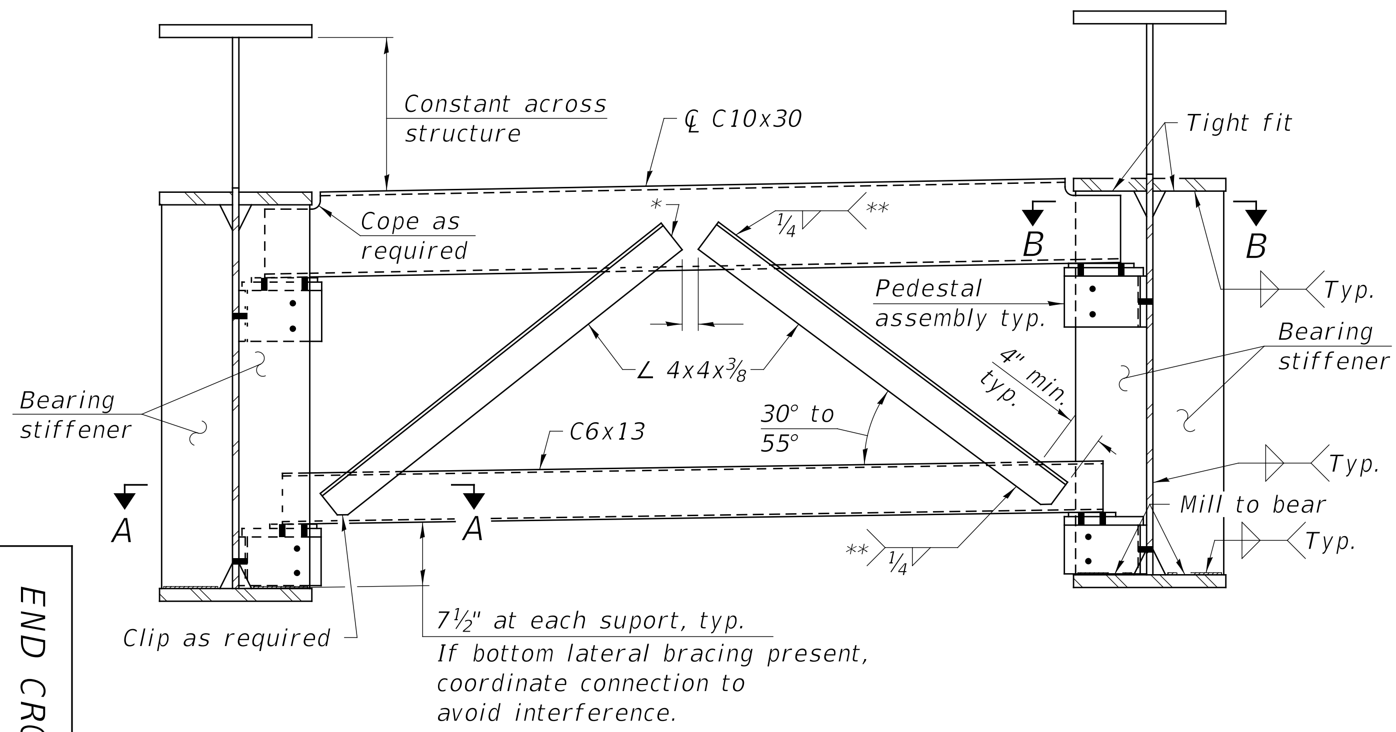


CONNECTION DETAIL

(Skews 20° – 45°)

END CROSS FRAME CONNECTION DETAILS FOR MODULAR JOINTS (SKEWS < 45°)

Figure 17 ABD 22.8



TYPICAL END CROSS FRAME

Notes:

Detail 15/16" Ø holes for all 3/4" Ø bolts (1 1/16" Ø holes for all 7/8" Ø bolts only if required by design).

Two hardened washers required for each set of oversized holes.

Place cross frame with channel flanges outward from abutment backwall.

* Use a minimum 2 bolt connection for stage construction.

** Weld angles along 3 sides to back face of channel: however, if cross frames are galvanized, weld all-around.

END CROSS FRAME DETAILS
FOR MODULAR JOINTS
(SKEWS ≥ 45°)

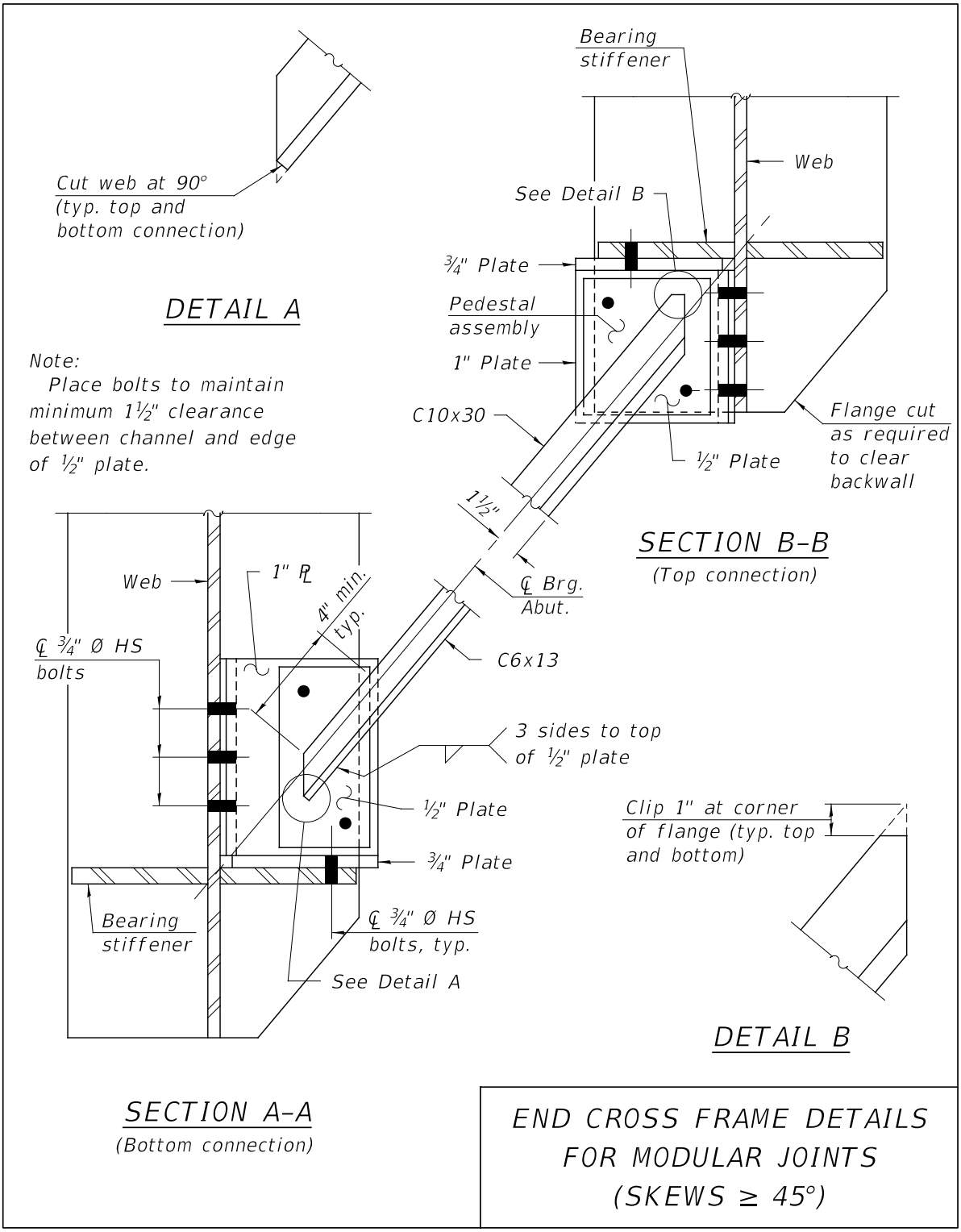
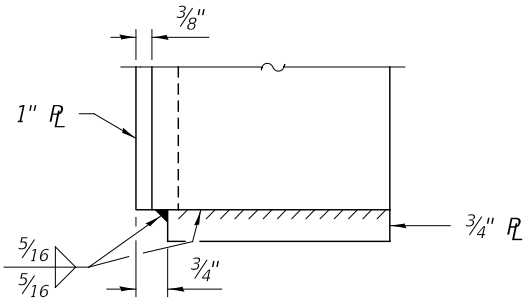
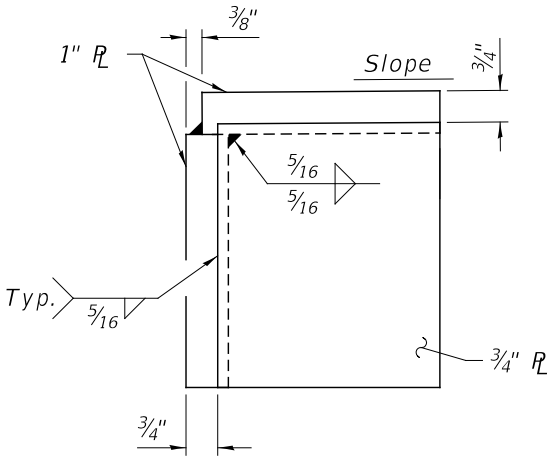


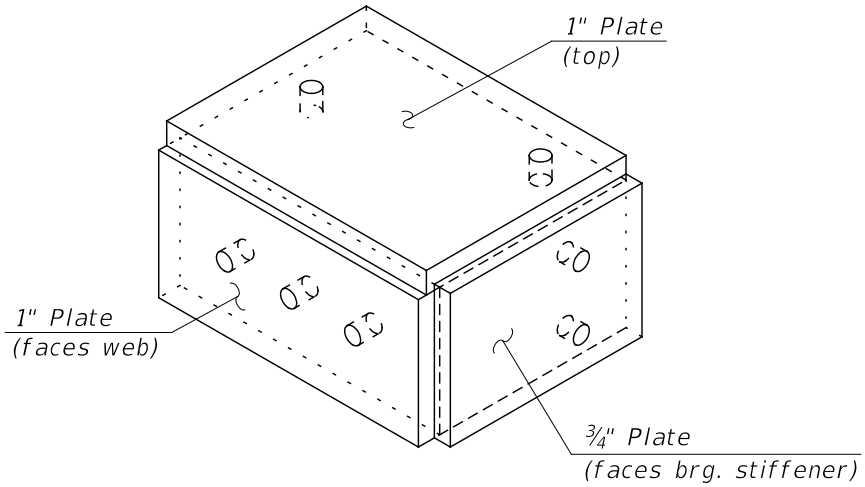
Figure 19 ABD 22.8



PEDESTAL ASSEMBLY
PARTIAL PLAN



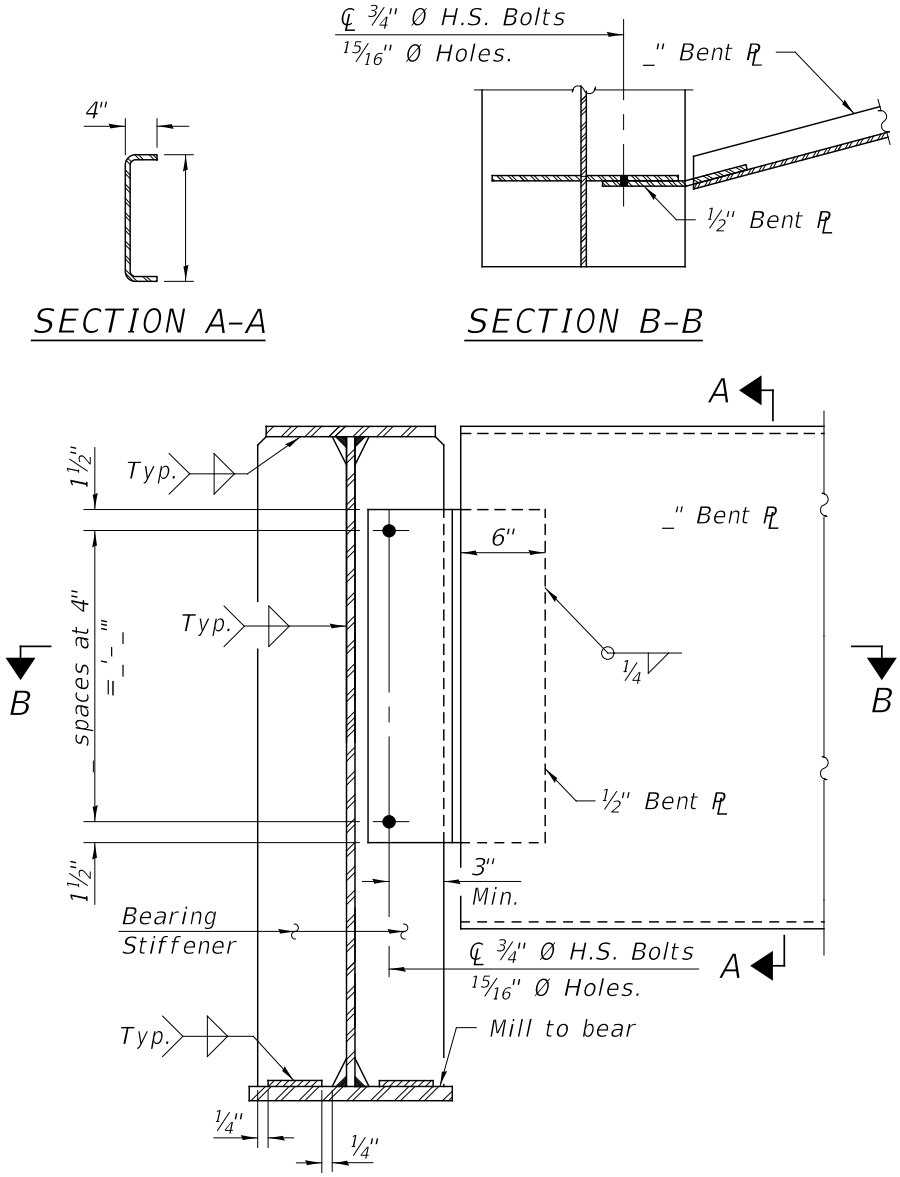
PEDESTAL ASSEMBLY
ELEVATION



PEDESTAL ASSEMBLY
ISOMETRIC VIEW

PEDESTAL ASSEMBLY DETAILS FOR
MODULAR JOINT END CROSS FRAME
(SKEWS ≥ 45°)

Figure 20 ABD 22.8



END DIAPHRAGM

Notes:

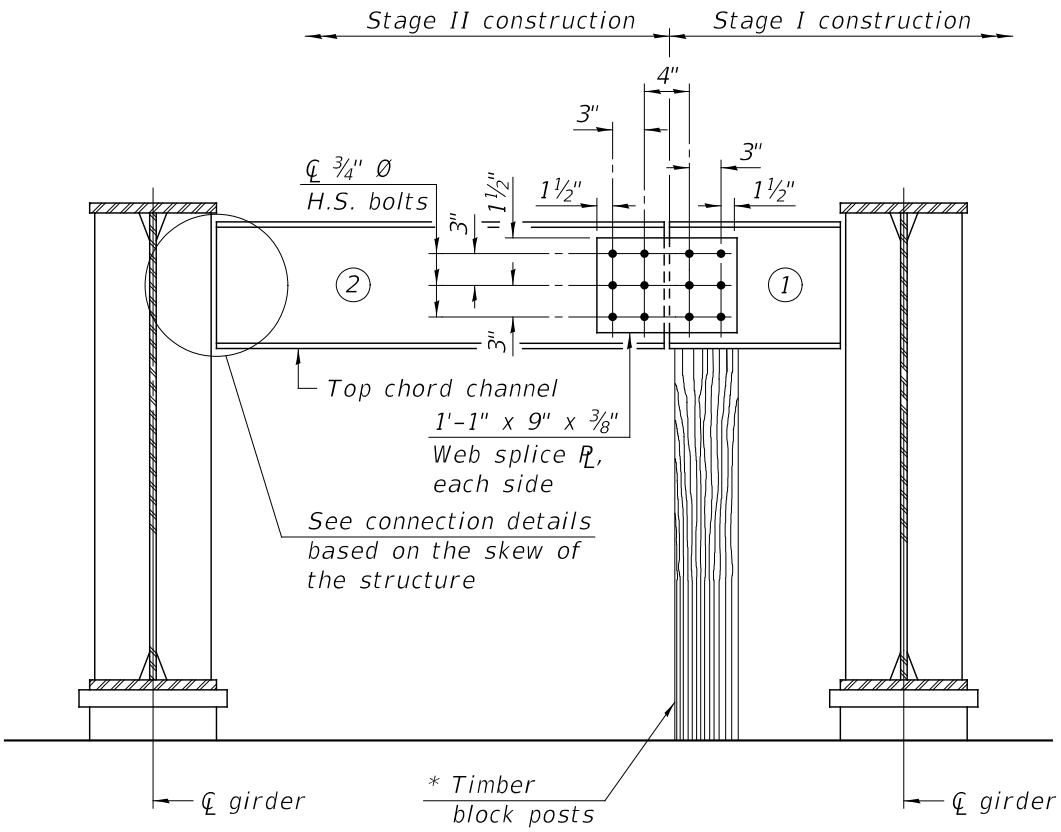
Detail 15/16" Ø holes for all ¾" Ø bolts (1 1/16" Ø holes for all ⅞" Ø bolts only if required by design).

Two hardened washers required for each set of oversized holes.

Place bent PL diaphragm with flanges outward from abutment backwall.

FINGER PLATE AND MODULAR JOINT END DIAPHRAGM (SKEWS ≤ 45°)

* Cost of timber block posts is included with Furnishing and Erecting Structural Steel.

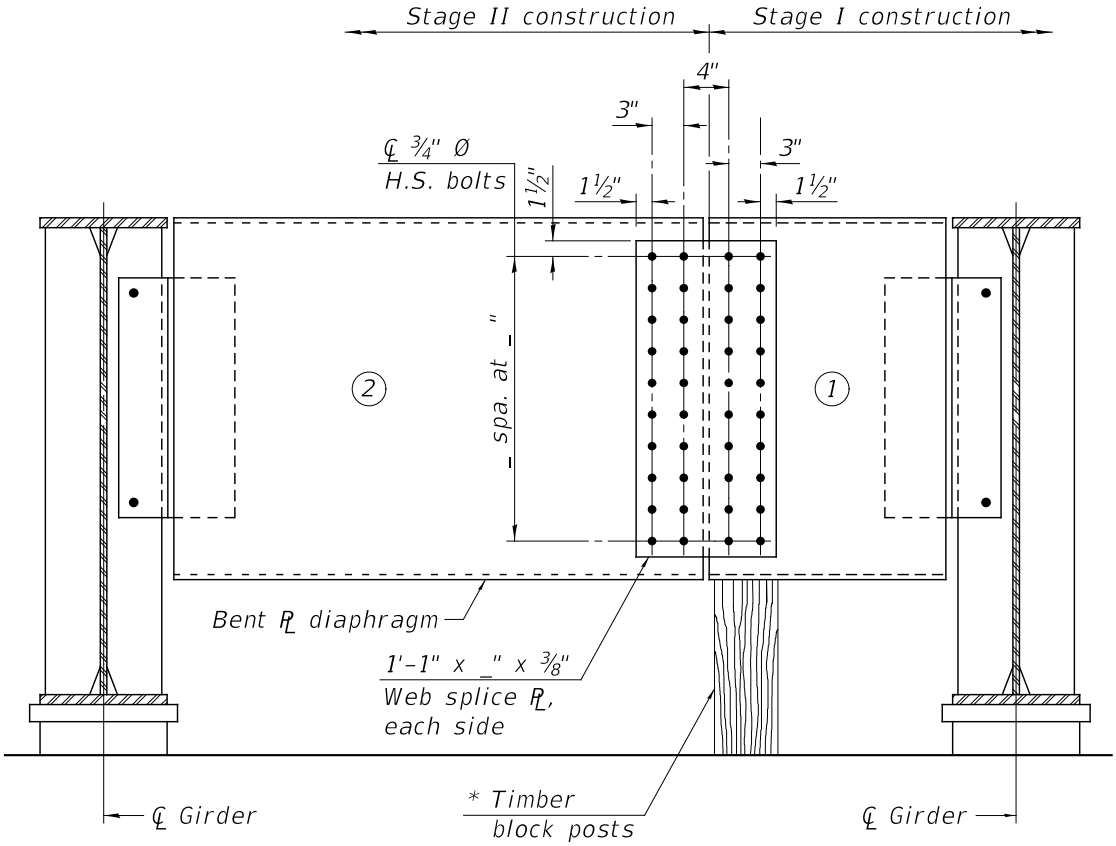


STAGE CONSTRUCTION SEQUENCE

1.) Order top chord in two sections.
2.) Attach section (1) of top chord to girder.
3.) Place timber block posts between section (1) of top chord and abutment bearing section.
4.) Attach section (2) of top chord to both girder and section (1) of top chord during stage II construction with splice plates.
5.) Attach remaining diagonal truss and bottom chord elements of end cross frame.
6.) Remove timber block posts.

END CROSS FRAME
STAGE CONSTRUCTION SEQUENCE

* Cost of timber block posts is included with Furnishing and Erecting Structural Steel.



STAGE CONSTRUCTION SEQUENCE

1.) Order bent ℄ in two sections.
2.) Attach section (1) of bent ℄ to girder.
3.) Place timber block posts between section (1) of bent ℄ and abutment bearing section.
4.) Attach section (2) of bent ℄ to both girder and section (1) of bent ℄ during stage II construction with splice plates.
5.) Remove timber block posts.

END BENT ℄ DIAPHRAGM
STAGE CONSTRUCTION SEQUENCE