



AMERICAN INSTITUTE OF TIMBER CONSTRUCTION

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AITC 104-2003 TYPICAL CONSTRUCTION DETAILS

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1. INTRODUCTION

- 1.1** These typical construction details are intended as guides for architects and engineers. They have been developed and used by the engineered timber construction industry and, being based on judgement and experience, will help to assure a high quality of construction.
- 1.2** **Warnings:** Because the details are to be used only as guides, dimensions have not been included and the drawings should not be scaled. Quantities and sizes of bolts, connectors and other fastening hardware are illustrative only. The actual quantities and sizes required will depend on the loads to be carried and the member sizes. End and edge distances, as well as spacing between fasteners, should be in accordance with the *National Design Specification for Wood Construction* by the American Forest & Paper Association. Sufficient clearance must be provided between sides of steel connection hardware and wood members to permit installation. This clearance should not exceed the member width plus 1/4 in.
- 1.3** **Designing for Strength.** Connection details must effectively transfer loads, utilize durable materials, and be as free from maintenance as possible. The strength of wood is different in the parallel and perpendicular grain directions. Wood also has much less strength in tension perpendicular to grain than in compression perpendicular to grain. These facts influence design details.

Vertical loads should be transferred so as to take advantage of the high compression perpendicular to grain strength of wood. For example, a beam should bear on the top of a column or wall or be seated in a shoe or hanger. Such a detail is preferred to the support of a beam by bolts at its end, particularly where there are large numbers of bolts.

Beams should be anchored at the ends in order to carry induced horizontal and vertical loads. Vertical loads may be either gravity loads or net uplift loads. The connections typically shown in this standard are primarily for vertical gravity loads. Provisions should be made to resist uplift or lateral loads as required. The bolts or fasteners at the beam ends must be located near the bottom bearing of the beam to minimize the effect of shrinkage of the wood member between the bottom of the beam and the fasteners.

In many cases, individual details do not include all structural elements, such as lateral bracing ties to connect all of the components of the building together.

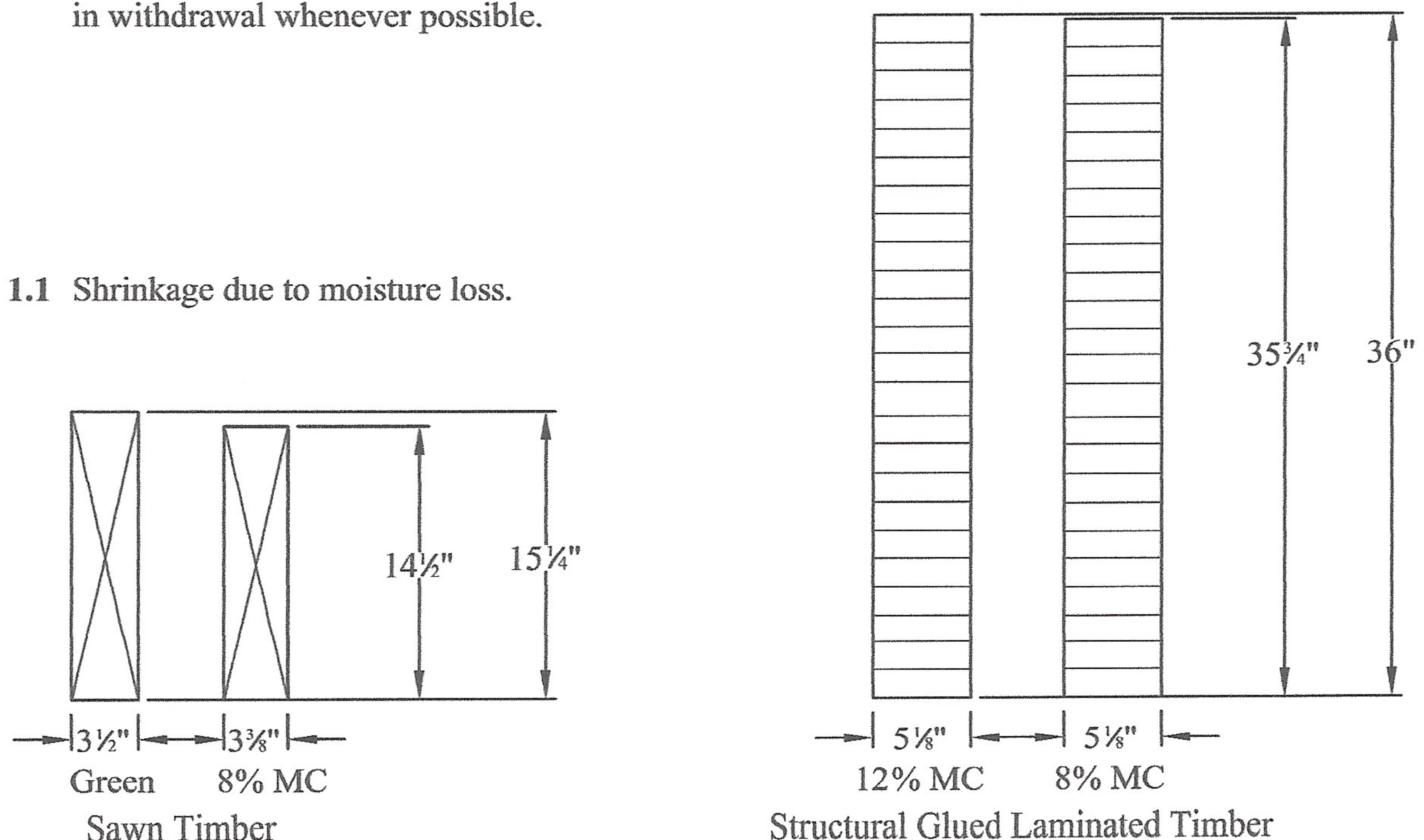
Loads suspended from glued laminated timber beams or girders should preferably be suspended from the top of the member or above the neutral axis.

- 1.4 Consideration of Shrinkage and Swelling.** In addition to designing connections to transfer loads, effort should be made to avoid splitting the member due to expansion and contraction of the wood. Consideration must be given to wood swelling and shrinking due to moisture content changes in service, similar to the consideration given to details in metal construction that must accommodate the expanding and contracting metal due to changes in temperature.

Because wood swells and shrinks (primarily in the perpendicular to grain directions) due to moisture content changes, connections should not restrain this movement. Figure 1.1 illustrates typical shrinkage in a sawn member when drying from green to 8% moisture content and a glued laminated timber drying from 12% to 8% moisture content. Even in covered structures, large laminated timbers may shrink after installation due to moisture loss from low relative humidity conditions. Long rows of bolts perpendicular to grain fastened to a single cover plate should be avoided. Although relatively dry at time of manufacture, glued laminated timber can still shrink to reach equilibrium moisture content in service.

When possible, designers should avoid joint details that could loosen in service due to wood shrinking or that could cause problems when wood expands due to increased moisture content. Machine bolts should be used rather than lag bolts whenever possible. When lag bolts are used, correct lead hole sizes are important. Connections should be detailed to avoid loading lag bolts in withdrawal whenever possible.

Figure 1.1 Shrinkage due to moisture loss.



- 1.5 Designing to Avoid Tension Perpendicular to Grain Stresses.** Whenever possible, joints should be designed to avoid causing tension perpendicular to grain stresses in wood members. Examples of connections that induce tension perpendicular to grain stresses are simple beams, which have been notched at the ends on the tension side (see Detail A5).

Long lines of fasteners spaced close together along the grain should be avoided, particularly if the bolts are in tightly drilled holes. These types of connections may induce tension perpendicular to grain stresses due to prying actions from secondary moments.

- 1.6 Consideration of Decay.** When proper construction details are used and other good design and construction practices are followed, wood is a permanent construction material. Moisture barriers, flashings and other protective features should be used to prevent moisture or free water being trapped (see Section 11, "Details to Protect Against Decay"). Preservative treatments are recommended when wood is fully exposed to the weather without roof cover. Materials should be protected during construction. Arch and column bases should not be embedded below finished concrete floor levels. Arch and column bases should be elevated a minimum of one inch above the concrete floor level if there is potential for wetting of the floor.
- 1.7 Other Considerations.** It is important to provide adequate site drainage to prevent moisture problems. Fasteners and connection hardware should be protected from corrosion by using corrosive-resistant metals or resistant coatings or platings. Additional guidelines for specifying and designing with structural glued laminated timber are outlined in other AITC standards and publications.
- 1.8 End Rotation of Beams.** Consideration should be given to end rotation of beams resulting from vertical load deflection. Location of fasteners that tend to create end fixity should be avoided. Splitting at fasteners can result unless such a connection is designed to develop a fixed end moment sufficient to resist end rotation due to deflection.

2. BEAM TO MASONRY ANCHORAGES

- 2.1** Figures 2.1 through 2.10 illustrate various beam to masonry anchorages. The seats illustrated may be anchored in the concrete or masonry with one or more anchors. An important point illustrated in several of the figures is that the timber member should be separated from the masonry or concrete by a minimum of 1/2 in. clearance on all sides. In the case of net uplift loads, notched beam shear should be checked.
- 2.2** For beams sloped where a 1/8 in. or greater gap might occur, the beam bearing should be detailed to obtain full contact between bearing surfaces (see Figures 2.6 and 2.7). Seat cuts at the top end of the slope should be checked for notched beam effect.

Figure 2.1 Common Beam Seat. Used to resist uplift and horizontal forces as well as gravity loads. In the case of uplift, the notched beam effect must be checked. The beam may be fastened to the tabs with one or more bolts or, where forces are greater, with bolts and shear plates.

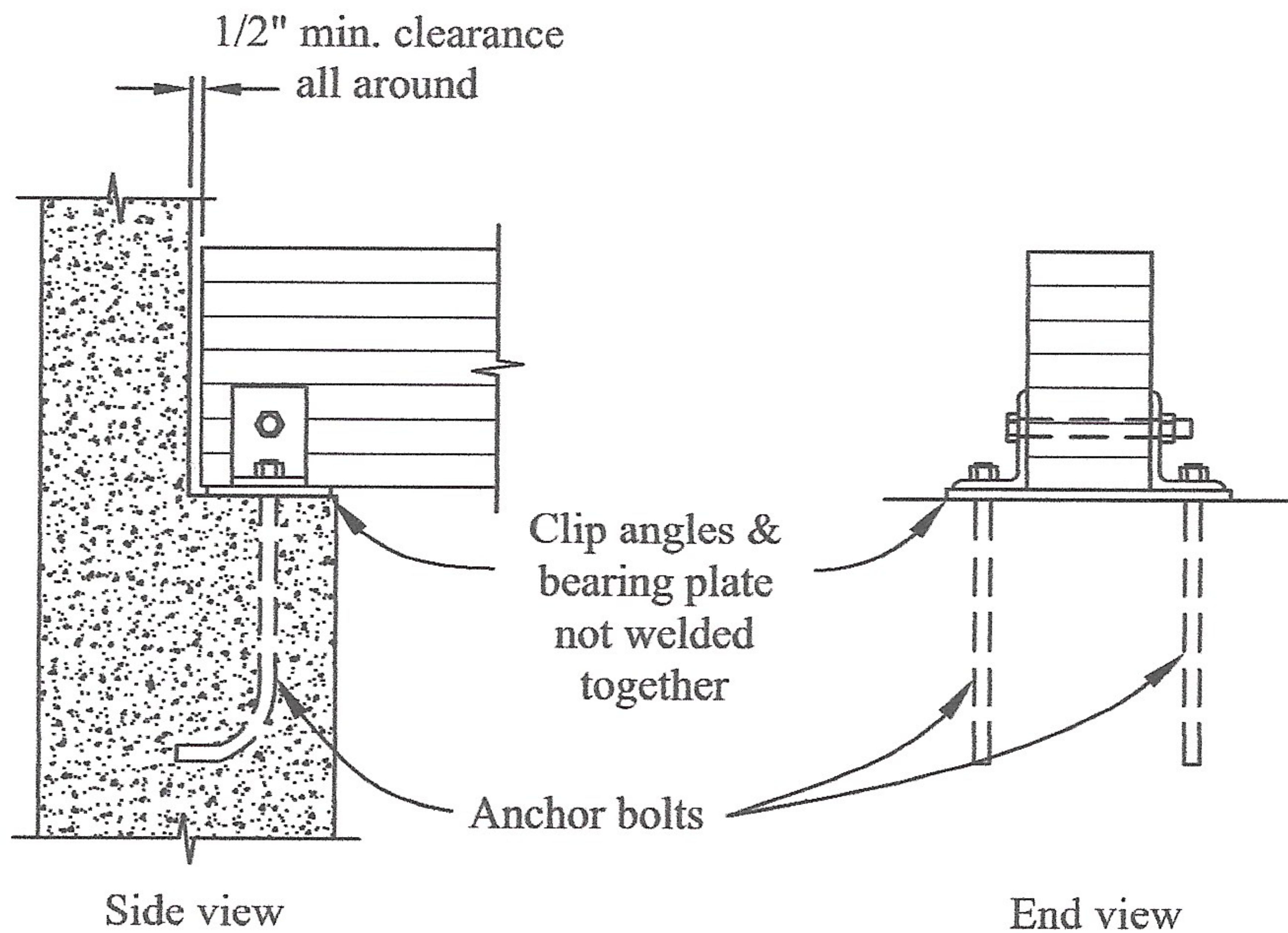
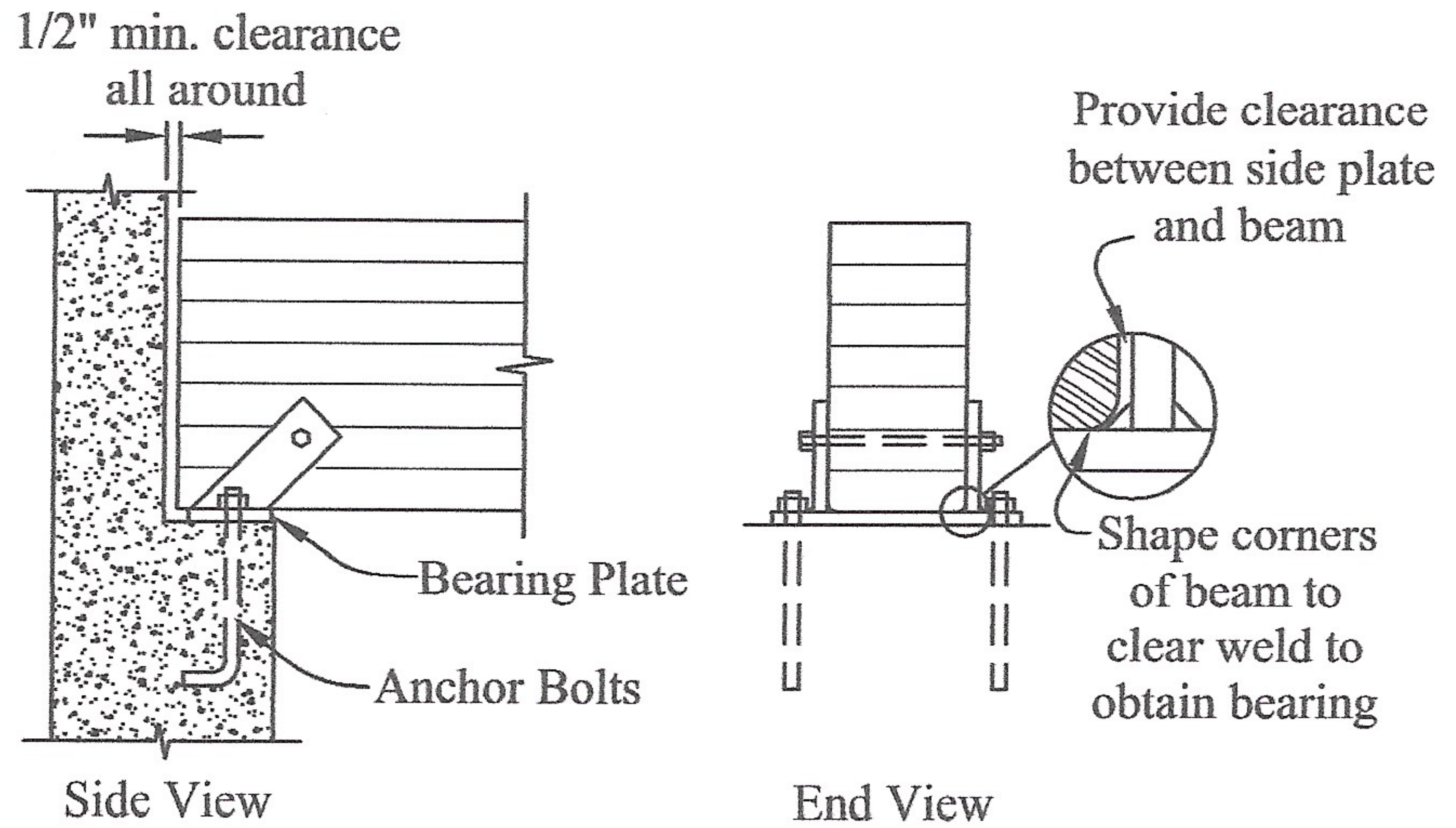


Figure 2.2 Shows steel angles with a separate bearing plate with only the anchor bolts being cast in place.

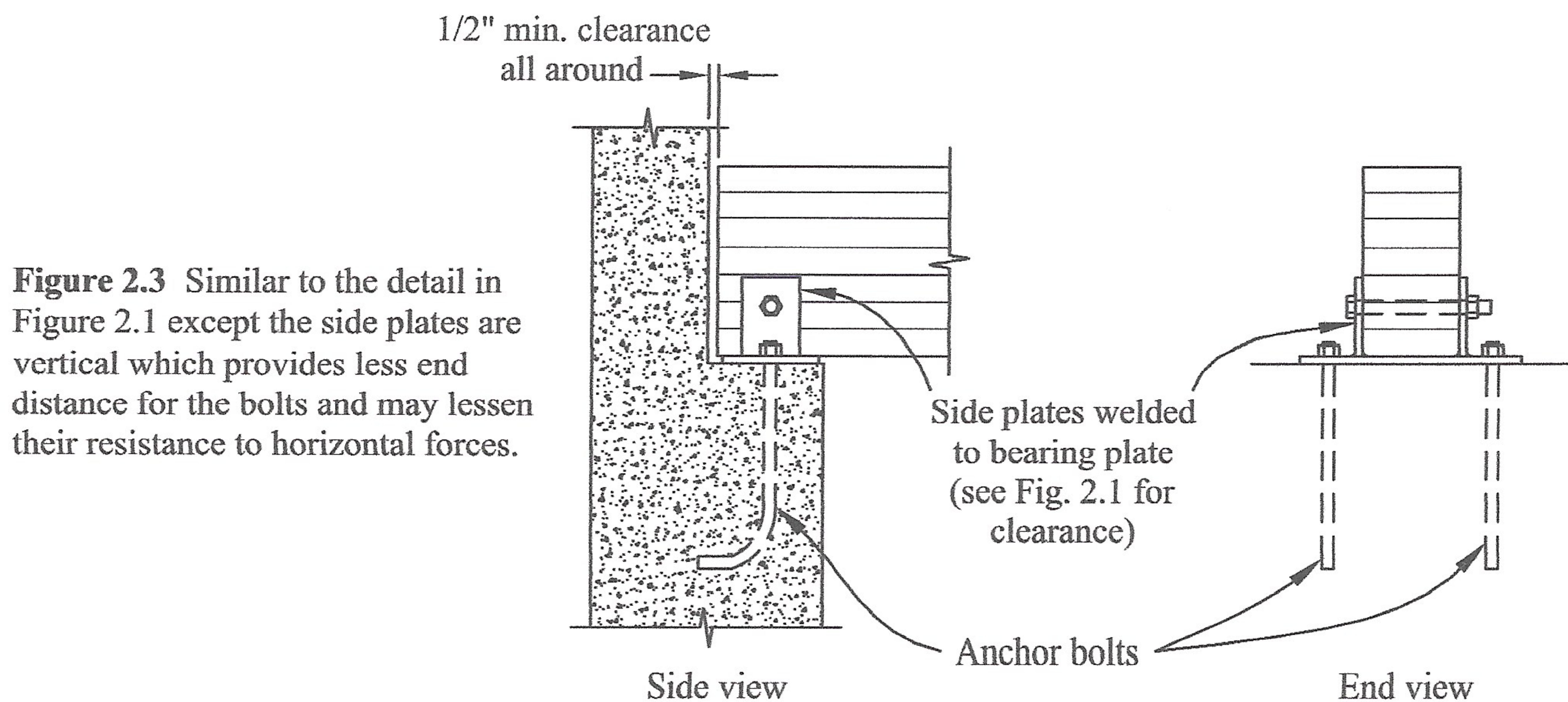


Figure 2.3 Similar to the detail in Figure 2.1 except the side plates are vertical which provides less end distance for the bolts and may lessen their resistance to horizontal forces.

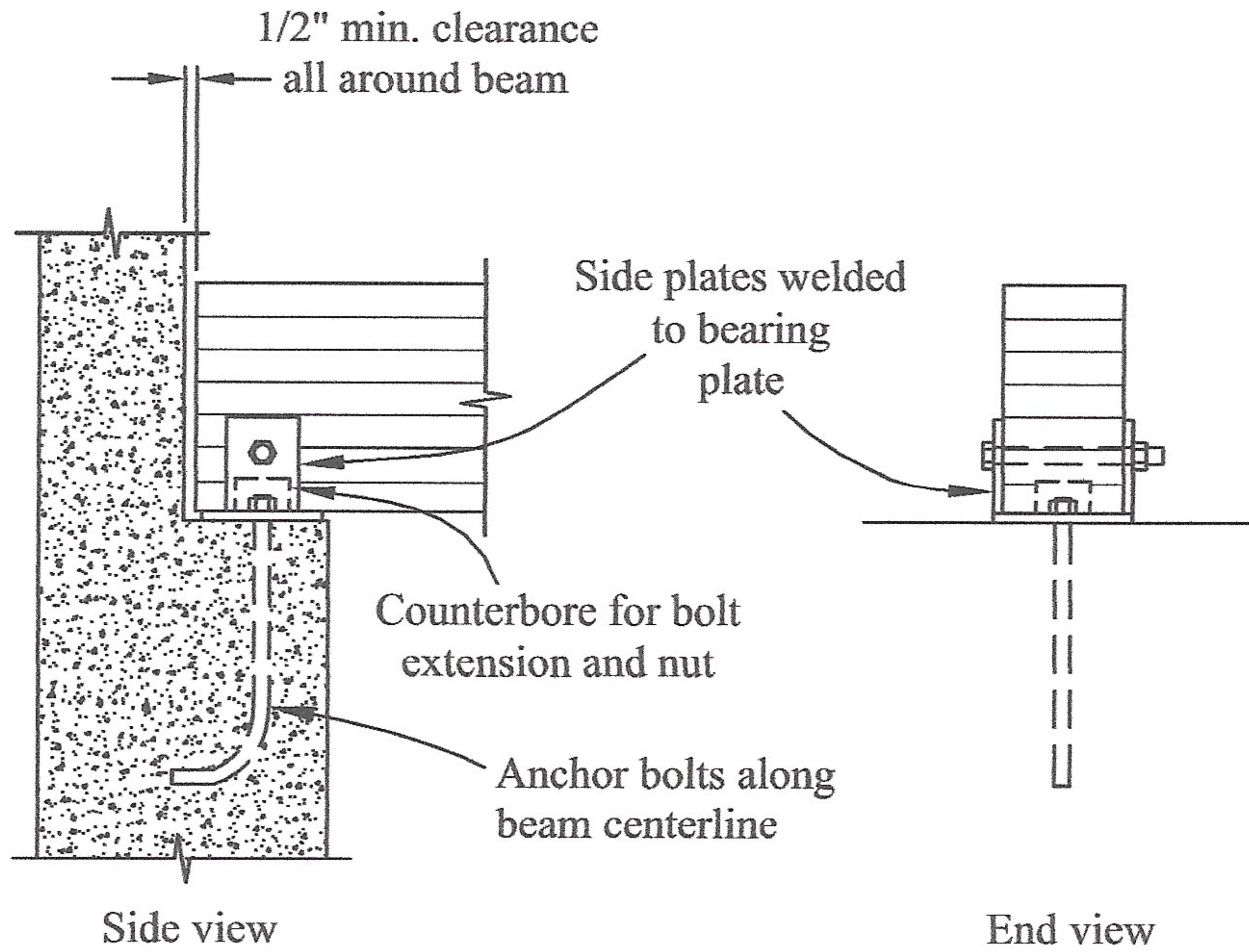


Figure 2.4 This detail may be used when the pilaster is not wide enough for outside anchor bolts. The anchor(s) may be welded to the underside of the bearing plate or the bolts and nuts may be located in holes counterbored into the bottom of the beam. This detail is for use where the width of the connection must be minimized or appearance is important.

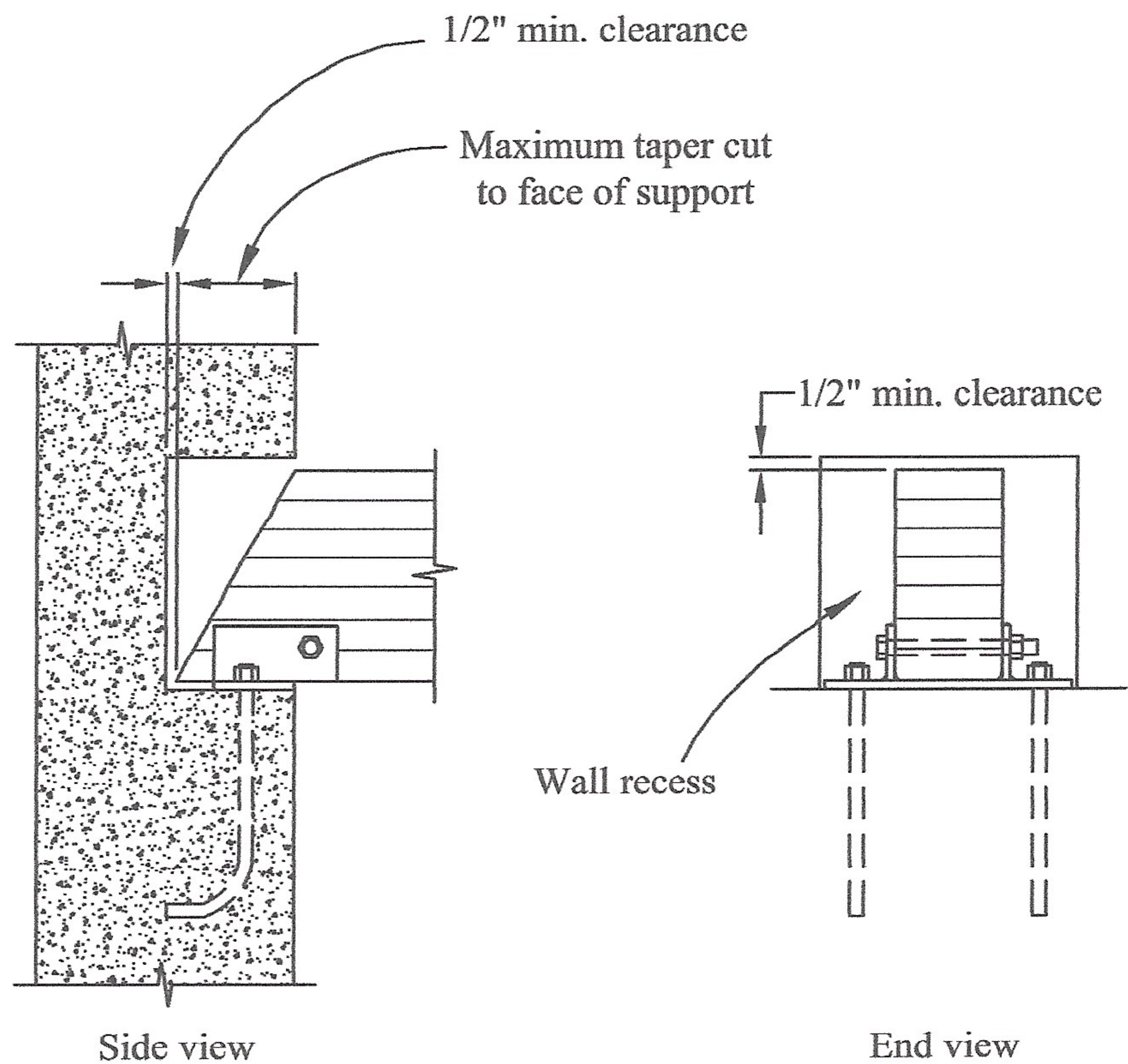


Figure 2.5 This detail illustrates a typical taper end cut sometimes referred to as a fire cut. The end of the beam is tapered so that the top of the beam does not hit the top of the wall recess if the beam deflects excessively during a fire.

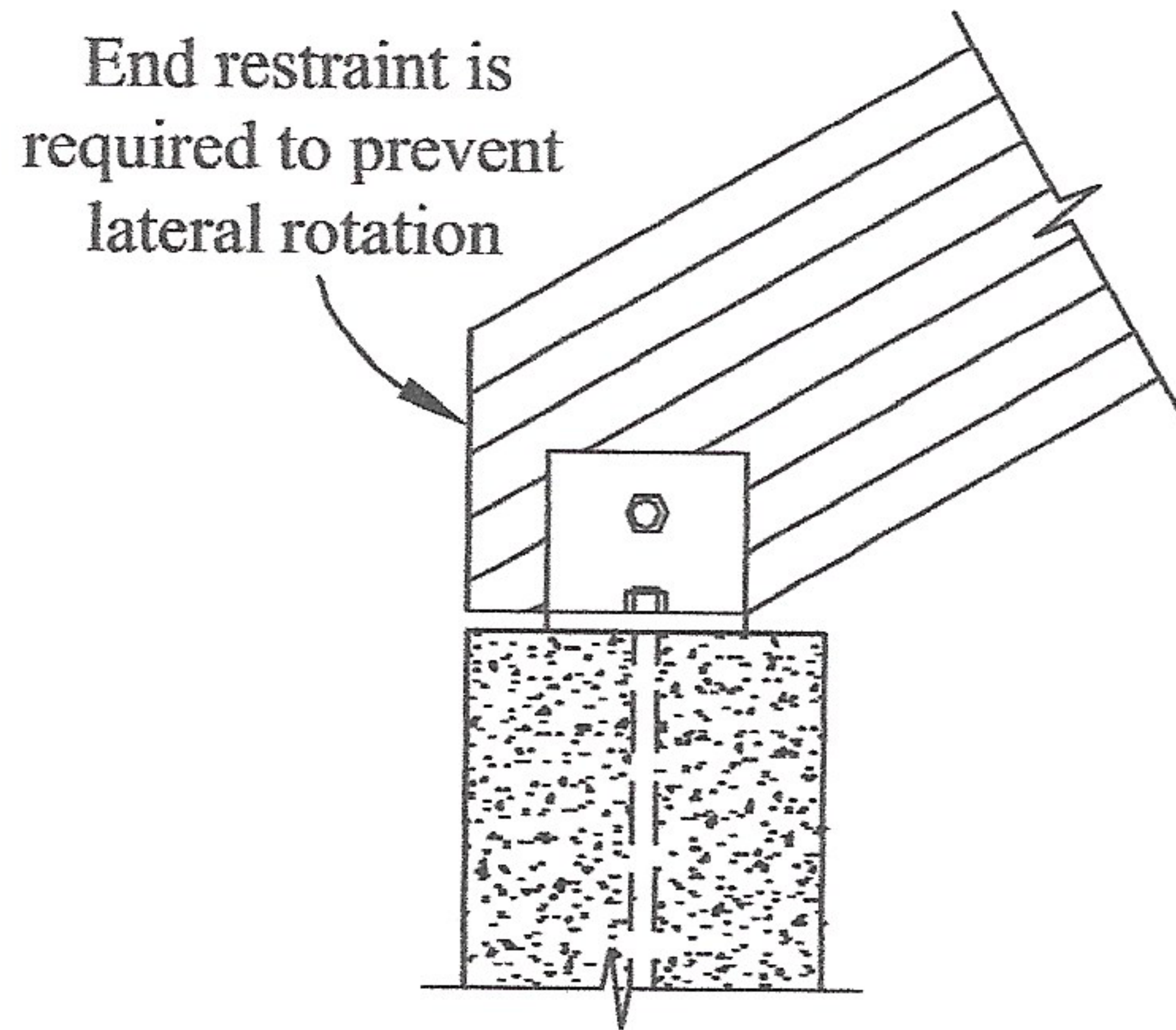


Figure 2.6 Sloped Beam - Lower end. The taper cut beam should be in bearing contact with the bearing plate. See Detail A6.

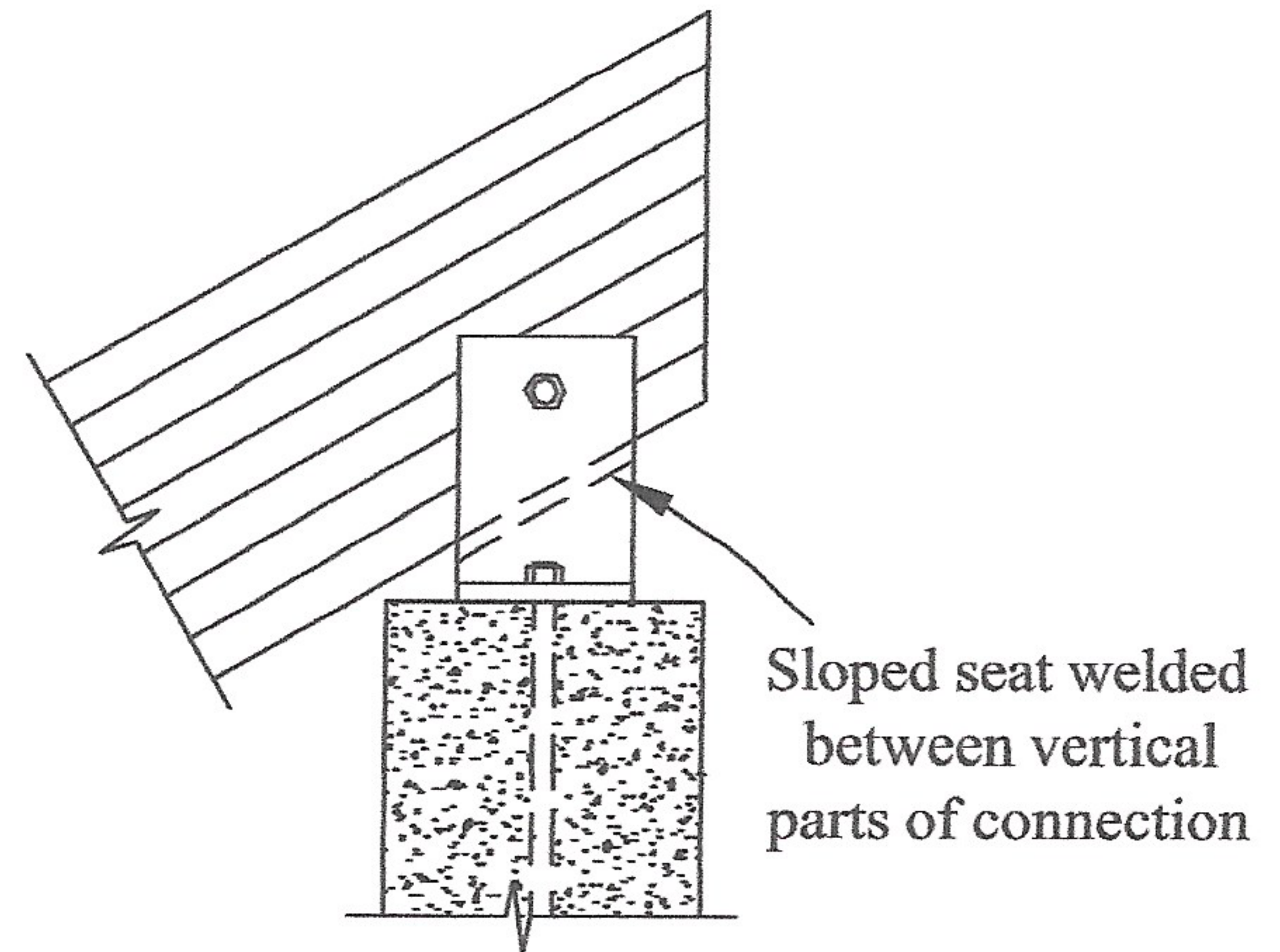


Figure 2.7 Sloped Beam - Upper End. The support at the top end of a sloped member should be designed with a sloping seat rather than a notched end. The bolt must be designed to resist the parallel-to-grain component of the vertical beam reaction. See Detail A7.

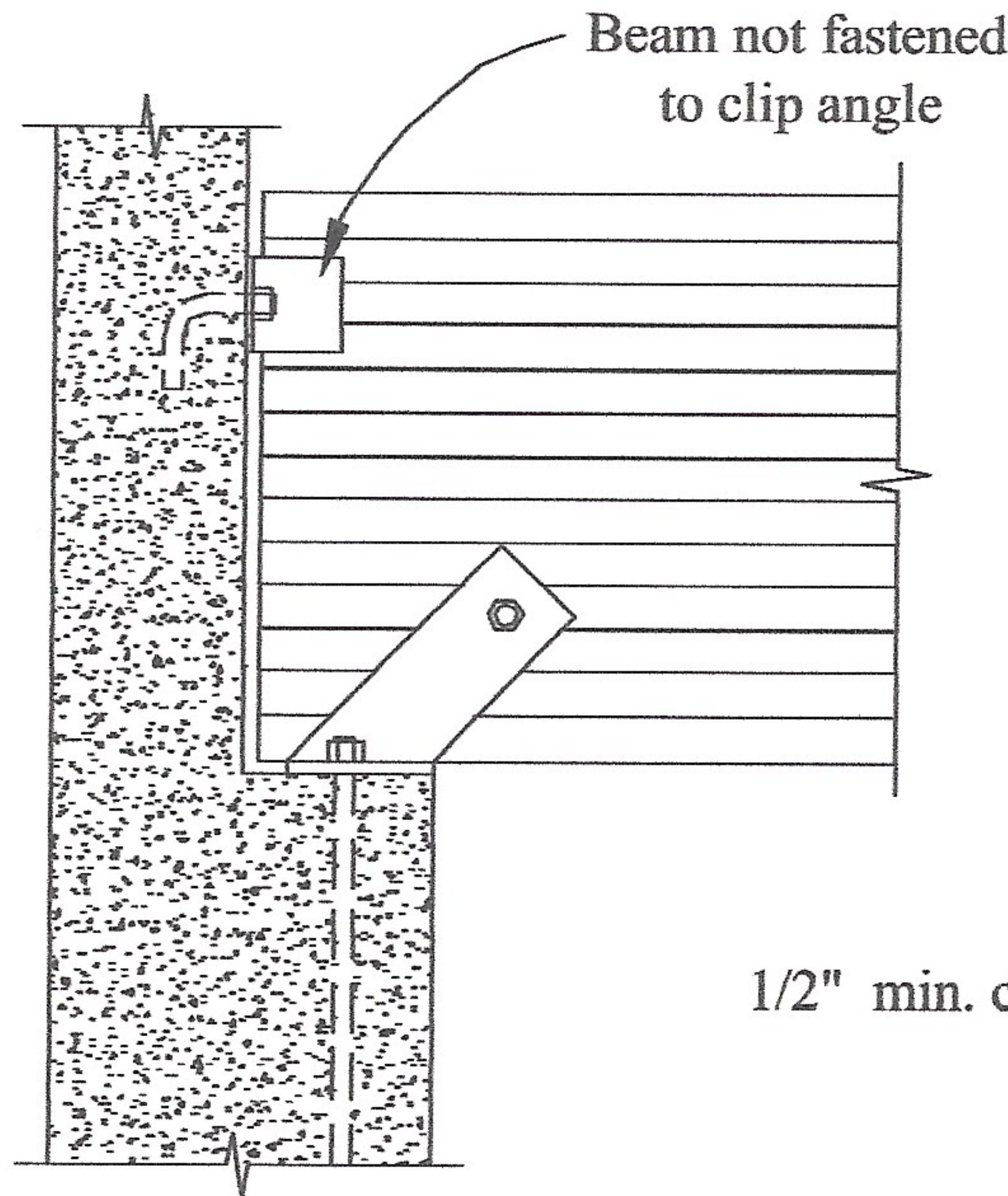
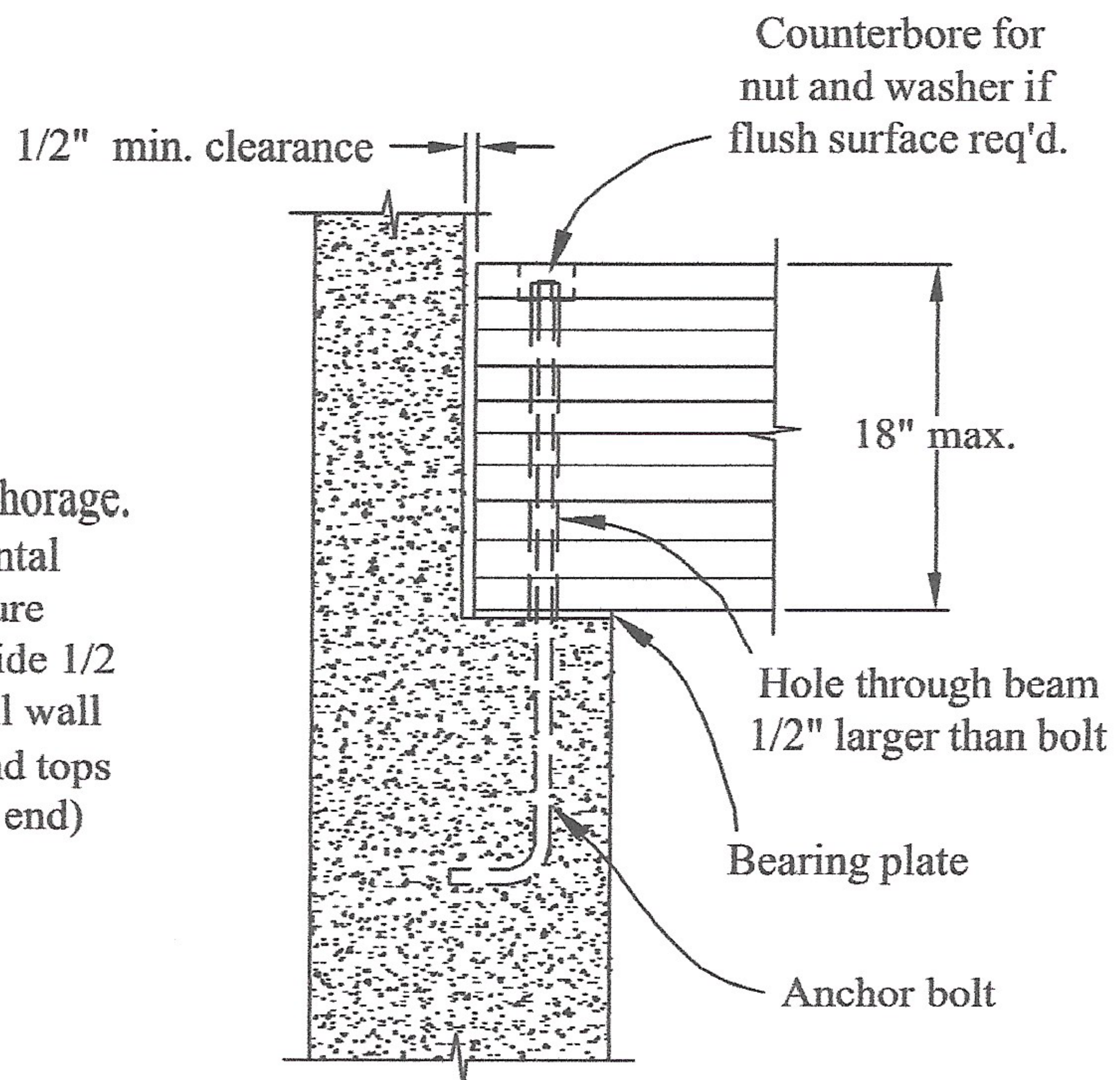


Figure 2.8 Lateral support of the ends of beams can be provided with clip angles anchored to the wall but without a connection to the beam. This will not restrain vertical movement due to end rotation or beam shrinkage. See Detail A8.

Figure 2.9 Simple Beam Anchorage. Resists small uplift and horizontal forces. Bearing plate or moisture barrier is recommended. Provide 1/2 in. minimum clearance from all wall contact surfaces, ends, sides and tops (if masonry exists above beam end)



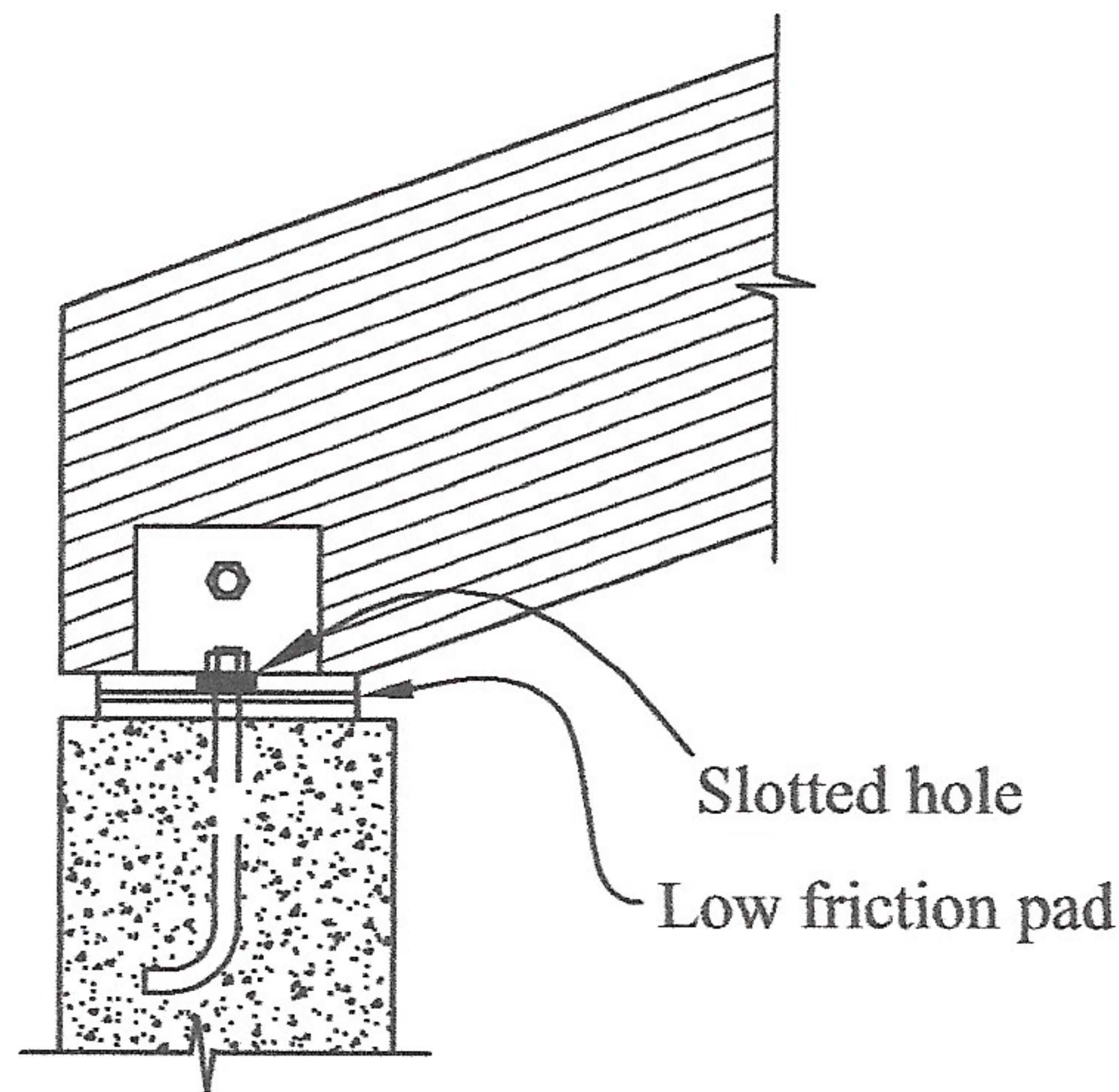


Figure 2.10 Curved or Pitched Beam Anchorage - Typical Slip Joint. Slotted or oversized holes at one or both ends of beam permit horizontal movement under lateral deflection or deformation. Length of slotted or oversized hole is based on calculated maximum horizontal deflection. Position bolt in slot to allow for anticipated movement. Bolts in slotted holes should be hand tightened only, so that movement is permitted. See Detail A6.

Wind or seismic loading may not permit use of this connection.

3. CANTILEVER BEAM CONNECTIONS

Figure 3.1 Cantilever Hinge Connection. See Detail A9.

This is a common type cantilever beam connector. The details that follow are examples using this connector.

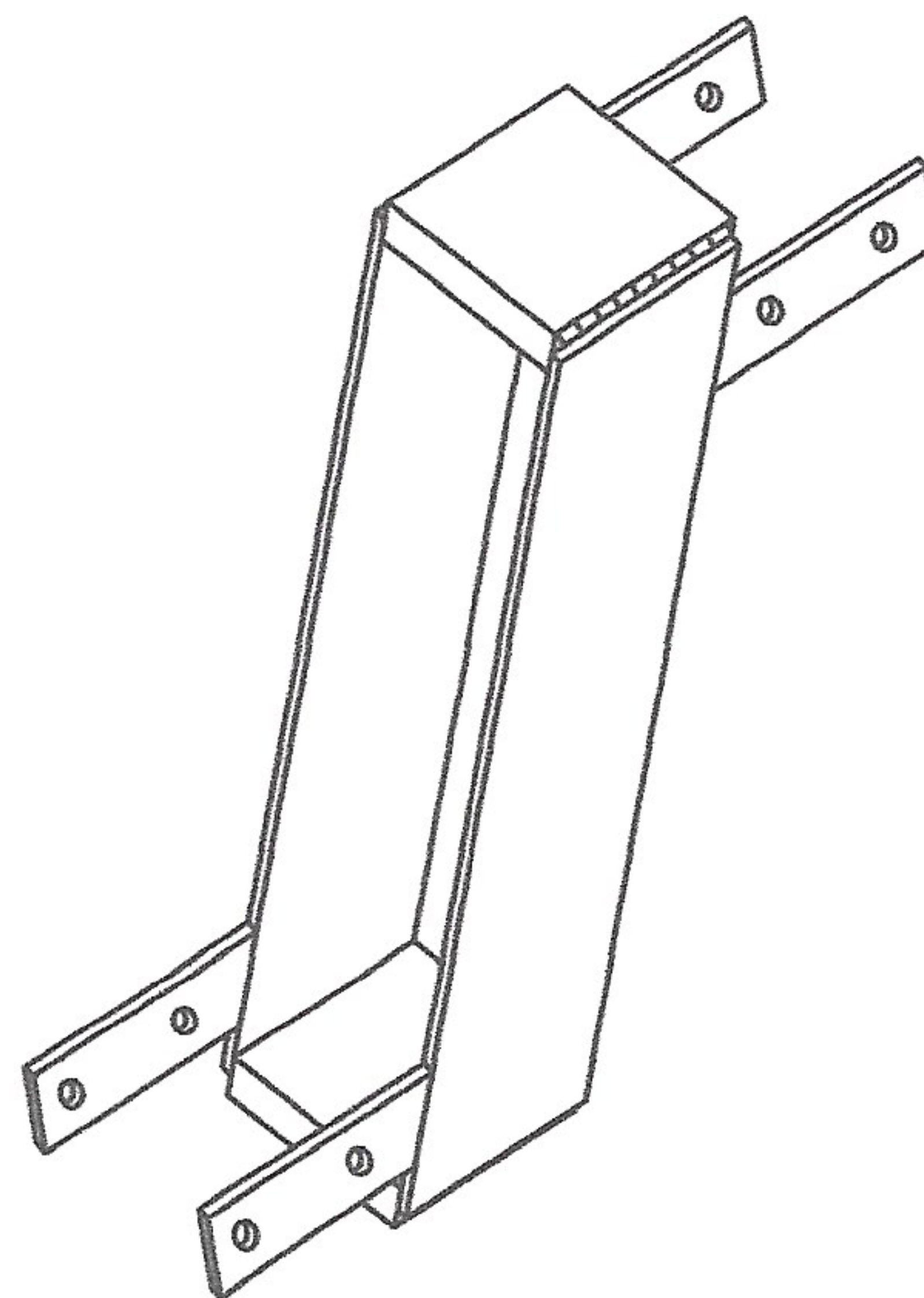
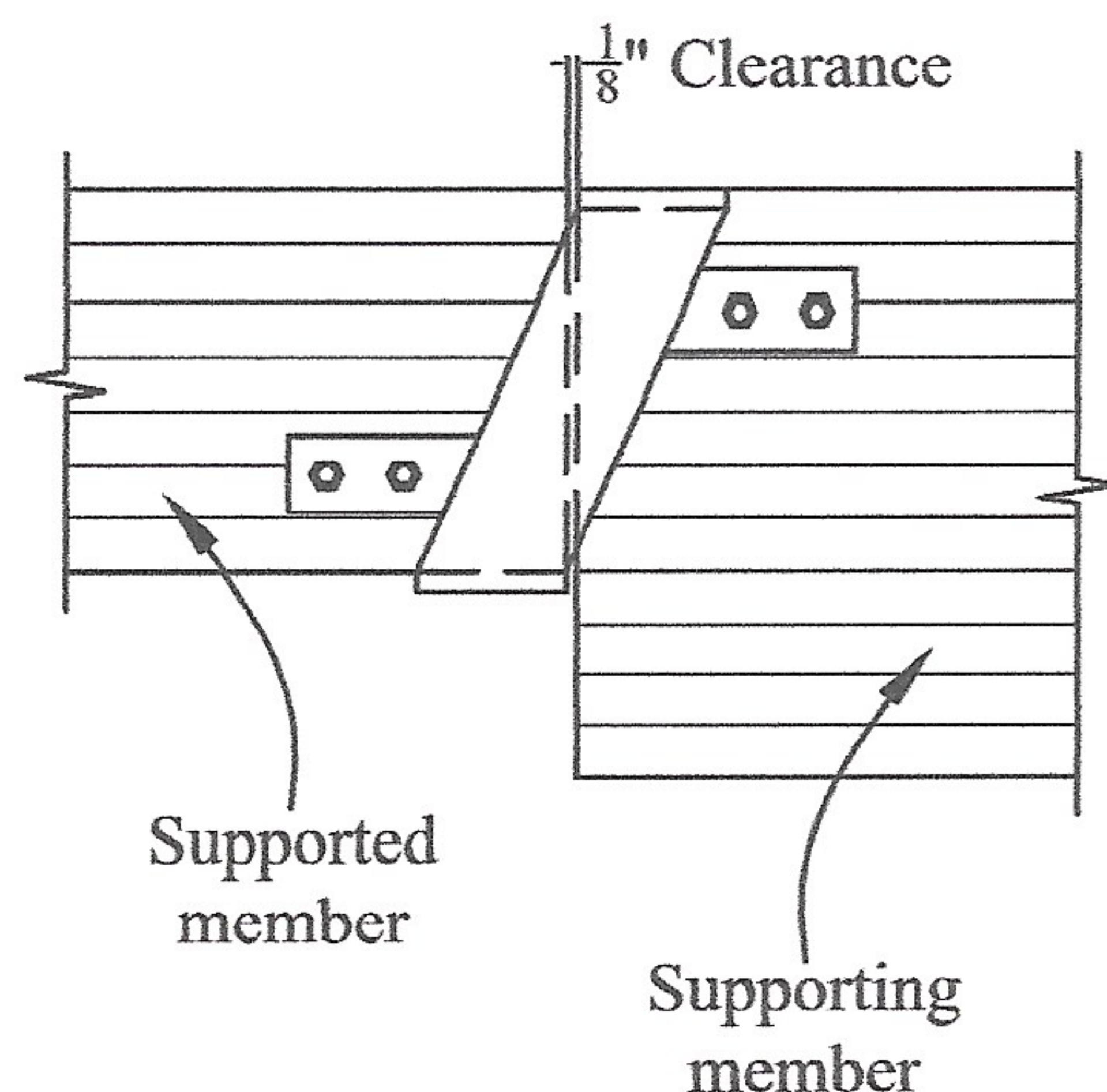


Figure 3.2 The vertical reaction of the supported member is carried by the side plates and transferred in bearing perpendicular grain to the supporting member. The rotation due to the eccentric loading is resisted by the bolts through the tabs at the top and bottom. The connector may be installed with the top (and bottom) bearing plates dapped into the members to obtain a flush surface or may be installed without daps. Notching on the tension side should be minimized.



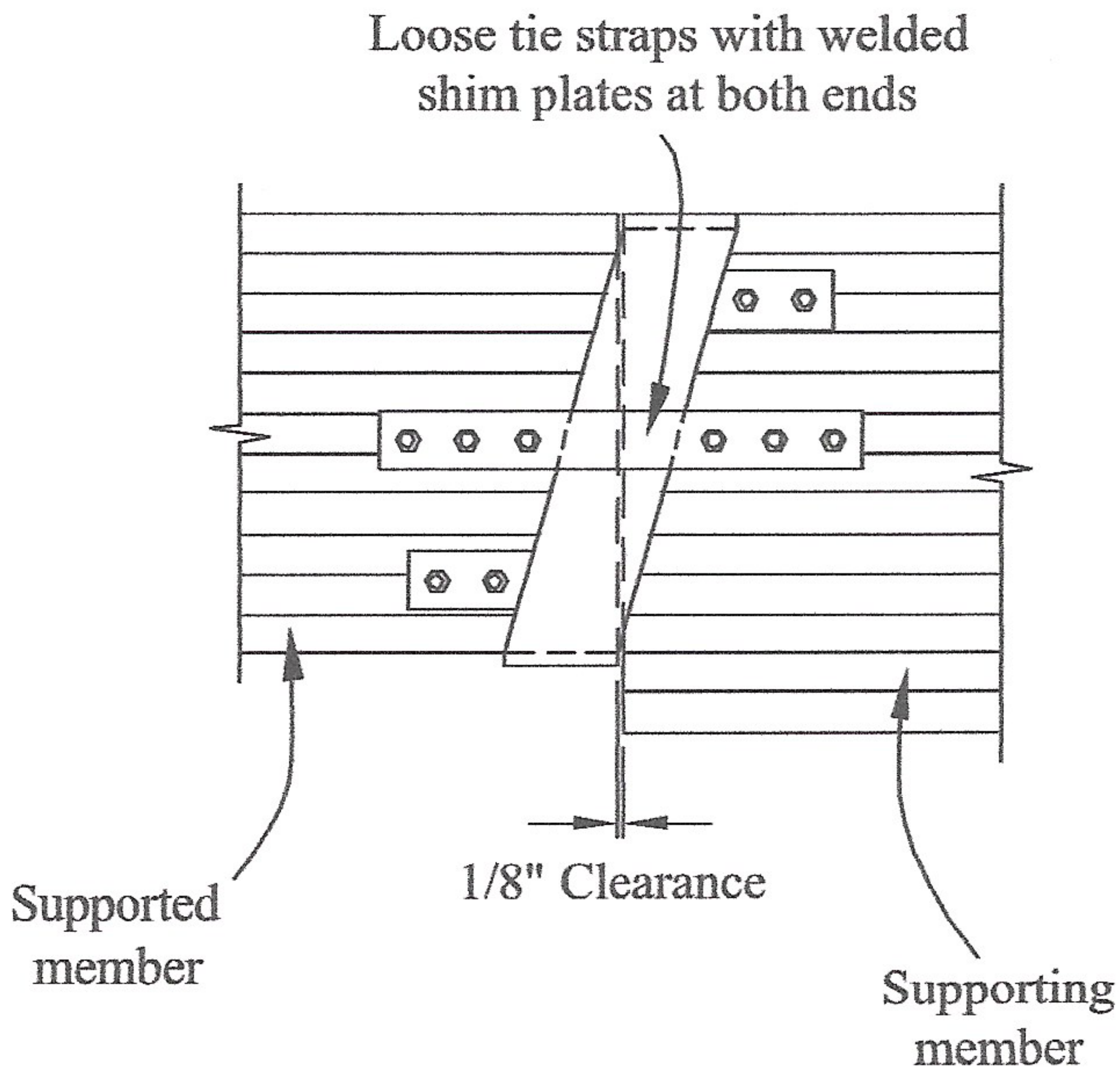
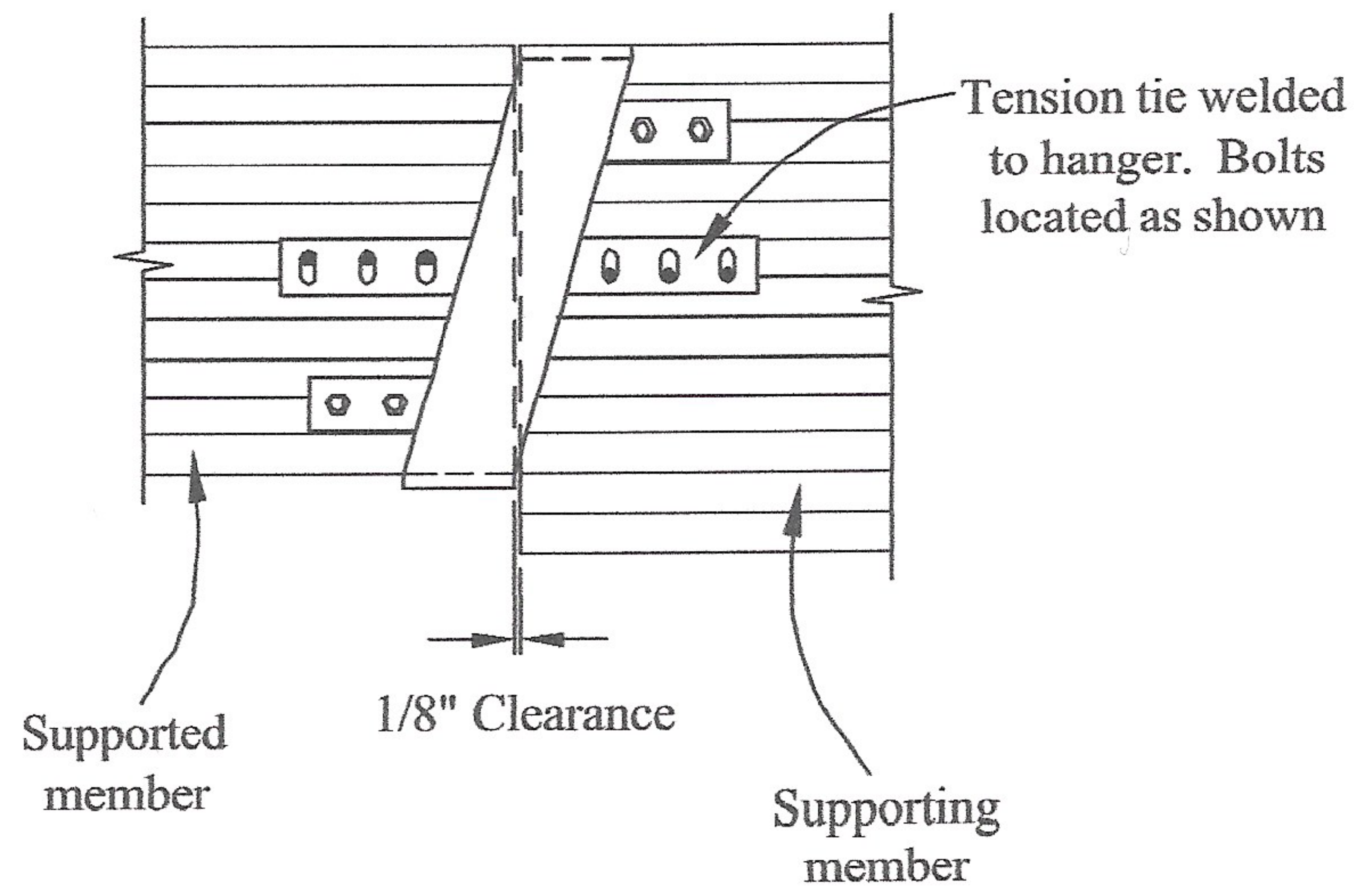


Figure 3.3 Where horizontal forces must be resisted by a hinge connection, loose tension ties may be installed on both sides of the beam. The tie shown is not fastened to the cantilever hanger.

Figure 3.4 If tension ties are fastened to the cantilever hanger, vertically slotted holes are required in the tie and careful location of the bolts in the end of the slot farthest from the bearing seat is required to prevent splitting due to shrinkage and seating deformations. Bolts in slotted holes should be hand tightened only, so that movement is permitted.



4. **BEAM AND PURLIN HANGERS FOR ROOF SYSTEMS.** In Figure 4.1 and similar details, locate fasteners as close as practical to the bearing surface to minimize splitting due to shrinkage (See Section 1.4). For floor systems, additional restrictions may be necessary to minimize the effects of differential shrinkage of connected members. See Detail A1.

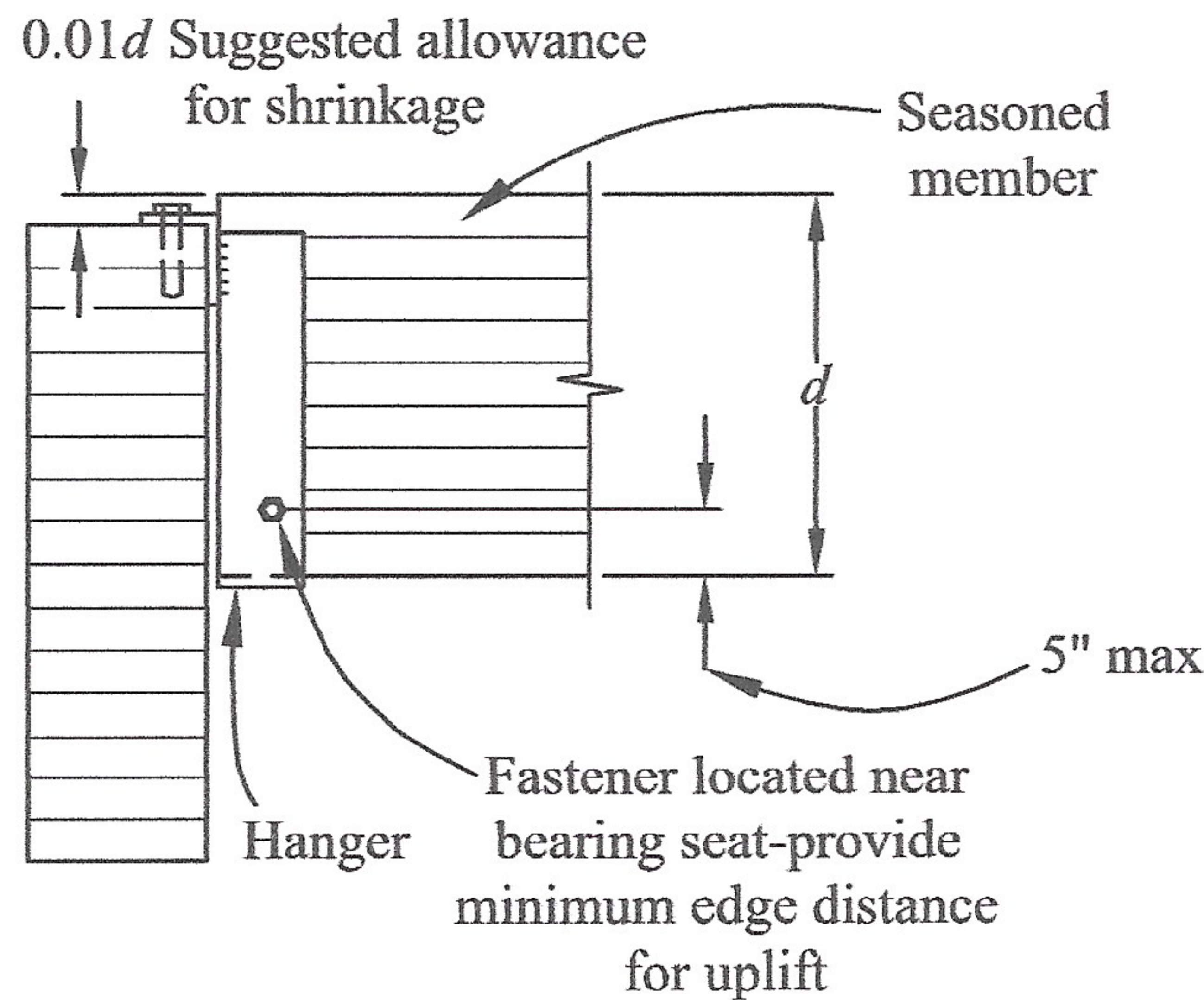
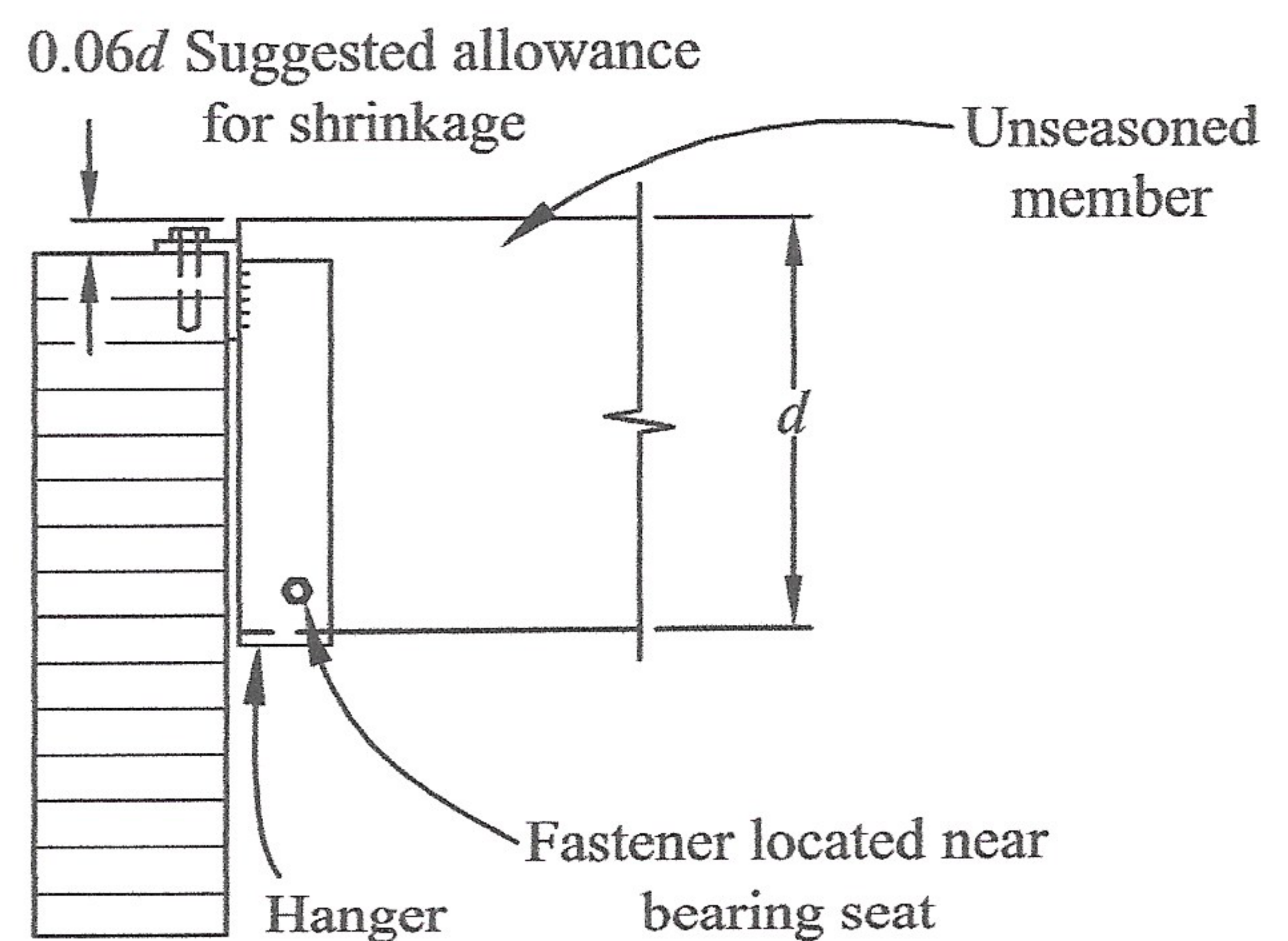


Figure 4.1 Seasoned Members. When supported members are of seasoned material, the top of the supported member may be set approximately flush with the top of the supporting member.

Figure 4.2 Unseasoned Members. When supported members are of unseasoned material, the hangers should be so dimensioned that the top edge of the supported member is raised above the top of the supporting member or the top of the hanger strap to allow for shrinkage as the members season in place. For supported members with moisture content at or above fiber saturation point when installed, the distance raised should be about 6% of the member's depth above its bearing point.



Note: For main members loaded on one side as in Figures 4.1, 4.2, and 4.3 provide a tie between the beam and purlin to restrain potential rotation of the beam due to eccentricity of the hanger load.

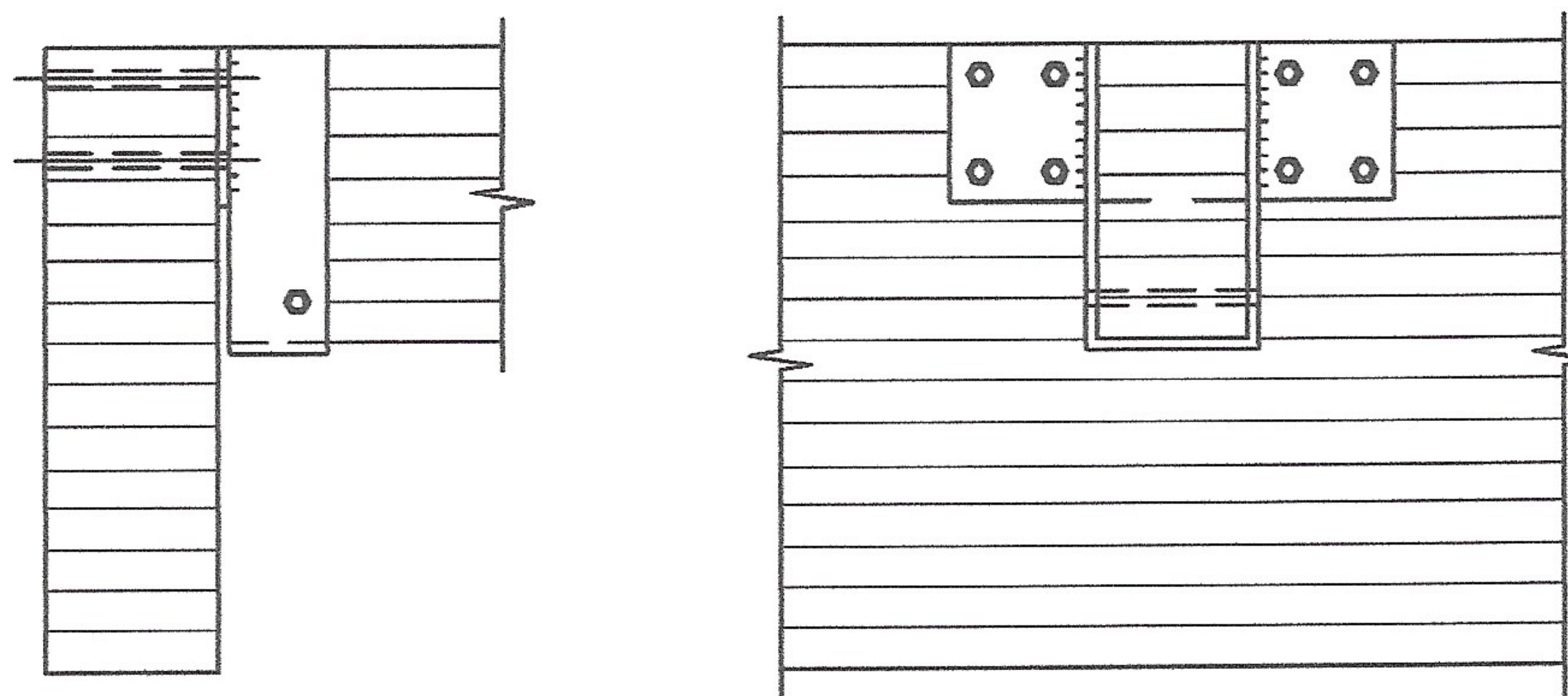


Figure 4.3 Welded Face Hanger. See Detail A2.

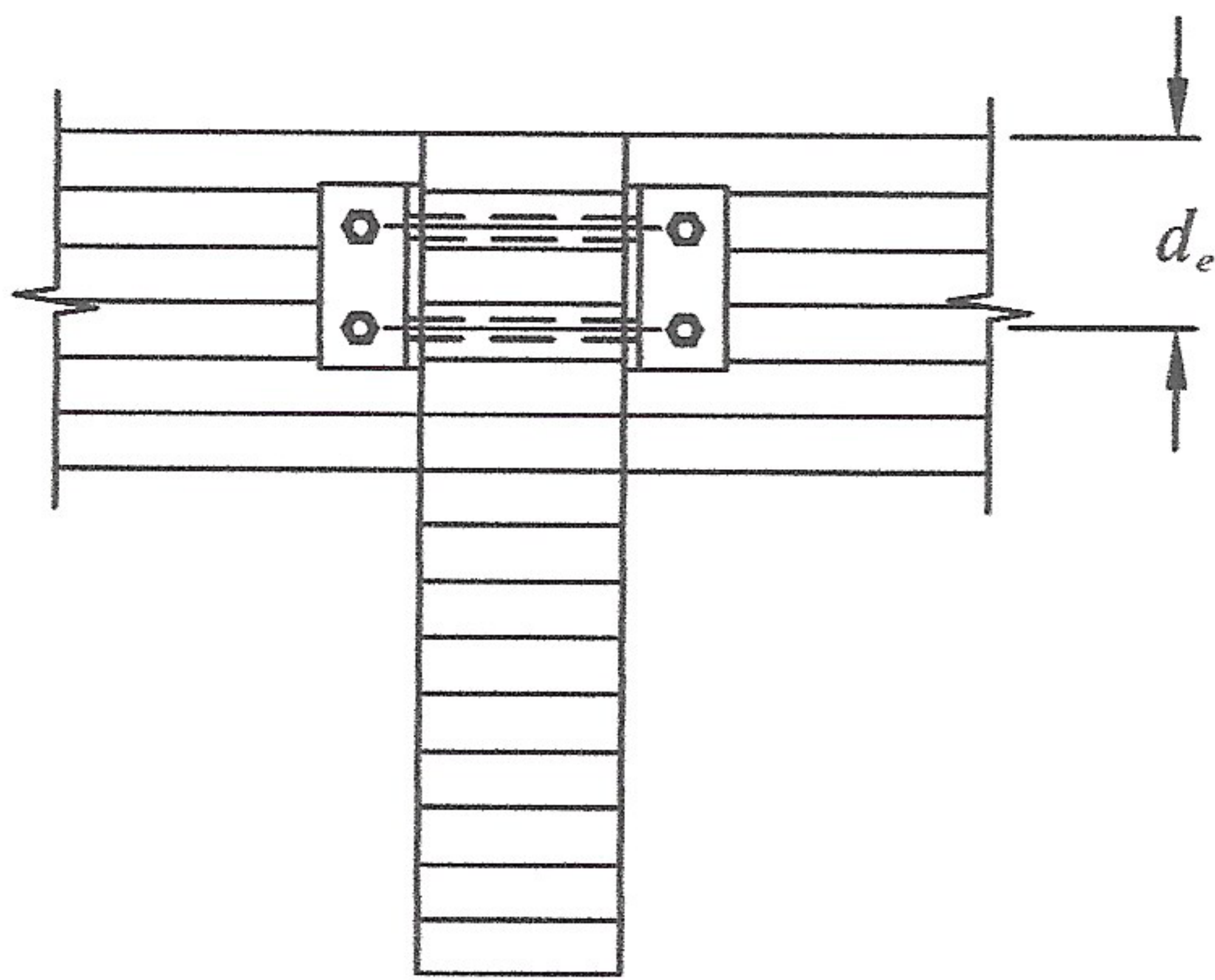


Figure 4.4 A clip angle connection without a bearing seat may be used for small beams and light loads. The connection should be designed for gravity loads as a notched beam using d_e as shown in the notched beam formula. The distance between bolts should be checked for possible effects of shrinkage. A bearing connection as shown in Figure 4.1 is preferred to the support of the beam by bolts. See Detail A3.

Figure 4.5 Welded and Bent Strap Hanger. A separate tension tie may be used across the top in lieu of the tabs to resist lateral forces.

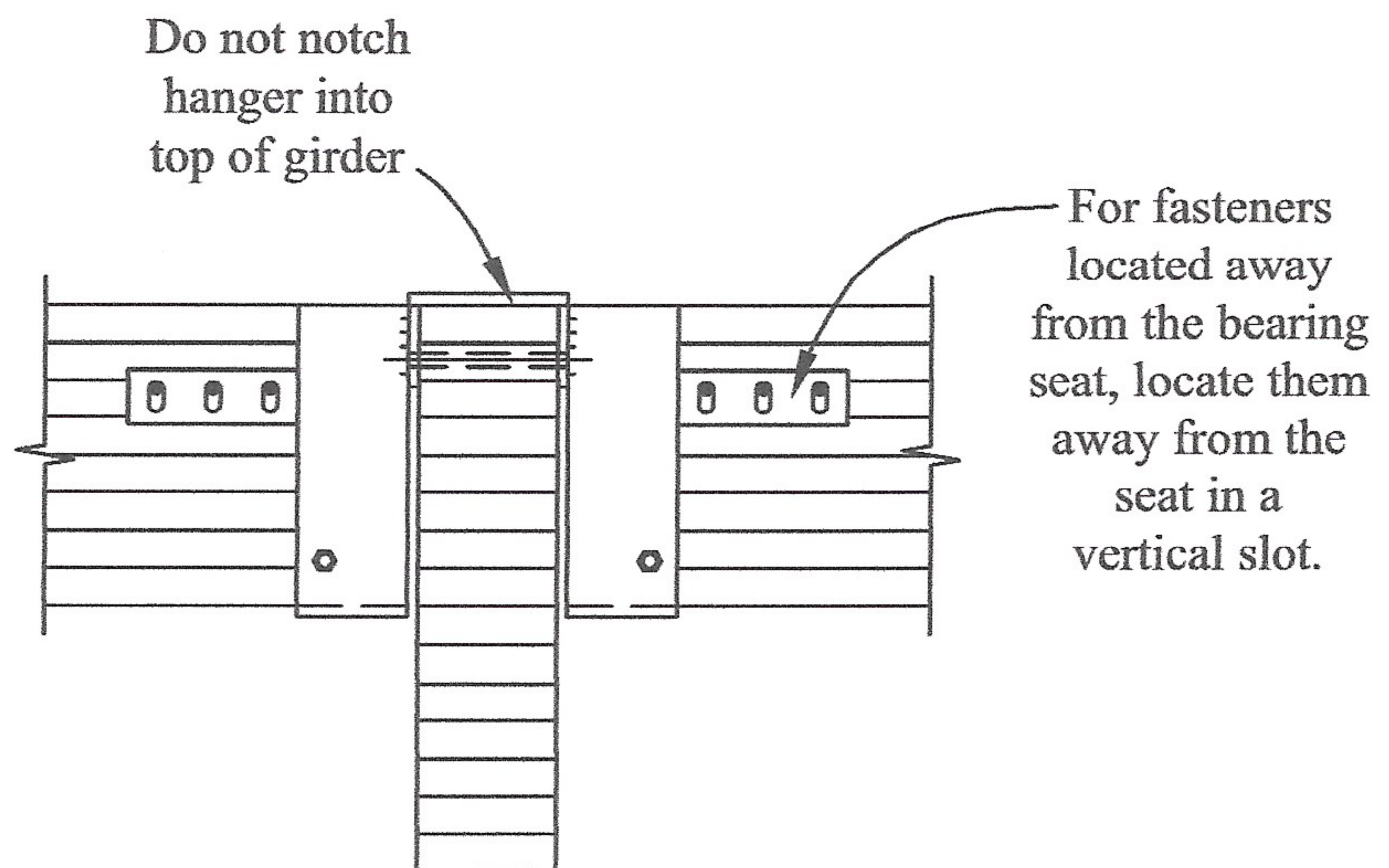


Figure 4.6 Partially Concealed Type. For moderate loads, base may be let in flush with bottoms of purlins. See Detail A4.

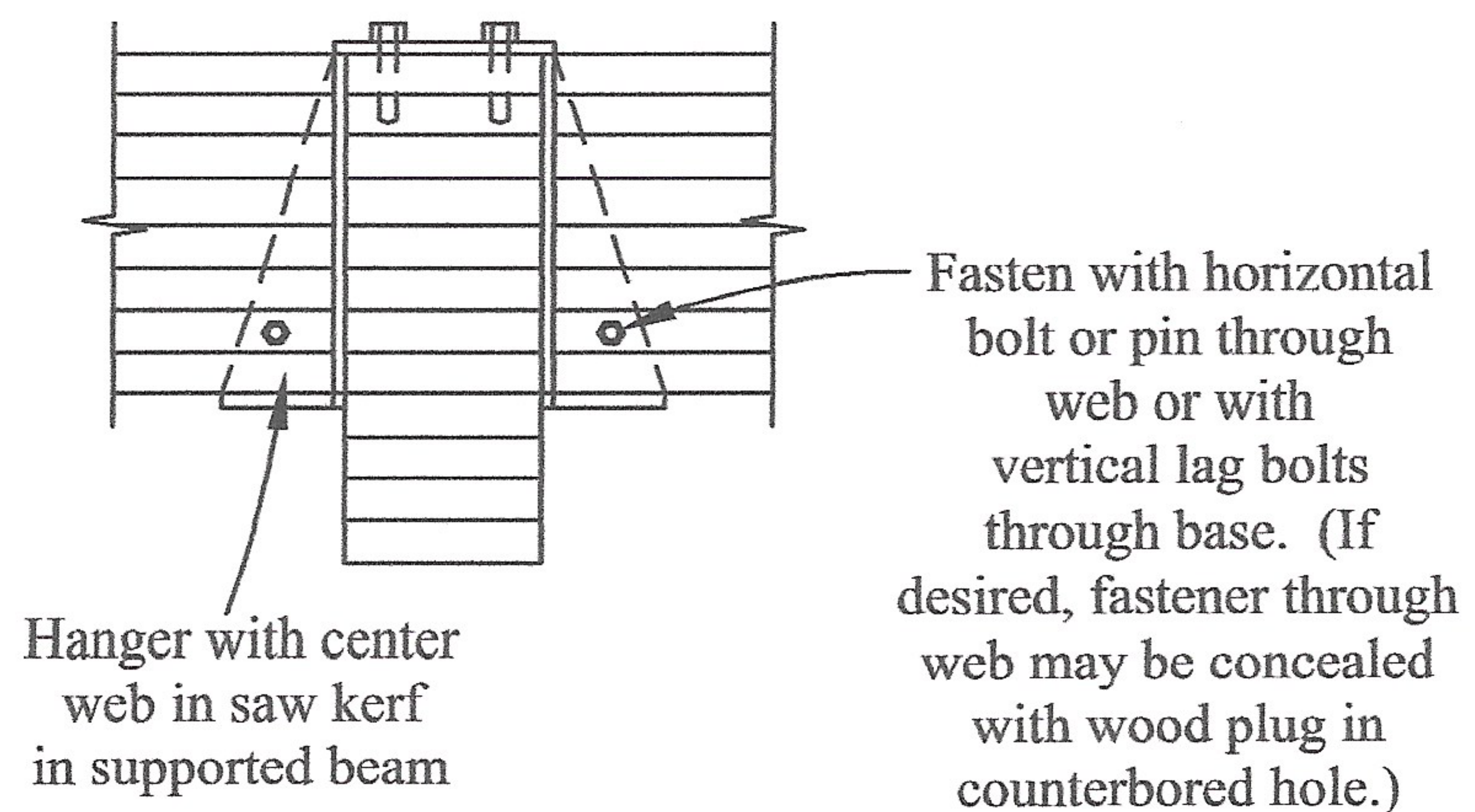
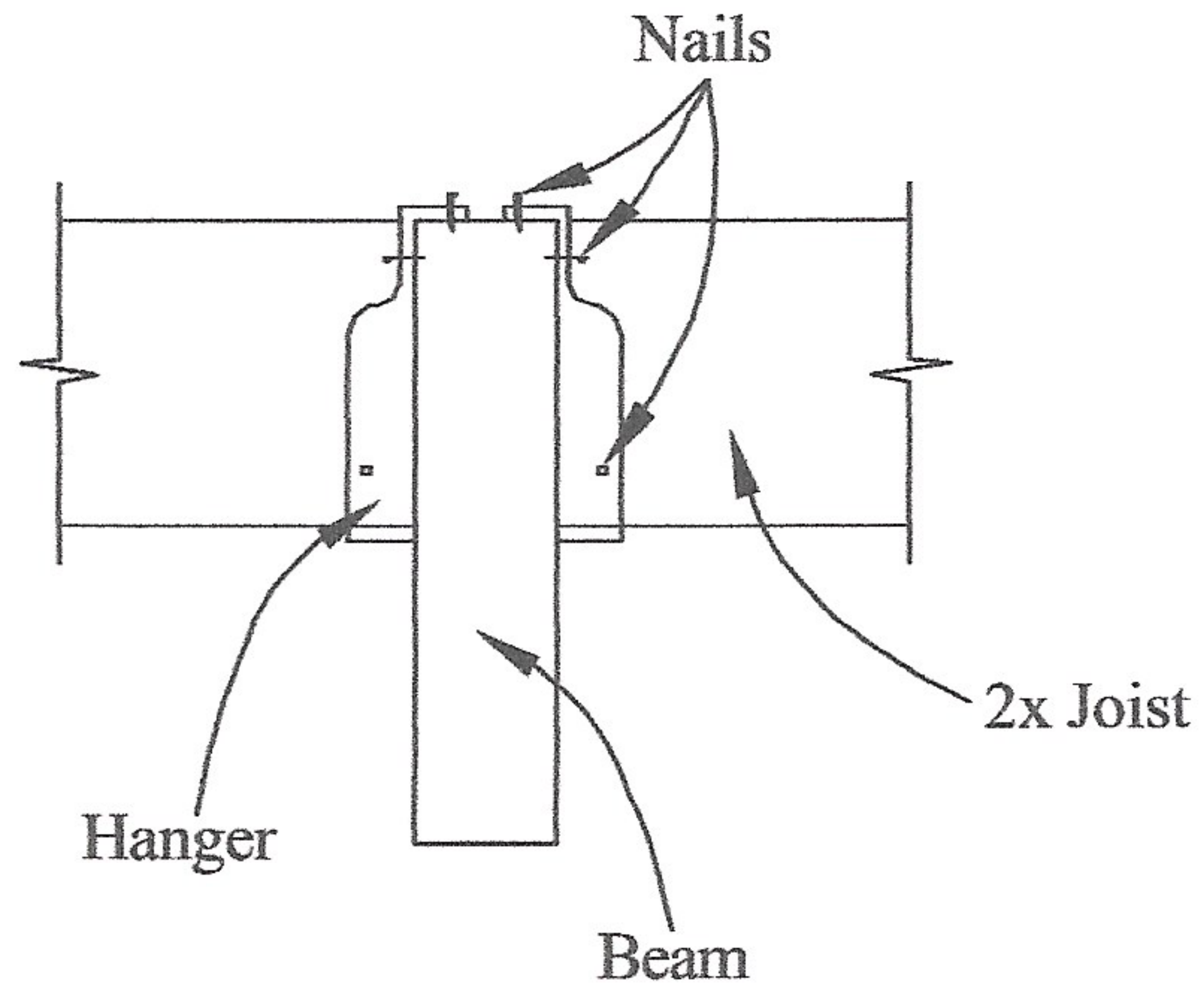


Figure 4.7 Stamped Joist Hanger for Light Loads. Stamped from light-gage metal.



5. BEAM TO COLUMN CONNECTIONS

Figure 5.1 Beams to Wood Column U-Plate. Welded steel assembly passes under abutting wood beams and is welded to steel side plate bolted to wood column.

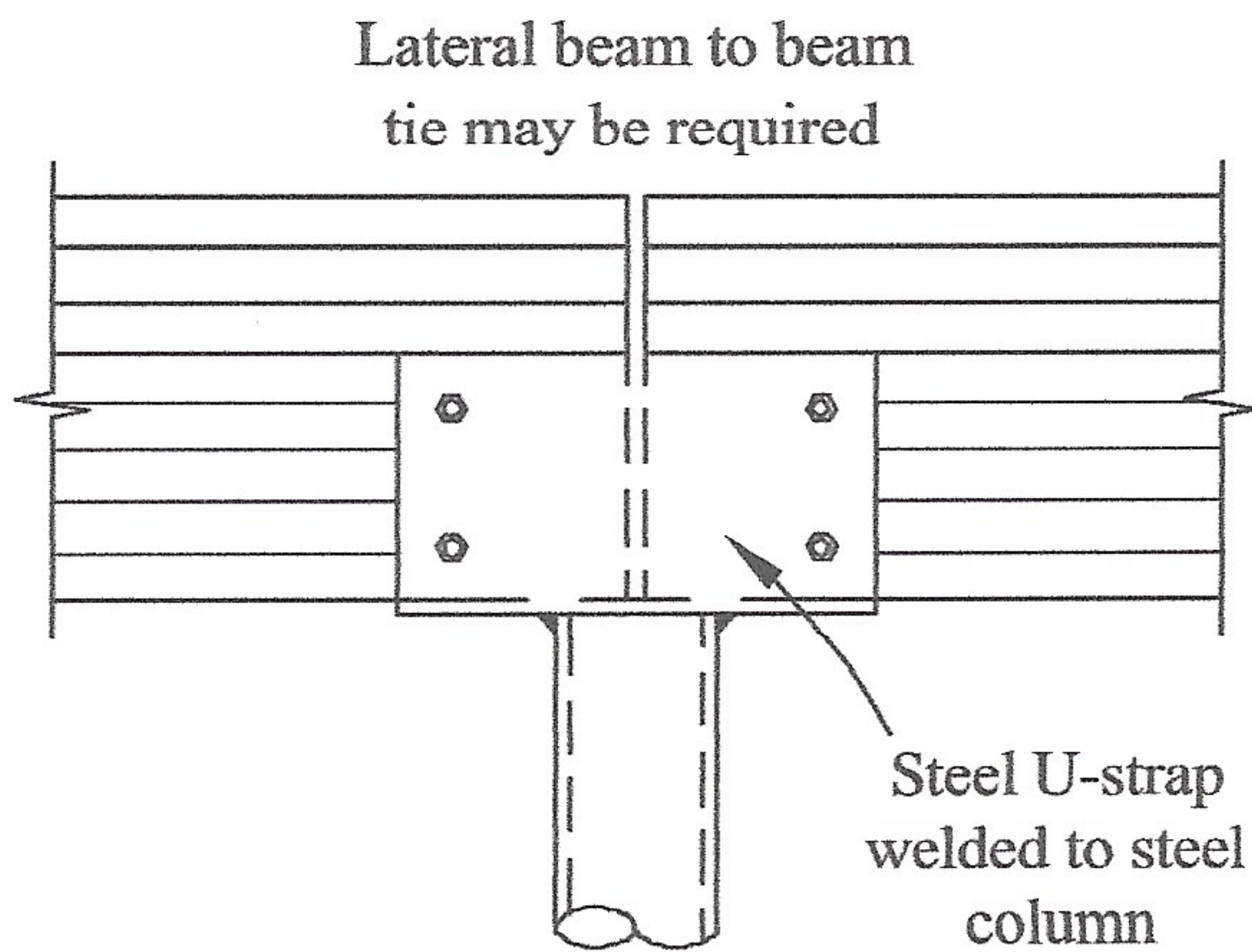
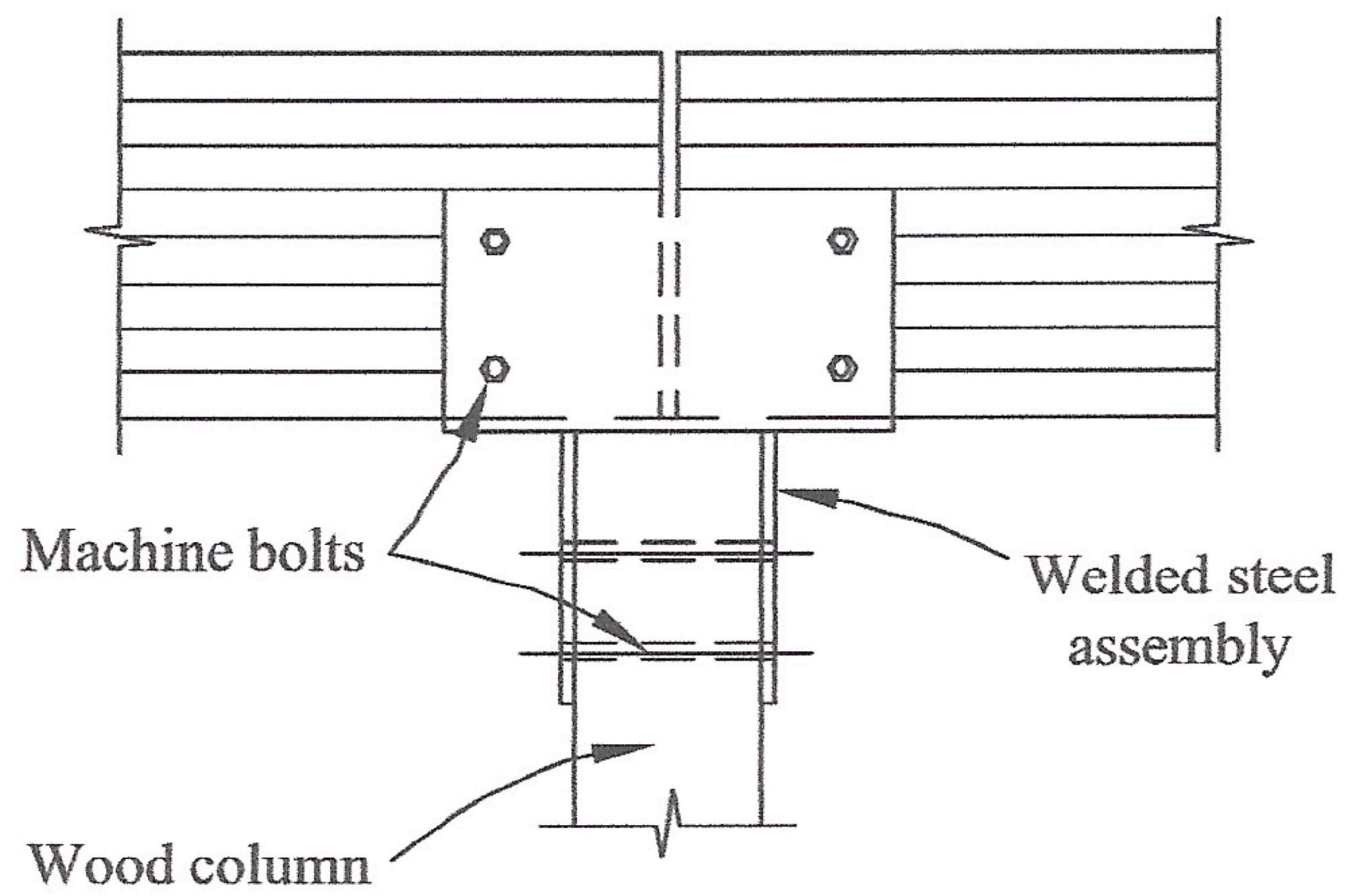


Figure 5.2 Beams to Steel Column. Similar to Figure 5.1.

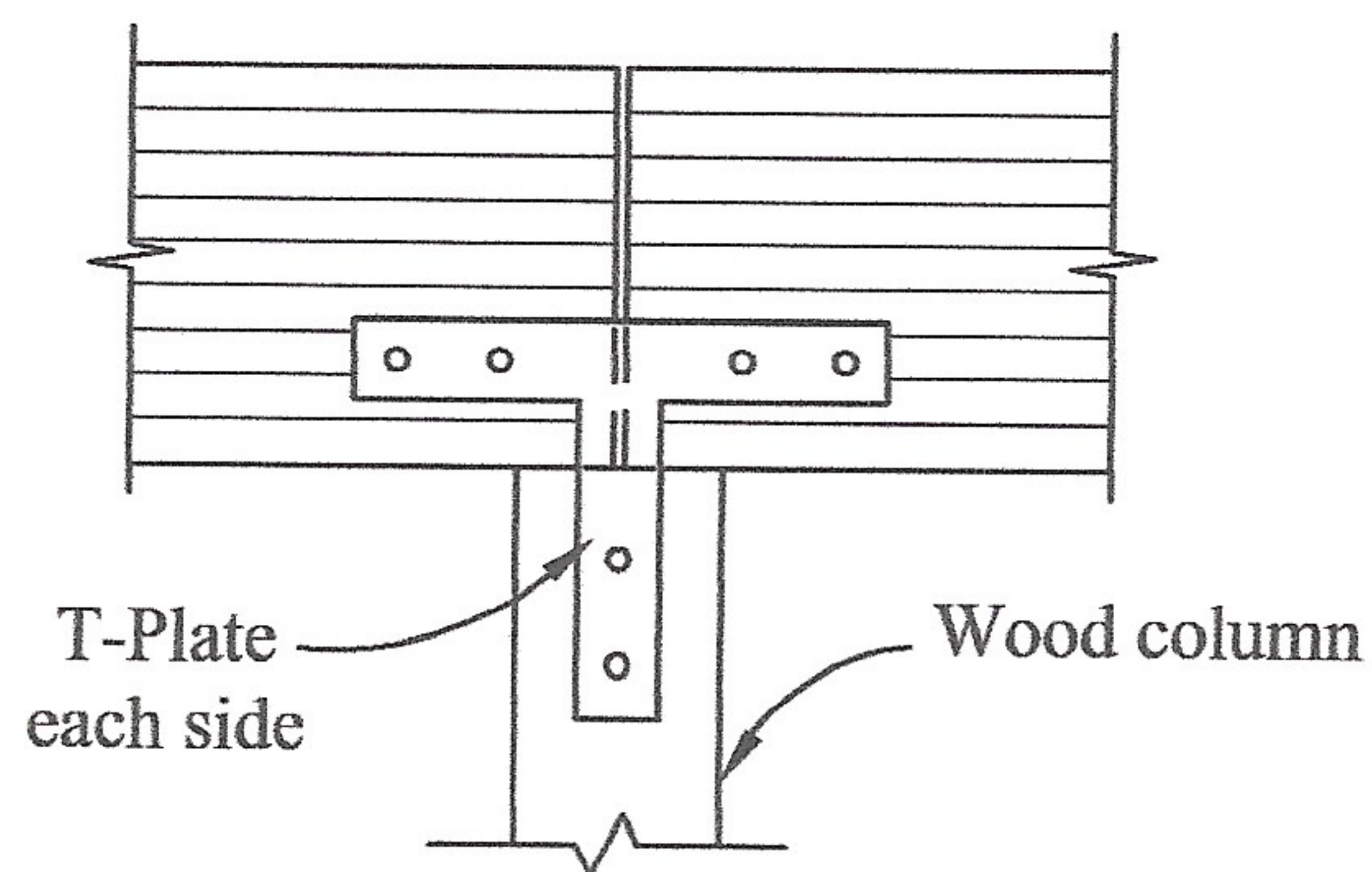


Figure 5.3 Beam to Wood Column T-Plates. Steel T-plate is bolted to abutting wood beams and to wood column. Loose bearing plate may be used where column cross sectional area is insufficient to provide bearing for beams in compression perpendicular to grain. Beams should be checked for notch shear with net uplift design.

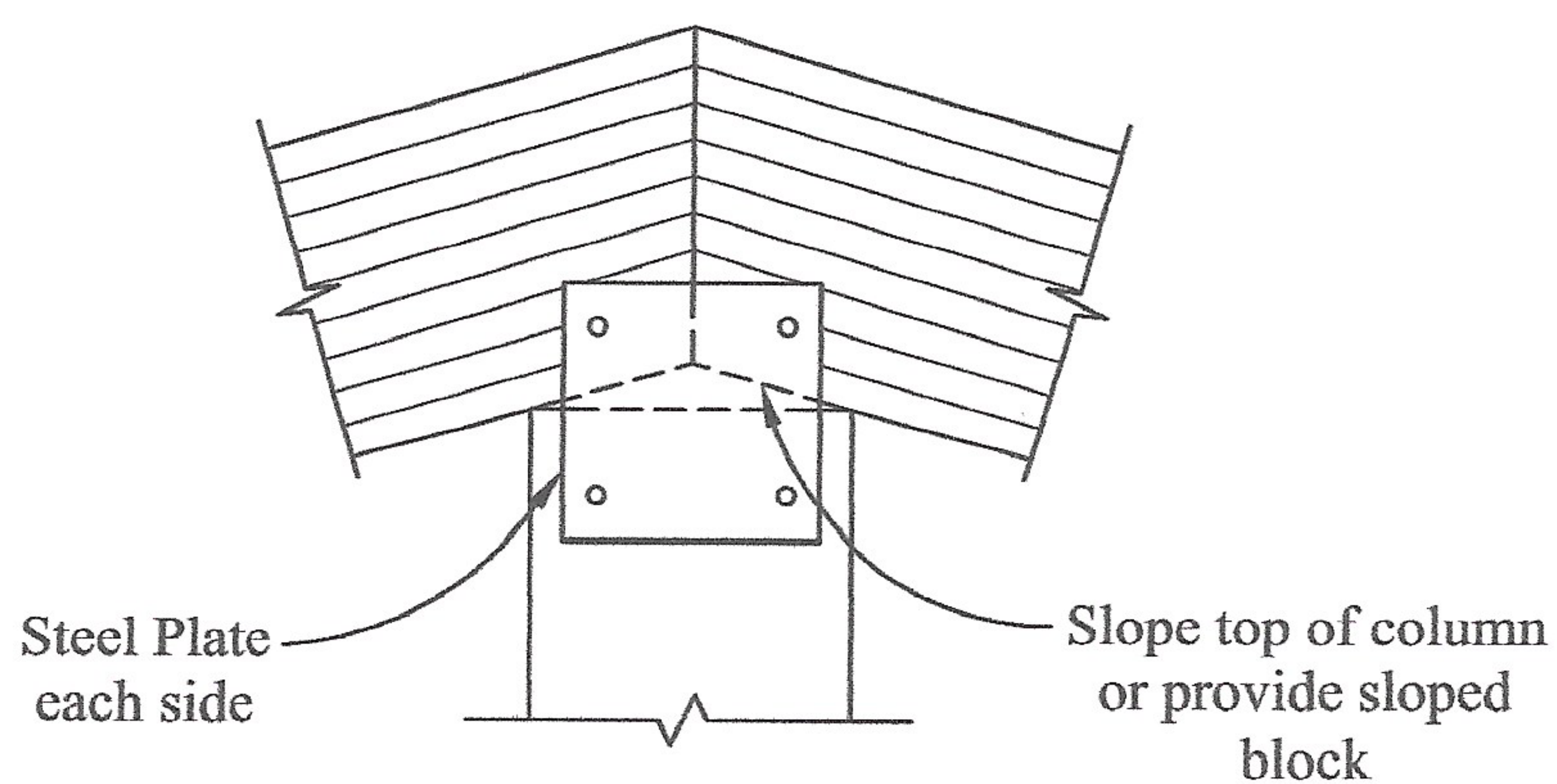
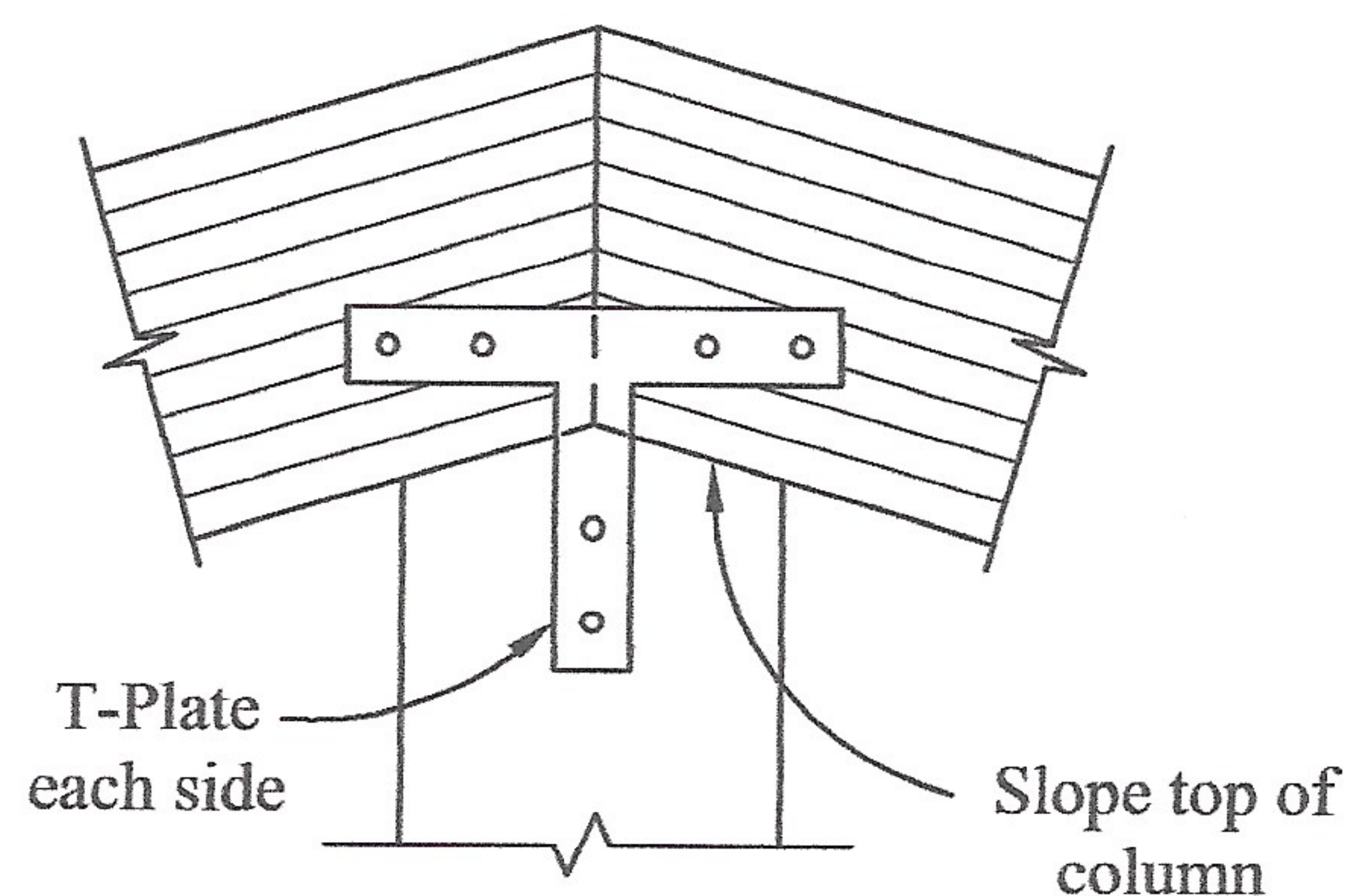


Figure 5.4 Shed Roof Type End Detail. Beams may be notched at bottom to rest on column, but notched beam shear must be checked. Beams may be pitched away from both sides or from only one side of column. See also Beam-to-Masonry Anchorages, Figure 2.7.

Figure 5.5 Beam to Wood Column. Metal bearing plate may be used where column cross-sectional area is insufficient to provide bearing for beam in compression perpendicular to grain. If connection is to be used for net uplift, beam must be checked for notched shear design.

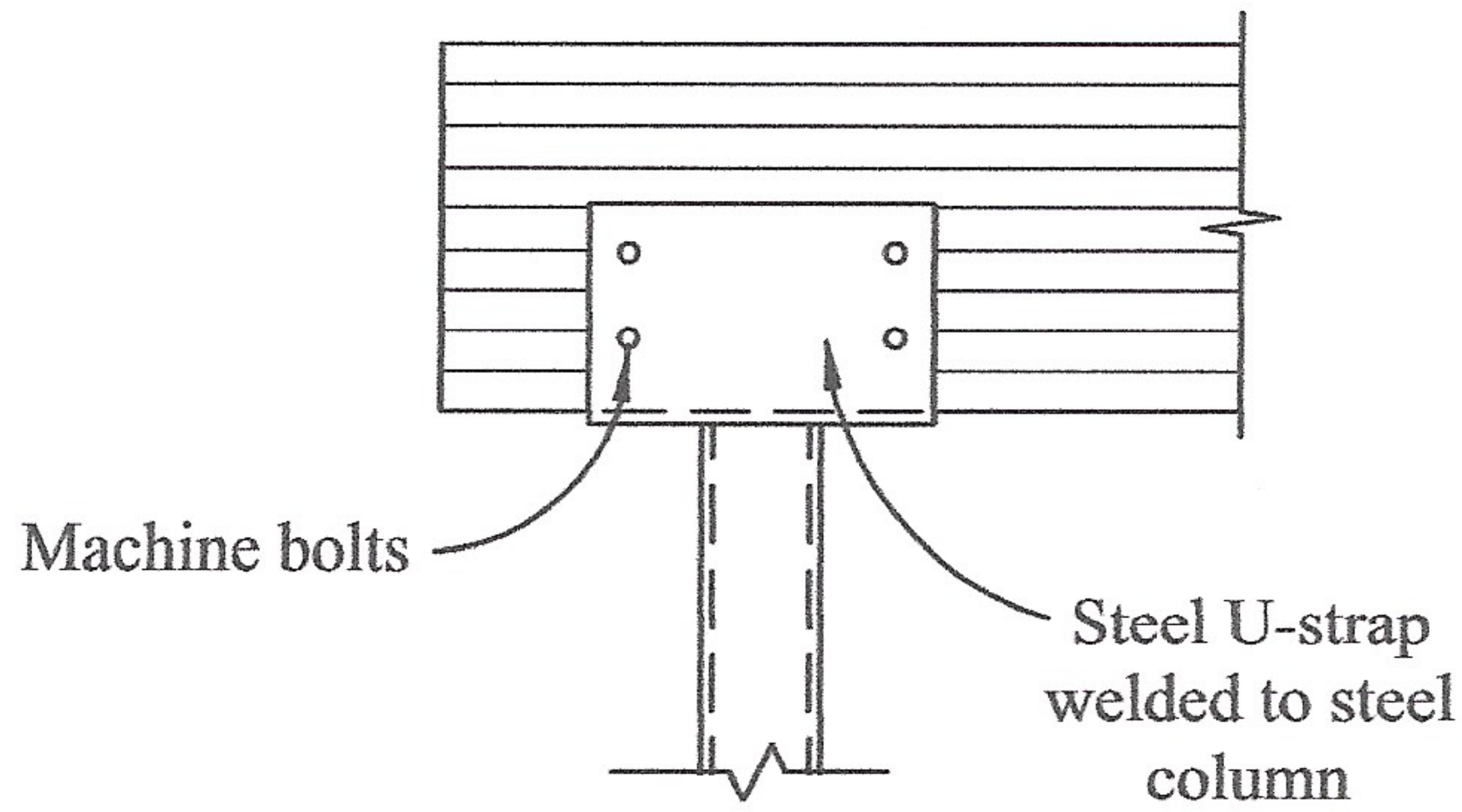
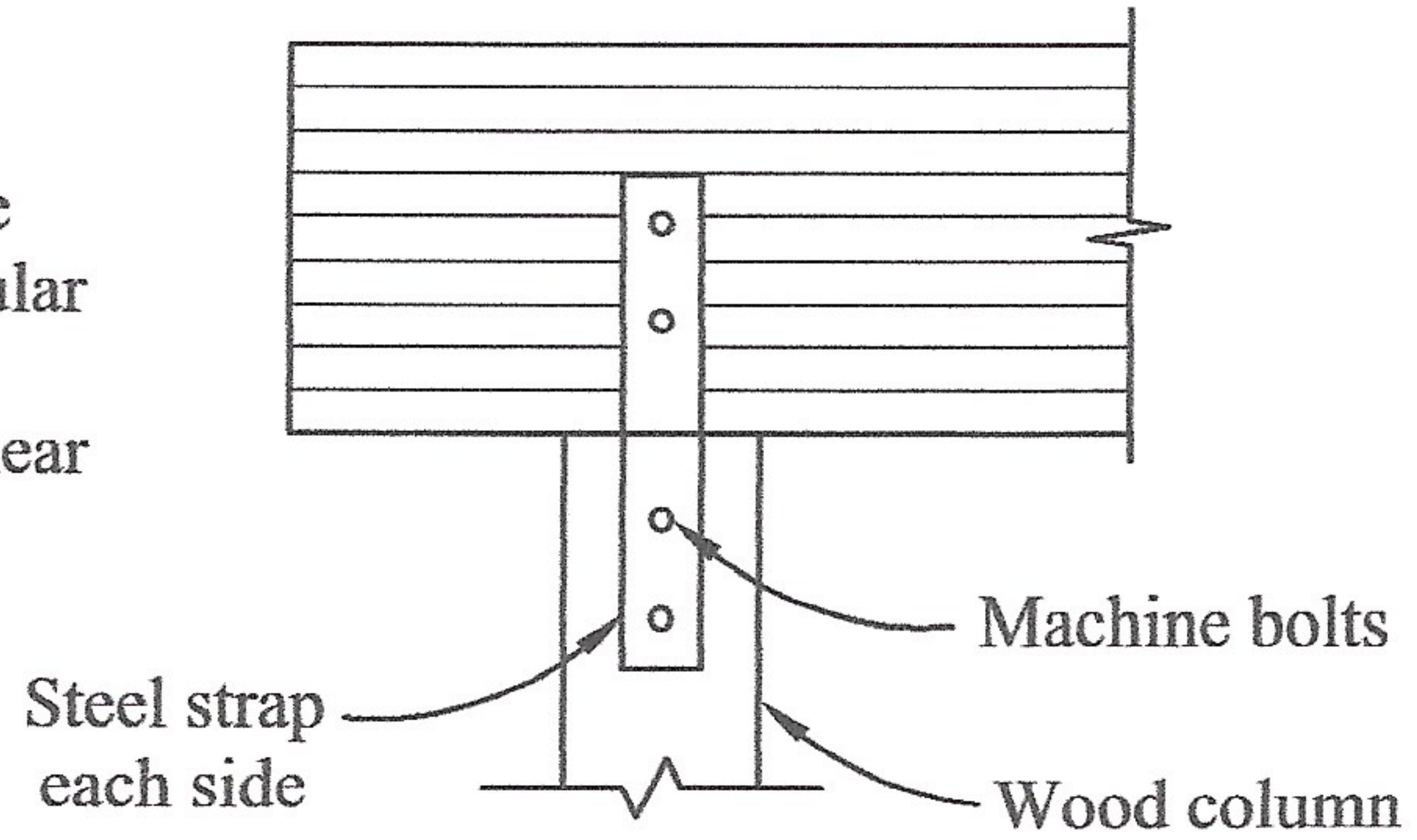
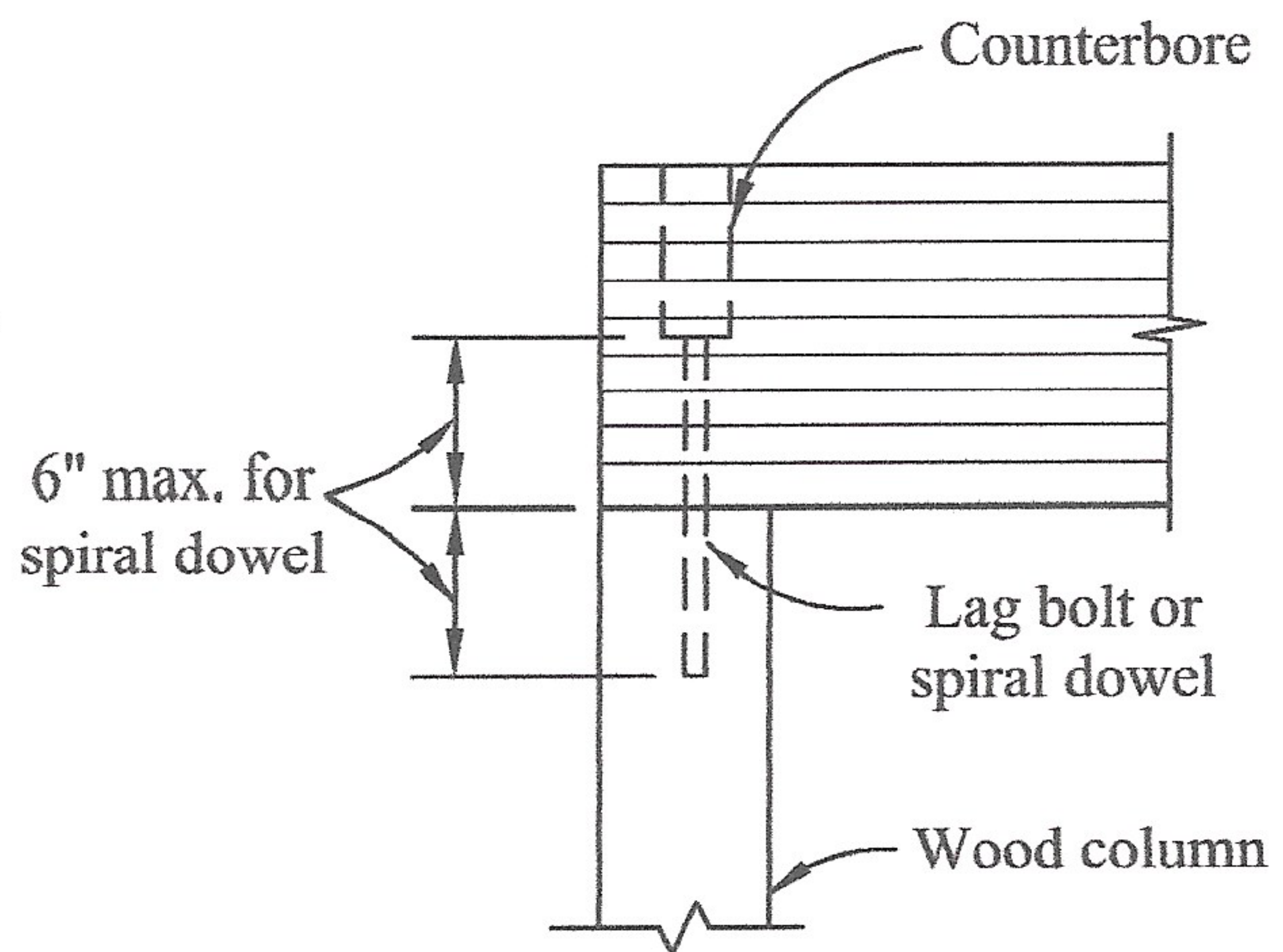


Figure 5.6 Beam to Steel Column. Steel U-strap passes under timber beam and is welded to top of steel column.

Figure 5.7 Concealed Type-Beam to Wood Column.



6. **COLUMN ANCHORAGES.** Column bearing elevation should be raised a minimum of one inch above finished floors that may be subjected to high moisture conditions. In locations where column base anchorages are subject to damage by moving vehicles, protection of the columns from such damage should be considered. Columns exposed to the weather or repeated wetting should be treated in accordance with *Standard for Preservative Treatment of Structural Glued Laminated Timber, AITC 109.*

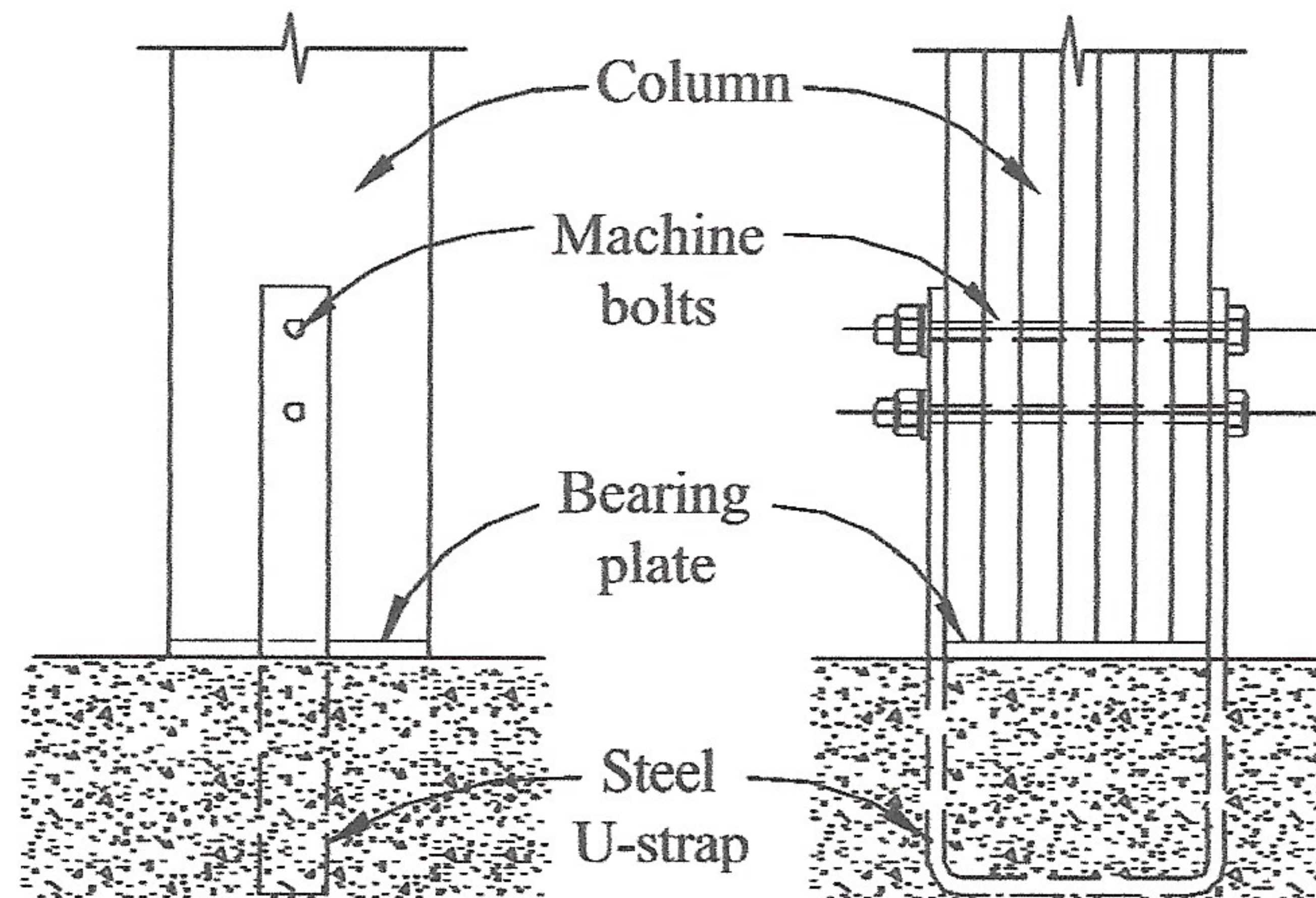


Figure 6.1 U-Strap Anchorage. Resists both horizontal forces and uplift. Bearing plate or moisture barrier is required. May be used with shear plates.

Do not place column below finished concrete floor level.

Figure 6.2 Clip Angle Anchorage to Concrete Base. Resists both horizontal forces and uplift. Bearing plate or moisture barrier is required.

Do not place column below finished concrete floor level.

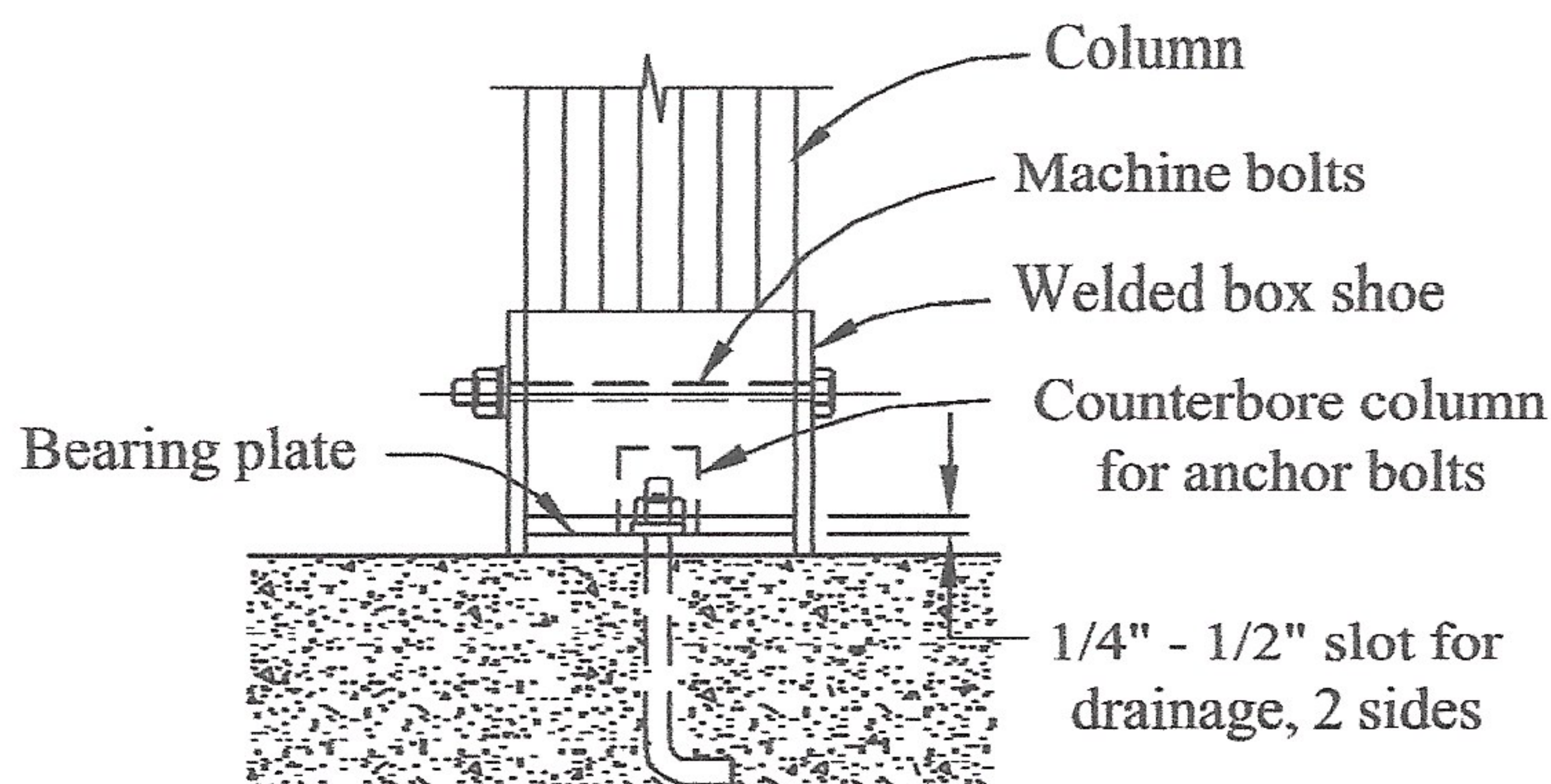
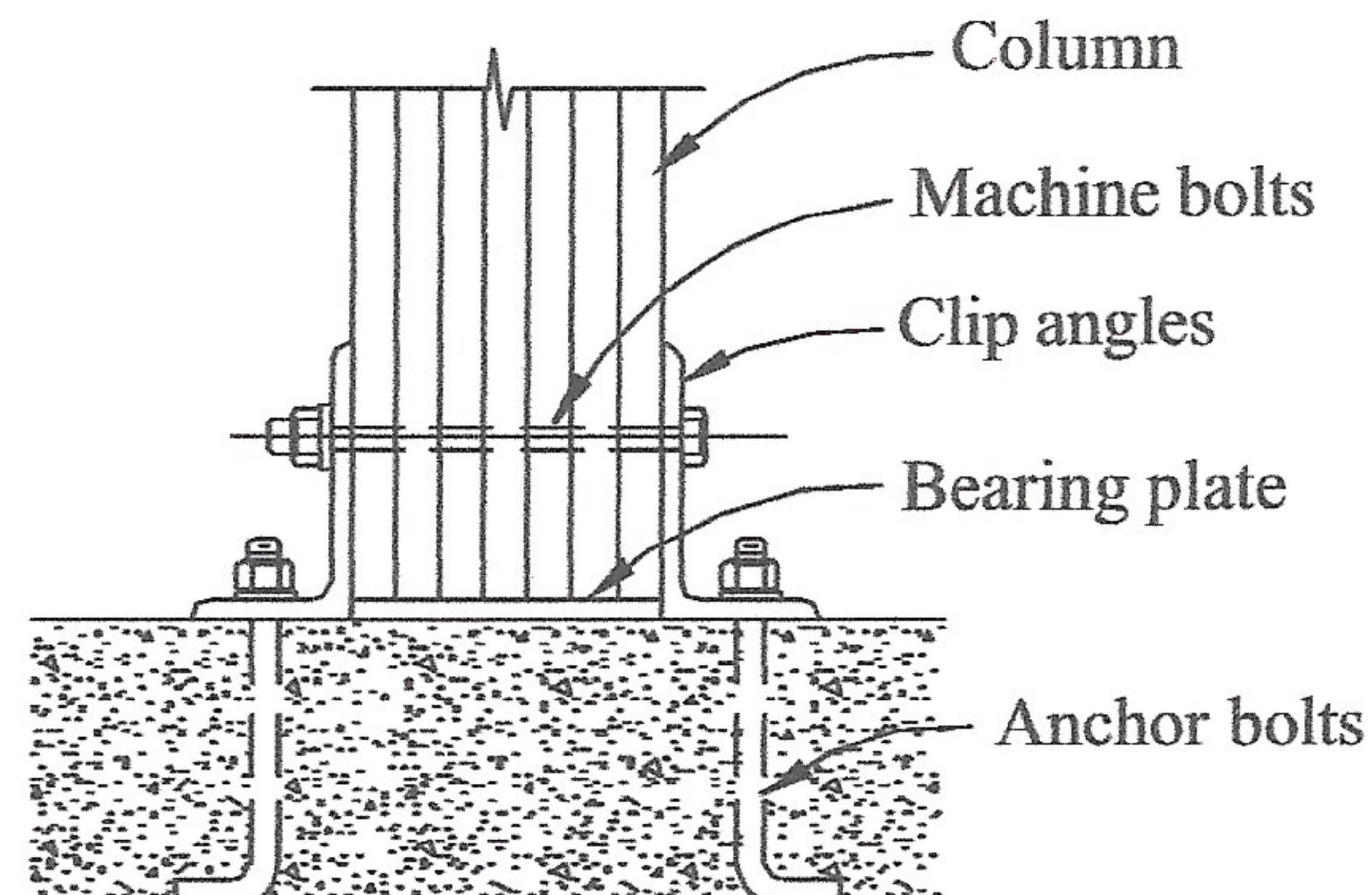
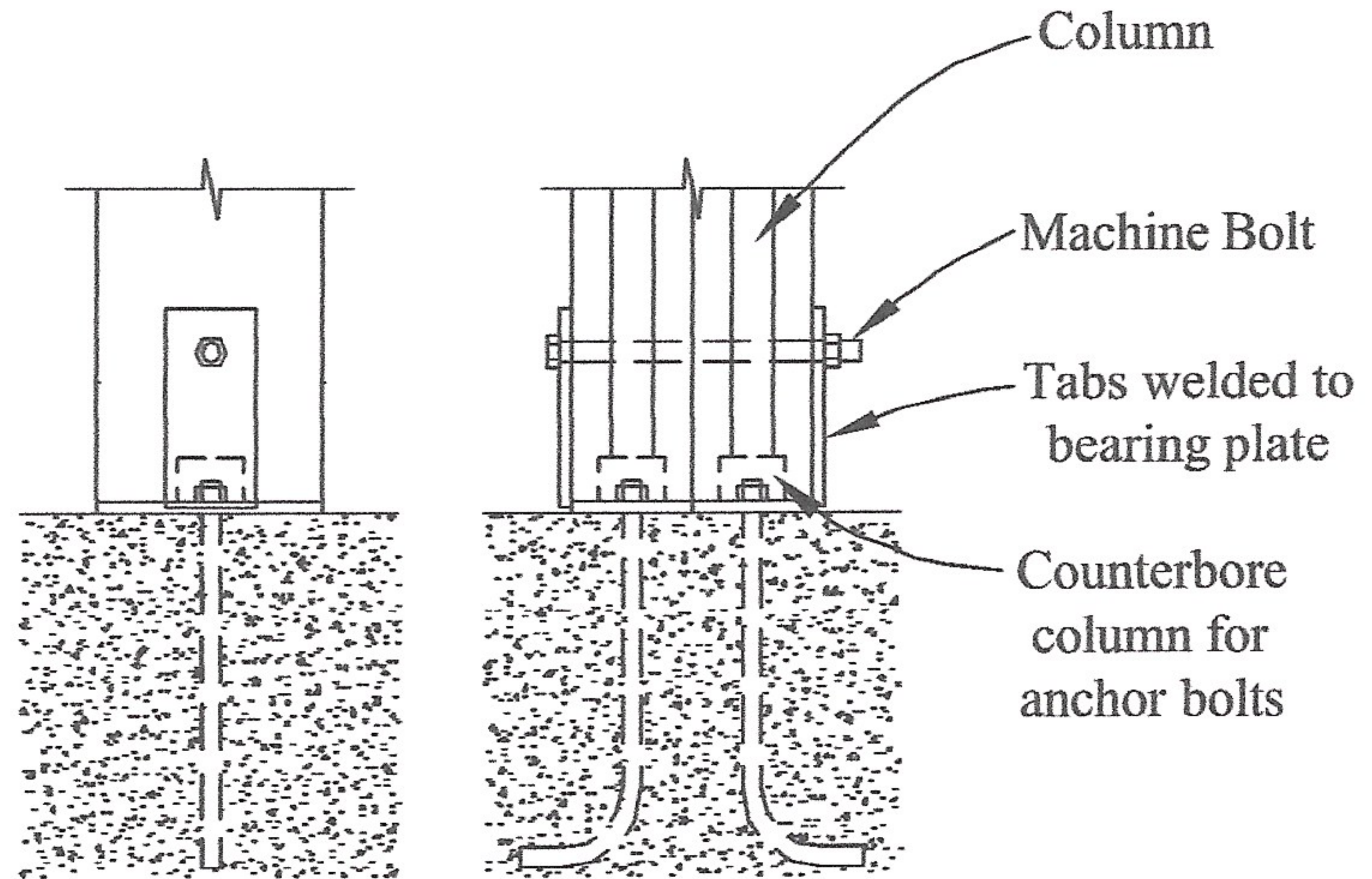


Figure 6.3 Box Shoe. For use when bottom of box is flush with top of concrete floor.

Do not place column below finished concrete floor level.

Figure 6.4 Semi-Concealed Column Anchorage. For use where concrete support area is limited in size. Resists both horizontal forces and uplift.

Do not place column below finished concrete floor level.



7. ARCH ANCHORAGES

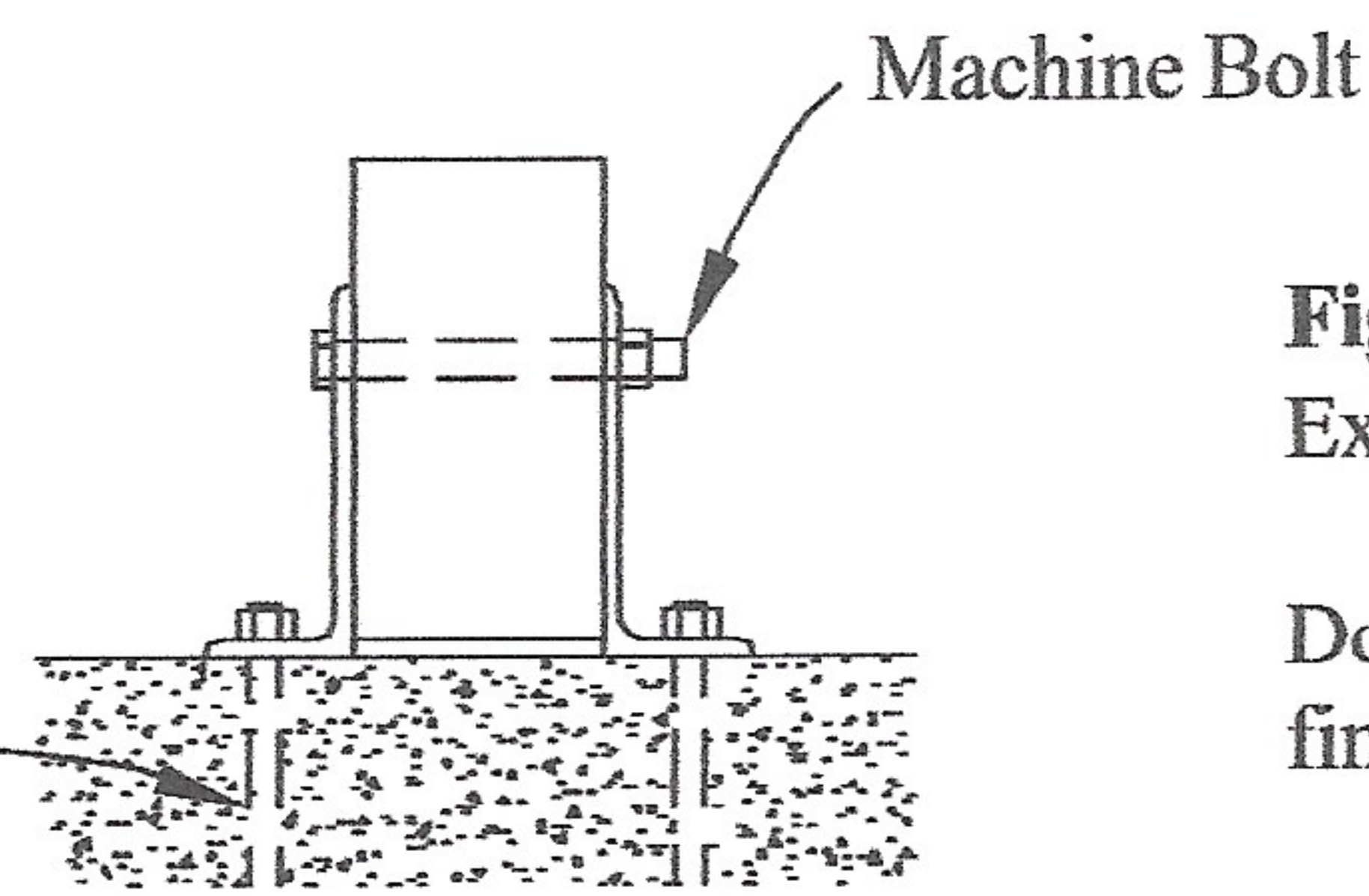
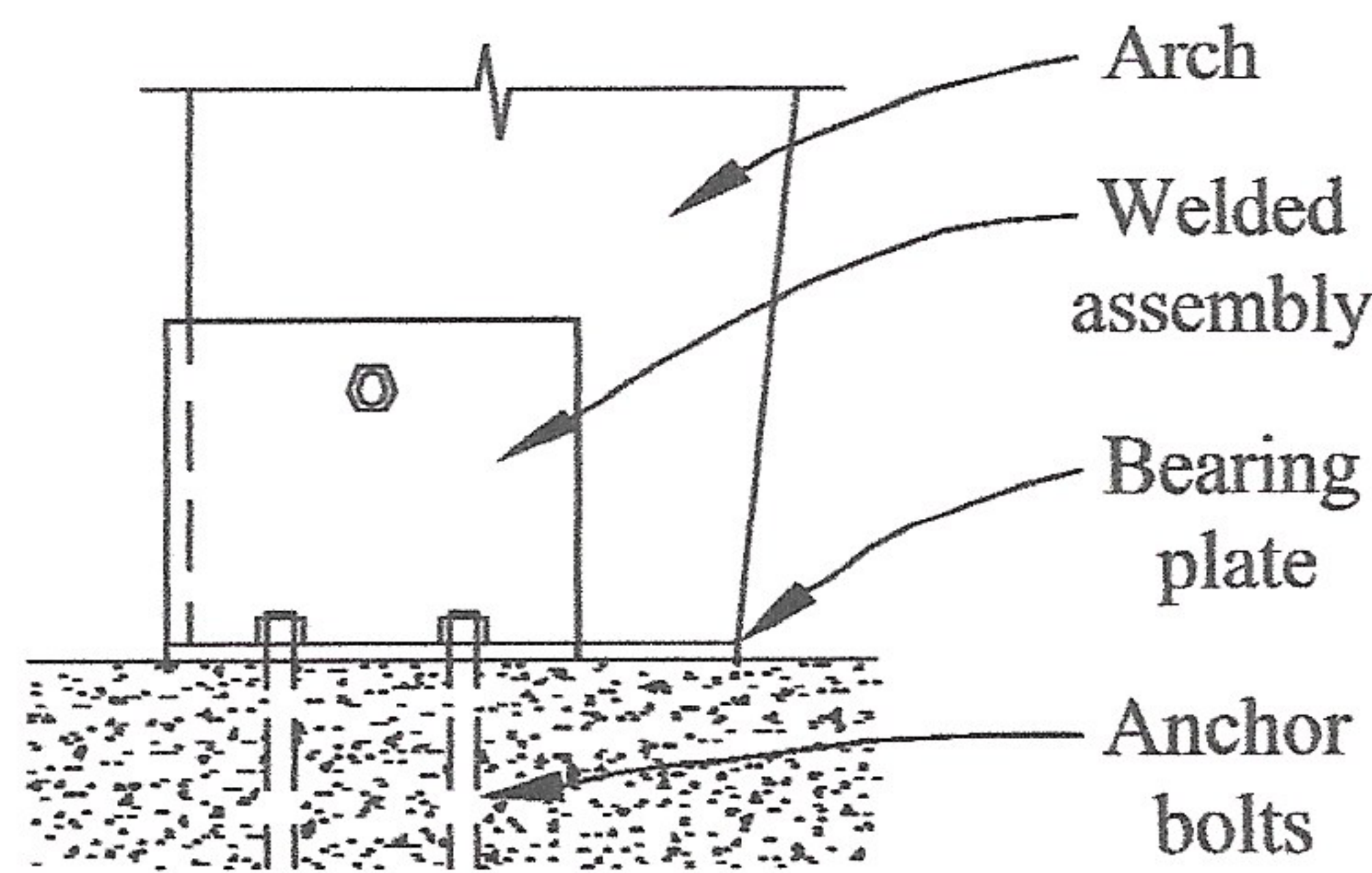
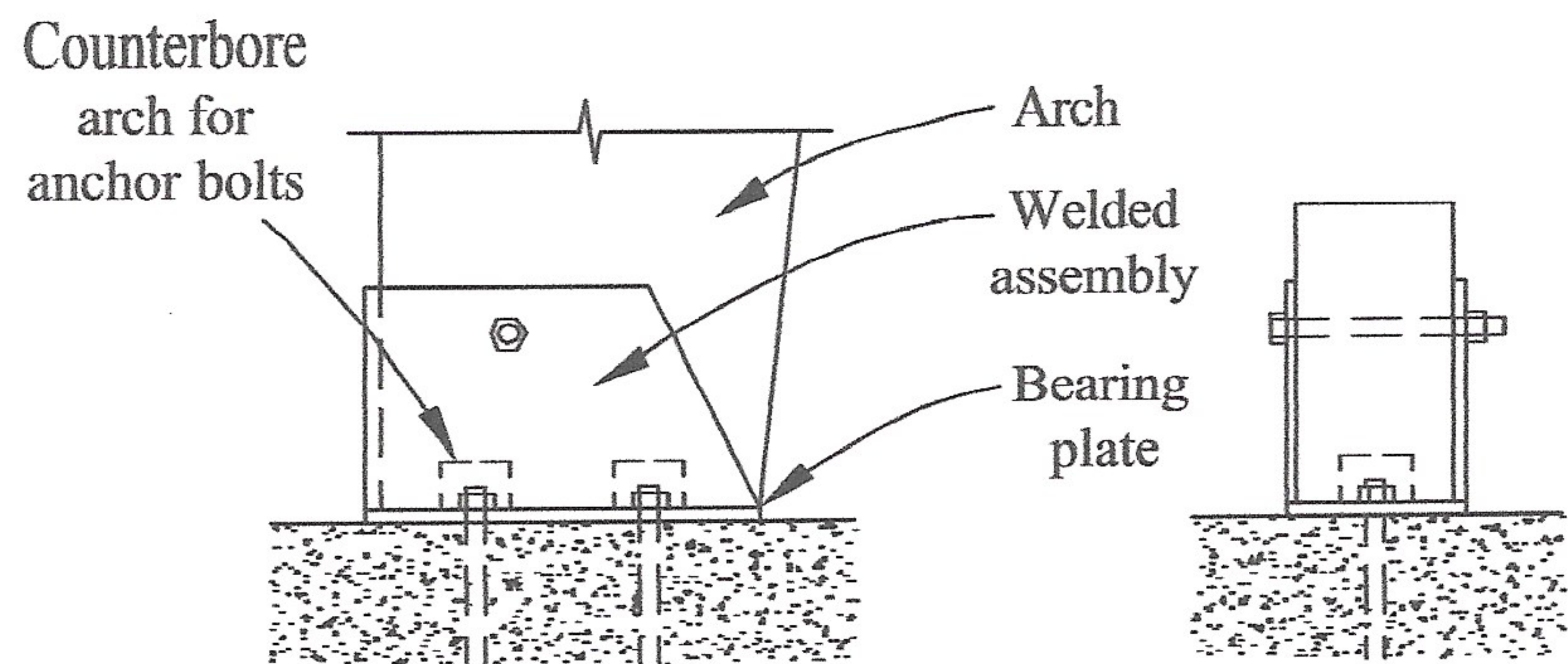


Figure 7.1 Arch Shoe with Exposed Anchor Bolts.

Do not place arch below finished concrete floor level.

Figure 7.2 Arch Shoe with Concealed Anchor Bolts. Counterbores are provided in arch base for anchor bolt projections.

Do not place arch below finished concrete floor level.



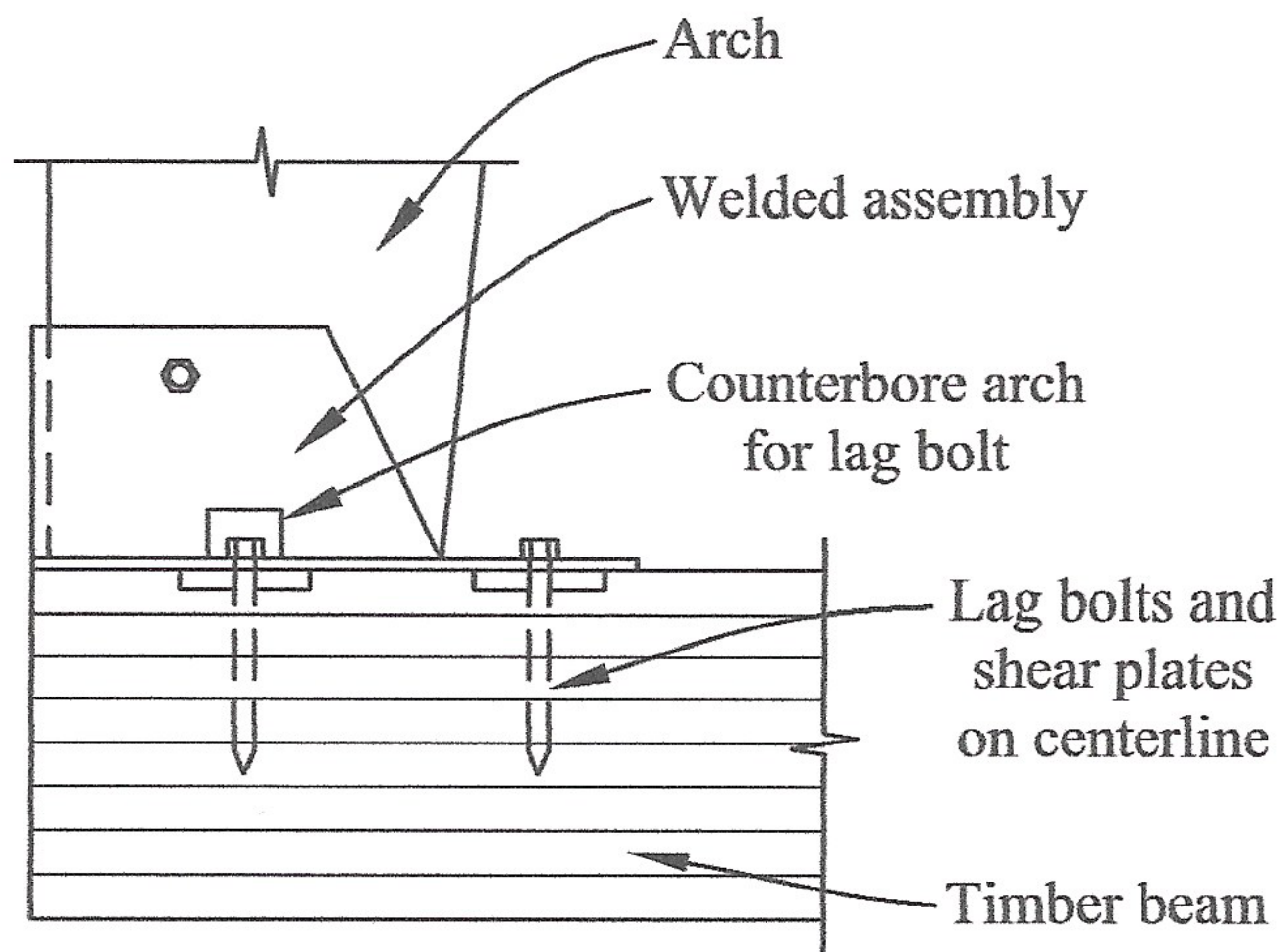


Figure 7.3 Arch Anchorage to Timber Beam. Vertical load is taken directly by bearing into timber beam. Vertical uplift and thrust are taken by the lag bolts and shear plates into the beam tie.

Figure 7.4 Arch Anchorage to Steel Girder.

Do not place arch below finished concrete floor level.

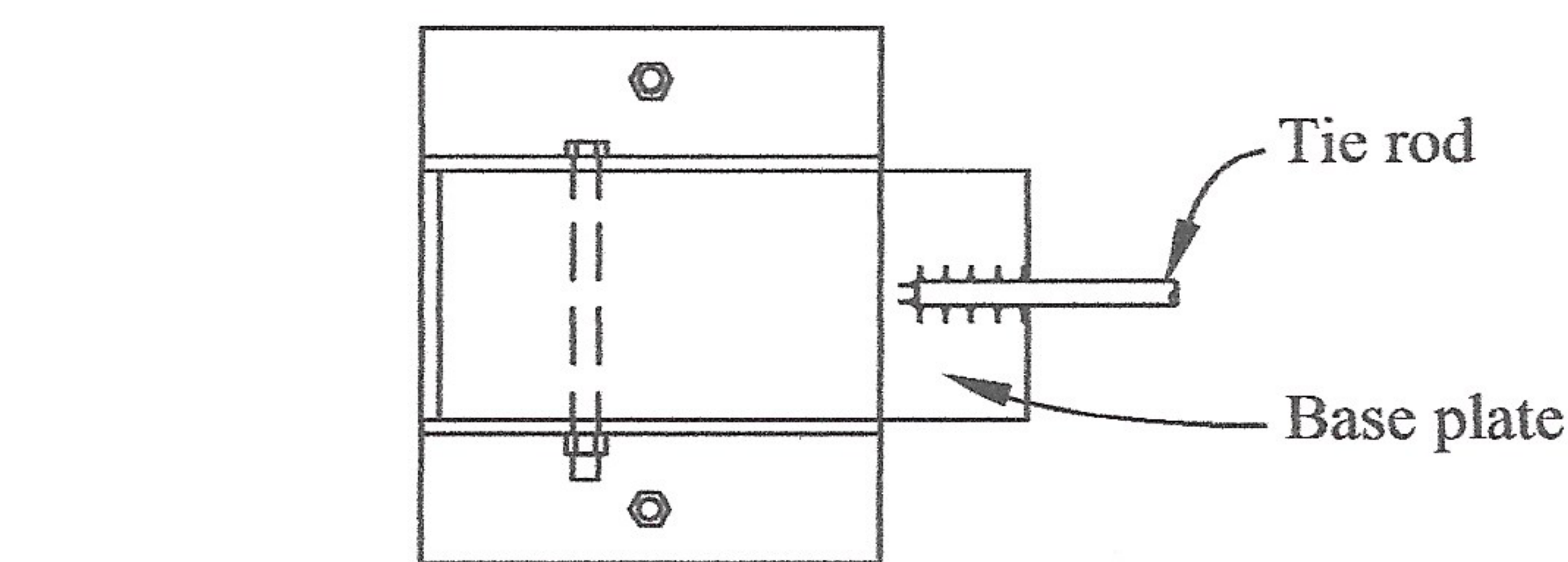
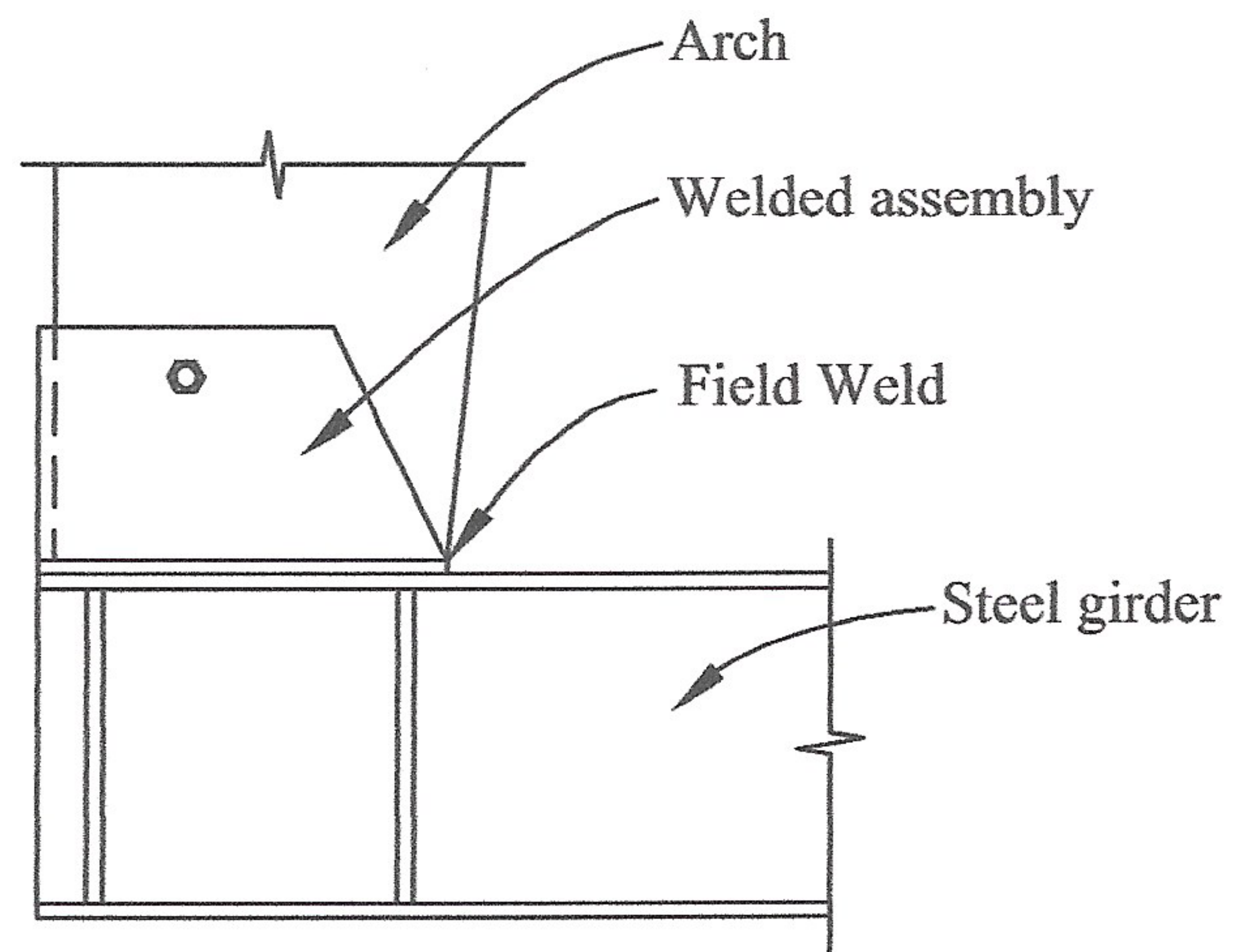
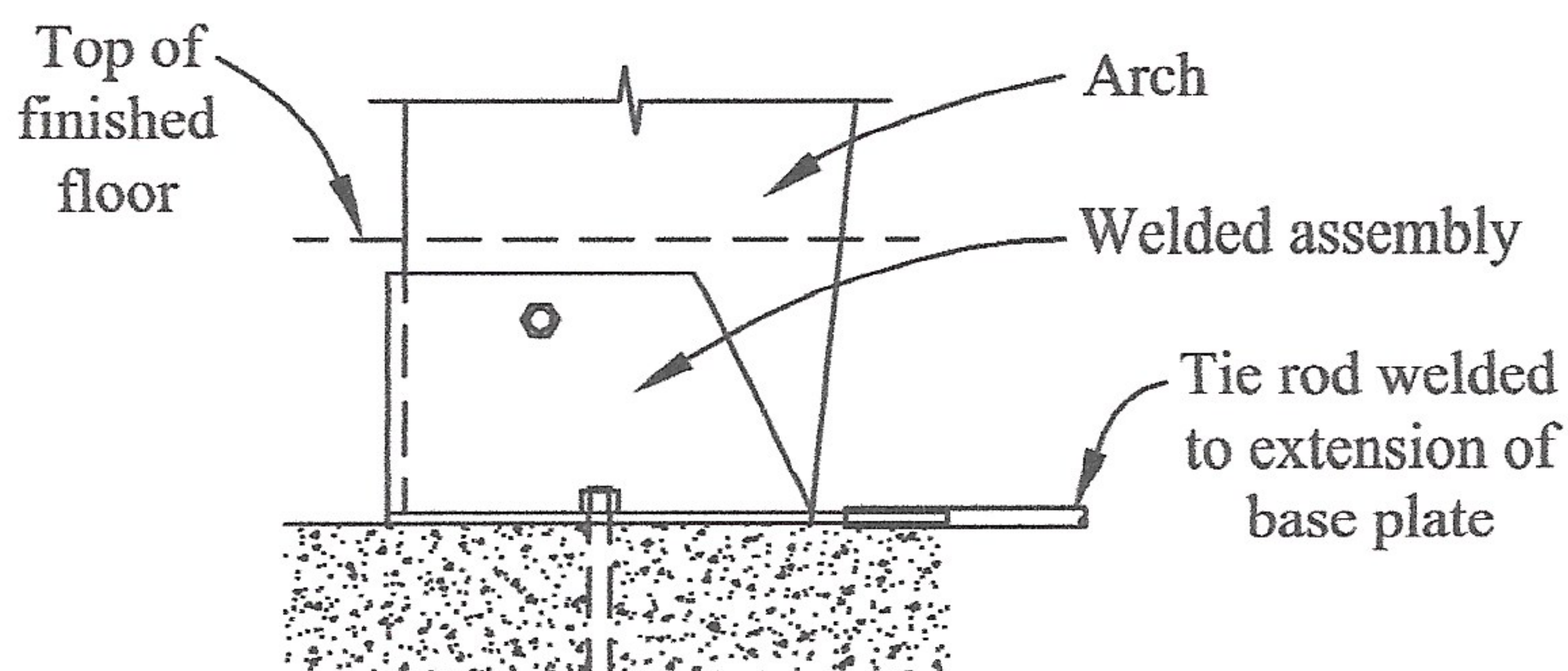


Figure 7.5 Tie Rod to Arch Shoe. Horizontal thrust is taken directly by the tie rod welded to the arch shoe. This detail is intended for use with a raised joist floor where the tie rod can be concealed.



Do not place arch below finished concrete floor level.

Figure 7.6 Tie Rod Arch.
Horizontal thrust is taken directly by the tie rod. For use where raised joist floor will conceal the tie rod.

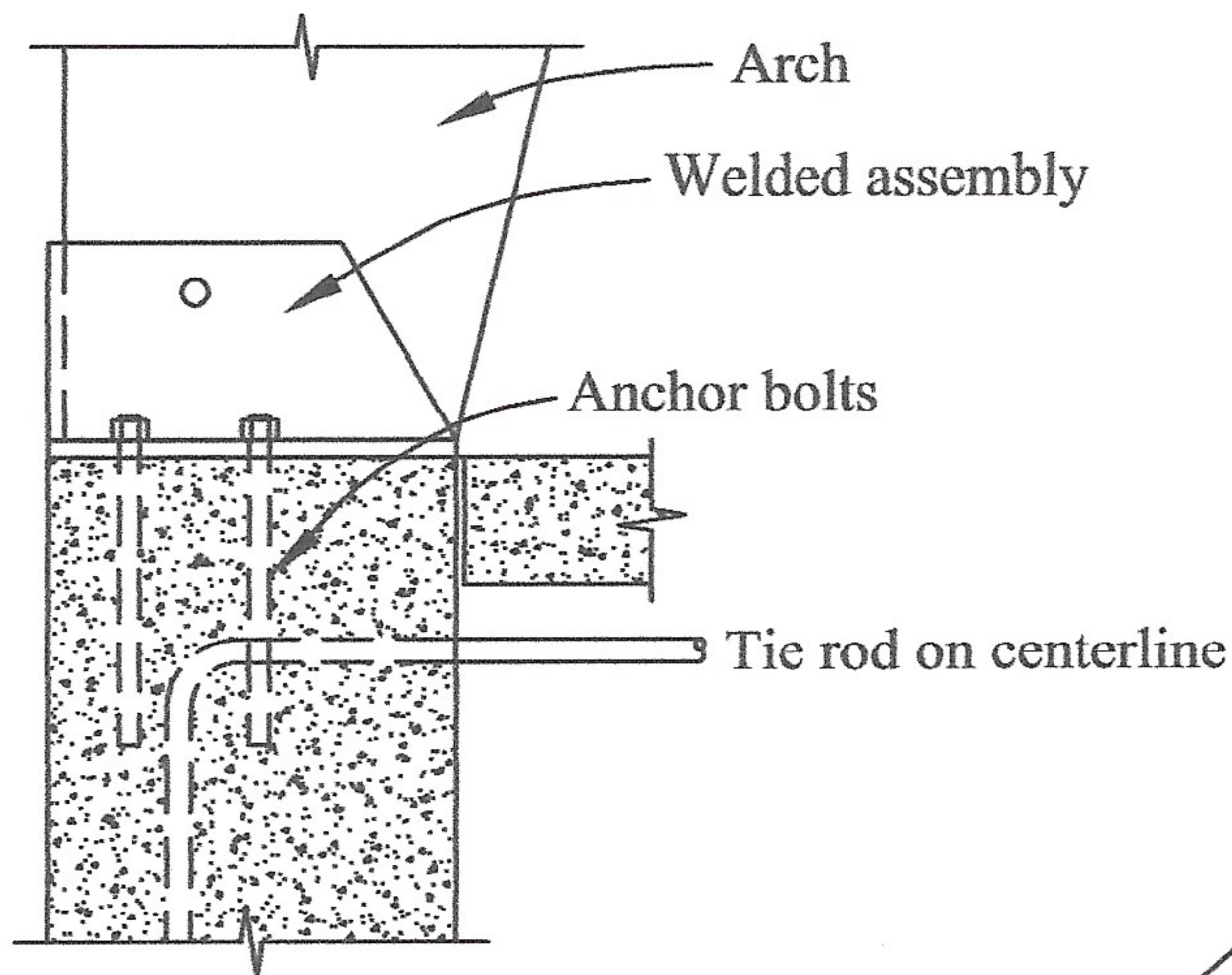
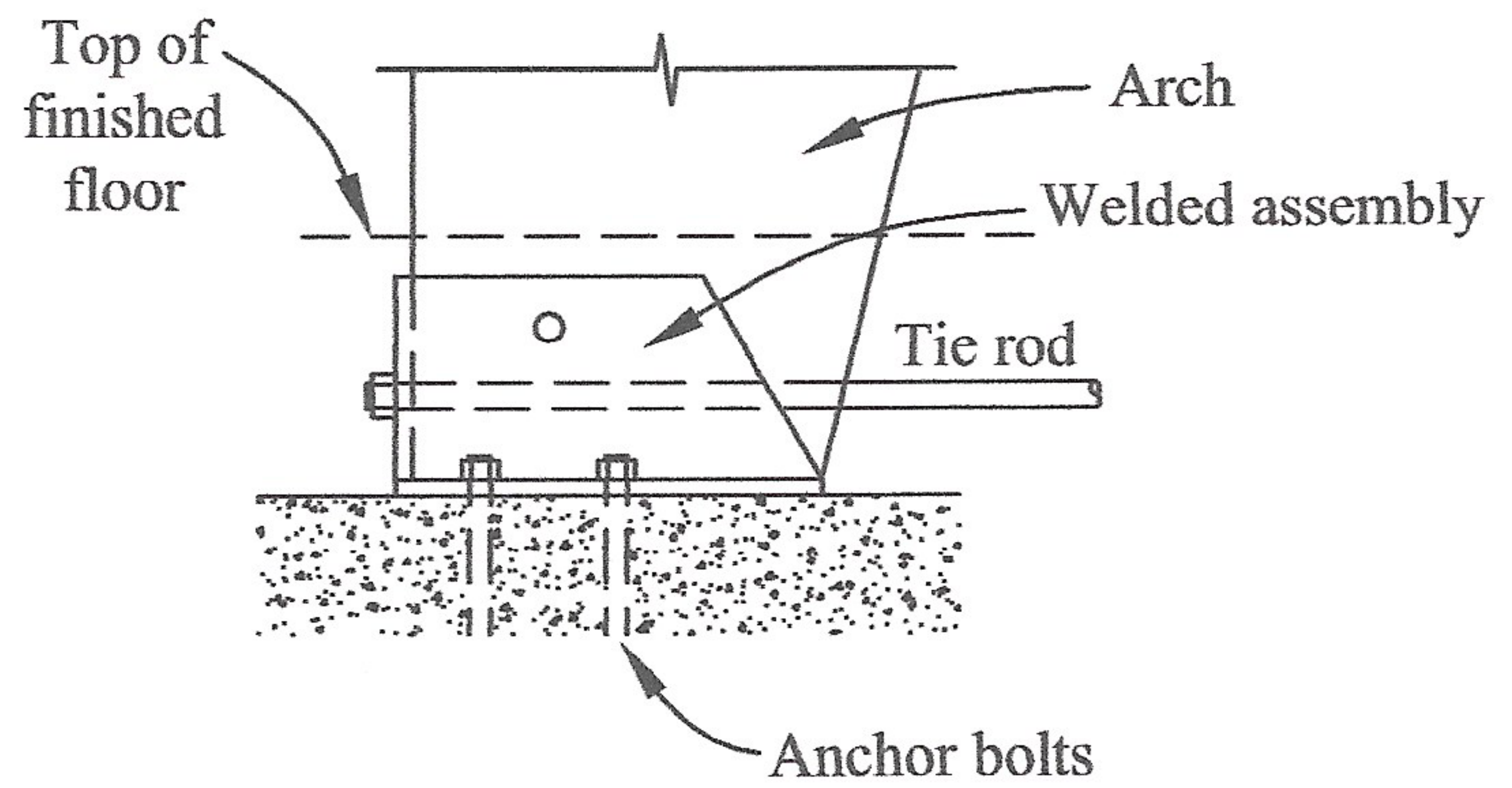


Figure 7.7 Tie Rod in Concrete. Thrust is taken by anchor bolts in shear into the concrete foundation and tie rod.

Do not place arch below finished concrete floor level.

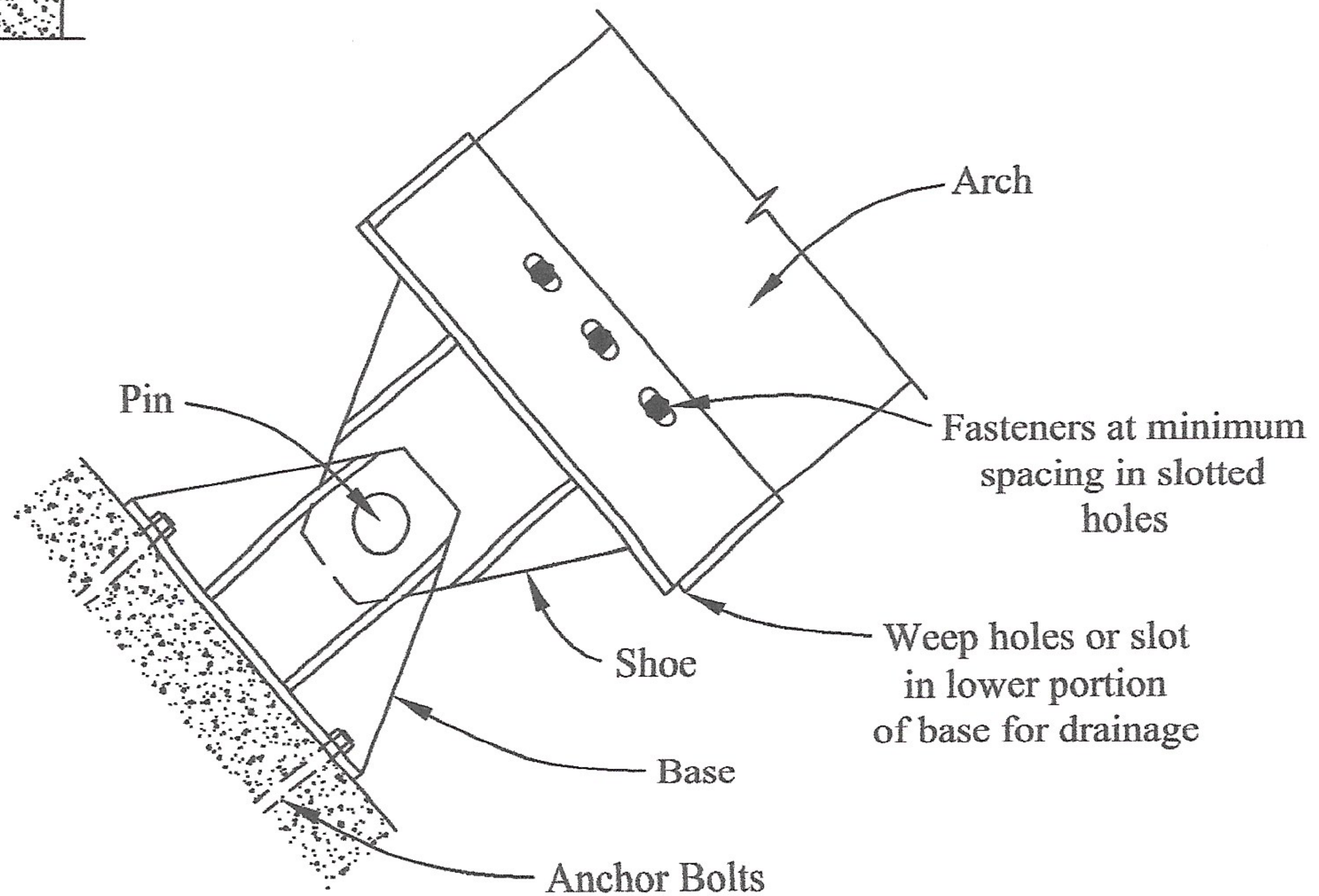


Figure 7.8 True Hinge Anchorage for Arches. Recommended for arches where true hinge action is desired (see Figure 11.6 for protection considerations).

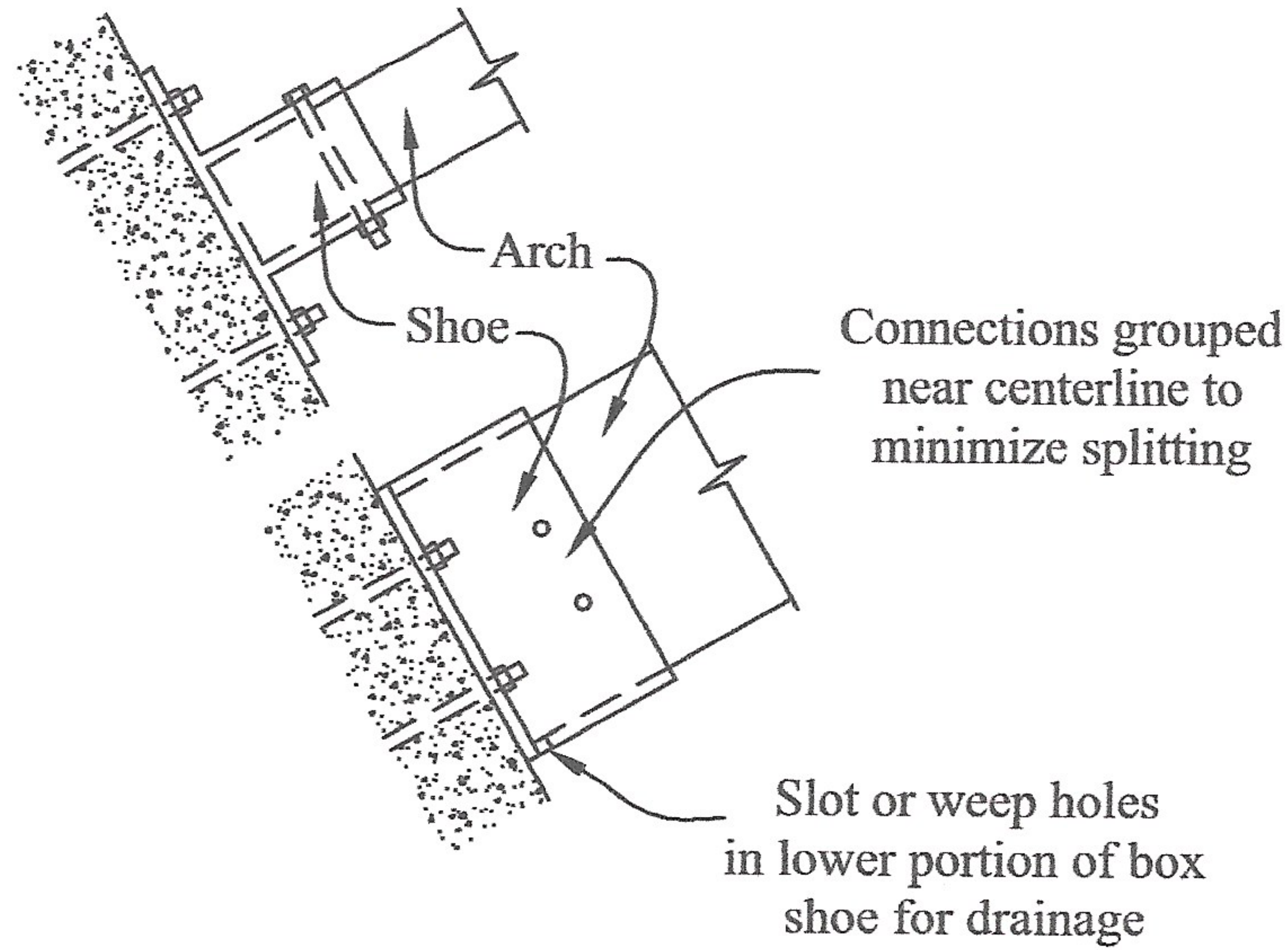


Figure 7.9 Arch Anchorage Where True Hinge Is Not Required. Recommended for arches where a true hinge is not required. Base shoe is anchored directly to buttress (see Figure 11.6 for protection considerations). Do not embed arch in concrete floor.

8. ARCH CONNECTIONS

Figure 8.1 Arch Peak. For Arches with slopes of 3:12 and greater. This connection will transfer both vertical forces (shear) and horizontal forces (tension and compression).

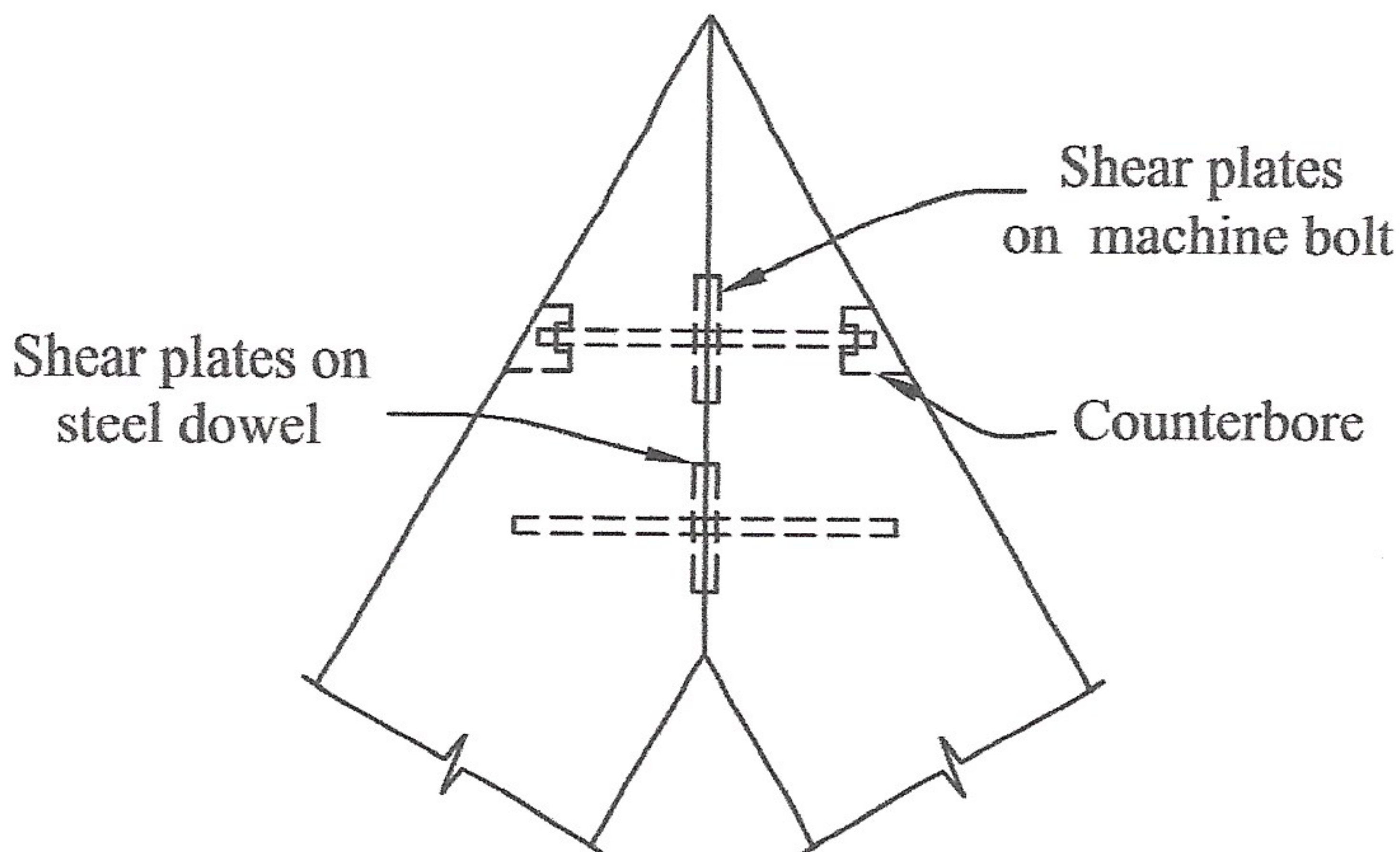
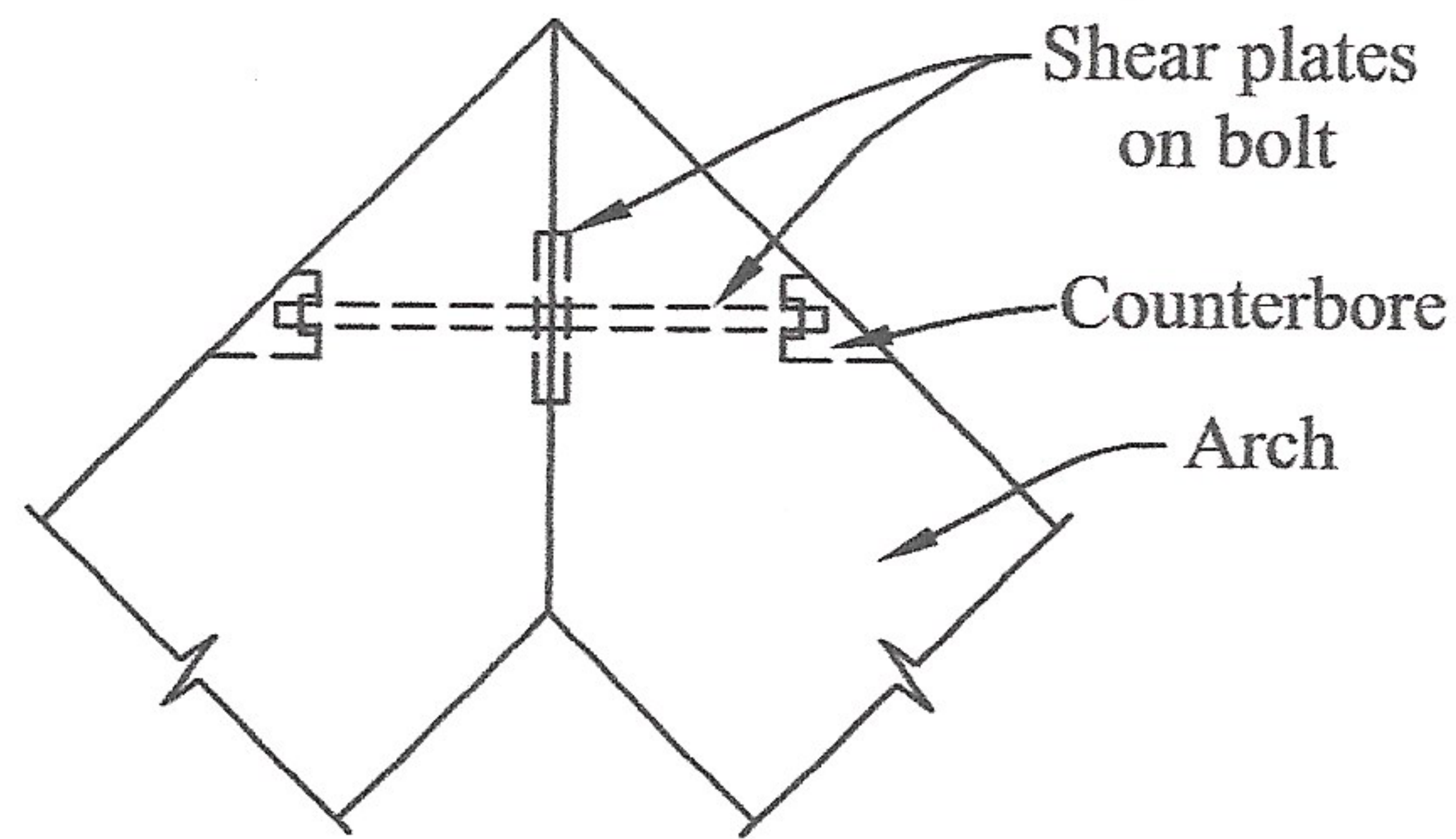


Figure 8.2 Arch Peak. When the vertical shear is too great for one pair of shear plates, or when deep sections would require extra shear plates for alignment, additional pairs of shear plates centered on dowels or machine bolts may be used.

Figure 8.3 Low Pitched Arches.
 For arches with slopes that would require excessively long through bolts; shear plates back-to-back centered on a dowel are used in conjunction with a tie plate and through bolts.

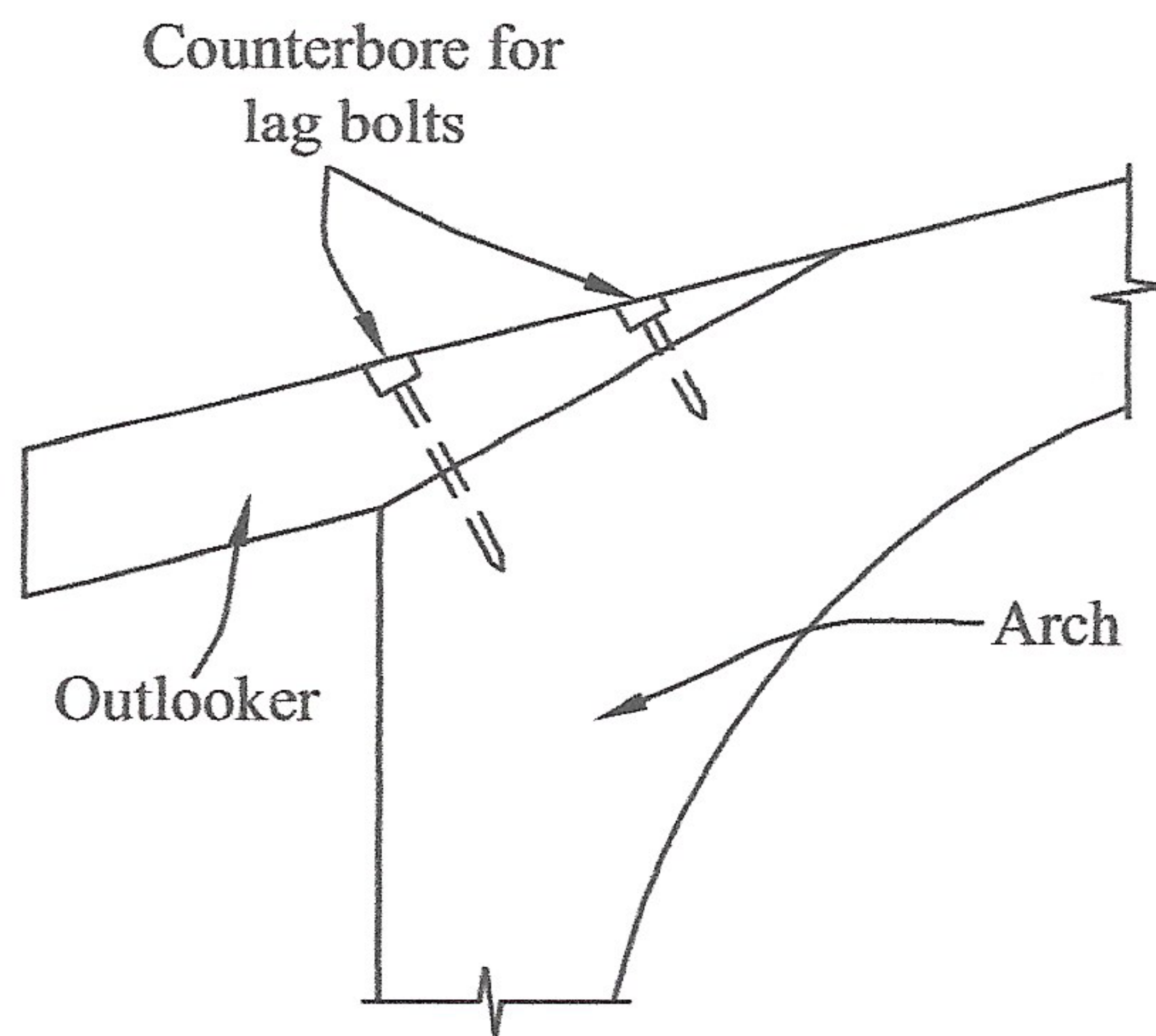
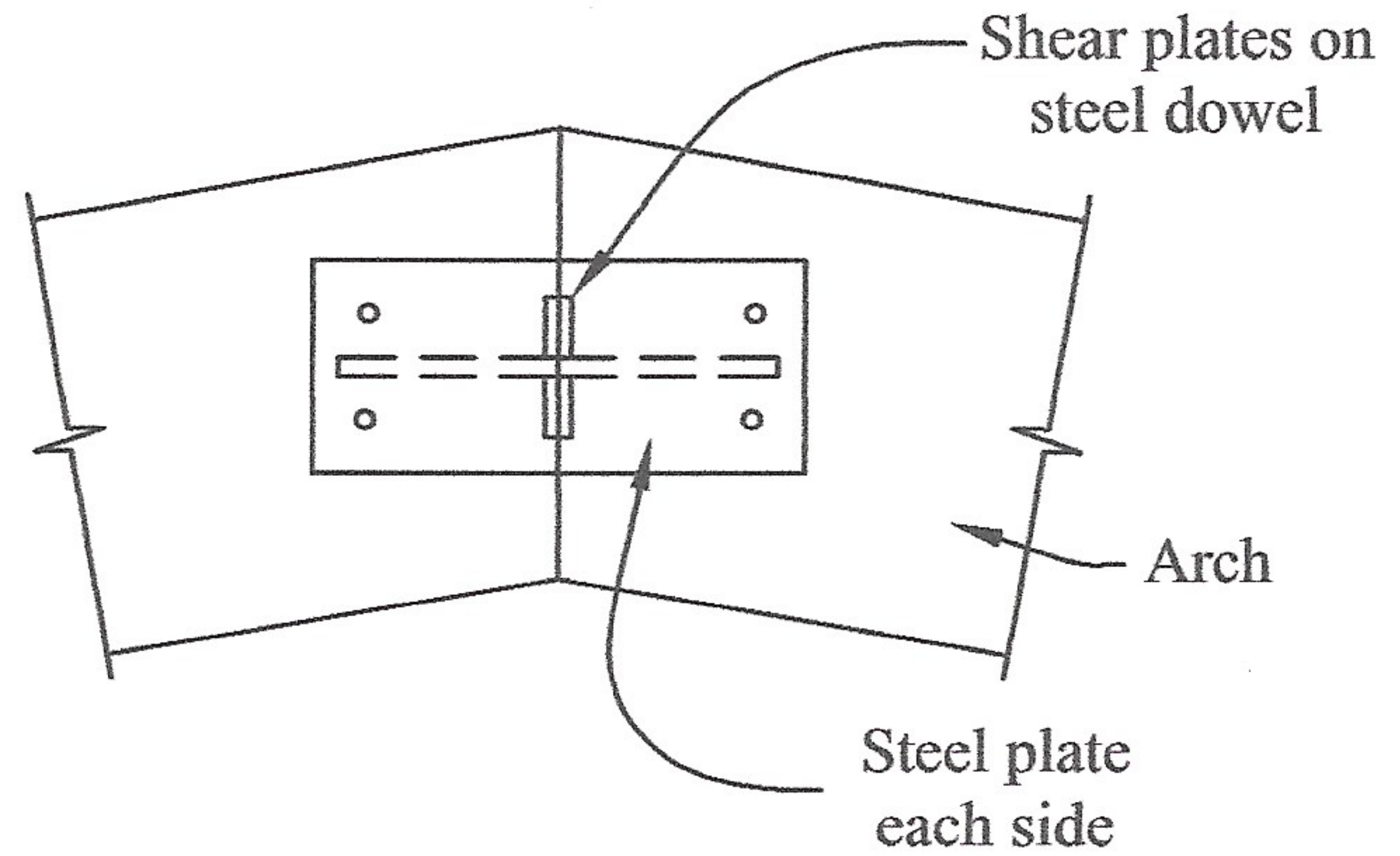


Figure 8.4 Outlooker Connection to Haunched Arch. Lag bolts used in this connection should be long enough so that the withdrawal resistance of the threads is in the main section of the arch. Connection must be designed to resist any cantilever action of the outlooker. Lag bolts may be counter-bored when decking is applied.

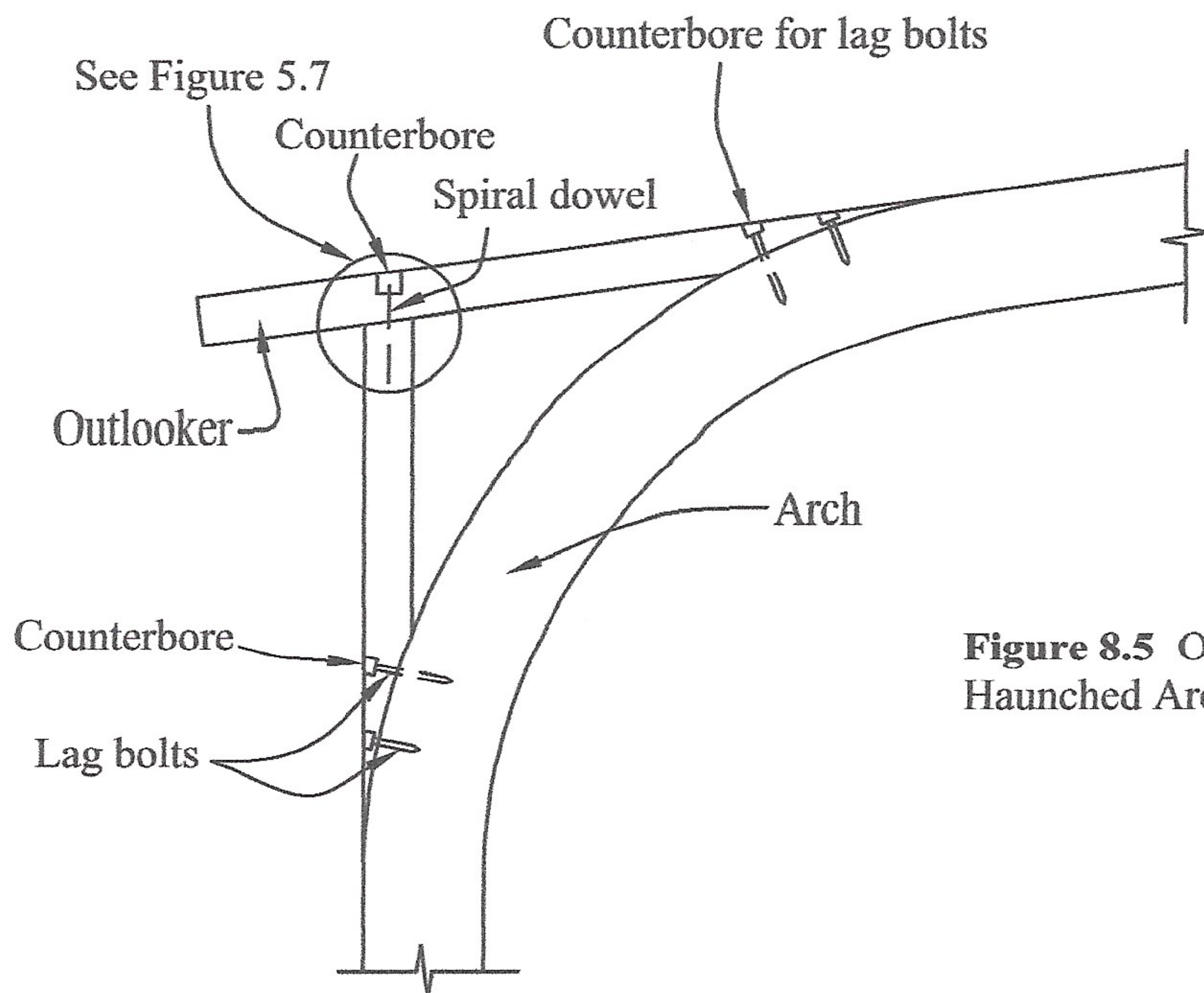
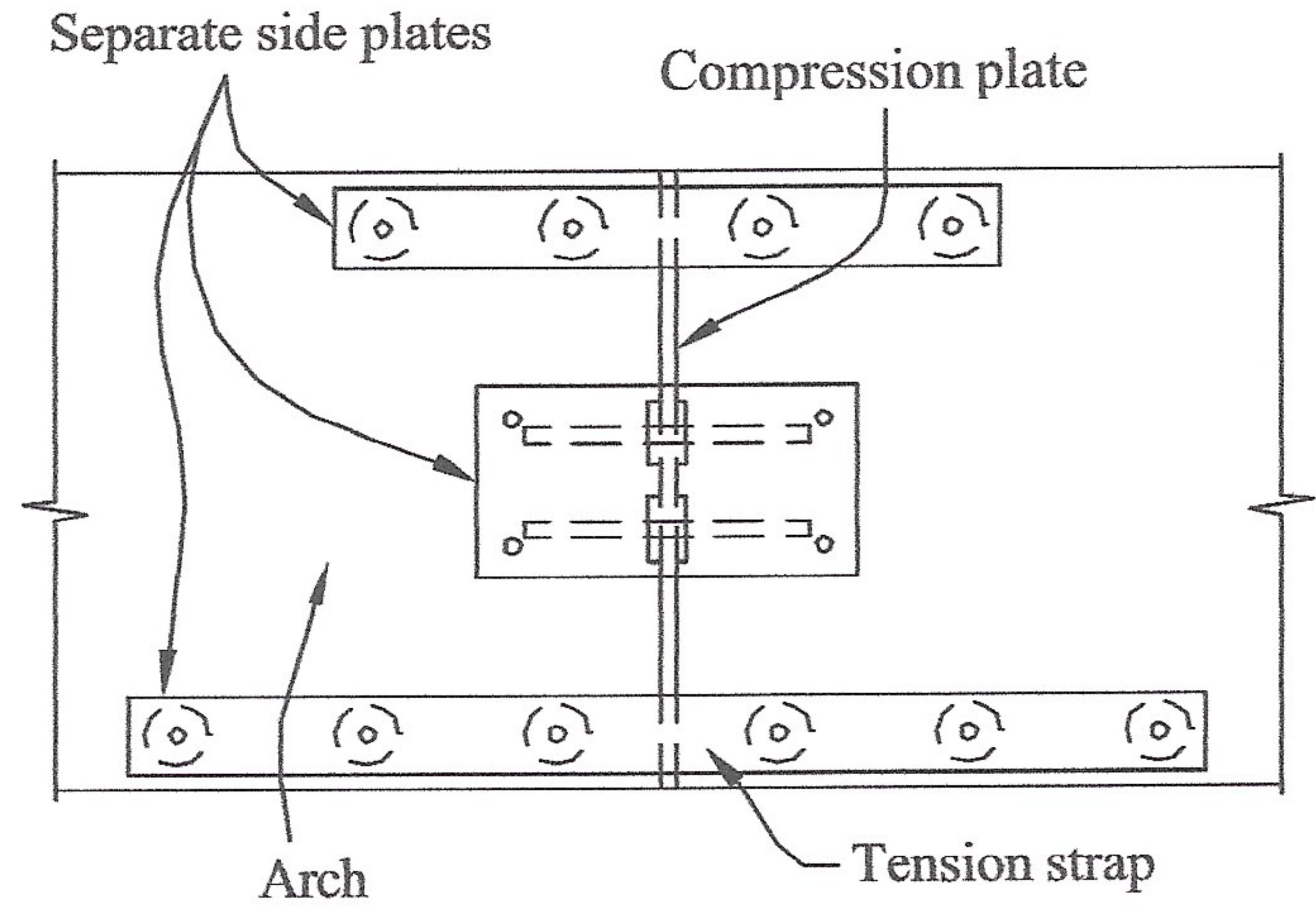


Figure 8.5 Outlooker Connection to Open Haunched Arch.

Figure 8.6 Arch Moment Splice. Drawing shows a typical moment splice. Compression stress is taken in bearing on the wood through a steel compression plate. Tension is taken across the splice by means of steel straps and shear plates. Side plates and straps are used to hold sides and tops of members in position. Shear is taken by shear plates in end grain.



9. TRUSS CONNECTIONS. When unseasoned lumber is used in truss construction, periodic inspection is recommended along with retightening of hardware and connections as necessary.

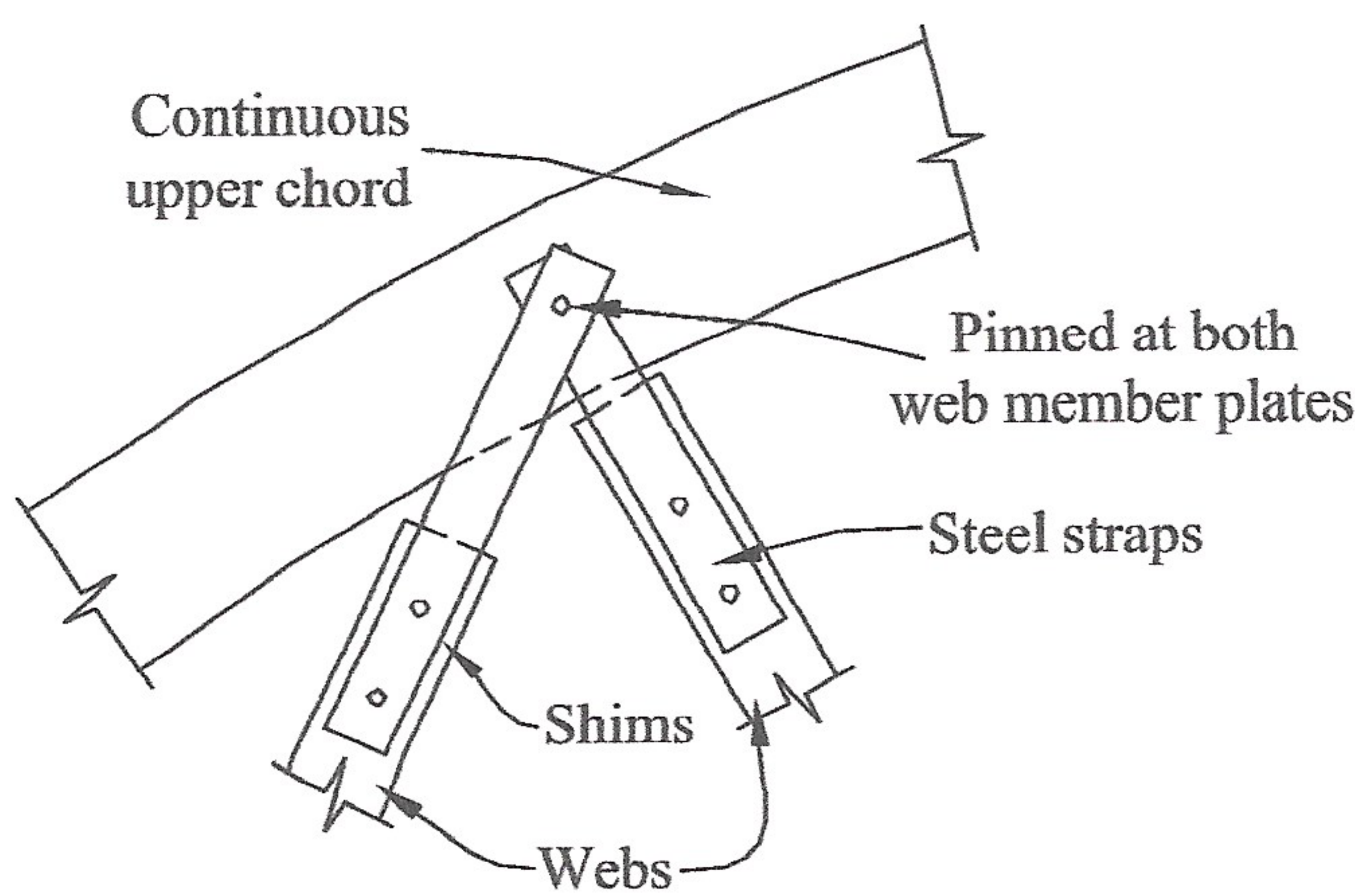


Figure 9.1 Monochord-Steel Straps. For trusses with continuous upper chord. Provide clearance between web ends and chord. Provide shims at web to prevent bending of straps.

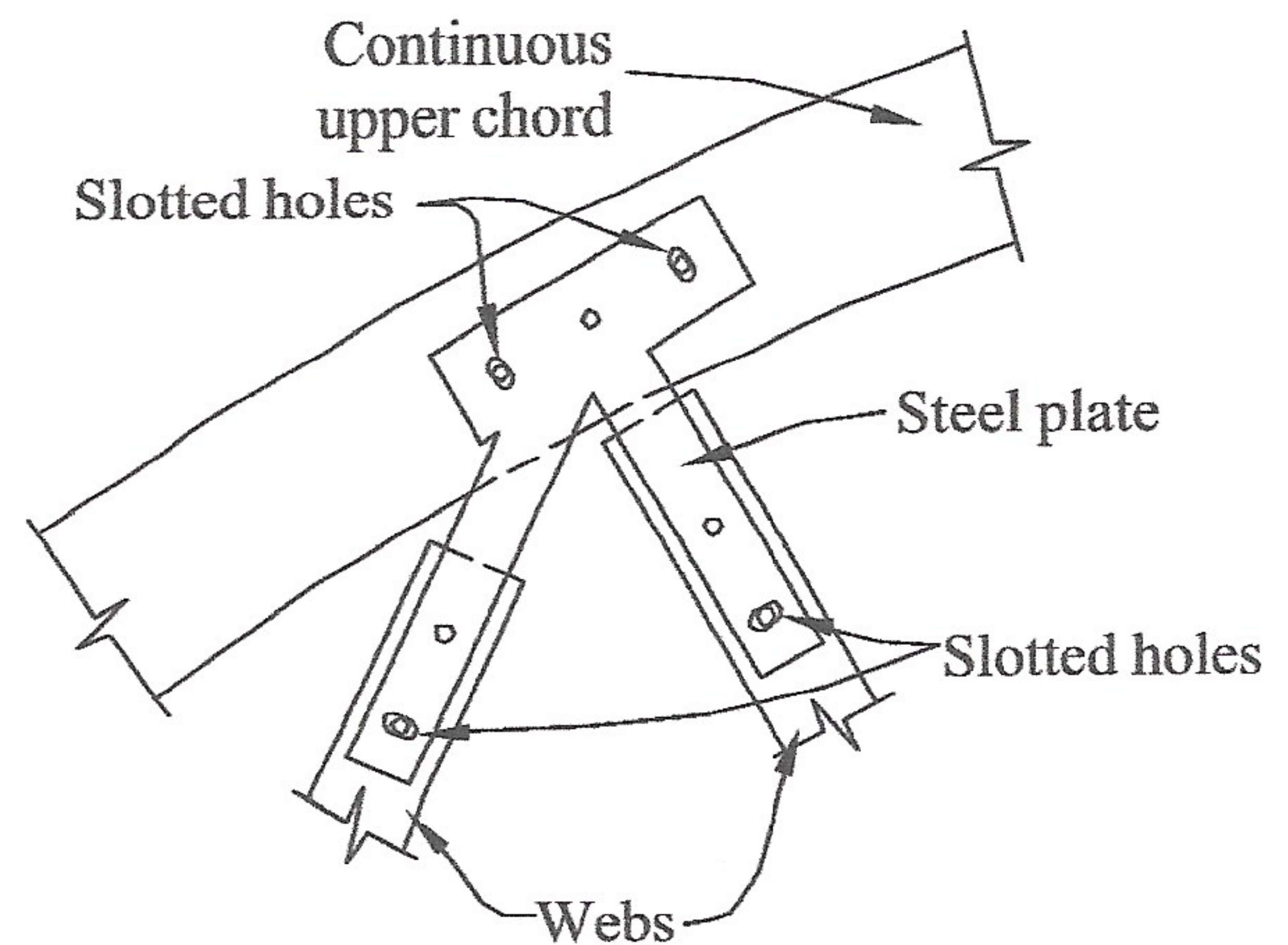


Figure 9.2 Slotted Gusset Plates. Alternate detail to Figure 9.1. Slotted holes allow rotation of joint, reducing tension perpendicular to grain stresses.

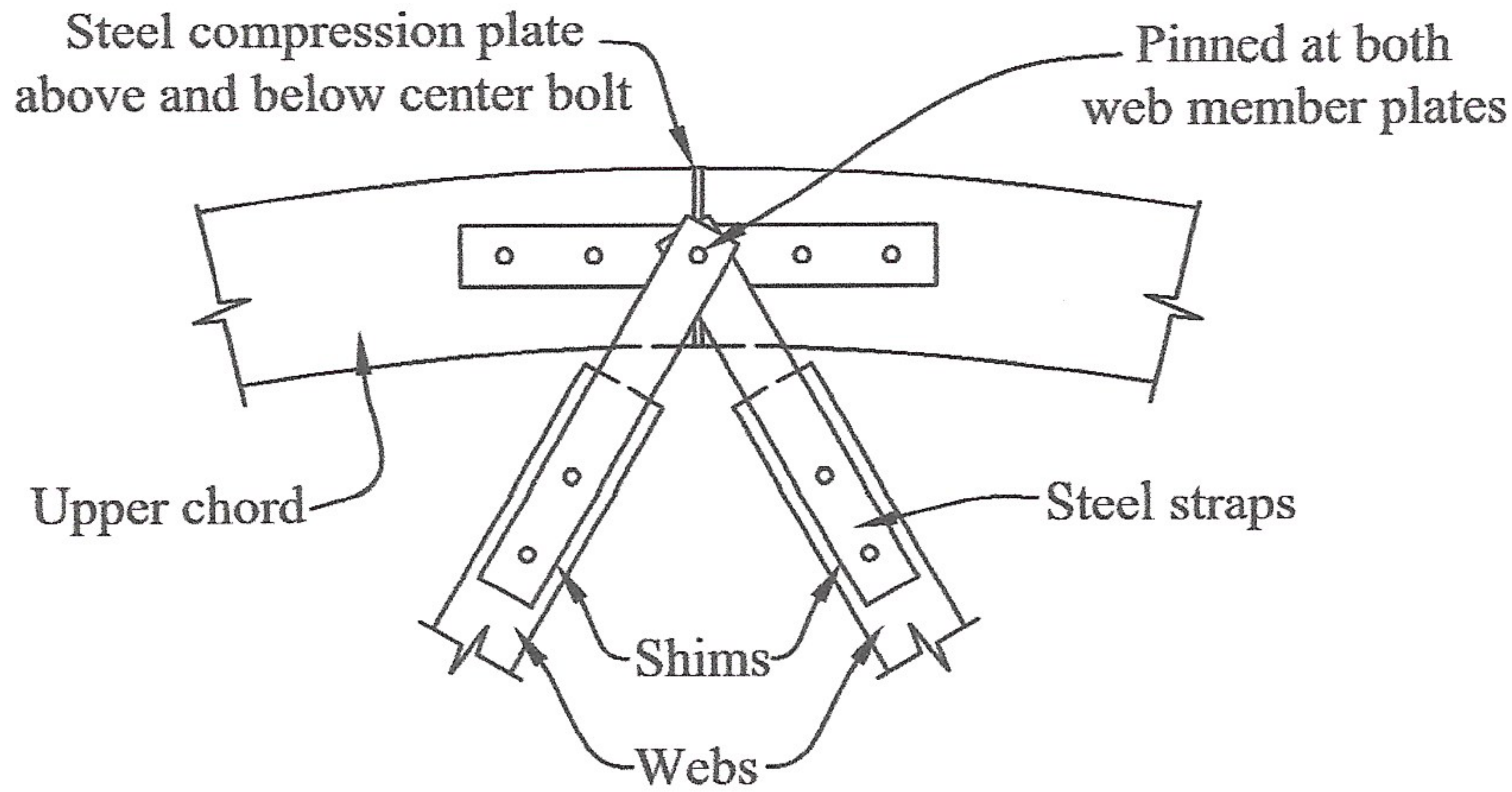


Figure 9.3 Monochord-Steel Strap Assembly. Similar to Figure 9.1. For use at ridge for upper chord splice. Provide shims at webs to prevent bending of straps.

Figure 9.4 Slotted Gusset Plate Connection with Chord Splice. Similar to Figure 9.2. For use at ridge for upper chord splice.

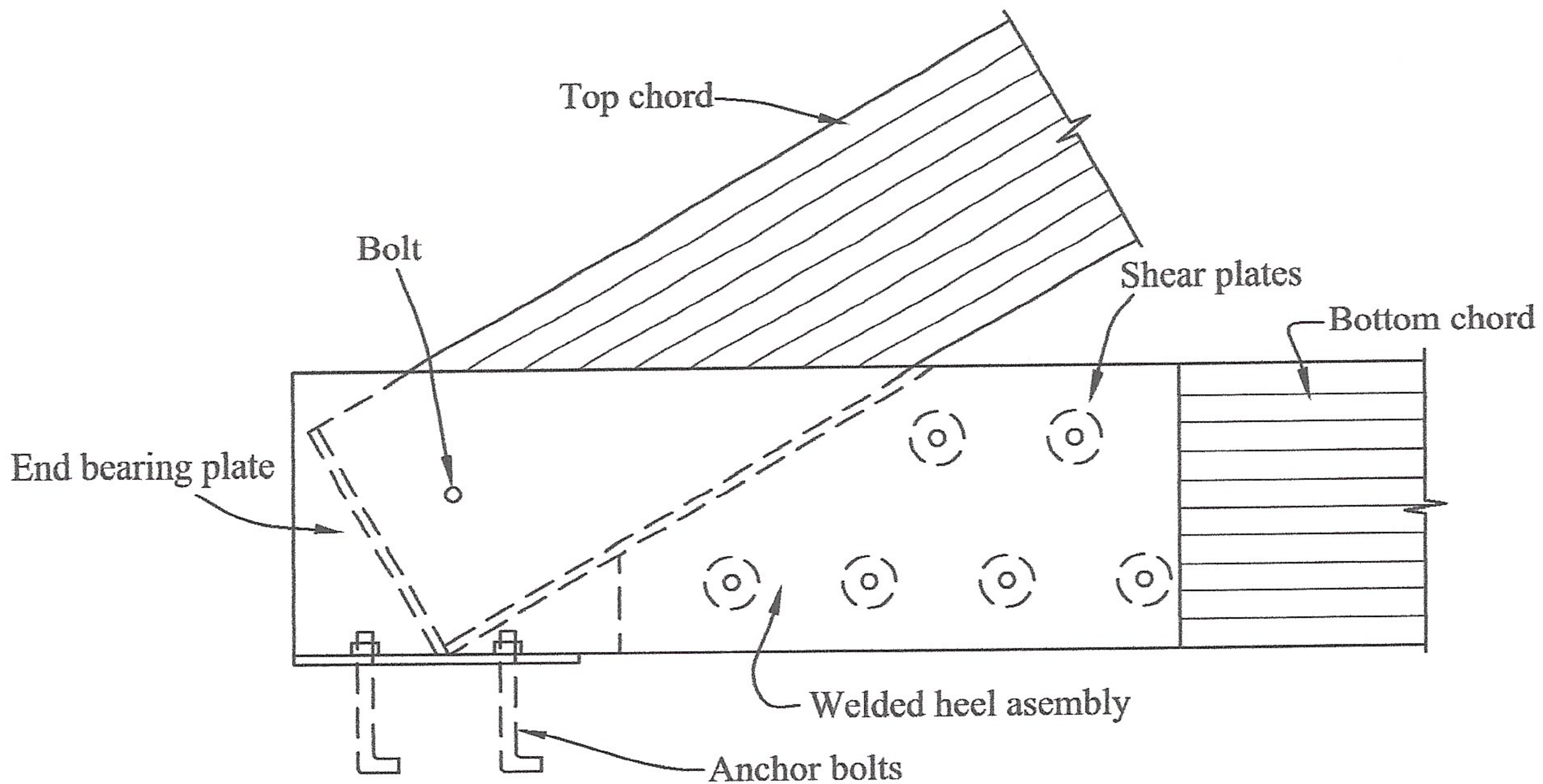
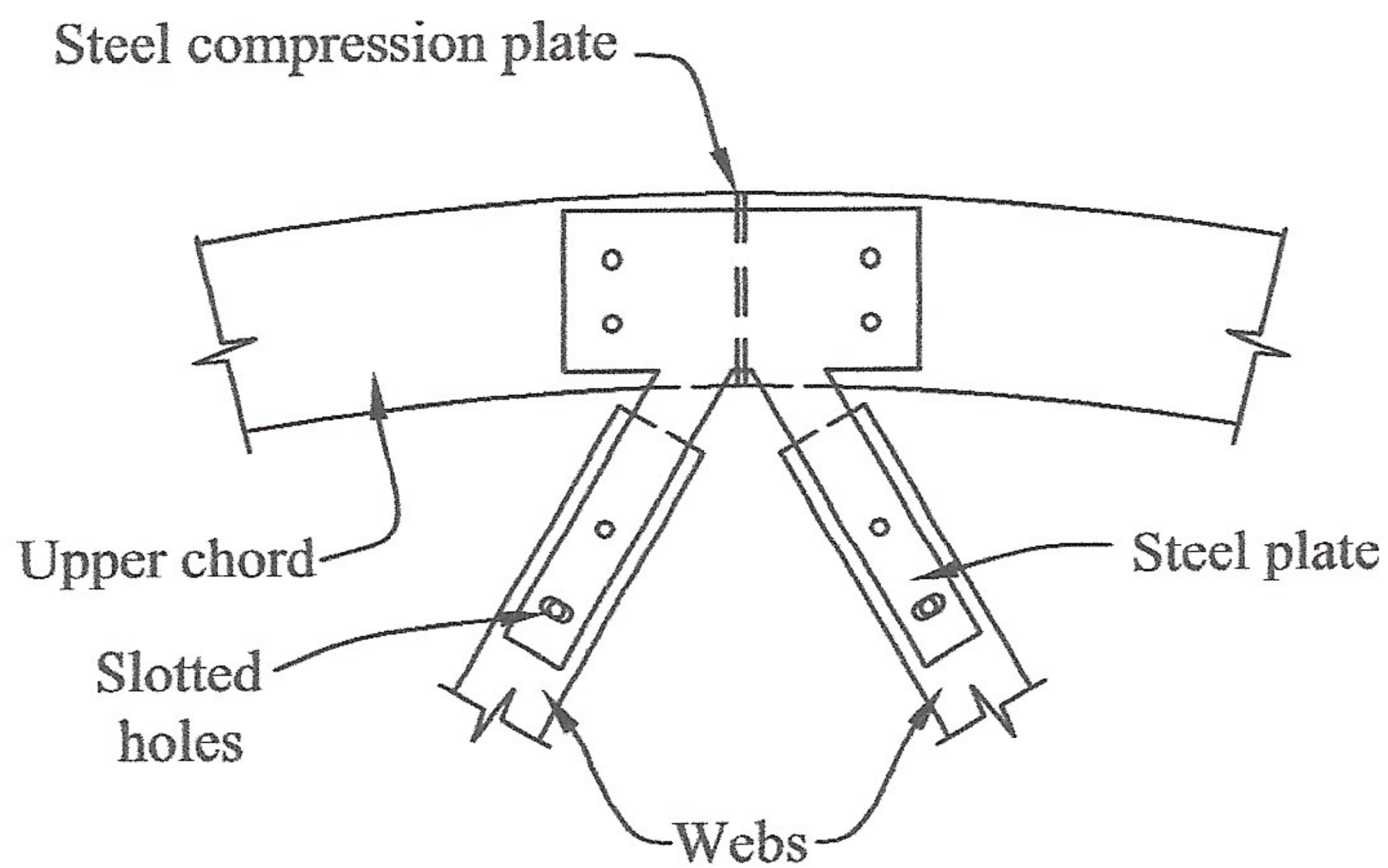
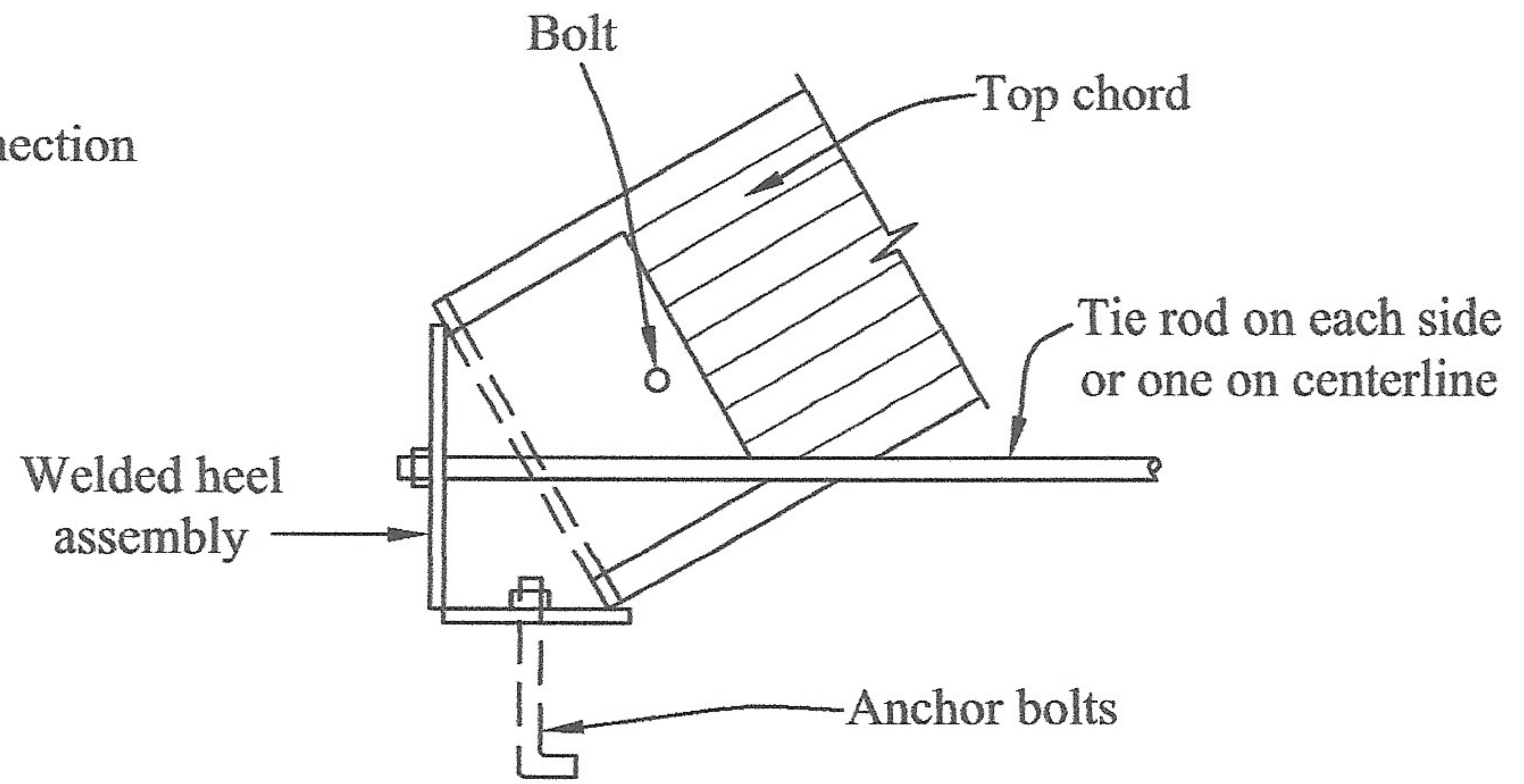


Figure 9.5 Truss Heel Connection. If substantial cross grain shrinkage is anticipated, double steel straps may be used in place of single plate along bottom chord.

Figure 9.6 Rod-Tied Arch Heel Connection



10. SUSPENDED LOADS

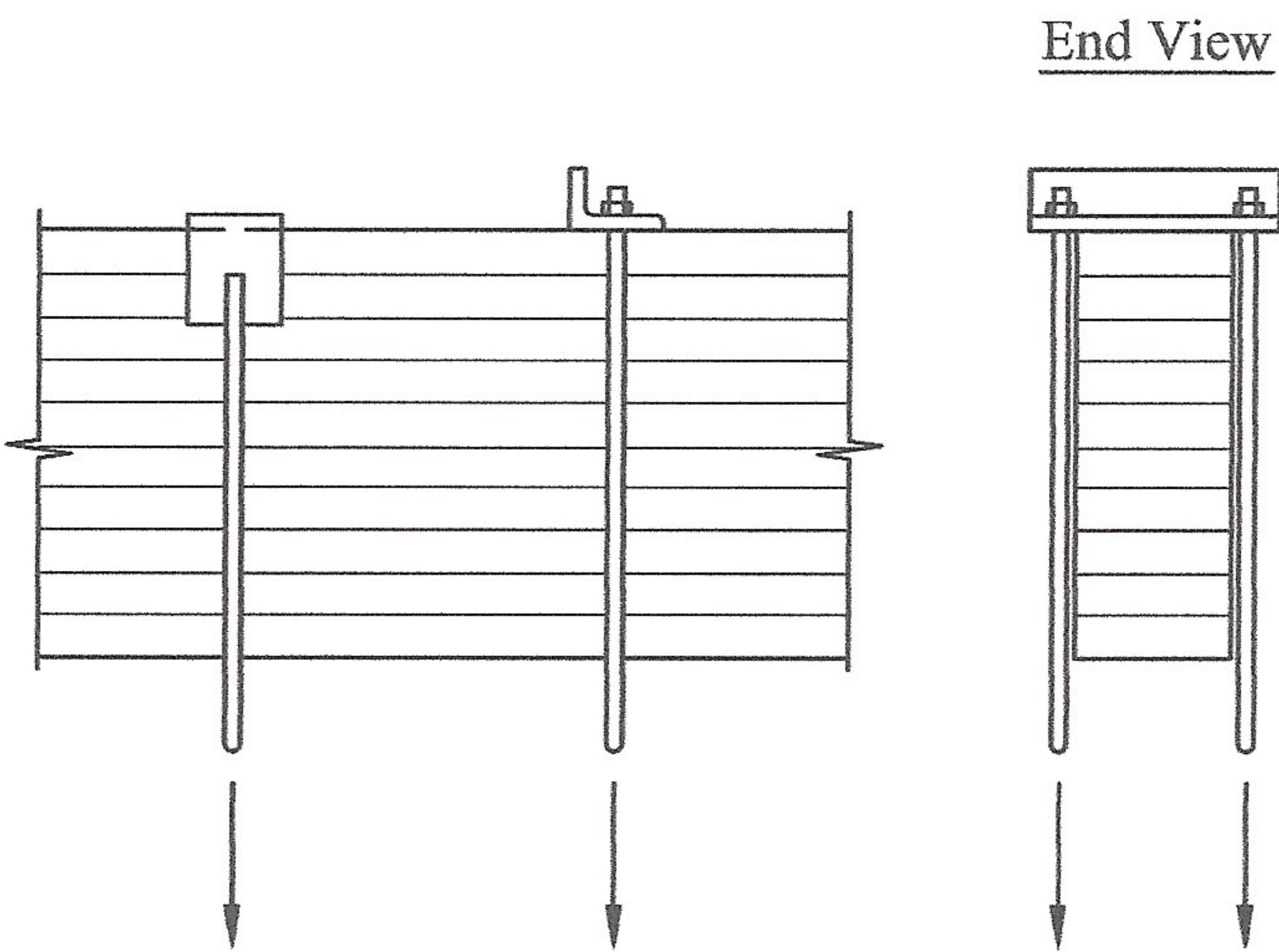
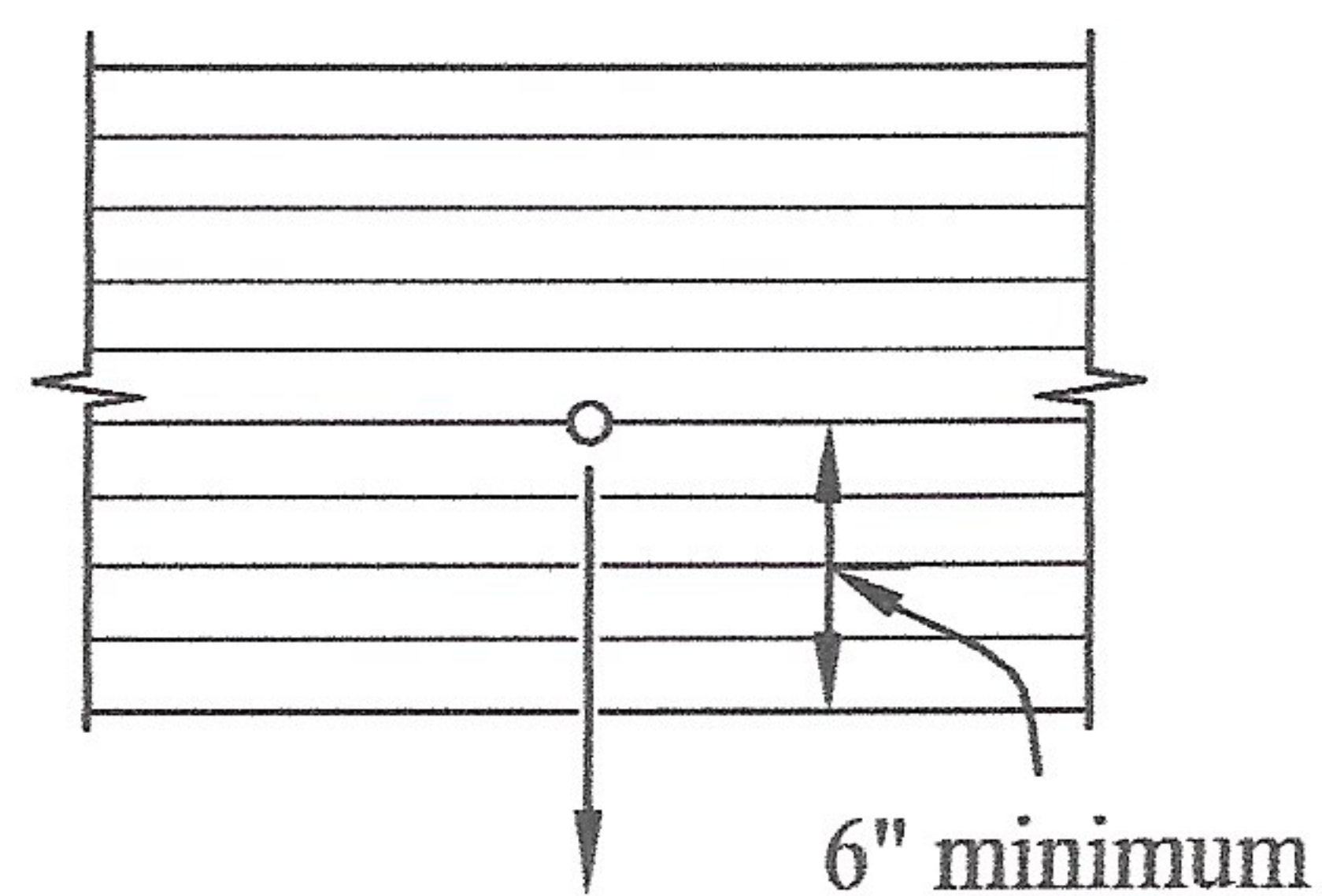


Figure 10.1 Loads suspended from glued laminated timber beams should be resisted from the top of the member or at least above the neutral axis.

Figure 10.2 Light loads such as small conduit may be suspended with small fasteners near the bottom of glued laminated timber beams as shown.



11. DETAILS TO PROTECT AGAINST DECAY

Figure 11.1 Wood Member near Continuous Masonry Wall. Minimum of 1/2 in. air space between member and wall or adequate moisture barrier must be provided. For arches, additional space may be required to permit outward deflection of the arch leg.

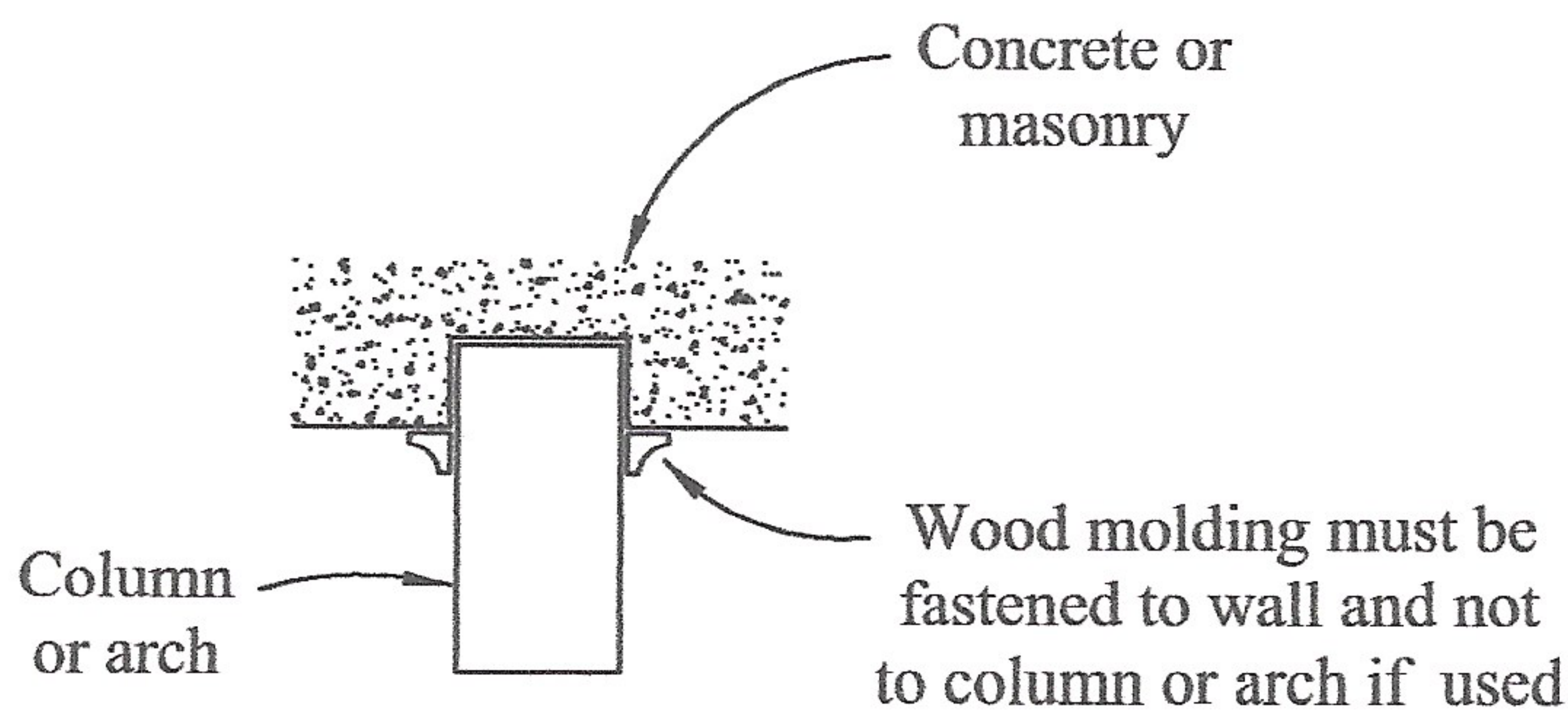
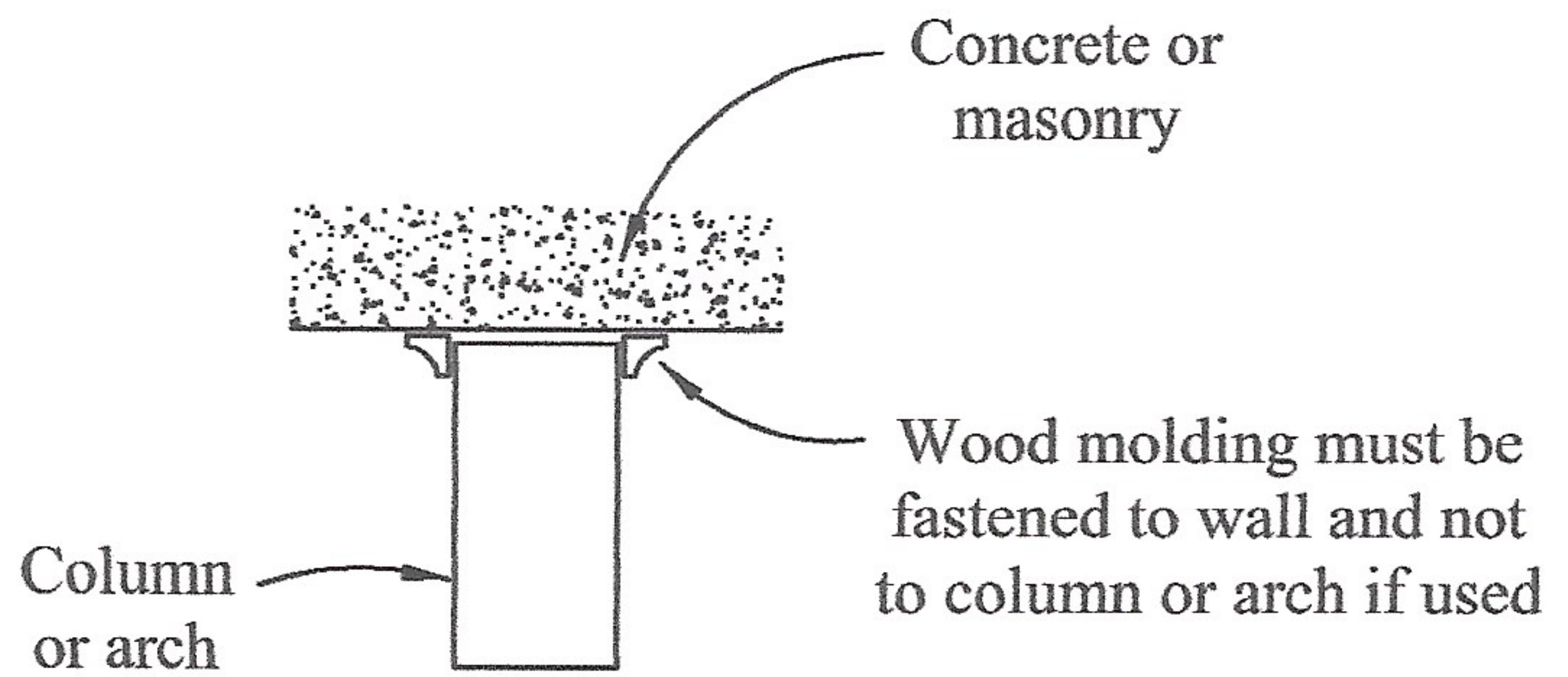


Figure 11.2 Wood Member Set in Masonry Wall Pocket. Minimum of 1/2 in. air space between member and wall pocket or adequate moisture barrier must be provided. For arches, additional space may be required to permit outward deflection of the arch leg.

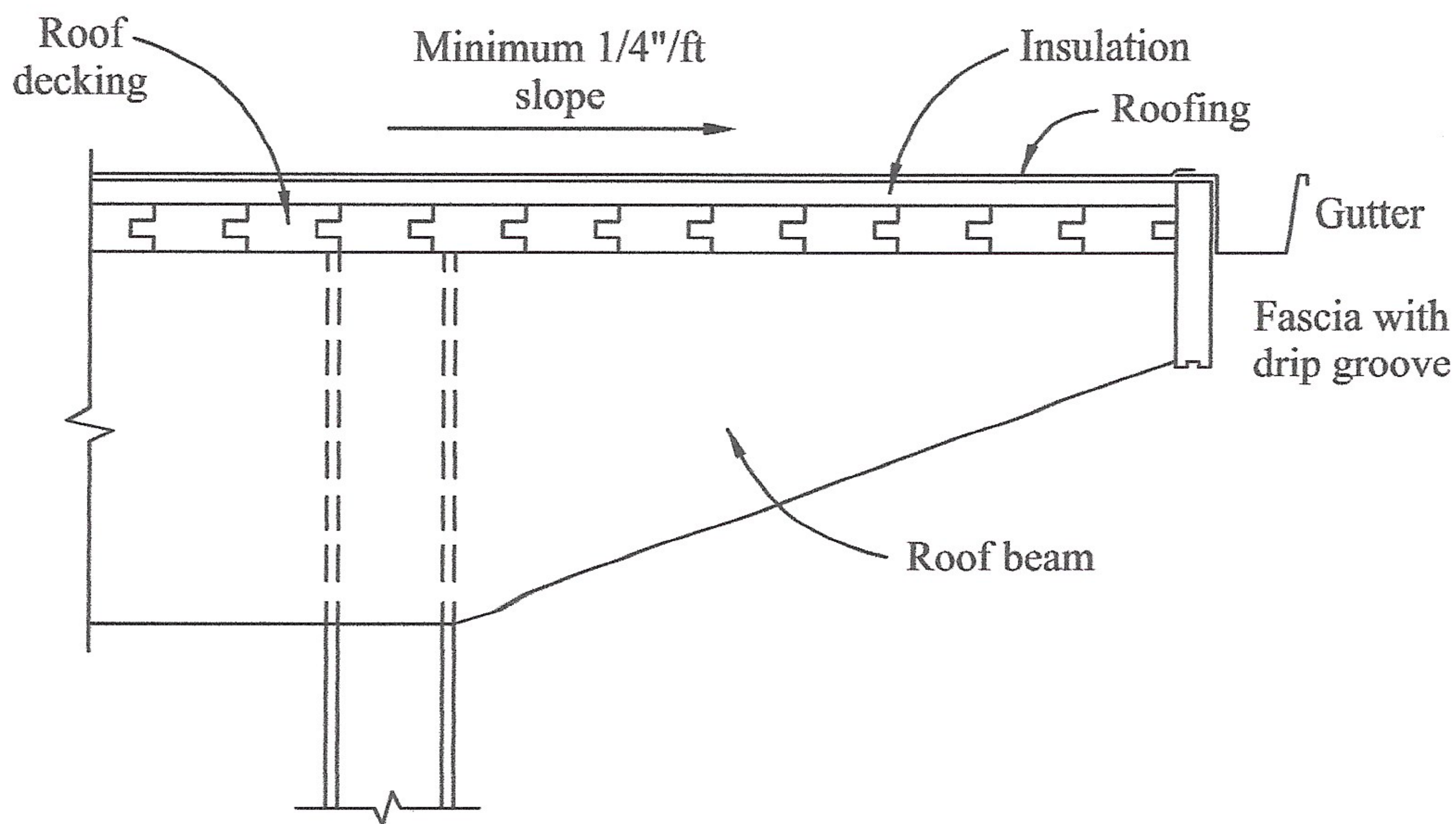


Figure 11.3 Protection Considerations for Buildings with Covered Overhang. Beam is protected from direct exposure to weather by fascia. Roof should be sloped for drainage and designed to prevent ponding of water. Fascia should be preservatively treated or made from decay-resistant species. Taper cut should be sealed.

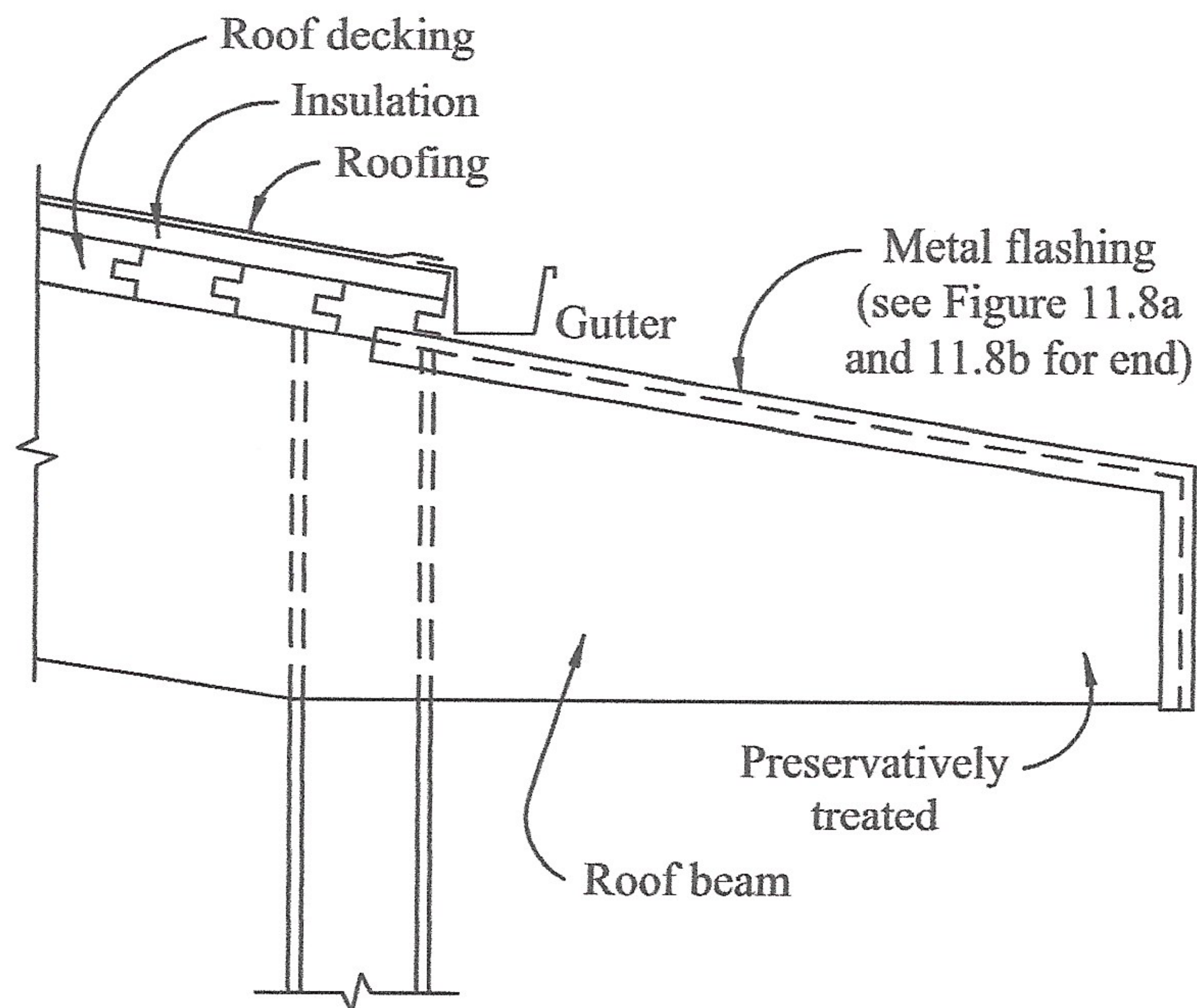


Figure 11.4 Protection Considerations for Buildings With Uncovered Overhang. Portion of beam extending outside of building should be protected by metal cap and preservative treatment. Periodic refinishing of the surfaces exposed to the weather will be required to maintain appearance.

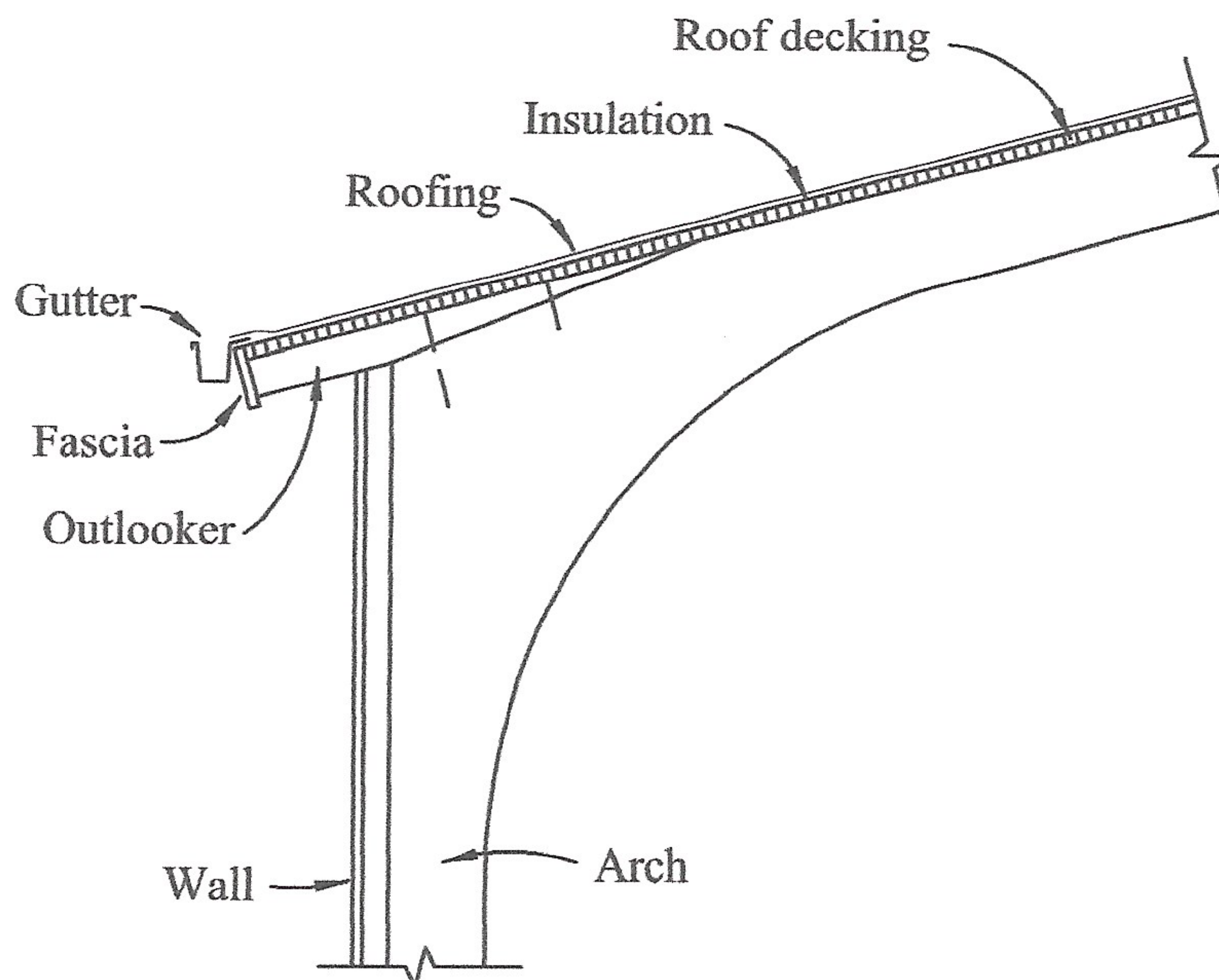


Figure 11.5 Protection Considerations for Arch Outlooker Overhang. Outlooker is protected from direct exposure to weather. Arch is protected by wall from direct exposure to the weather.

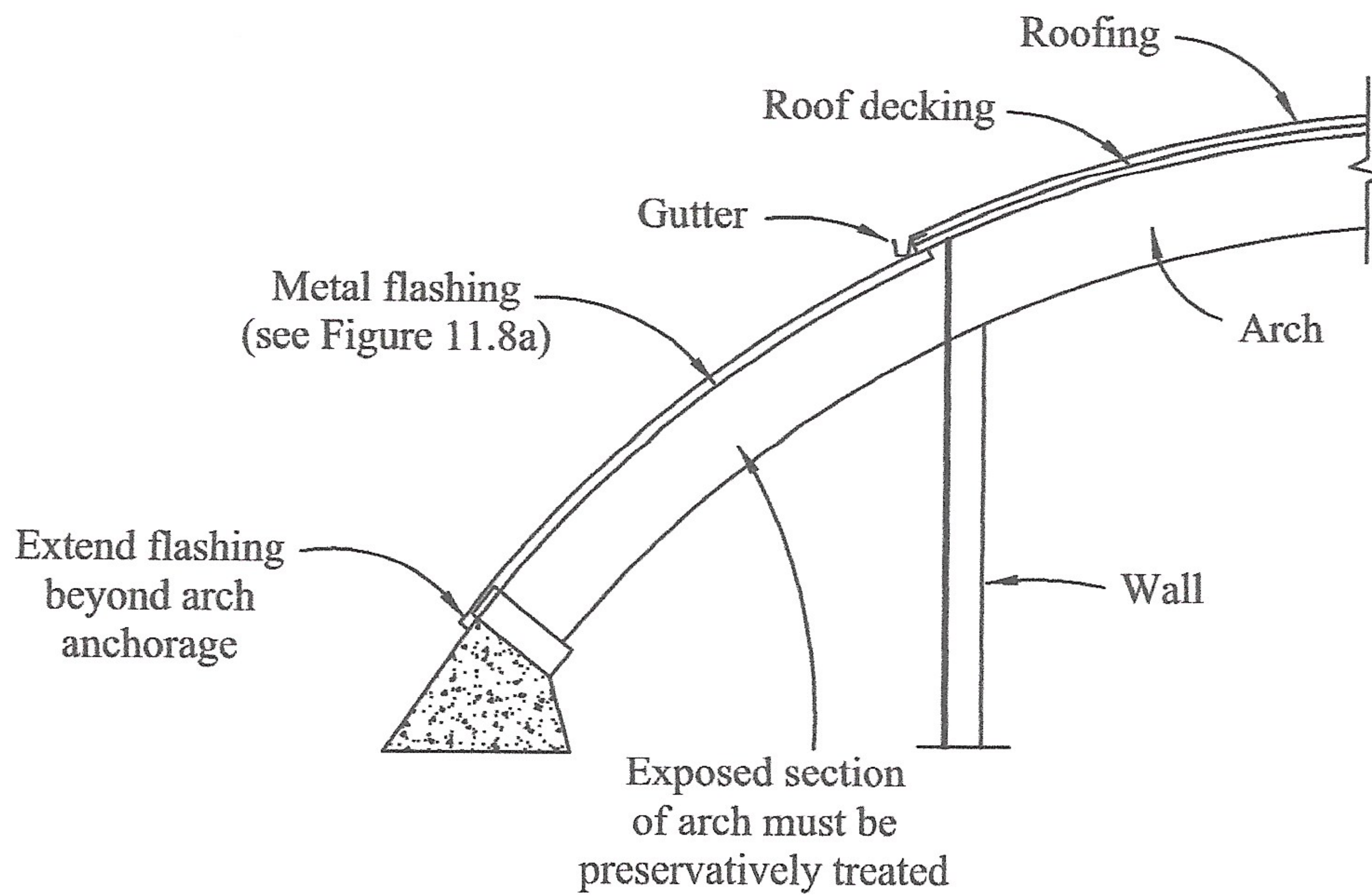


Figure 11.6 Protection Considerations for Partially Exposed Arches. Portion of arch leg extending outside of building should be protected by metal flashing and preservative. At least 12 in. clearance must be provided between arch base and grade. Preservative treatment in accordance with *Standard for Preservative Treatment of Structural Glued Laminated Timber*, AITC 109, must be used for exposed portion of arch.

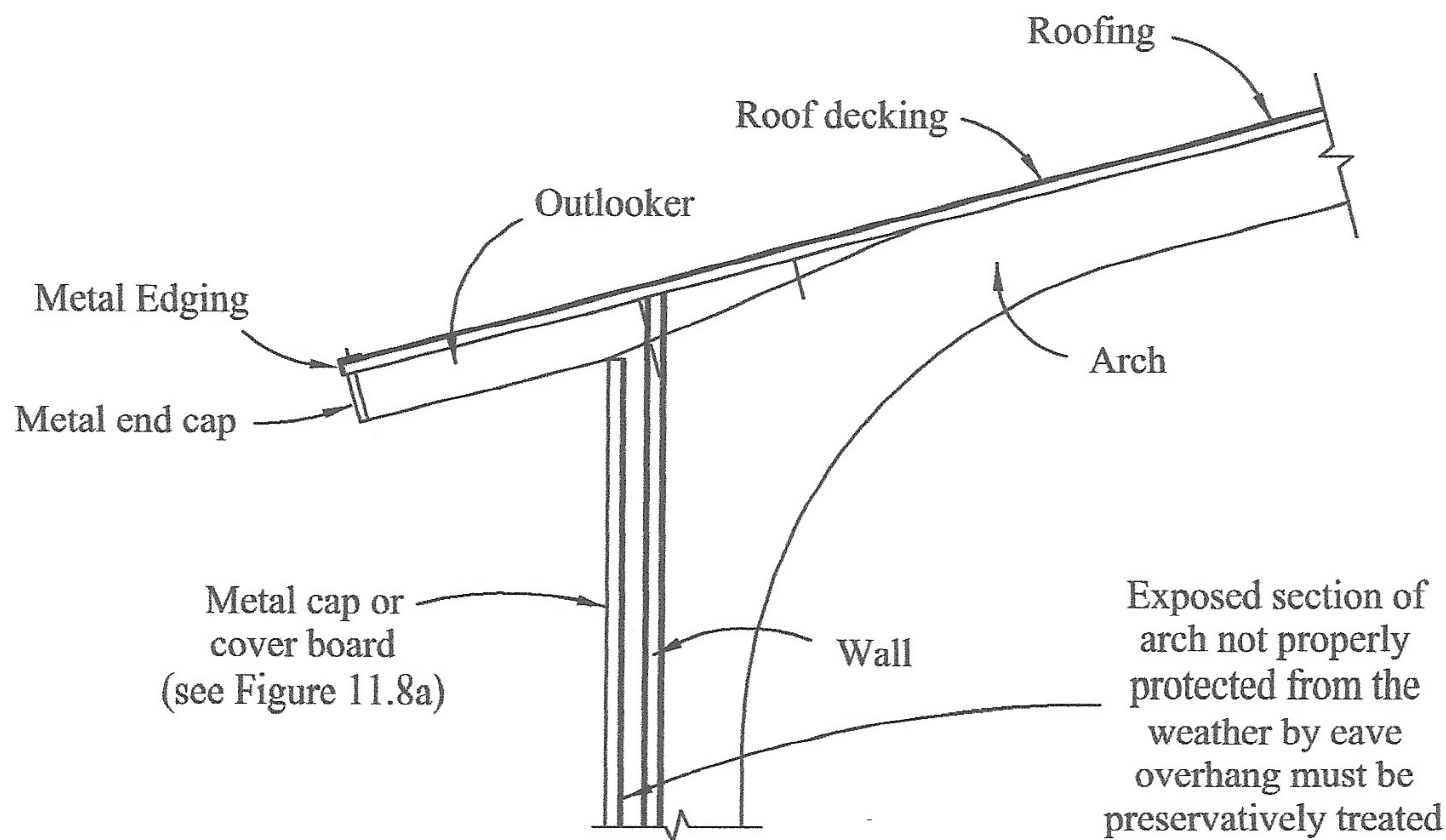
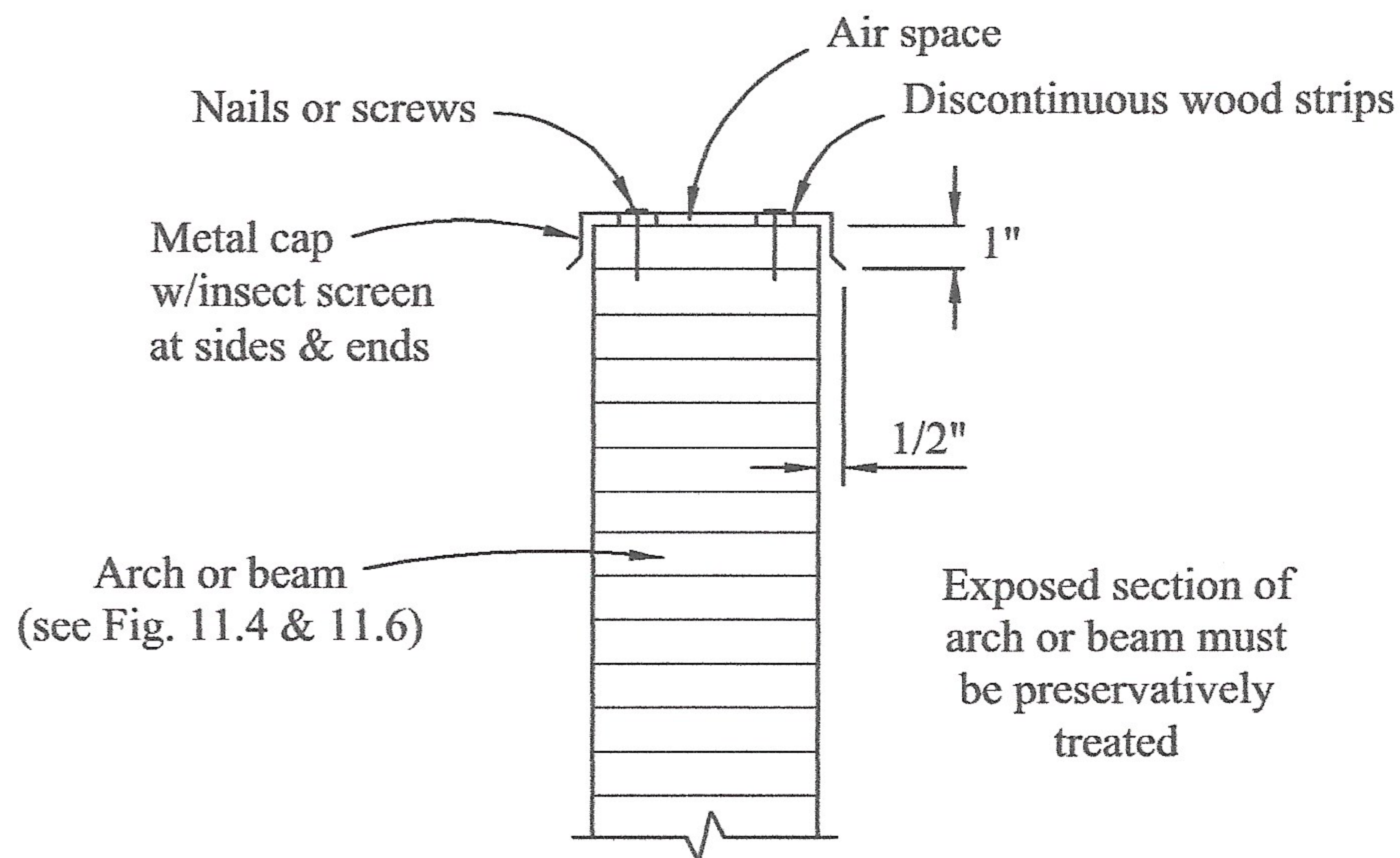
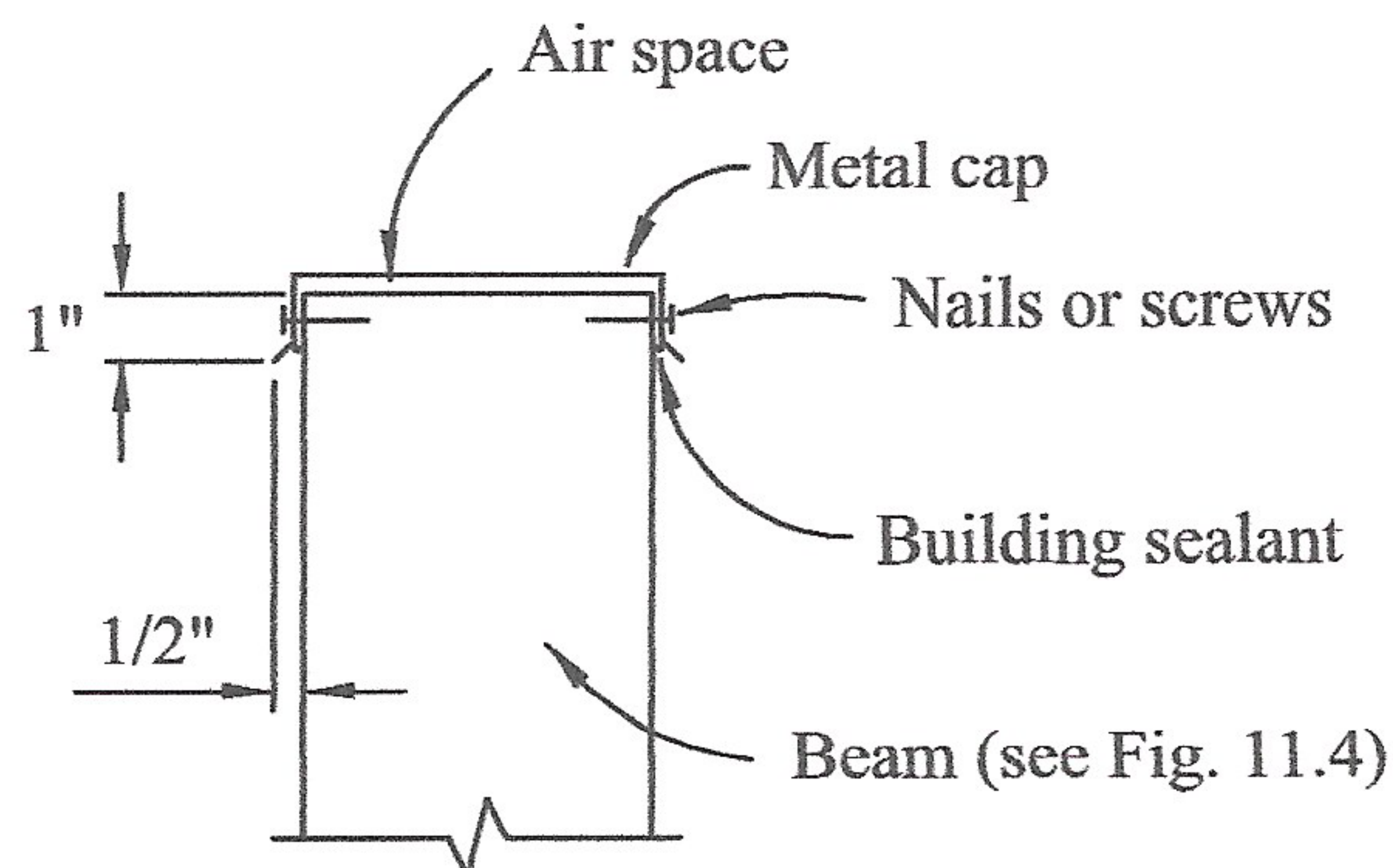


Figure 11.7 Arch Leg Protection. Metal end cap or treated cover board should be used on edge of exterior portion of arch in conjunction with preservative treatment of the arch leg. Metal cap is as illustrated in Figure 11.8. Cover board should be vertical grain material set in building sealant and attached with weatherproof nails or screws. All wood with exterior exposure must be adequately protected and maintained.



a) Top cap for horizontal or sloped members



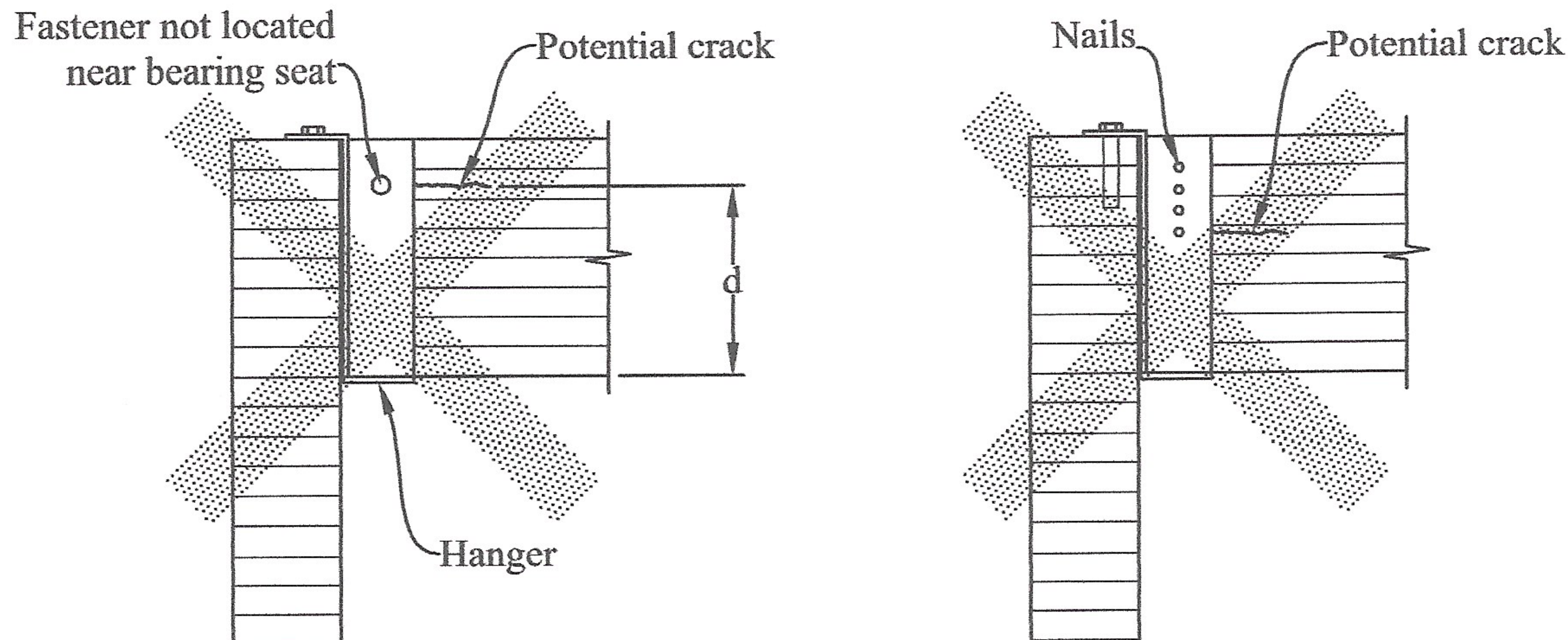
b) End cap for exposed beams or vertical members

Figure 11.8 Protection Metal Cap or Flashing Details. Caps or flashings are made of 20-gage minimum thickness weatherproof metal. Nails or screws are weatherproofed and heads are sealed with building sealant or neoprene washers. A minimum of 1/2 in. air space must be provided between cap and the face of the wood section. For vertical use conditions, a continuous bead of building sealant is required.

APPENDIX TO AITC 104

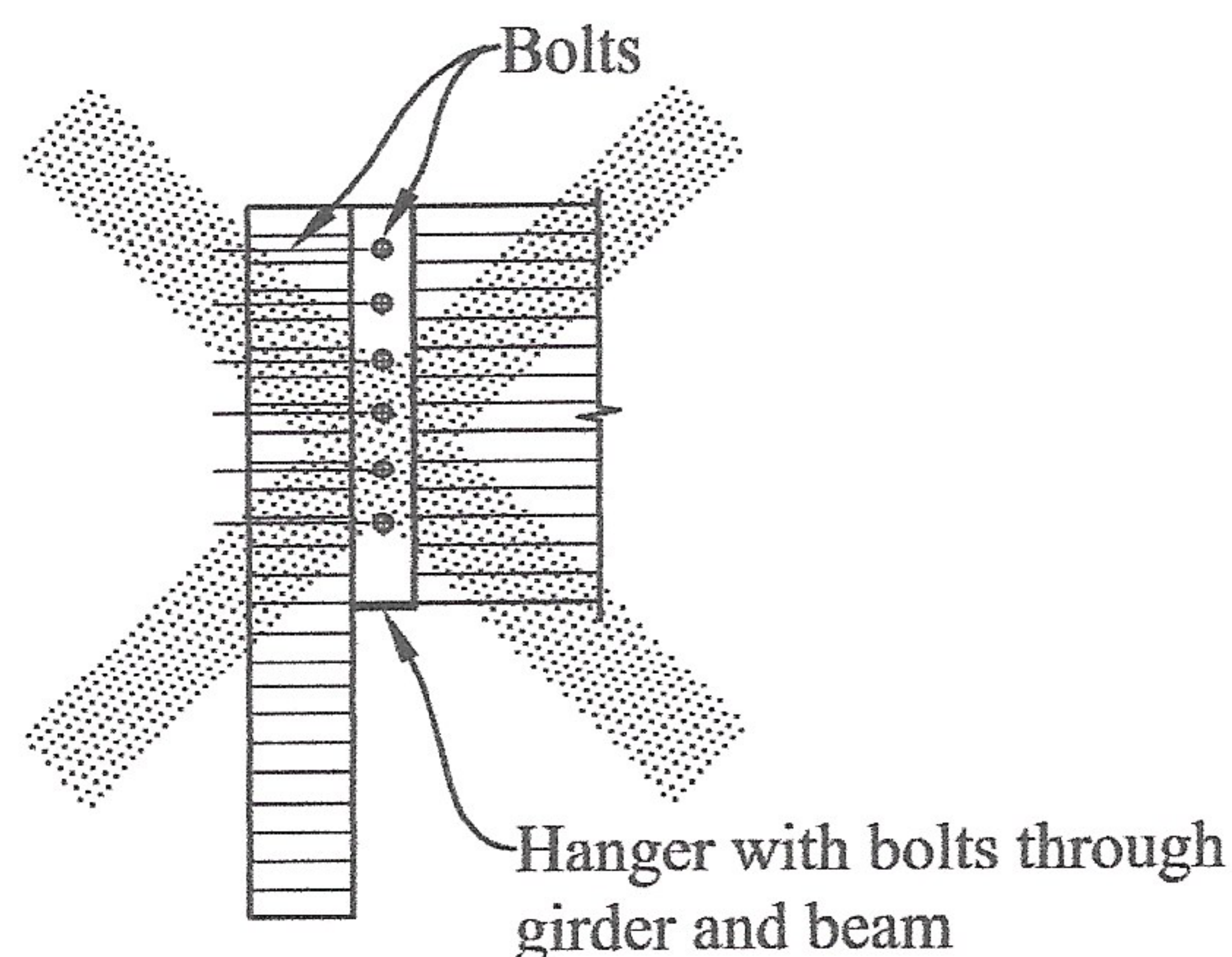
CONNECTION DETAILS TO BE AVOIDED

The following are examples of poor detailing practice and suggestions for improvement of the poor details.



Detail A1 - Glued laminated timbers, although relatively dry at the time of manufacture, may shrink as they reach equilibrium moisture content in service. When fasteners are not located near the bearing seat but in the upper portion of the beam, shrinkage in the beam over the depth, d , can cause the beam reaction to be carried by the fasteners rather than in the bearing on the hanger. This induces notch shear and tension perpendicular to grain stresses that can cause splitting along the beam as shown.

SUGGESTED REVISION - Detail the connection as shown in figure 4.1 with the fasteners located near the bearing seat, or slot the hole in the steel hanger and place the fastener in the top of the slot.

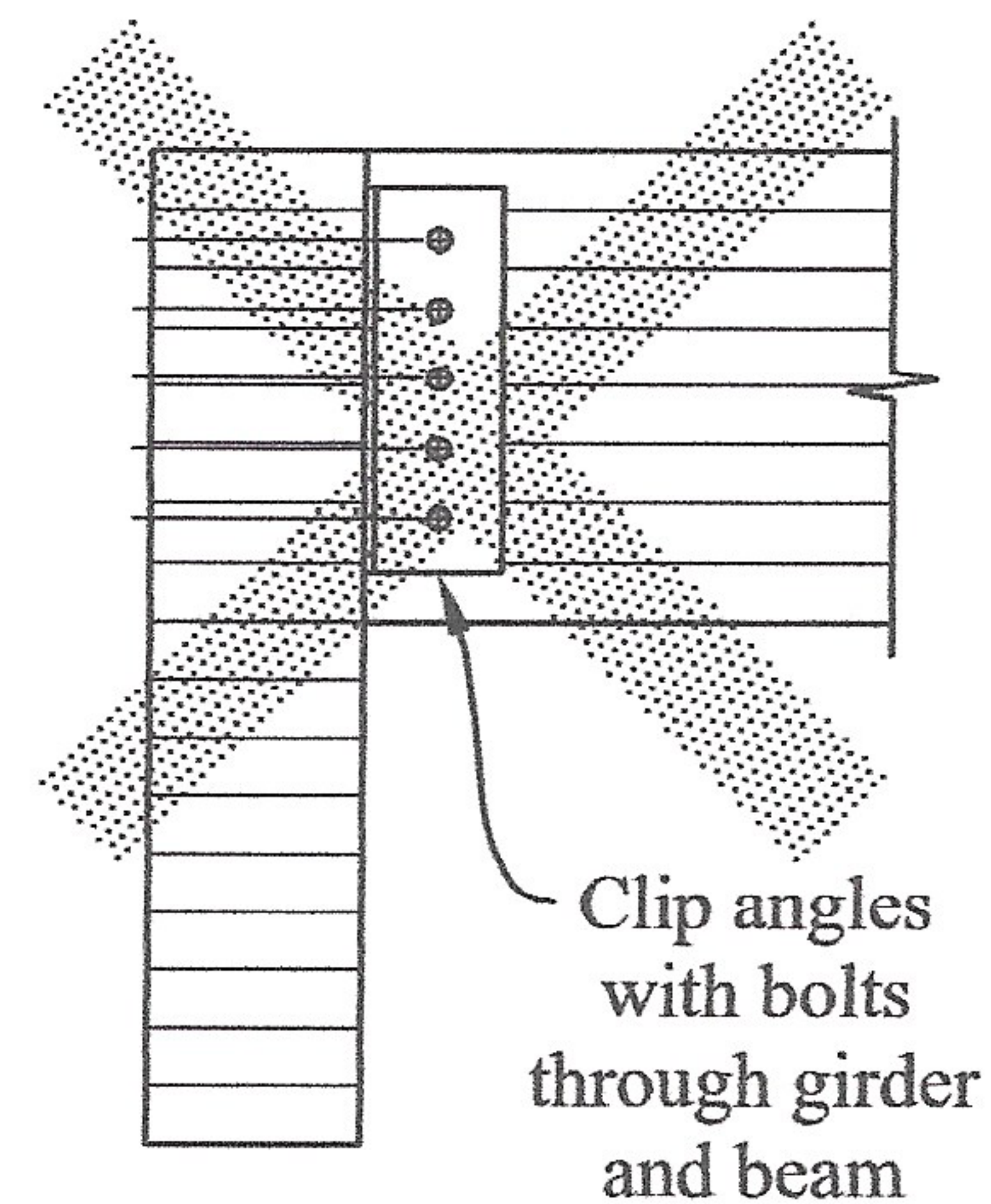
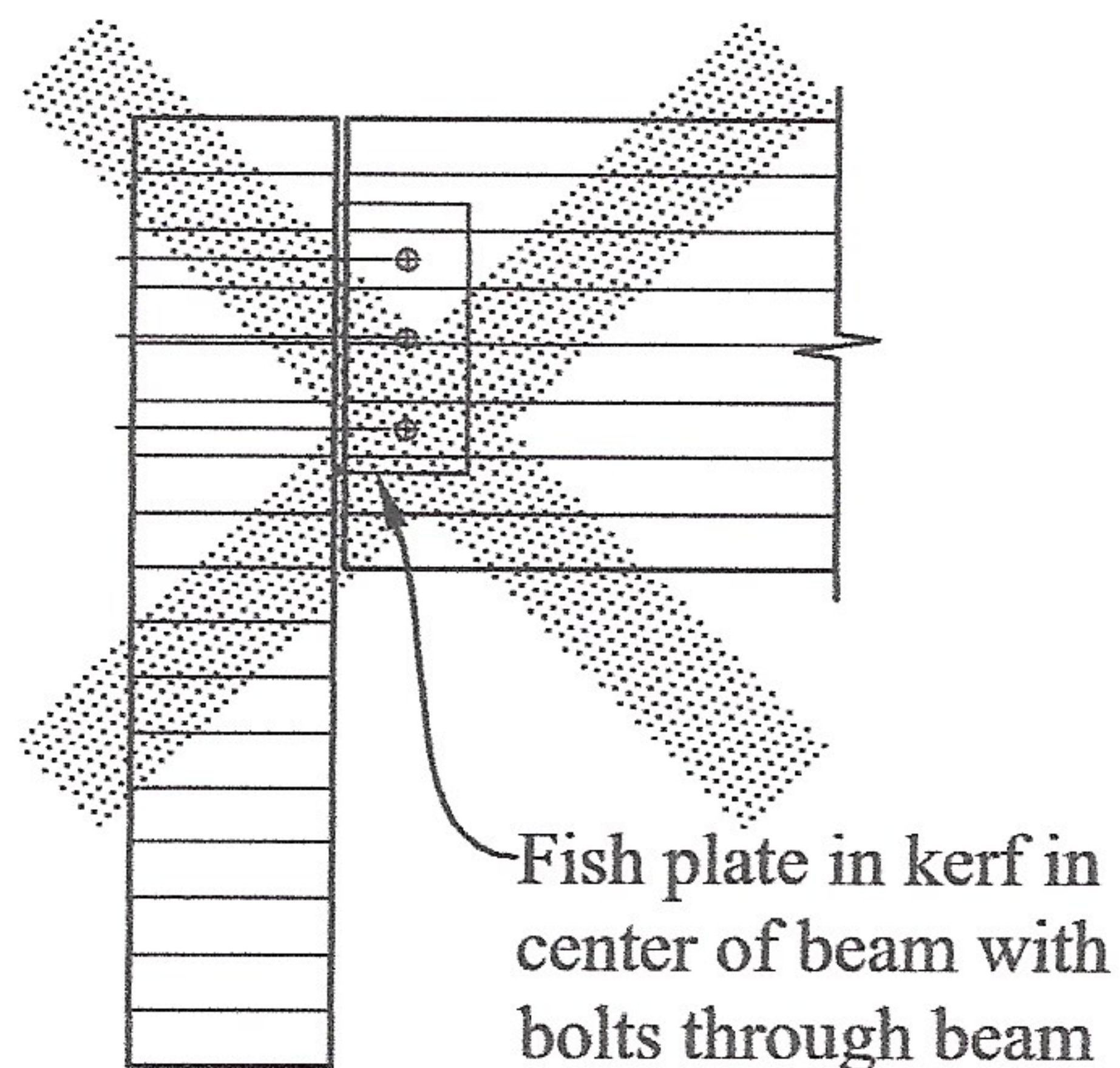


Detail A2 - This detail is similar to Detail A1 in that shrinkage in the beam can result in the bearing being carried by the fasteners rather than the bearing on the hanger seat which, in turn, results in notch shear and tension perpendicular to grain stress. Also, see Detail A3 concerning long rows of fasteners perpendicular to grain as it relates to the hanger-to-girder connection. Section 1.8 discusses the effect of end rotation on the fasteners in this type of connection.

SUGGESTED REVISION - Detail the connection as illustrated in Figure 4.3 with the fasteners in the beam located near the bearing seat and the fasteners in the girder grouped near the top of the girder.

Detail A3 - End connections which include long rows of fasteners perpendicular to grain through steel side members should be avoided. Shrinkage of the wood will be restrained by the steel resulting in tension perpendicular to grain stresses. Because the beam is not supported by a bearing plate, notch shear and tension perpendicular to grain stresses at the end of the beam will also result. The individual or combined effect may cause splitting of the member. See also section 1.4

SUGGESTED REVISION - Change to a bearing connection as shown in Figure 4.1 with the beam being supported in bearing and the fasteners located only near the bearing seat.

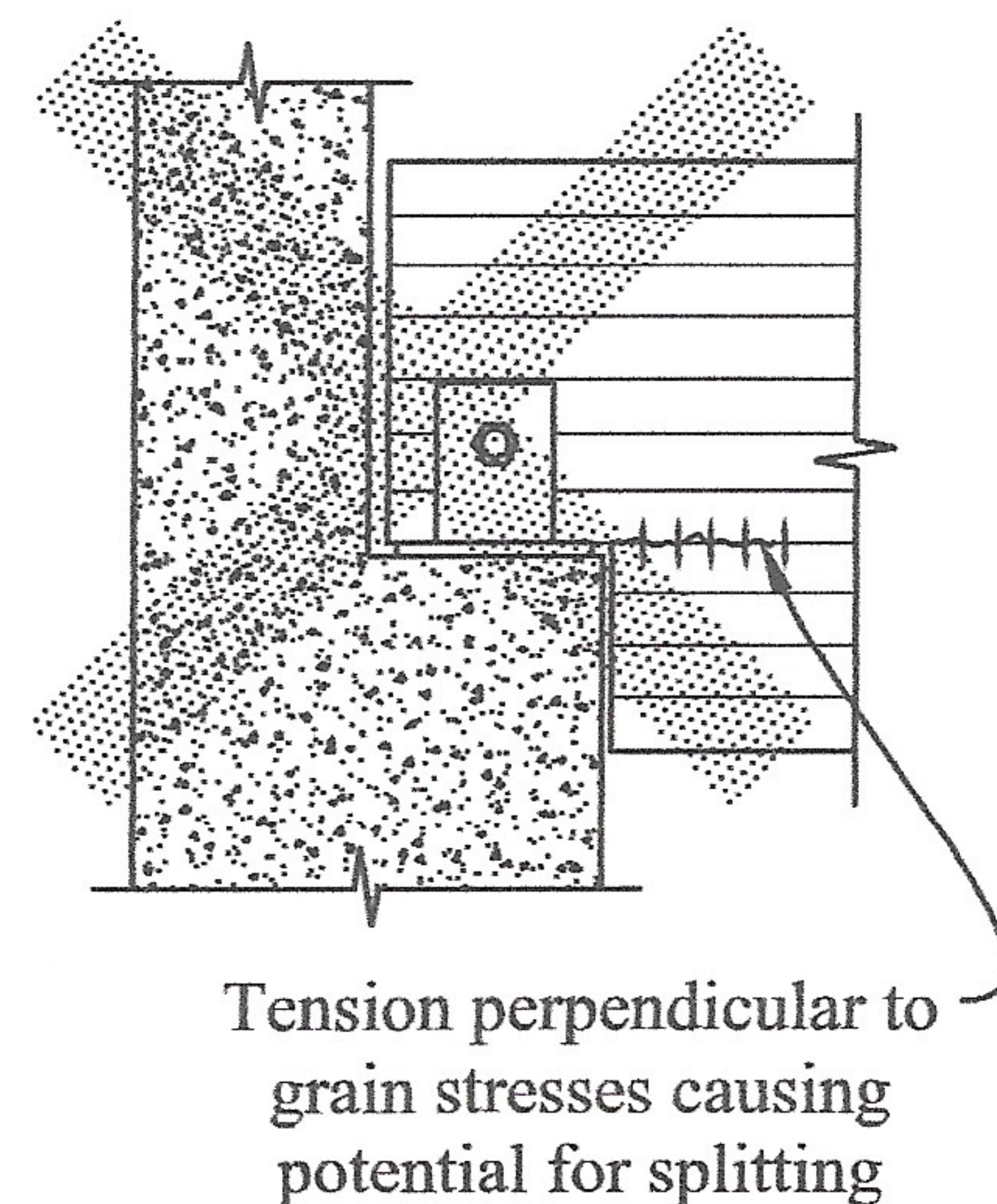


Detail A4 - This detail is similar to Detail A3 except that the beam is supported by bolts through the plate located in a saw kerf in the center beam. See also Section 1.4

SUGGESTED REVISION - Detail the connection as shown in Figure 4.6 where a bearing seat has been added and the bolts away from the bearing seat have been omitted.

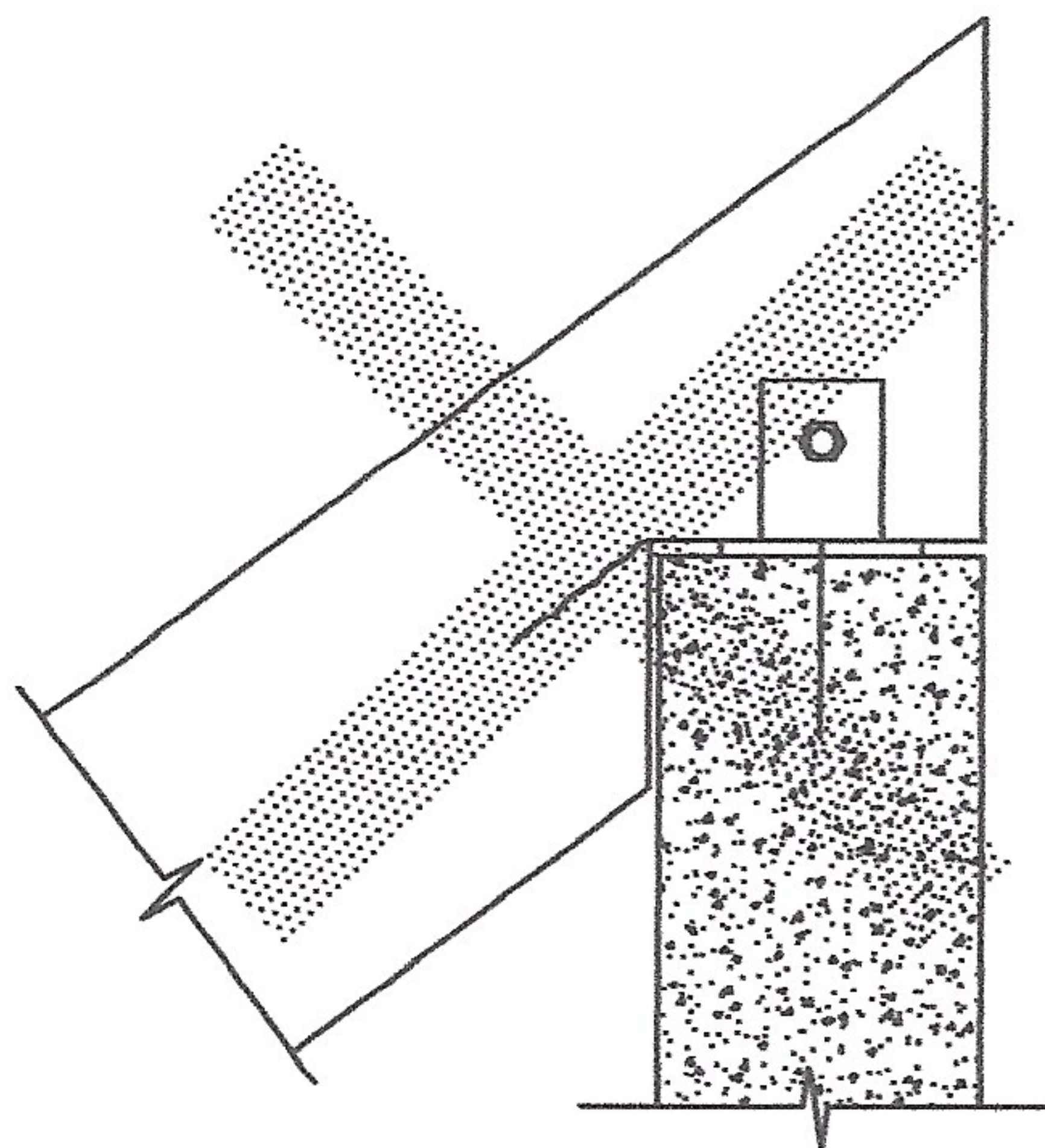
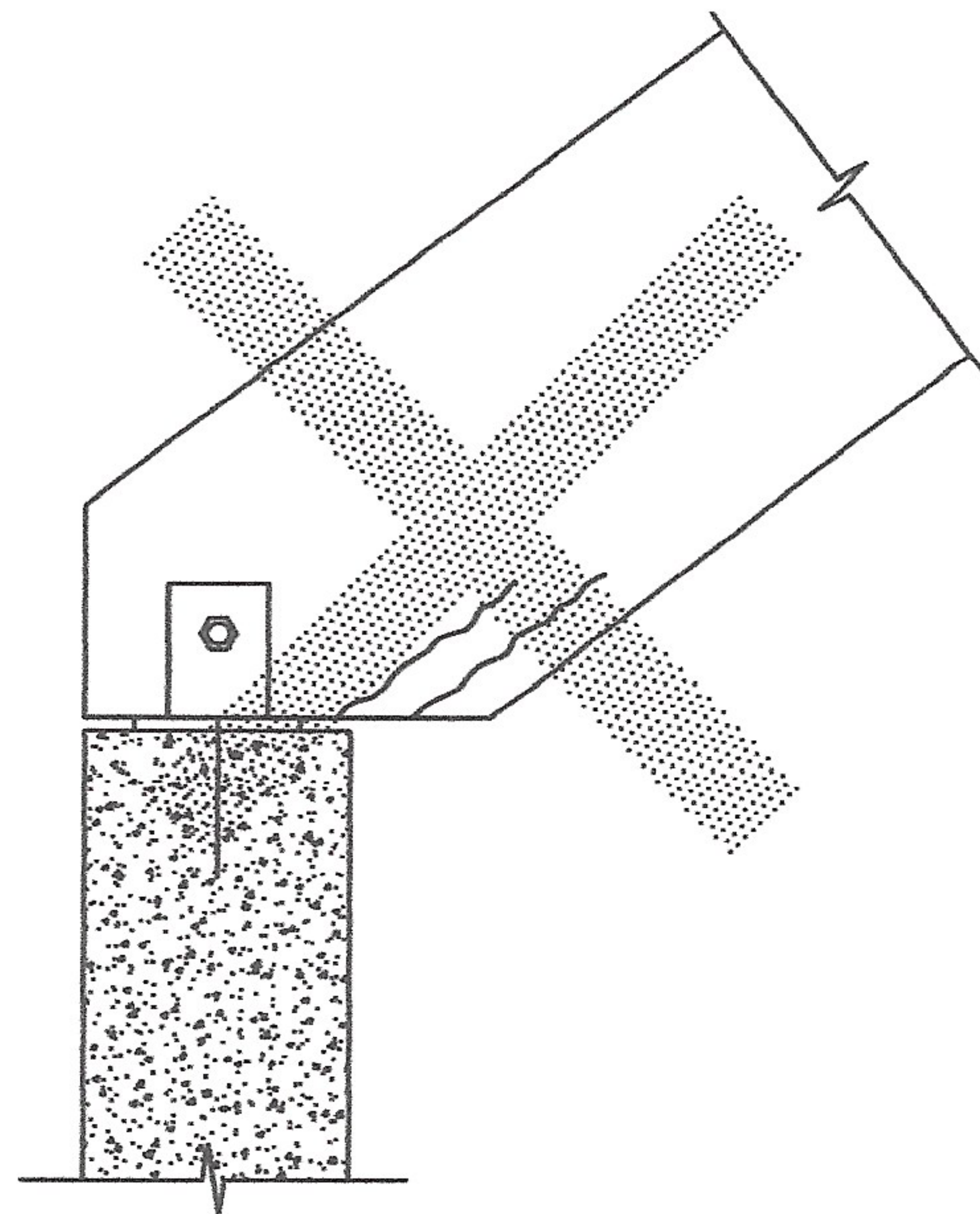
Detail A5 - An abrupt notch in the end of a wood member creates two problems. One is that the effective shear strength of the member is reduced because of the end notch. The other is that the exposure of end grain in the notch will permit a more rapid migration of moisture in the upper portion of the member. The individual or combined effect may cause the indicated split.

SUGGESTED REVISION - Detail the connection as shown in Figure 2.1 without the end notch. Notches are not recommended on the tension side of glued laminated timber, but if used, they should not exceed the lesser of 10 % of the depth or 3 inches and shear stresses should be checked by the notched beam formula.



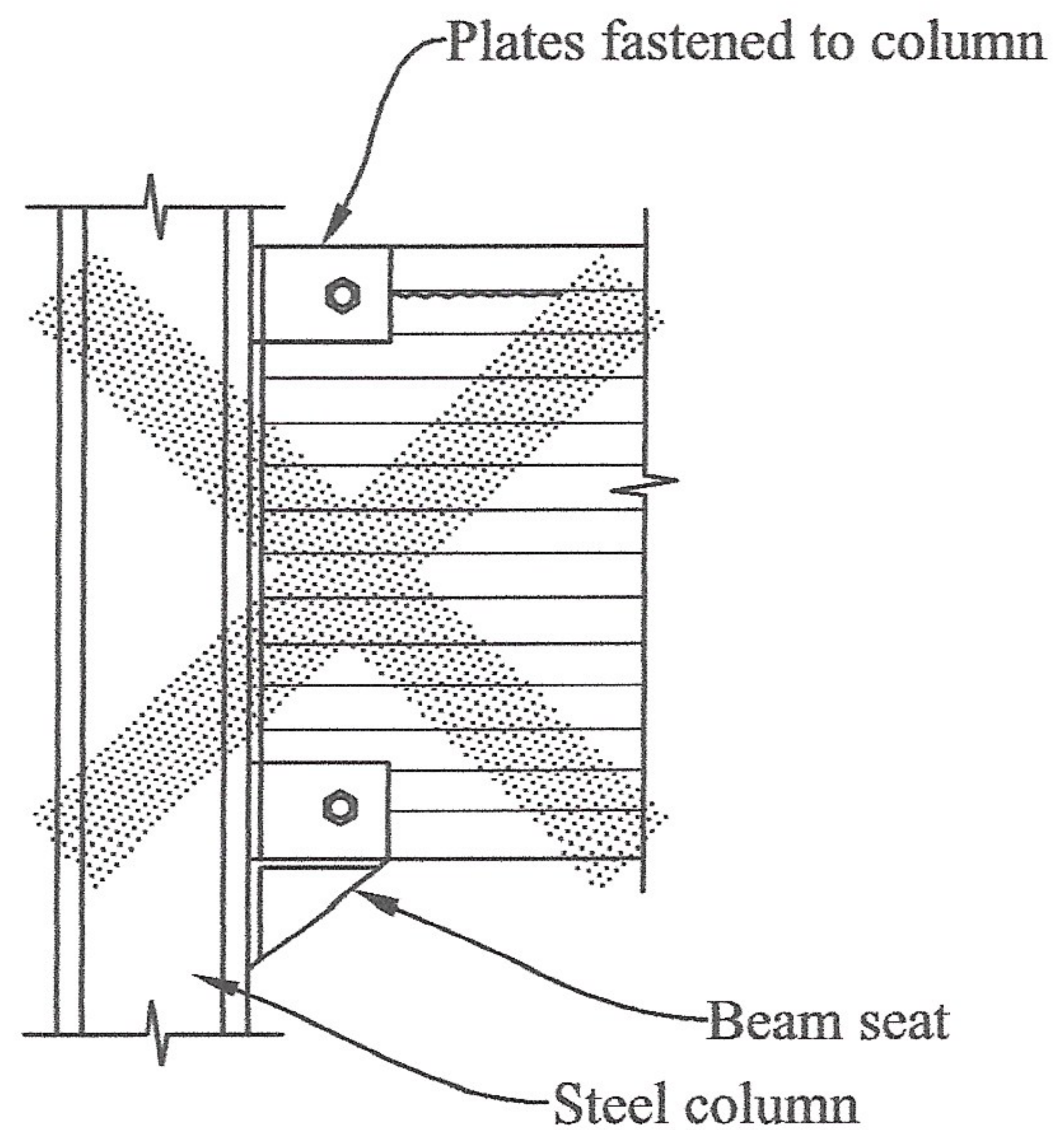
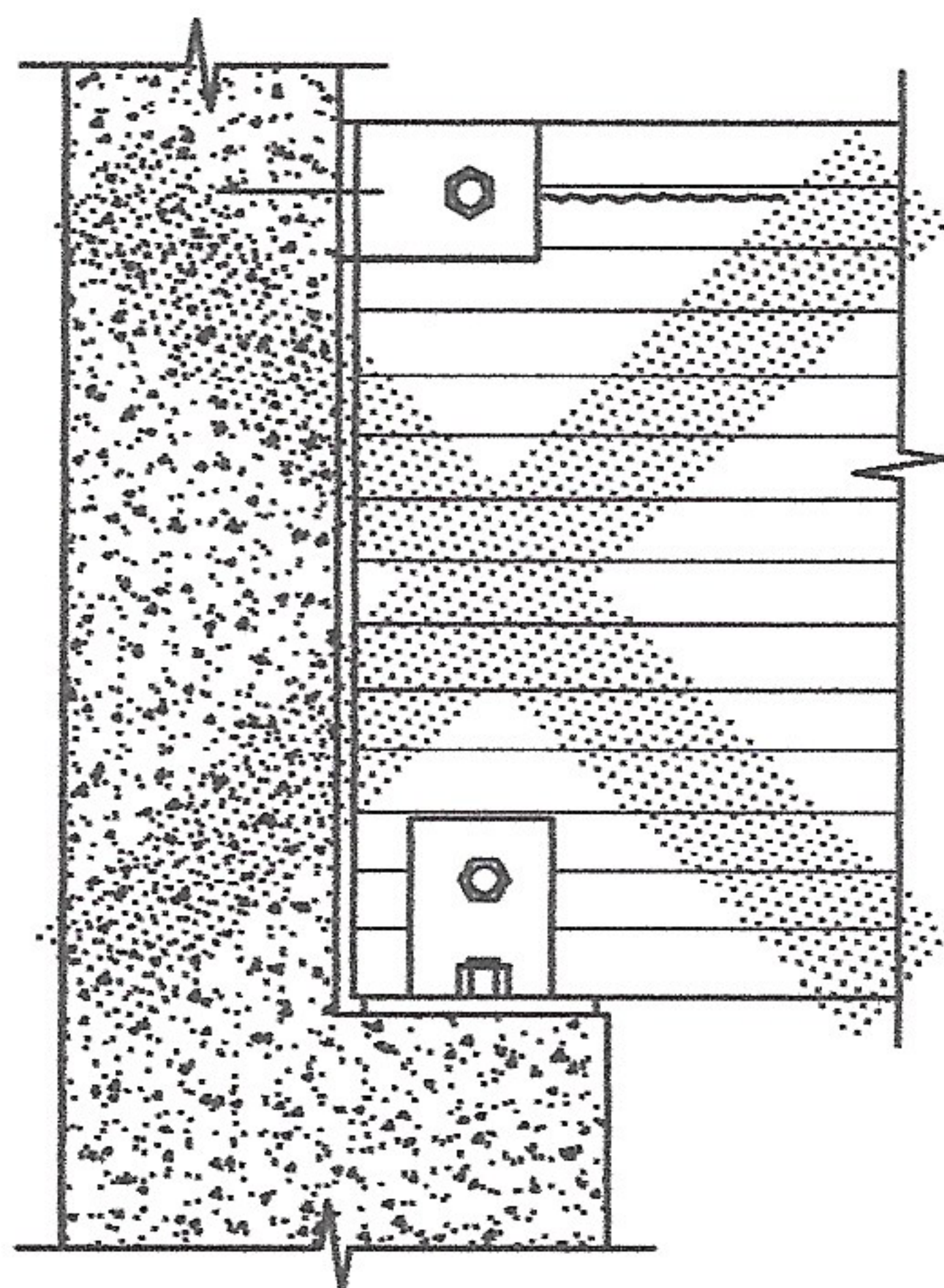
Detail A6 - This condition is similar to that shown in Detail A5. The shear strength of the end of the member is reduced, tension perpendicular to grain stresses are induced and the exposed end grain may result in splitting because of rapid drying.

SUGGESTED REVISION - Revise the taper cut to provide bearing as shown in Figure 2.6.



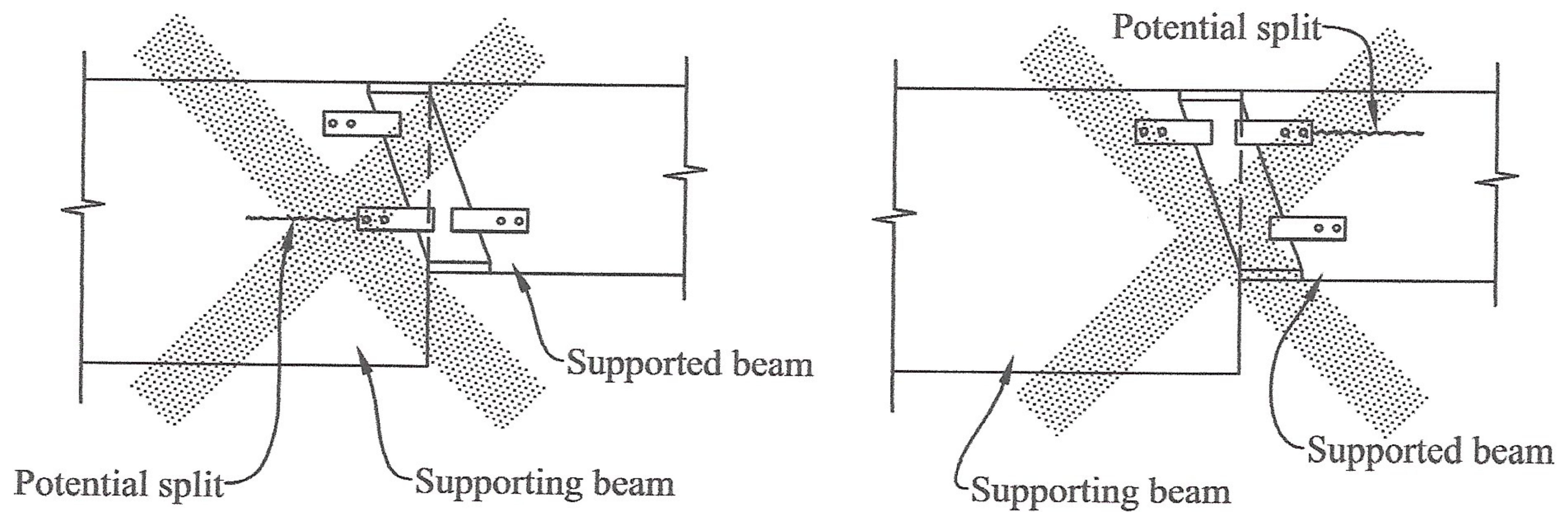
Detail A7 - This detail at the upper end of a sloped beam is similar to the notched beam detail shown in Detail A5.

SUGGESTED REVISION - Provide a sloping seat as shown in Figure 2.7.



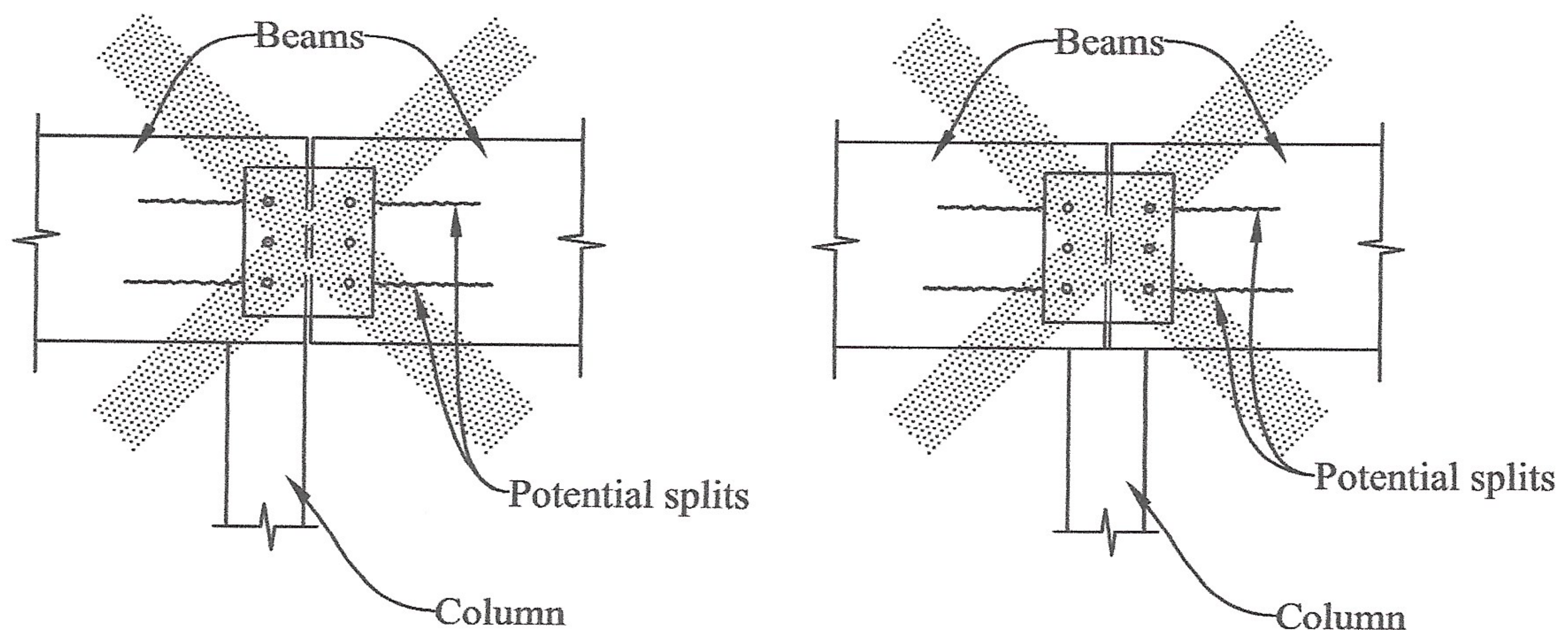
Detail A8 - In this situation, the beam is bearing on the beam seat and the top is laterally supported by clip angles or similar hardware. In a deep beam, the shrinkage due to drying reduces the depth of the beam and will create a split at the upper connection. This connection will also resist deflection of the beam, creating a horizontal reaction force that may cause damage to the wall or the beam.

SUGGESTED REVISION - Provide restraint against lateral rotation without restraining the member against shrinkage or deflection as shown in Figure 2.8.



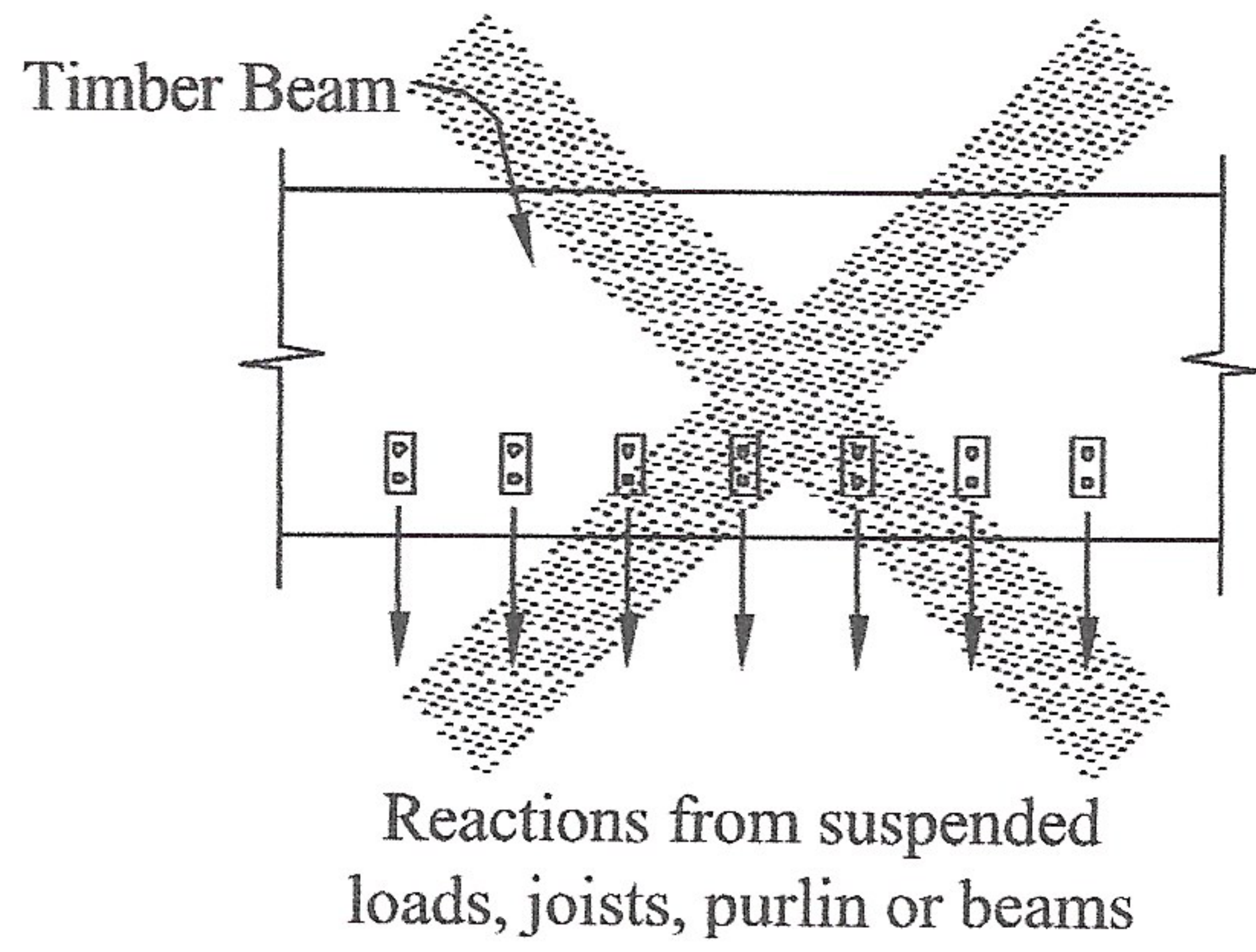
Detail A9 - When a tension connection across a cantilever beam hanger is designed using integral tabs either at the top or bottom of the hanger, splitting may occur due to shrinkage between the bearing point of the hanger and the bolts as shown.

SUGGESTED REVISION - Detail as shown in Figure 3.1 for suggested cantilever hanger with a loose tension tie. If tabs are provided as shown, detail vertically slotted holes in the tabs and locate the bolts in the end of the slot farthest from the bearing seat. Bolts in slotted holes should be hand tightened only so that movement is permitted.



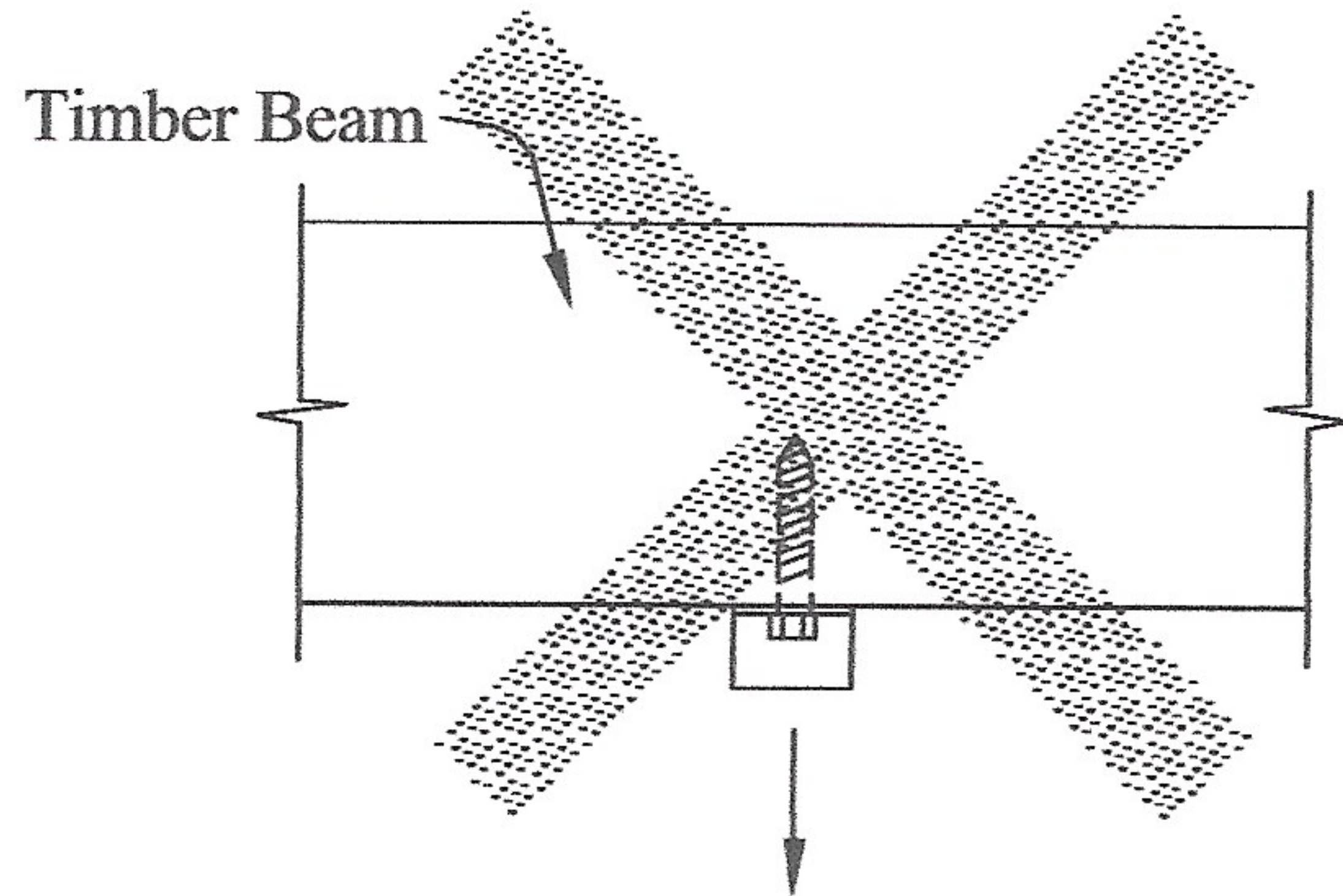
Detail A10 - This situation is similar to Detail A3 where deep splice plates are applied to both faces of the beam. This may be a splice over the column or a situation where one beam is supporting the next one. As the wood shrinks, the steel side plates resist the shrinkage effect causing splits in the beams. This condition is particularly hazardous if one beam is supporting the next one as shown on the left or as a cantilever connection, because the splits at the bolt holes will reduce the effective strength of the beam.

SUGGESTED REVISION - See details in section 5 for recommended column connections and Figure 8.6 for recommended moment splice if continuity over column is desired. Moment splices are not recommended for beams.



Detail A11 - Loads suspended from beams as shown induce tension perpendicular to grain stresses.

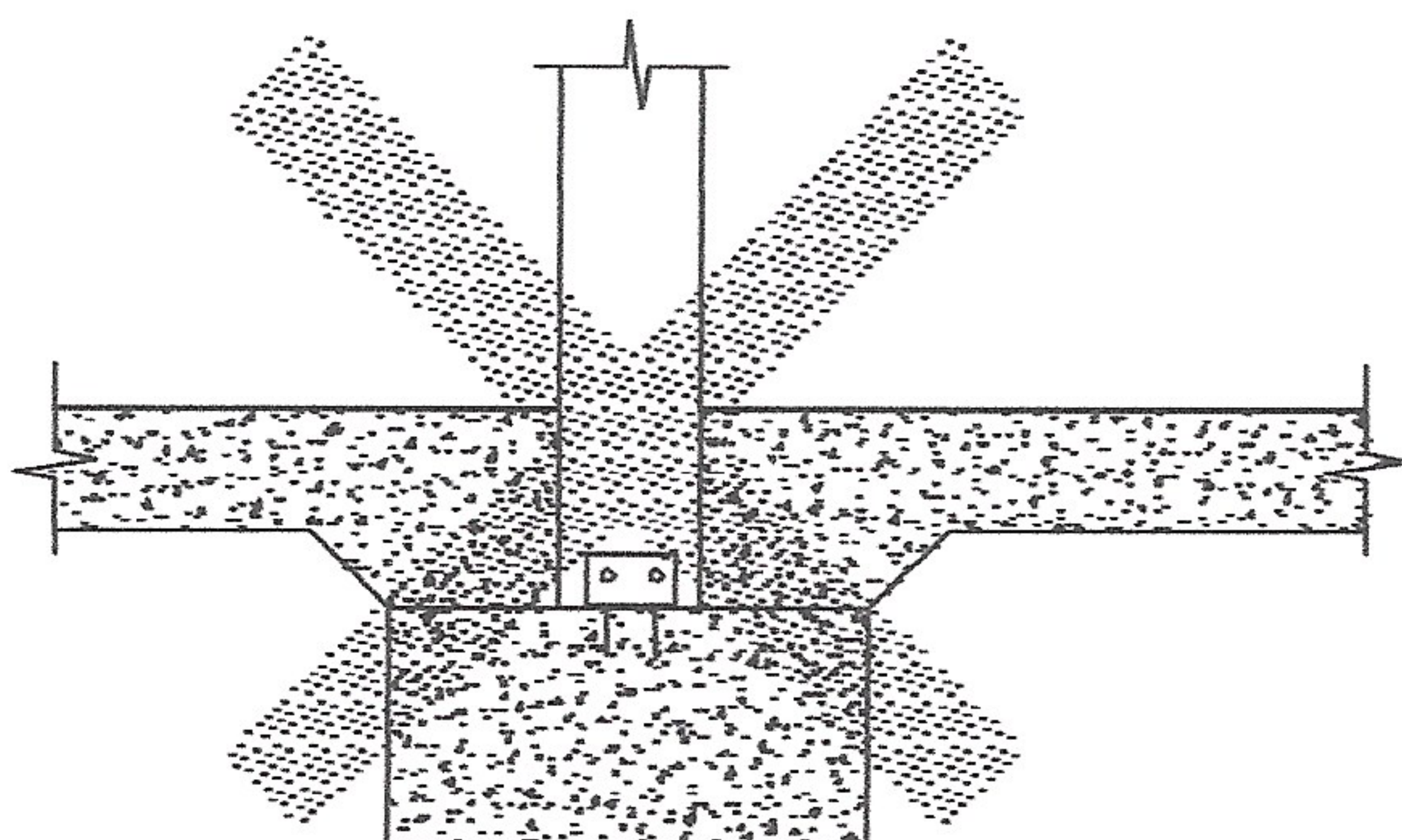
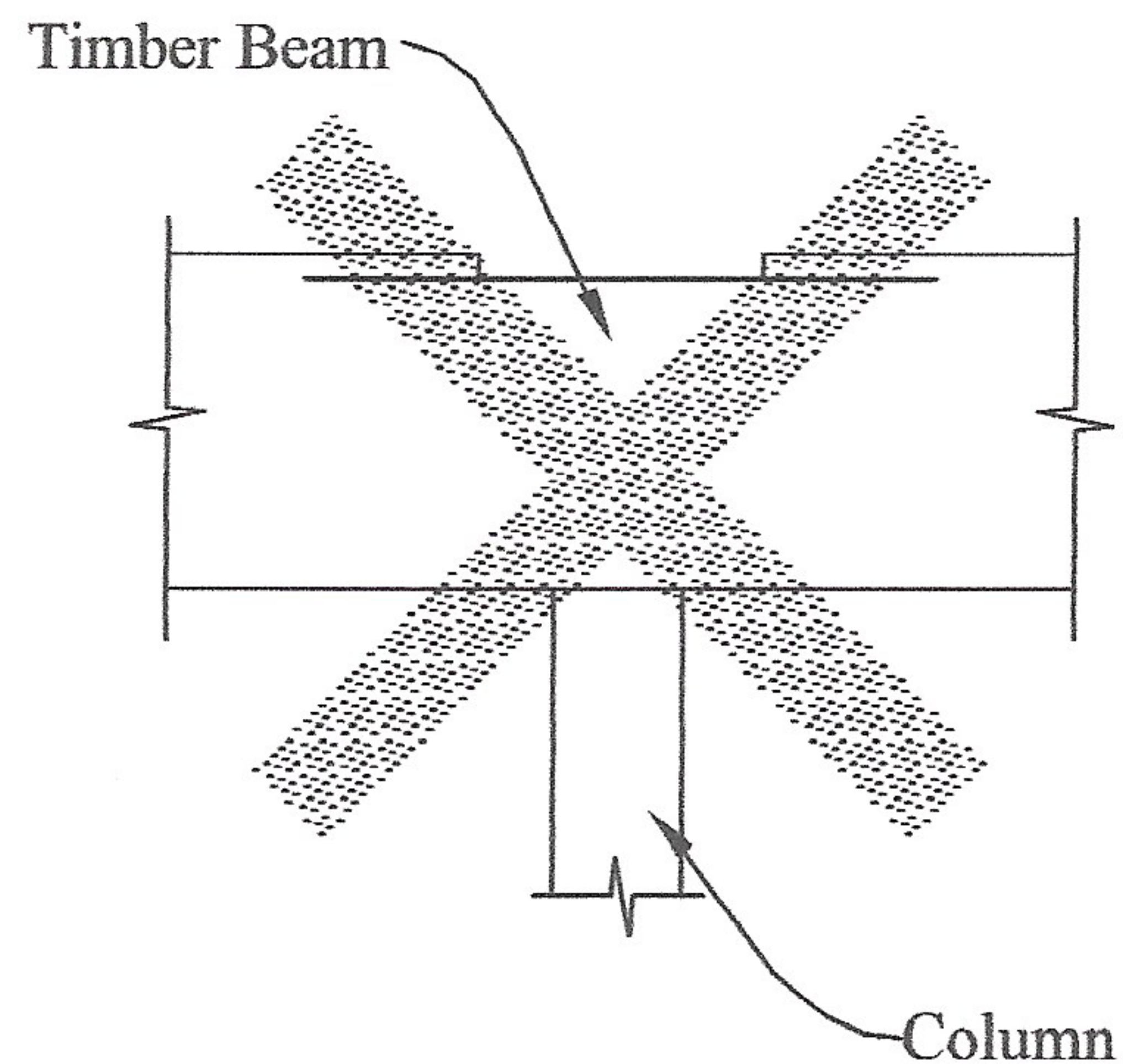
Suggested Revision - See Section 10 for recommendations for supporting loads from beams.



NOTE - This type of connection is to be used to carry light loads only and must be designed by a qualified design professional.

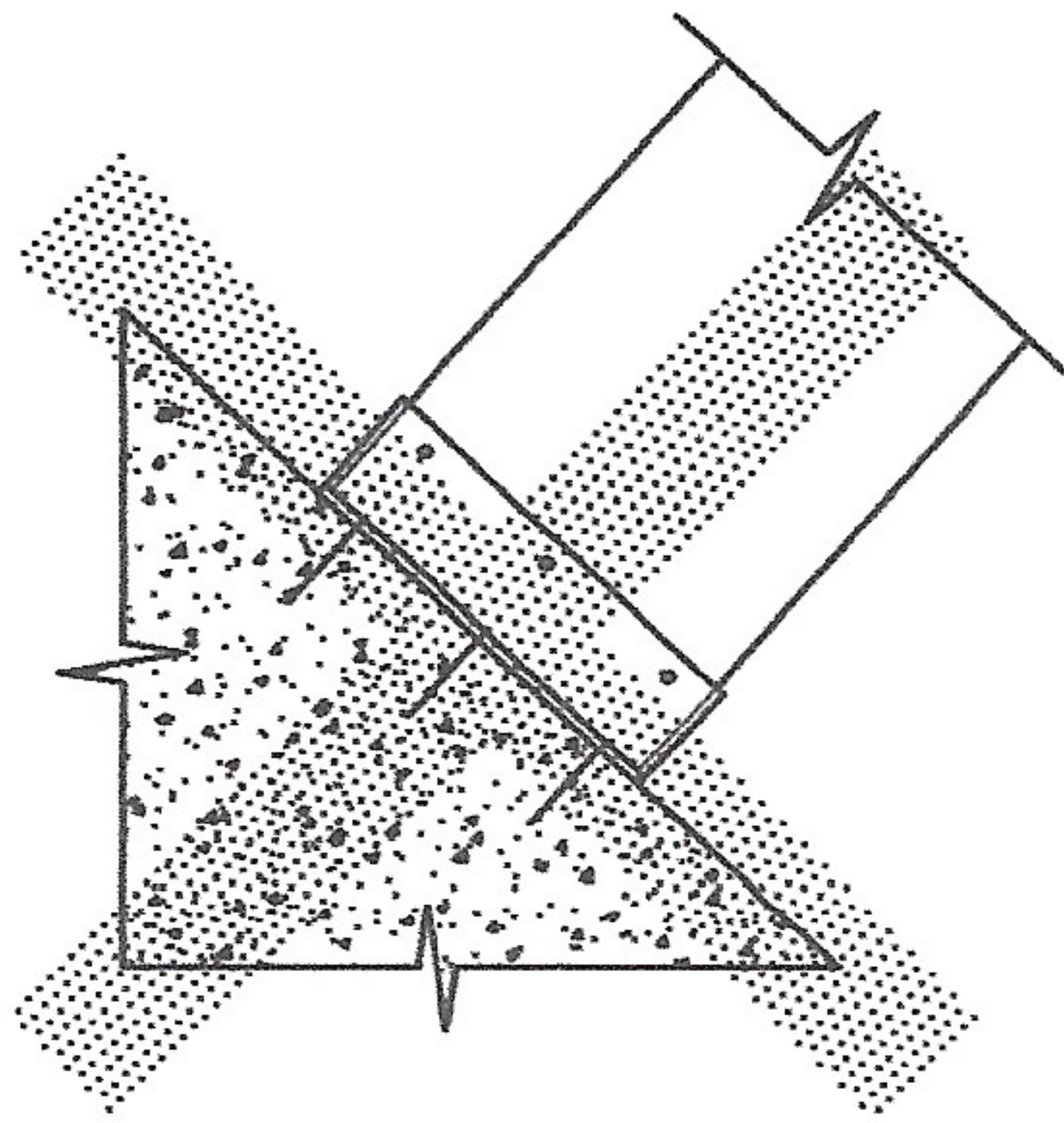
Detail A12 - This shows a general condition where, particularly in continuous framing, the top tension fibers have been cut to provide for a recessed hardware connection or for the passage of conduit or other elements over the top of the beam. This is particularly serious in glulam construction since the tension laminations are critical to the proper performance of the structure.

SUGGESTED REVISION - Detail the connection as shown in Figure 4.5 without the notch in the tension side of the cantilever member. If recessed hardware is required, provide mechanically fastened blocking.



Detail A13 - Some designers try to conceal the base of a column or an arch by placing concrete around the connection. Moisture will migrate into the lower part of the wood and cause decay.

SUGGESTED REVISION - Detail column bases as shown in Section 6 or arch anchorages as shown in Section 7.

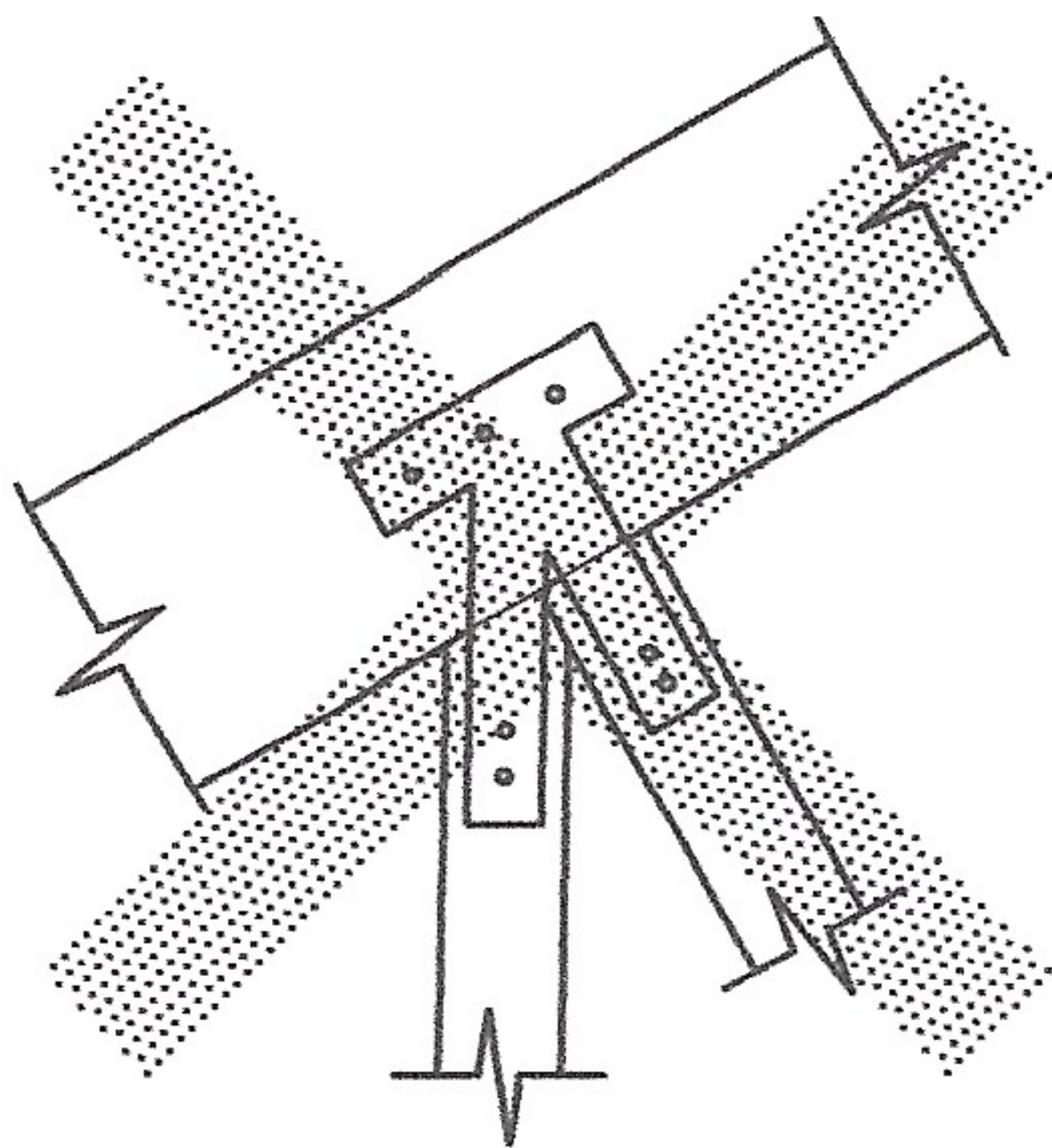
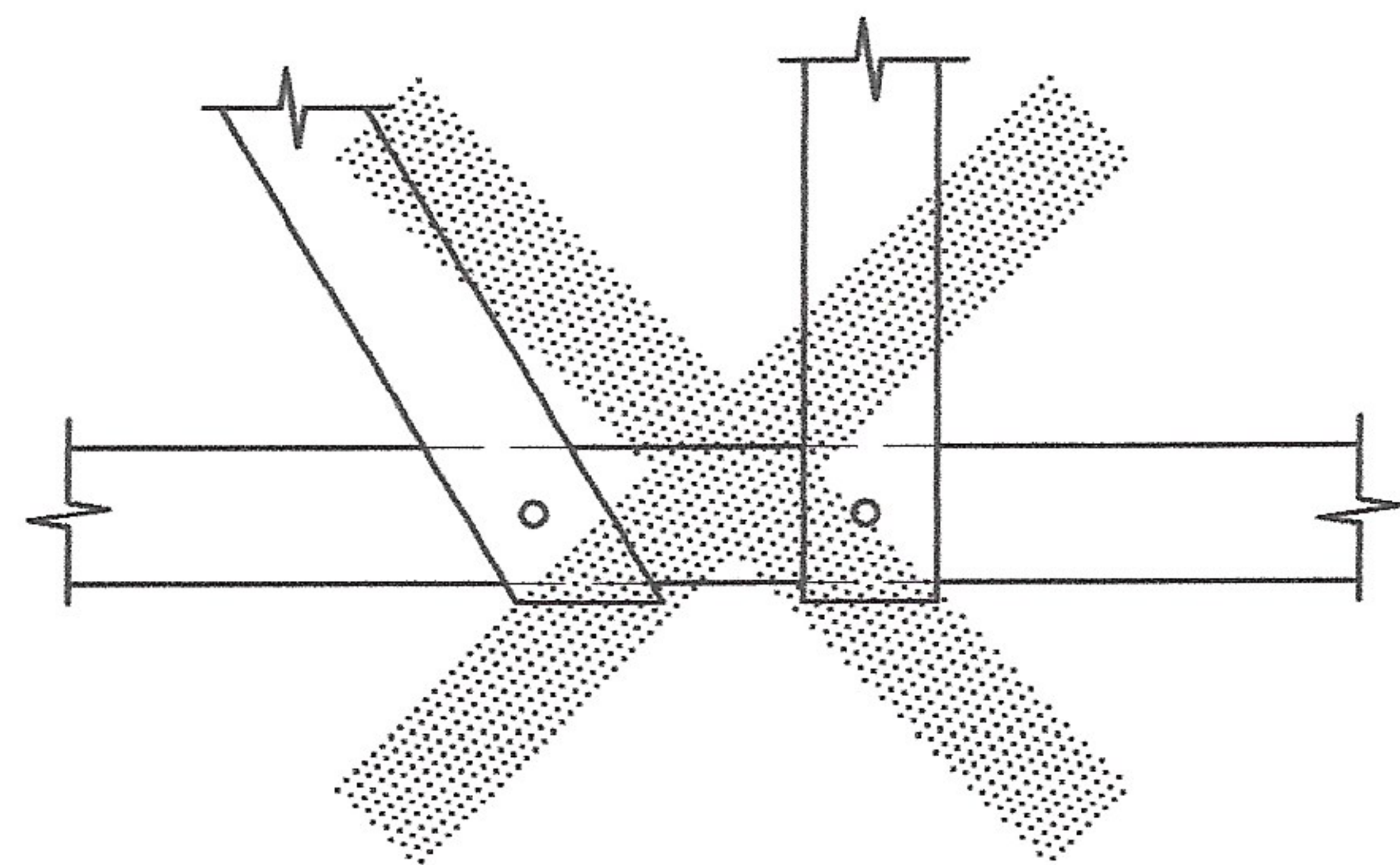


Detail A14 - Similar to Detail A13 in that the base of an arch or column is placed in a closed steel box where moisture will accumulate and cause decay.

Suggested Revision - Detail arch base as shown in Figure 7.9 with connections grouped near the center of the arch and drainage provided to prevent collection of water in the shoe.

Detail A15 - When the centerlines of members do not intersect at a common point in a truss, considerable shear and moment stresses may result in the bottom chord. When these are combined with the presumably high tension stress in the member, failure may occur.

Suggested Revision - Detail web to chord connections to be concentric as shown in Figure 9.1.



Detail A16 - Truss chord to web connection made from a single plate or plates welded rigidly together. Not recommended when truss deflections could produce rotation of members, which could cause splitting.

Suggested Revision - Detail as shown in Figure 9.1 with pinned connection at the web and chord with clearance provided between webs and chords. Alternatively, slotted bolt holes can be utilized to allow for joint rotation as shown in Figure 9.2.

Detail A17 - Truss heel connection with eccentric force lines that cause prying action which may result in splitting of the members.

Suggested Revision - Detail connection similar to Figure 9.5.

