S C E F

Mid - Atlantic States

COMPILED SEPTEMBER 2000

MID-ATLANTIC STATES

STRUCTURAL COMMITTEE

FOR ECONOMICAL FABRICATION

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STANDARD 101

PARTIAL PAYMENTS

STRUCTURAL

STEEL

June 2000

Add the following to the appropriate section of the State Standard Specifications and make necessary editorial changes to other portions of Standard Specifications. In the interim, portions of the following can be adopted as a Special Provision and used on a project by project basis.

101.1 APPLICATION PROCEDURES

101.1.1 Partial payment will be made upon application by the Contractor, for structural steel for structure components, delivered to the site of fabrication. The contractor shall submit the following with each request for partial payment.

101.1.1.1 Mill invoices or shipping reports indicating the actual weight of the material delivered to the fabrication site. Partial payment will not be made when the invoice total submitted for payment is less than $1,000.00, or 2,500 pounds of steel.

101.1.1.2 Written consent of Contractor's surety.

101.1.1.3 Written proof that the location and manner of storage has been approved by the Owner's Engineer.

101.1.1.4 Mill test data in the format acceptable to the Engineer which verifies that the material meets applicable specification requirements.

101.1.1.5 A certification that the payment requested does not contain materials for which payment has been previously requested.

101.1.2 Within 30 days after date of payment by the Owner, the Contractor shall submit a copy of certified invoice stating that payment in full has been made by the fabricator for the materials. If this certification of payment is not presented within the 30 day period, the advanced payment will be deducted from future progress payments.

101.2 WEIGHT PAYMENT

101.2.1 The maximum weight of raw structural steel for which partial payments will be allowed will be based upon the Contract listed quantity or theoretical weights computed from the approved shop drawings. Payment for full invoice amounts will be allowed until the Contract quantity or theoretical weight is reached but not to exceed 90 percent of the Contract amount for structural steel. No further partial payments for structural steel will be allowed.

101.2.2 When the theoretical weight of the various completed sections is used to compute the pay quantities of the material incorporated in the completed structure, no allowance will be made for overrun in scale weights or for erection bolts, excess field bolts or similar items, or the weight of any paint, galvanizing, or weld material. Deduction will not be made for bolt holes in the material.

101.3 BASIS OF PAYMENT

101.3.1 All structural steel, regardless of size, shape and material specifications, will be paid for at the same unit price by the following: (NOTE: For projects with multiple grades of steel, additional unit prices will have to be established. Any of the following options may be selected. Options A & B could apply to lump sum bid items. Options C & D could apply to unit price contracts.)

101.3.1.1 Option A: Structural steel will be paid for at the unit price per pound, as indicated in the Contract Documents, times the total weight included on the submitted invoice.

101.3.1.2 Option B: Structural steel will be paid for at the unit price as published in the ***Producer Prices and Price Indexes*** by the US Department of Labor for the month in which the bidding date occurs as indicated in the Contract Documents. If a unit price is not listed in the ***Price Index*** for the month in which the bid date occurs, the nearest previous month for which a price is listed will be used to determine the unit price. The partial payment will be determined by multiplying the total weight included in the submitted invoice times the unit price specified in the appropriate ***Price Index***. An allowance of 100 percent of the cost to the Contractor, not to exceed 90 percent of the contract amount of structural steel will be allowed.

101.3.1.3 Option C: Structural steel will be paid for by taking 40 percent of the bid price for Fabricated Structural Steel times the total weight included in the submitted invoices. An allowance of 100 percent of the cost to the Contractor, not to exceed 90 percent of the contract amount for structural steel will be allowed.

101.3.1.4 Option D: The monthly payment for structural steel shall equal the certified invoice payment by the Contractor to the Supplier, but the total maximum partial payment shall not exceed 40 percent of the bid price for Fabricated Structural Steel.

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STANDARD 102

TECHNICAL

SPECIFICATION

FOR STRIP SEAL TYPE

EXPANSION JOINTS

(MOVEMENTS UP TO FOUR INCHES)

OCTOBER 1994

102.1 DESCRIPTION

102.1.1 The strip seal expansion joint furnished and installed shall be in accordance with this specification and in conformity with the details and dimensions shown on the contract plans.

The scope of this specification is limited to preformed non-reinforced, polychloroprene strip seal glands that mechanically lock into steel retainers. The steel retainers shall be anchored into the structure in accordance with the contract requirements.

102.2 MATERIALS AND MANUFACTURE

102.2.1 The strip seal gland shall be preformed and manufactured from a vulcanized elastomeric compound using polychloroprene as the only base polymer.

102.2.2 The steel retainers acting as the locking edge rails shall maintain a minimum cross sectional thickness of 3/8" when measuring the vertical backwall and any flanges. The steel retainers shall be manufactured from extruded or hot rolled steel.

102.2.3 Maximum range openings will be as specified. Minimum will be 1/2" and the openings will be measured in the direction of travel.

102.2.4 The adhesive lubricant used to install the strip seal gland into the locking steel retainer shall be a one part moisture curing polyurethane compound, meeting the requirements of ASTM D4070.

102.3 MATERIAL REQUIREMENTS

102.3.1 The strip seal gland shall conform to the requirements of Table 1.

102.3.2 The steel locking retainer shall conform to the requirements of AASHTO M270 (ASTM A709).

102.3.3 Plates and shapes used in the makeup of the strip seal joint shall conform to the requirements of AASHTO M270 (A709-A).

102.4 CONSTRUCTION PRACTICES

102.4.1 The strip seal gland shall be delivered to the jobsite in lengths suitable for continuous one piece installation for each individual expansion joint. Field splicing is not permitted.

102.4.2 In order to facilitate ease of installation of the strip seal gland, it is recommended that the joint opening be not less than 1-1/2" at 68°F.

102.4.3 All steel surfaces that come in contact with the strip seal gland shall be cleaned to meet the requirements of SSPC-SP6.

102.5 CORROSION PROTECTION

102.5.1 The corrosion protection system for the steel locking retainers, if required, shall be covered under the contract drawing requirements.

102.6 SPECIAL CONDITIONS

102.6.1 Special conditions such as doglegs, tees and crosses shall be shop fabricated in a mold under heat and pressure.

102.6.2 The contractor shall be aware that the strip seal gland installation will be severely restricted at joint openings of less than l-l/2".

TABLE I

PHYSICAL PROPERTIES FOR PREFORMED ELASTOMERIC STRIP SEALS

Property	Requirement	ASTM Test Method
Tensile strength, min. psi (MPa)	2000 (13.8)	D 412
Elongation at break, min. %	250	D 412
Hardness, Type A durometer, points	60 + 5	D 2240 (Modified)[A,C]
Oven aging, 70 h at 212°F (100°C)		D 573
Tensile strength, loss, max. %	20	
Elongation, loss, max. %	20	
Hardness, Type A durometer, points change	0 to +10	D 2240 (Modified)[A,C]
Oil swell, ASTM oil 3		D 471
70 h at 212°F (100°C)		
Weight change, max. %	45	
Ozone resistance	No Cracks	D 1149 (Modified)[B]
20% strain, 300 pphm in air, 70 h at 104°F (40°C)		
Low temperature stiffening		D 2240
7 days at 14°F (-10°C)		
Hardness, type A durometer, points change	0 to +15	D 2240 (Modified)[A,C]
Compression set, 70 h at 212°F (100°C), max. %	40	D 395 Method B (Modified)[A]

FOOTNOTES:

A The term "modified" in the table relates to the specimen preparation. The use of the strip seal as the specimen source requires that more plies than specified in either of the modified test procedures be used. Such specimen modification shall be agreed upon by the purchaser and producer or supplier prior to testing.

B Test in accordance with procedure A of ASTM D 518 and ozone concentration is expressed in pphm.

C The hardness test shall be made with the durometer in a durometer stand as recommended in Method D 2240.

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STANDARD 103

SPECIFICATION FOR APPLICATION

OF INORGANIC

ZINC RICH PRIMER

OCTOBER 1994

103.1 SCOPE

This specification covers shop application of self-curing inorganic zinc-rich primers for use on iron and steel surfaces.

103.2 APPLICATION

103.2.1 Surface Preparation: Abrasives used for blast cleaning shall be either clean dry sand, mineral grit, steel shot or steel grit and shall be of a grading suitable to produce satisfactory results. All structural steel shall be blast cleaned to a "near white" condition as defined in SSPC-SP 10. The "near white" surface condition is critical to the performance of the system and shall be determined by the use of NACE No 2 Visual Standard TM-01, if shot or steel grit blast is used, or SSPC Standard Visual - 1, grade 2 1/2 if sand or mineral abrasive is used. After blast cleaning, the anchor pattern shall be from 1 to 3 mils deep in a dense uniform pattern of depressions and ridges as determined by an approved surface profile comparator.

All oil, grease and related substances shall be removed prior to blasting in accordance with SSPC SP1.

103.2.2 Conditions for Painting: Paint shall only be applied on clean and thoroughly dry surfaces. Paint shall only be applied when the temperature of the air, paint and metal and the humidity is within the manufacturer's recommended criteria. Painting will not be allowed when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

Each coat of paint shall be allowed to cure before the succeeding coat is applied. The Engineer will make the decision as to when the paint is cured sufficiently for application of the succeeding coat. In no case will the cure time be less than the minimum time recommended by the manufacturer's printed instructions for any coat of paint, including spot coats.

103.2.3 Application of Primer: The zinc primer coat shall be applied as recommended by the manufacturer in a single application employing multiple spray "passes" to achieve a dry film thickness of 3 to 5 mils above the anchor pattern. Measurement of dry film thickness shall be determined by use of a magnetic dry film thickness gauge. Prior to use, the magnetic dry film thickness gauge shall be calibrated with either NBS No. 1362 certified coating thickness calibration standards or nonmagnetic shims, whichever is appropriate for the gauge type, or by comparison with a Tooke Gauge or other means approved by the owner. The applied coating shall present a dense and uniform appearance after curing. The applied coating shall be considered deficient in thickness if the measured thickness values are found to be less than 3 mils when measured in accordance with SSPC-PA 2. Areas found deficient from the minimum specified coating thickness shall be repaired according to the manufacturer's written recommendations. Coated areas exhibiting mudcracking shall be repaired according to the manufacturer's written recommendations. Any thinning of the paint shall only be done in accordance with the manufacturer's printed recommendations.

The powder component shall be added to the liquid component with thorough stirring continued until the powder is well dispersed. The mixture shall be strained through a 30-60 mesh screen to remove large particles. Pots containing the mixed paint shall be equipped with a mechanical agitator which shall be kept in motion throughout the application period. The agitator blades shall come within one inch of the bottom of the spray pot.

The coating shall be applied within 24 hours after the metal is blast cleaned and prior to any visible rust-bloom.

The Contractor shall be responsible for the satisfactory application of paint and neither conditions in the shop nor the laboratory acceptance of the paint shall relieve him of responsibility for providing a satisfactory product. Painting shall be done in a workmanlike manner. If rusting occurs or the paint coat lifts, blisters, wrinkles, or shows evidence of having been applied under unfavorable conditions, or if the workmanship is poor, or if impure or unauthorized paint has been used, or if for any other reason the painting is unsatisfactory, the effected paint shall be removed and the metal thoroughly cleaned and repainted.

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STANDARD 104

MANUAL OF

RECOMMENDED PRACTICES

FOR A QUALITY ASSURANCE PLAN

FOR STRUCTURAL STEEL

OCTOBER 1994

PREFACE

The Quality Assurance Plan is composed of the fabricator's Quality Control (QC) Plan and the Owner's Acceptance Testing Plan. The fabricator's Quality Control Plan includes inspection and testing. The Owner will provide independent inspection and testing personnel and equipment for verification testing. The verification inspection and testing may be at a lower frequency than the quality control inspection and testing. Verification testing may be accomplished by witnessing quality control tests and/or performing independent tests.

Standard acceptance testing procedures usually required the Owner to provide independent testing personnel and equipment; but, at a reduced level of testing as compared to QC testing. Whether the Owner's verification tests are by witnessing QC tests or performing independent tests or both will not affect the use of this Manual. This Manual assumes a specified level of quality. As part of this specified level, the fabricator shall have an acceptable quality control plan prior to commencement of work. This Manual includes a requirement of AISC shop certification or as approved by the Owner.

104.1 SCOPE

104.1.1 This Manual establishes requirements and activities for a Quality Assurance Plan. These requirements and activities pertain to the inspection, measurements, and tests necessary to substantiate material and product conformance to Contract requirements. The fabricator's Quality Control Plan shall be designed and implemented with the objective of assuring that all materials incorporated into the work conform to Contract requirements, and that the processing of materials are controlled to assure that the finished product conforms to the Contract Documents and and the Acceptance Testing Plan.

104.1.2 Inherent in this recommended practice is the assumption that design details and specifications allow maximum flexibility in procedures and processes to allow the most cost-effective fabrication to be performed consistent with the quality level specified.

Alternative sampling methods, processes, procedures, and inspection equipment may be used by the fabricator when procedures and equipment provide, as a minimum, the quality assurance required by the Contract Documents. Prior to applying such alternative procedures, the fabricator shall describe the procedure in a written proposal and shall demonstrate to the satisfaction of the Owner that their effectiveness conforms to or exceeds the Contract requirements. In case of dispute the procedures stipulated in the Contract Documents shall apply.

104.2 FUNCTIONS AND RESPONSIBILITIES

104.2.1 The Owner: The Owner will monitor the fabricator's control of the operations to assure conformity with the Contract Documents. The Owner may perform testing of materials and of the fabricated product to the extent considered necessary to confirm the effectiveness of the fabricator's Quality Control Plan and to verify acceptability of the finished product. At no time will the Owner's representatives issue instructions to the fabricator on how to perform the fabrication operations. However, the Owner's representatives will question or advise the fabricator against continuation of any operations or sequences observed which will obviously result in noncompliance with the Contract requirements.

104.2.2 The Fabricator: Prior to fabrication the fabricator shall have a Quality Control Plan acceptable to the Owner. The Plan shall be in sufficient detail to enable the Owner to determine the adequacy of the Plan to assure compliance with the Contract Documents.

104.3 DEFINITIONS

104.3.1 Owner - A transportation agency with the responsibility for planning, contracting, erecting, and maintaining a fabricated structure.

104.3.2 Engineer - The Owner's Engineer or authorized representative, limited by the scope of duties assigned.

104.3.3 Fabricator - The Contractor/subcontractor/fabricator/shop (hereinafter referred to as the fabricator) that provides the materials and processes to fabricate structural steel members.

104.3.4 Quality Assurance Plan (QAP) - The QAP will consist of the fabricator's Quality Control Plan (QCP) and the Owner's Acceptance Testing Plan (ATP).

104.3.5 Quality Control Plan (QCP) - The formal written procedures that are composed by the fabricator to assure that materials, personnel, procedures, and processes utilized during fabrication of steel members meet the quality levels specified in the Contract.

104.3.6 Acceptance Testing Plan (ATP) - The formal procedures adopted by the Owner to monitor the fabrication process to assure that the quality levels specified are being achieved. This also includes a description of corrective actions to be taken when the fabricator is not controlling the fabrication operation according to the accepted QCP.

104.3.7 Acceptance Testing Inspector (ATI) - An employee or representative of the Owner, responsible for performance of duties specified in the ATP.

104.3.8 Quality Control Inspector (QCI) - The fabricator's representative responsible for performance of duties specified in the QCP.

104.4 FABRICATOR'S QUALITY CONTROL PLAN

104.4.1 General Requirements: The QCP shall be a complete manual detailing the procedures, personnel, policies, equipment, and records utilized by the fabricator during planning, ordering, fabrication, cleaning, painting, and shipping of structural steel items. The fabricator shall be certified under the American Institute of Steel Construction (AISC) "Quality Certification Program", Category I, II, or III, as appropriate, or as approved by the Owner. The Owner reserves the right to review the fabricator's operations prior to acceptance of the fabricator to perform the work. The Contractor shall be responsible for the cost incurred by the Owner for this review, regardless of whether the fabricator is accepted or not. If the fabricator is not found to possess the capability of providing the quality level desired, it is the Contractor's responsibility to engage an acceptable fabricator. Delays in approval to allow this review to take place shall not be a basis for time extensions.

For AISC certified plants, the results of the latest AISC evaluation checklist, including the results of the annual self audit, shall be made available to the Owner. Any findings noted in the exit interview reports shall be resolved prior to fabrication. All the findings noted during the review by the Owner shall be resolved prior to fabrication.

104.4.2 Fabricator's Management: The QCP shall show the organizational structure indicating the lines of responsibility.

104.4.3 Engineering and Drafting: This section shall be responsible for assimilating the Contract and producing acceptable shop drawings within the confines of the Contract. These drawings shall depict the type of welds, the type of nondestructive testing, the reference to any Special Provision or procedure, the material identification and traceability according to item number. Modification to contract drawings shall be shown in detail on shop drawings.

The Plan shall also show the procedures used to maintain a record of the revisions and distribution of the shop drawings.

104.4.4 Procurement: The Plan shall indicate the procedures used for ordering, receiving, storing, and verification of Specification compliance, and material traceability for all materials. The Plan shall also indicate the types of records to be maintained and any distribution of the records, including certifications, mill analysis, inventory control, and disposition of nonconforming materials.

104.4.5 Operations: The Plan shall outline the procedures used to assure that the fabrication is performed utilizing the latest revision of shop drawings, by qualified personnel, using correct procedures. The Plan shall also state the methods utilized for control of welding rods, wire, flux, or combination thereof, maintenance of material identity, selection, calibration or qualification of equipment. The Plan shall indicate the action to be taken when the process of fabrication is not providing the desired results.

The shop operation is generally under the direct supervision of a shop superintendent. This supervisor is responsible for the production of an acceptable product in accordance with the Contract Documents.

104.4.6 Quality Control: The Plan shall specify the qualifications of personnel, the equipment, inspections, reports, and the system to segregate materials needing corrective work. The quality control function shall be separate from production.

104.4.6.1 The fabricator shall have a quality control program that will assure that all materials and products submitted to the Owner for acceptance conform to the Contract requirements, whether manufactured or processed by the fabricator or procured from suppliers or subcontractors. The inspection, measurements, and tests required to substantiate conformance to the Contract requirements shall be the fabricator's responsibility and shall be documented.

104.4.6.2 Documentation: The fabricator shall maintain appropriate records of inspections, measurements, and tests performed. The records shall indicate the number and type of deficiencies found, the quantities approved and rejected, and the nature of any corrective action taken. Ultrasonic testing (UT) reports shall follow the documentation requirement found under 18.5.4.2.2. The fabricator's documentation procedures will be subject to the review and acceptance by the Owner prior to the start of fabrication and to compliance checks during the progress of the work. Records shall be kept up to date and complete, and shall be available to the Owner's representatives at all times. Records documenting the quality control tests and inspections shall become the property of the Owner upon completion of the work.

104.4.6.3 Measuring and Testing Equipment: The fabricator shall furnish all measuring and testing equipment and supplies necessary for performing the inspections, measurements, and tests required by the Quality Control Plan. To assure accuracy, the testing equipment will be checked and calibrated periodically in accordance with applicable standards.

104.4.6.4 Sampling and Testing: Sampling and testing methods and procedures used by the fabricator shall be as required by the Contract Documents and the QCP.

104.4.6.5 Measurements: The methods and frequency of dimensional measurements that the fabricator intends to make to control the work will be included in his Quality Control Plan.

104.4.6.6 Nonconforming Materials: The fabricator shall establish and maintain an effective system for controlling nonconforming material, including procedures for identification, isolation, and disposition. Reclaiming or reworking nonconforming materials shall be in accordance with procedures acceptable to the Owner.

104.4.6.7 Owner Inspection at Subcontractor or Supplier Facilities: The Owner reserves the right to inspect materials not manufactured within the fabricator's facility. This inspection shall not constitute acceptance nor shall it in any way replace the fabricator's inspection or otherwise relieve the fabricator of this responsibility to furnish an acceptable material or product.

104.4.6.8 Personnel: The personnel for NDT and shop inspection shall be adequately trained in their field, as required, and the training and certification records shall be available to the Owner. Welder/operator/tacker qualification test results shall be available for review. Minimum levels of training and qualification shall be as required by AWS/AASHTO D1.5, *Bridge Welding Code.*

Personnel performing nondestructive testing shall be certified in accordance with the American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A, or as approved by the Owner. The employer of the NDT personnel shall establish, and submit to the Engineer for approval, a Written

Practice as required by paragraph 5 of SNT-TC-1A. Certification of Level I and Level II individuals shall be performed by a Level III individual who has been certified by (1) ASNT, or (2) has the education, training, experience, and has successfully passed the written examination prescribed in ASNT SNT-TC-1A. Only individuals certified as NDT Level II or III, or individuals certified for NDT Level I working under the direct supervision of an individual certified for NDT Level II or III may perform nondestructive testing.

104.5 ACCEPTANCE TESTING PLAN (ATP)

104.5.1 General Requirements: The ATP shall be a manual of procedures, qualifications, inspections, equipment, personnel, and records to be used by the Owner for acceptance testing and inspection.

104.5.2 Inspectors

104.5.2.1 For structures requiring fabrication by AISC Category III shops, the lead inspector (ATI) shall possess the qualifications of the AWS Certified Welding Inspector (CWI) program as documented by possession of a CWI certificate or equal per AASHTO/AWS. For structures with AISC Category I and II members, the Owner will establish qualification levels for the ATI's.

104.5.2.2 ATI's involved in nondestructive examination, other than visual, will possess the appropriate American Society of Nondestructive Testing Level II Certification or as approved by the Owner.

104.5.3 Materials

104.5.3.1 Structural Steel: Steel shall be accepted based on the certifications of compliance or certified mill test reports, based on heat or plate frequency as required. The Owner may perform independent physical and chemical tests, at the Owner's expense, on material at the fabrication plant. These tests will be performed as soon as practical, prior to fabrication if possible. If the independent tests indicate noncompliance, after considering normal variability in structural steels, use of the material will be prohibited until agreement is reached between the Owner and fabricator as to acceptability.

104.5.3.2 Weld Consumables: Welding rods, wire, flux and combinations thereof shall be accepted based on the annual tests as certified by the supplier. Storage requirements for weld consumables shall also be as recommended by the supplier and shall be strictly adhered to by the fabricator.

104.5.4 Testing Frequency

104.5.4.1 Welds (All Inclusive): All welds are subject to visual examination. In addition to random spot-checks by the ATI during the welding process, any NDT tests performed by the ATI shall be compared to results of QCI tests. ATI testing will be performed after QC testing is completed and presented to ATI. Testing performed by UT or RT shall be verified by UT or RT respectively. This testing should preferably be conducted during the fabrication of members concurrently with fabricators station operation. Where different interpretations are present, the difference shall be resolved prior to acceptance of the weld. This may require a third test by joint QCI/ATI or by an independent authority acceptable to the Owner and fabricator.

104.5.4.2 Groove Welds: A minimum of one complete groove weld representative of each procedure or process of a previously inspected joint, shall be tested, with a maximum of 10 percent of the groove welds as selected by the ATI. Where rejectable or planar-type indications are found by the ATI, the two consecutive welds of the same type shall also be tested by the ATI.

104.5.4.2.1 Where specified, radiographs (RT) obtained by QCI shall be provided to ATI. Radiographs obtained by ATI shall be compared to radiographs obtained by QCI for that same weld. RT may be witnessed in lieu of actually performing the test.

104.5.4.2.2 Ultrasonic testing (UT) reports for welds where specified shall record all rejectable indications and nonrejectable indications with defect severity ratings within 5 db of being rejectable, indicating rating, size and location. UT may be witnessed, but preferably the ATI will conduct the tests.

104.5.4.3 Other Full Penetration Welds: Acceptance will be by UT and/or RT, unless otherwise permitted. The Owner may use discretion in the percent of welds subject to acceptance testing.

104.5.5 Owners Stamps: Prior to shipment of the member/component to the structure site, the ATI shall affix an Owners stamp or mark on the piece indicating the work has been inspected by an Owners representative. The presence of this stamp does not relieve the Contractor of final fit of the member/component into the structure.

MID-ATLANTIC STATES

STRUCTURAL COMMITTEE

FOR ECONOMICAL FABRICATION

STANDARD 104A

RECOMMENDED PRACTICE

FOR THE

PREPARATION OF A

QUALITY CONTROL PLAN

OCTOBER 1994

104A.1 SCOPE OF QUALITY CONTROL PLAN

This section of the plan must be prepared by fabricator to describe the overall scope of the quality control plan.

104A.2 FUNCTIONS AND RESPONSIBILITIES OF QUALITY CONTROL SECTION

This section of the plan must describe in general terms the functions, duties, responsibilities and authority of the quality control section. Specific reference must be included which will establish lines of communication within the fabricator's organization and describe in detail what actions are to be taken when non-compliance situations are encountered by quality control personnel. Procedures must be established within the management structure of the fabrication shop which will provide for constant interaction of quality control personnel with production management. When quality problems are discovered by quality control, this information must be used by production personnel to determine the cause for the non-compliance and initiate appropriate revision to production techniques which will prevent a recurrence of the non-compliance.

104A.3 STATEMENT OF SUPPORT FOR QUALITY FABRICATION

This section of the plan must include a statement prepared by the fabrication shop management personnel, which will indicate their support of a program designed to produce a quality product.

104A.4 FABRICATOR ORGANIZATION

This section of the plan must show the fabricator's overall plant organization structure. The information may be included in the form of an organization chart and attached to the quality control plan. The chart must clearly establish lines of authority and must include position title and the name of the individual assigned to the position.

104A.5 QUALITY CONTROL SECTION ORGANIZATION

This section of the plan must show in detail the fabricator' s organization structure of the Quality Control Section. The information may be included in the form of an organization chart and attached to the quality control plan. The chart must clearly establish lines of authority and must include position titles.

104A.6 QUALITY CONTROL PERSONNEL - EDUCATION, EXPERIENCE AND CERTIFICATION REQUIREMENTS

This section of the plan must include education, experience and certification requirements for all Quality Control positions. As a minimum, the quality control plan will include the following provisions for personnel qualification. The fabricator may add additional requirements or provide further details as deemed necessary.

104A.6.1 Quality control Inspectors responsible for inspection, acceptance or rejection of materials or workmanship shall be qualified. The basis of inspection qualification shall be documented. Acceptable qualification basis are:

104A.6.1.1 Current or previous certification as an AWS Certified Welding Inspector (CWI) in accordance with the provisions of AWS, QC1, Standards for Qualification and Certification of Welding Inspectors; or

104A.6.1.2 Current or previous qualification by the Canadian Welding Bureau (CWB) to the requirements of the Canadian Standards Association (CSA) Standard W178.2, Certification of Welding Inspectors; or

104A.6.1.3. An engineer or technician who, by training and/or experience in metals fabrication inspection and testing is acceptable to the Engineer as an equivalent to (1) or (2).

104A.6.2 The inspector may be supported by assistant inspectors who may perform specific inspection functions under supervision of the inspector. Assistant inspectors shall be qualified by training and/or experience to perform the specific functions to which they are assigned. The work of assistant inspectors shall be regularly monitored by the inspector, generally on a daily basis. The duties of these individuals should be documented as well as their names, training, and experience.

104A.6.3. Personnel performing nondestructive testing shall be qualified and certified in accordance with the requirements of the fabricator's "Written Practice for Qualification and Certification of Nondestructive Testing Personnel. The "Written Practice" is to be prepared in accordance with the American Society of Nondestructive Testing Recommended Practice No. SNT-TC-1A and shall be approved by the Engineer prior to conduct of any nondestructive testing. A copy of the fabricator's "written practice" should be included. A discussion of the documentation and record keeping procedures should be included. All certification must be in accordance with AWS D1.5, Section VII.

104A.7 FABRICATION PLANT CERTIFICATION

Plant certification should be AISC or approved equal. If AISC is required, the following items are applicable. Fabricators of rolled beam bridges, sign structures, expansion dams, drainage products, bearings, inspection walkway systems, and other minor components of bridges shall be certified as a Category I plant. Fabricators of welded plate girder bridges, trusses, and other major steel bridges shall be certified as a Category III plant. All AISC inspection-evaluation reports will be made available to the Engineer for review.

104A.8 GOVERNING SPECIFICATIONS

This section of the plan will make direct reference to the following specifications which may be applicable to the particular project or bridge to be fabricated:

104A.8.1 State Standard Specifications.

104A.8.2 Supplemental Specifications.

104A.8.3 Contract Plans and Contract Proposal for project.

104A.8.4 Special Provisions normally included in Contract Proposal.

104A.8.5 Title and year of welding code applicable to the work.

104A.9 SHOP DRAWINGS

This section of the plan must detail the fabricator's procedures regarding the following subject areas:

104A.9.1 Preparation responsibility.

104A.9.2 Size and drawing layout.

104A.9.3 Bill of material content, layout and location.

104A.9.4 Layout, dimensioning and logic for Shop Assembly and Blocking Drawings.

104A.9.5 Distribution of approved drawing within the fabricating shop.

104A.9.6 Control and distribution procedures for "Revised" drawings.

104A.10 MILL ORDERS AND PURCHASE OF MATERIALS

This section of the plan will enumerate the fabricator's procedures and controls necessary to assure that all materials purchased from outside suppliers and vendors are in accordance with the specification requirements whether delivered to the fabricating shop or shipped directly to the project site. Subject areas to be addressed in the plan, as a minimum, are as follows:

104A.10.1 Governing specifications and testing requirements.

104A.10.2 Certified mill test data.

104A.10.3 "Customer " or "Engineer" inspection requirements at the manufacturer's plant.

104A.10.4 Sublet Fabrication, Quality control responsibilities for work performed by outside vendors, Inspection and NDT requirements, Blast and paint, requirements for inspection.

104A.10.5 Use of materials from fabricator's stock, Identification of heat numbers and tie-in to certified mill test data.

104A.11 CERTIFIED MILL TEST DATA AND CERTIFICATIONS

This section of the plan will outline the fabricator's policies and procedures with regard to obtaining and review of certified mill test data and certifications for raw materials used in the fabrication of the bridge. As a minimum, the plan will establish the fabricator's procedures in the following areas:

104A.11.1 Review of mill test data for specification compliance;

104A.11.2 Customer requirements for submission of mill test data for approval (Submit to, format, number of copies, when to submit);

104A.11.3 Procedures for control, identification and recovering of mill test data for steel materials used from the fabricator's stock.

104A.12 WELDING PROCEDURES

This section of the plan will establish the procedures to be used by the fabricator regarding preparation and utilization of a standard Welding Procedure as required by the governing specifications. As a minimum, the plan will cover the following areas:

104A.12.1 Preparation Responsibility **-** Who or what section of the fabricator's organization is responsible for preparation of the formal Welding Procedure. If qualification testing is required, who or what section will preform welding of test plates, prepare specimens for testing, conduct actual testing, prepare reports, etc.

104A.12.2 Format and forms.

104A.12.3 Customer submission requirements.

104A.12.4 Distribution of the approved welding procedure in the fabricating shop.

104A.12.5 Use of the approved welding procedure by production and quality control section personnel.

104A.12.6 Procedure for revision of welding procedure.

104A.13 WELDING CONSUMABLE

This section of the plan will give details to be utilized by the fabricator concerning the welding consumable to be used in fabrication of the bridge. As a minimum, the following major subject areas will be addressed:

104A.13.1 What quantities, material specifications.

104A.13.2 Test data and certification requirements from the consumable manufacturer.

104A.13.3 Warehouse storage procedures.

104A.13.4 Storage procedures in the fabricating shop.

104A.13.5 Control procedures for drying and "time out of storage oven" for shielded metal arc welding (SMAW) electrodes.

104A.13.6 Control procedures for drying and storage of submerged arc welding (SAW) flux.

104A.13.7 Storage and moisture control procedures for flux cored arc welding (FCAW) electrodes.

104A.13.8 Storage procedures for gas metal arc welding (GMAW) electrodes.

104A.14 WELDER QUALIFICATION

This section of the plan will be used by the fabricator to establish the administrative procedures to be used to qualify welders, welding operators, and tack welders. Detailed testing procedures need not be included as they are adequately specified by the governing Welding Code. As a minimum, the following areas will be addressed:

104A.14.1 What section of the fabricator's organization will be responsible for administering the qualification test program.

104A.14.2 Will independent testing laboratories be employed in any phase of the qualification, and to what extent?

104A.14.3 To what extent will the fabricator's quality control section be involved in the qualification program.

104A.14.4 Who will perform the testing of the qualification test plates?

104A.14.5 Forms and records to be maintained.

104A.14.6 How fabricator will document continued experience of welders beyond six (6) months after qualification date. See "Period of Effectiveness" portion of applicable Welding Code.

104A.14.7 Format, layout and example of fabricator's "Master List of Qualified Welders, Welding Operators and Tack Welders". List must include all pertinent variable as specified by the applicable Welding Code.

104A.15 NONDESTRUCTIVE TESTING (NDT)

This section of the plan will be developed by the fabricator to cover all phases of nondestructive testing to be utilized in the shop. As a minimum the plan will include the following:

104A.15.1 NDT personnel qualification requirements. (See Section 104A.6.3).

104A.15.2 NDT equipment calibration procedures, calibration frequency, equipment maintenance procedures, recalibration requirements, forms, and documentation to be maintained to establish proper calibration and maintenance.

104A.15.3 NDT frequency requirements for groove welds and fillet welds. Minimum frequency is established by the applicable Welding Code. The fabricator may perform additional NDT as felt necessary to assure that fabrication is in accordance with governing specifications.

104A.15.4 Nondestructive testing procedures for ultrasonic (UT), radiographic (RT), magnetic particle (MT) and dye penetrant (PT) testing of groove and fillet. Where procedures are to be in accordance with some other national code, the fabricator may reference those codes or specifications in lieu of duplicating those requirements in the QC Plan.

104A.15.5 Safety requirements for all NDT processes with particular emphasis on radiographic testing safety.

104A.15.6 Interpretation and acceptance criteria for all groove and fillet welds. Where acceptance criteria is to be as per some other national code, the fabricator may reference those codes or specifications in lieu of duplicating those requirements in the QC Plan.

104A.15.7 NDT report formats will be included to be used by technicians for documentation of all testing. Full signature blocks are required as well as signature blocks for witnessing personnel when appropriate.

104A.15.8 Retesting requirements for all NDT will be addressed to include extent of retesting and acceptance criteria.

104A.16 INSPECTION PROCEDURES FOR INCOMING RAW MATERIALS

104A.16.1 Shop identification of raw material received from the mill will be covered in detail. Full explanation will be provided for order number, item numbers, heat identification, size and dimensions of materials. How the fabricator matches mill identified materials to shop drawing piece marks will be documented as well as fabricator marking system.

104A.16.2 Procedure to be used by the fabricator to verify that mill test data has been supplied by the producing mill for all heats of steel will be detailed.

104A.16.3 Identification of material by color coding throughout the shop may be required on selected projects. Procedures and methods to be utilized will be fully detailed.

104A.16.4 Acceptable surface quality of plates must be verified prior to start of fabrication. The plan must establish inspection point (locations), who is responsible for inspection as well as acceptance criteria and methods to be used for repair of unacceptable surface defects.

104A.16.5 Procedures must be included for inspection of raw materials to assure that no unauthorized repairs have been performed at the producing mill.

104A.16.6 Inspection procedures and acceptance criteria for handling and shipping damage must be included. Repair methods to be utilized must also be detailed.

104A.16.7 All inspections performed must be documented. The QC Plan must contain sample forms and established which shop personnel are responsible for inspection and preparation of reports.

104A.16.8 The QC Plan must establish the frequency of inspection. The minimum frequency for incoming raw materials is 100 percent inspection of all material.

104A.17 INSPECTION PROCEDURES FOR PREPARATION OF MATERIAL

This section of the QC Plan will be developed by the fabricator to provide inspection of all material preparation areas. As a minimum, the plan will include the following:

104A.17.1 Inspection procedure for quality of thermal cutting and shearing of material.

104A.17.2 Inspection procedures for edge of plate defects.

104A.17.3 Acceptance criteria for thermal cutting, shearing and edge of plants defects.

104A.17.4 Repair procedures to be used for roughness and edge of plate defects.

104A.17.5 NDT requirements for repairs and NDT acceptance criteria.

104A.17.6 Inspection procedures and tolerances for dimensional accuracy of component parts.

104A.17.7 The QC Plan must establish the frequency of inspection. The minimum frequency is 100 percent of all thermal cut edges for quality of cutting and edge defects. Sheared edges must be random spot check 25% for quality. Dimensional accuracy of parts must be random spot checked for 25% except where parts are manufactured from templates or jigs when 10% will be acceptable.

104A.17.8 An example of the documentation for non-compliance will be included.

104A.18 INSPECTION PROCEDURES FOR FITTING

104A.18.1 Dimensional accuracy and location of all components must be verified.

104A.18.2 All members must be within specified tolerance prior to welding.

104A.18.3 "Mill to bear" and "tight fit" conditions must be verified.

104A.18.4 The plan must establish the frequency of inspection. Minimum frequency for dimensional accuracy, location of members and fit prior to welding is 25%. Minimum frequency for "mill to bear" and "tight fit" is 50% of all such specified fits.

104A.18.5 An example of the documentation for non compliance will be included.

104A.19 WELDING INSPECTION PROCEDURES

This section of the QC Plan will outline all duties and responsibilities of the welding inspector. The Specific duties of the welding inspector are detailed in several industry publications such as the book by AWS titled "Welding Inspection" and others. Code requirements are well documents by the Bridge Welding Code AWS D1.5 and the AASHTO Fracture Control Plan. As a minimum the QC Plan will include the follow inspection tasks:

104A.19.1 Quality of cut edges or faying surface.

104A.19.2 Condition of mill scale in weld area.

104A.19.3 Fit of members components.

104A.19.4 Proper Joint preparation for groove welds, as per welding procedure.

104A.19.5 Copy of welding procedure available for reference by welder.

104A.19.6 Tack welds properly cleaned and of suitable quality and size.

104A.19.7 Welding consumable stored properly prior to use (See 104A.13).

104A.19.8 Weld electrodes of size and classification as required by welding procedure.

104A.19.9 Welding flux (SAW) is proper as required by welding procedure.

104A.19.10 Welding machine controls set as per welding procedure.

104A.19.11 Welder qualification for process and position to be welded.

104A.19.12 Method of verifying pre-heat.

104A.19.13 Pre-heat prior to welding.

104A.19.14 Welding variables, Amps-Volts-Travel Speed -Wire Feed Speed-Gas Flow etc., as per welding procedure.

104A.19.15 Interpass cleaning performed properly.

104A.19.16 Weld back-gouging proper.

104A.19.17 Fillet weld profile acceptable.

104A.19.18 Groove weld reinforcement proper

104A.19.19 Welds ground or finished as required.

104A.19.20 Welding distortion acceptable.

104A.19.21 Visual weld quality requirements.

104A.19.22 Flux recovery (SAW) system acceptable.

104A.19.23 The plan must establish the frequency of inspection for each inspection function. If inspection frequency varies from one shop location to another, the variation will be fully described or a separate frequency established for each shop location.

104A.19.24 An example of the documentation for non-compliance will be included.

104A.20 HEAT CAMBER, CURVING AND STRAIGHTENING

This section of the plan will include all inspection points to be verified by the QC personnel regarding heat camber, curving and straightening. Code requirements for this operation are adequately documented by the AWS Bridge Welding Code D1.5 and the AASHTO Standard Specifications for Highway Bridges. As a minimum the QC Plan will include inspection of the following operations:

104A.20.1 Verification of dimensions prior to start of operations

104A.20.2 Check for proper blocking

104A.20.3 Verify size and locations of heating patterns.

104A.20.4 Assure maximum temperatures are not exceeded.

104A.20.5 Verify dimensions upon completion of operations.

104A.20.6 The plan must establish the frequency of inspection for each inspection function.

104A.20.7 An example of the documentation for non-compliance will be included.

104A.21 SHOP ASSEMBLY OF MAIN MEMBERS - GIRDERS,BEAMS,CHORDS,ETC.

104A.21.1 Verify dimensional accuracy of each piece.

104A.21.2 Individual member camber, sweep, twist, tilt of flanges,etc.

104A.21.3 Clearance or bearing fit of member in assembly.

104A.21.4 Blocking dimensions, elevation, sweep as per shop drawing.

104A.21.5 Splice plates of proper dimension, fit in proper location and secured.

104A.21.6 Holes drilled full size or reamed proper.

104A.21.7 No elongated holes present.

104A.21.8 Bolt hole edge distance is proper.

104A.21.9 Splice plates properly match marked.

104A.21.10 All drilling burrs removed.

104A.21.11 "As built" shop assembly report prepared and accurate.

104A.21.12 The plan must establish the frequency of inspection for each inspection function.

104A.21.13 An example of the documentation for non-compliance will be included.

104A.22 STUD WELDING OPERATIONS

This section of the plan must establish inspection points and criteria for stud welding operations. Code requirements for quality of material and fabrication are adequately documented by the AWS Bridge Welding Code D1.5. A partial list of QC Plan inspection points are shown below. Additional inspection requirements as contained in the Code must be included in the QC Plan:

104A.22.1 Visual inspection requirements for studs prior to installation.

104A.22.2 Verify proper mill test data or other documents required by customer.

104A.22.3 Confirm stud base qualification tests have been conducted by manufacturer.

104A.22.4 Workmanship and technique inspection criteria for installation (See Code).

104A.22.5 Production control inspection (See Code).

104A.22.6 Fabrication and verification inspection requirements (See Code).

104A.22.7 Frequency of inspection.

104A.23 SHOP HIGH STRENGTH BOLT INSTALLATION

This section of the QC Plan must contain all QC inspection responsibilities to assure fasteners are properly installed. Installation specifications are adequately documented by AASHTO Standard Specifications for Highway Bridges and the FHWA Memorandum dated November 1989 titled "Supplemental Contract Specifications for Projects with AASHTO M 164 (ASTM A 325) High-Strength Bolts". As a minimum the plan shall contain the following QC inspection responsibilities:

104A.23.1 Verify all fasteners have been approved as per the customer's requirements prior to installation.

104A.23.2 Inspect fastener markings to verify proper identification of grade, type and manufacturer's marks.

104A.23.3 Verify contact surfaces are acceptable and holes are true and accurate.

104A.23.4 Inspect bolt tension calibrator and torque wrench for proper working order and latest calibration date.

104A.23.5 Verify rotational capacity testing to assure test is properly conducted.

104A.23.6 Assure proper fastener length is used for thickness of material.
104A.23.7 Turn of nut tightening:

104A.23.7.1 Verify testing of 3 bolts in tension calibrator to define snug tight condition and verify bolt tension after installation.

104A.23.7.2 Witness bolt installation and verify snug tight condition of joint.

104A.23.7.3 Observe bolt tightening and assure proper nut rotation of each fastener in sequence required by specification.

104A.23.8 Calibrator wrench tightening

104A.23.8.1 Verify testing of 3 bolts in tension calibrator to define snug tight and establish applicable torque-to-tension relationship.

104A.23.8.2 Assure a hardened washer is used under turned element during installation.

104A.23.8.3 Assure wrenches are set to provide proper bolt tension and are calibrated at proper intervals.

104A.23.8.4 Monitor surface condition of bolt threads, nuts and washers and require recalibration of wrenches when necessary.

104A.23.8.5 Assure bolt head or nut rotation does not exceed maximum allowable.

104A.23.8.6 When manual torque wrenches are used, assure torque is measured with nut moving in the tightening direction.

104A.23.8.7 Assure all fasteners in a joint are brought to snug-tight condition prior to final tightening.

104A.23.8.8 Inspect tightening operation to assure fasteners are tightened from the most rigid part of a joint towards it's free edges and wrench is returned to previously tightened bolts to "touch up" any bolts which may have been relaxed from tightening other bolts in the joint.

104A.23.9 Frequency of inspection

104A.23.10 Documentation of inspection, forms, report preparation.

104A.24 BLAST CLEANING AND SHOP PAINTING

This section of the QC PLAN must establish inspection points and criteria for cleaning and shop painting. The requirements for the extent of cleaning and the type of paint to be used are adequately covered by the special provisions, plans, and specifications for the individual project involved. A partial list of the items to be addressed are shown. Additional items will be added as the specific nature of the coating system necessitate.

104A.24.1 Inspection for surface contamination prior to mechanical cleaning.
104A.24.2 Method of solvent cleaning and method of determining if desired level of cleanliness is achieved.

104A.24.3 Where blast cleaning is required the type of equipment to be used, as well as the method for determining the surface profile required.

104A.24.4 After cleaning the member, it shall be visually compared to the SSPC PICTORIAL STANDARDS.

104A.24.5 The method of determining the air temperature, the steel temperature, the relative humidity, and the dew point as well as the intervals during painting will be listed. The method of documentation will also be indicated.

104A.24.6 The procedures for painting including but not limited to the following shall be detailed for each location within a shop where coatings are applied.

104A.24.6.1 Oil and air trap maintenance.

104A.24.6.2 Painting equipment being used.

104A.24.6.3 Method of agitation.

104A.24.6.4 If thinning is permitted by the type of coating system being used, how is this controlled?

104A.24.6.5 How is the millage to be controlled during application?

104A.24.7 After painting is complete a through inspection will be conducted by the fabricator and corrections if necessary, will be completed prior to presentation of the piece to the owner's representative.

104A.24.8. An example of the forms to be used in tracking the above shall be supplied.

104A.25 LOADING AND SHIPPING

This area of the QC Plan will document QC inspection responsibilities in the loading and shipping operations. As a minimum, the Plan will contain the following:

104A.25.1 Verify that all members have been stamped or otherwise identified as being "accepted" by the customer's shop inspector prior to loading for shipment.

104A.25.2 Assure all members are loaded, blocked and secured to prevent damage in shipment.

104A.25.3 Assure all areas where shop coat paint may have been damaged from loading operations has been repaired in accordance with governing specifications.

104A.25.4 Minimum frequency of inspection is 100 percent of all members loaded and shipped.

104A.25.5 The QC Plan will contain sample forms to be used by QC personnel to document inspection of loading and shipping operations.

MID-ATLANTIC STATES

STRUCTURAL COMMITTEE

FOR ECONOMICAL FABRICATION

STANDARD 104B

QUALITY ASSURANCE MANUAL

GUIDE FOR THE ACCEPTANCE TESTING

PLAN OF STRUCTURAL STEEL

FABRICATION

OCTOBER 1994

104B.1 PREFACE

This Acceptance and Testing Plan (ATP) is a requirement of the umbrella document titled "Manual of Recommended Practices for the Quality Assurance Plan for Structural Steel Fabrication".

104B.2 SCOPE

The fundamental concept is that the Owner or his representative monitors the implementation of the fabricators Quality Control Plan and approves or accepts the fabrication as being in compliance with Contract Plans and Specifications based on that monitoring. The Acceptance Testing Plan (ATP) is a manual that provides guidance on procedures, qualifications, inspections, equipment, personnel and recordkeeping used for acceptance testing and inspection. The plan is intended to be used by experienced and qualified acceptance testing inspectors to provide **GENERAL** guidelines for performance of their duties. This plan, in no manner, can be used by the inspector in lieu of the governing specifications for the contract. The omission from this plan of any shop inspection function does **NOT** relieve the acceptance testing inspector from performance of that duty where specification compliance must be verified. Acceptance testing and inspection of structural steel fabrication for highway bridges involves inspection of all phases of the work from initial receipt of the raw materials from the mill through shop cleaning, painting and shipping operations. This plan does not attempt to fully list all of the inspector's responsibilities. Inspection points and the attention to detail of compliance will vary with type of structure, experience of the fabricator, strength or weakness of the fabricator's QC organization, material of construction, weather conditions, etc. No inspection guidelines can be substituted for a knowledgeable and experienced structural steel shop inspector.

Many publications are available which provide detailed duties and responsibilities for welding inspectors. Among which are the ANSI/AWS (D1.1)Structural Welding Code, ANSI/AASHTO/AWS (D1.5) Bridge Welding Code, AWS publications titled "Welding Inspection," (WI-80) and "Certification Manual for Welding Inspectors," (CM-80).

104B.3 SPECIFICATIONS AND DOCUMENTS

104B.3.1 Shop quality assurance inspectors shall have as a minimum the following specifications and documents available to them at the fabrication shops:

104B.3.1.1 (A) Latest Standard Specifications, Supplements, and addenda

(B) Special Provisions
(1) Fabricators Quality Control Plan
(2) Copy of the Prefabrication meeting minutes

(C) Approved Shop Drawings

(D) Mill test reports for material being fabricated

(E) Welder & tacker qualification reports

(F) Approved welding procedure qualification reports, (PQR) where applicable

(G) NDT report for welds which have been inspected and accepted by Non-Destructive testing

(H) Copies of appropriate specifications:
ANSI/AASHTO/AWS D1.5 Bridge Welding Code or
ANSI/AWS D1.1 Structural Welding Code as required
ASTM A-6/A-6M
AASHTO M-160/M-160M
ASTM A-325 (or A-490) as required
ASTM A-709
AASHTO M-270
AASHTO - FCM guide, if required
SSPC, etc.

(I) Copy of approved non-destructive testing procedure along with calibration records

(J) Procedure as prescribed by the Fabricator for the Shops Operation

104B.3.1.2 Inspection Equipment

(A) 100 Ft. (30 m) steel tape
25 Ft. (10 m) belt rule

(B) Weld inspection tools ie. fillet weld gauges, undercut gauges, etc.

(C) Temperature indicating crayons
Surface pyrometer

(D) Surface roughness gauge both machine and flame cutting
ANSI B46.1 or AWS C4.1-G

(E) Coating testing equipment, ie. thickness gauge, thermometer - both surface and air sling psychrometer, etc.

(F) Flashlight

(G) Camera

104B.3.1.3 Facilities

(A) An appropriate office from which to conduct needed functions, to include desk, chairs, filling cabinet, outside phone, etc.

(B) Access to fabricators NDT facilities

(C) Access to other fabrication facilities and records as necessary, when work is being performed

104B.4 SHOP INSPECTOR QUALIFICATIONS AND APPROVAL

104B.4.1 Quality assurance personnel assigned to perform structural steel shop inspection must have the education, training and experience equivalent to that of AWS-CWI, and have functioned as an inspector in a structural steel shop for at least 3 of the last 5 years. Where an AWS/CWI equivalent is permitted, the State must have an established program for Qualification and Certification.

104B.4.2 Personnel assigned to witness the fabricator's non-destructive testing may require certification as a level II technician in the appropriate method in accordance with the American Society for Non-Destructive Testing Recommended Practice SNT-TC-1A and supplements thereto.

104B.4.3 Prior to assignment of quality assurance personnel to perform structural steel shop inspection, a complete resume for each individual to be assigned to the work shall be submitted to the state involved. The state shall review such qualification and resumes and either approve or disapprove the assignment of such personnel proposed based on the specific requirements of the project involved.

104B.5 INSPECTION PROCEDURES

The Quality Assurance Inspector, whose primary function is to monitor the workings of the Quality Control operations in the facility, is not restricted to only this function. The (QA) inspector shall on a periodic basis verify the results of the fabricators inspections and compare the results. These "hands-on" verifications are to be conducted within the time frame of the fabricators operations with as little interference to the work in process as possible. The Quality Assurance Inspection is the owners responsibility and at no point shall it remove the contractor (fabricator) from his responsibility to make a quality product and perform all testing or inspection as required by his Quality Control Plan.

104B.5.1 All structural steel, both primary and secondary members shall be shop inspected. During the course of the shop inspection the inspector shall verify that all members are fabricated of the designated type of steel.

104B.5.2 The inspector shall verify with shop management that there is a mutual understanding as to the methods and procedures to be followed in all details of fabrication and that shop equipment is capable of producing work equal to that of accepted general shop work.

104B.5.3 The inspector shall inspect work done in the fabricating shop, giving careful attention to the condition of the material, the quality of the workmanship, accuracy of punching and burning, care in assembly alignment and torque of high strength bolts to include the rotational capacity testing.

104B.5.4 The inspector shall visually examine steel and steel castings for surface and shape defects prior to the start of fabrication. The inspection shall be as thorough as possible to preclude any objectional material being passed on for fabrication.

104B.5.5 The inspector shall see that the proper preparation is made of material to be welded, that approved welding procedures are followed verifying as a minimum, volts, amps, and travel speed, and that the electrodes are of the proper size and quality to meet the appropriate specifications. Particular attention will be given to the accuracy of finishing, alignment, and welding of matching joints, and to the thoroughness of cleaning prior to applying shop primer and general finish after painting. The inspector shall make frequent inspections during the progress of fabrication, so that errors may be prevented and defects are caught and corrected at the earliest possible stage.

104B.5.6 With reference to shop painting of steel, at the earliest time possible the inspector shall check each paint container to determine if the paint has been pretested or approved as dictated by the state's requirements. Where applicable the inspector shall submit a sample for testing and analysis. The inspector shall withhold approval of the paint until such time as acceptance is made by the state involved.

104B.5.7 In addition, the inspector will give careful attention to typical inspection details which shall include, but are not limited to the following items:

(a) Make visual inspections for surface defects as materials are being worked and exposed to view. Defects rejectable shall be brought to the attention of the shop management in a timely fashion.

(b) Review the field connections paying particular attention to clearances, verify fit-up, matching of holes for ease of erection, the size of sections, thickness of plates, and permit only acceptable and approved materials to be used.

(c) Inspect reamed holes to ensure that they are cylindrical and perpendicular, and that burrs are removed and no chips or steel drilling remain between contact parts.

(d) Verify that the correct size punches and dies are used.

(e) Verify hole location and ensure required diameter.

(f) Ensure that reaming templates are properly set up and secured in position.

(g) Verify that all splices are properly fitted and that milled surfaces required to transmit bearing are in close contact.

(h) Ascertain that proper camber blocking or corresponding equipment is used in assembling girders and that desired camber is secured before reaming or drilling.

(i) Ensure that all spliced members and other assembled members are **plainly** matched marked, and check shop preparation of a match mark diagram.

(j) Inspect for twists, bends, kinks, or excessive sweep in finished members.

(k) Verify erection and shipping marks.

(l) See that all loose pieces are bolted in place for shipment and small parts are properly boxed or otherwise secured against loss in transit. Check for proper number of pieces indicated and that they bear legible stamping indicating approval.

(m) Observe the shop assembling of all girders or other parts required for reaming (drilling) of field holes.

(n) Verify that metal has been cleaned as specified before painting, and that humidity, temperature, and dew point conditions are satisfactory for painting. Where multi-coat systems are used verify cure of each coat prior to the application of the subsequent coats.

(o) See that paint is properly applied to clean prepared surface which meets the requirements of the coating being applied, and that no material is loaded for shipment until paint has dried sufficiently to resist damage from handling and shipment.

(p) Verify that no unauthorized corrections were made by flame cutting, particularly re-entrant cuts and other "stress raisers."

(q) Verify that only qualified welders/tackers, with current certificates covering the type of welding required are employed on the work.

(r) Inspect at frequent intervals the welding to see that welding procedures, including fit-ups, condition of material, welding equipment, electrodes, preheat, and other requirements are being followed and that workmanship is satisfactory.

(s) Inspect fillet and groove welds for proper size, profile and contour. In addition the inspector is responsible for verification and witnessing (where required) of the non-destructive testing of welds.

(t) Bearing plates and bearing assemblies, including rockers and shoes for structural steel and expansion dams shall be checked for conformance with the plans and specifications. In addition the surface roughness of all machined surfaces shall conform to applicable specifications, and all pieces (if required) are properly coated with a rust preventive material as described in the specifications.

(u) Make a visual examination of the completed member.

(v) Verify acceptance of all samples submitted to the state.

(w) Verify all reports covering the shipment are submitted.

(x) Verify proper loading for shipment.

(y) Indicate acceptance or rejection at the time of shipment, ie stamp/tag each piece or pallet.

104B.5.7 In addition, the inspector on welding will check as a minimum the items listed below. These checks are to be performed as early in the fabrication sequence as possible, and verified throughout the operation.

(a) Check the condition of the welding machines, verifying calibration and working gauges

(b) Review welding operators qualifications

(c) Check welding procedure qualification for approval

(d) Check type of electrode used to verify that they are consistent with the steel and they agree with the specifications

(e) Check storage of welding electrodes and periodically check oven temperature range

(f) Inspect flame cut edges for straightness, cracks, lamination, etc.

(g) Inspect shape and dimensions of edge preparation

(h) Check alignment of fitted parts prior to welding and closeness of fit

(i) Check location of stiffeners and connection plates

(j) Check welding current and voltage

(k) Check pre-heat, interpass and post-heat temperatures as required

(l) Check root of butt welds to be back gouged for complete removal of unsound metal

(m) Check workmanship of individual welders

(n) Witness the welding of any joint welding procedures qualification tests

(o) Investigate qualification of welders/tackers

(p) Examine the welds to see that they conform to dimensions on shop drawings and AWS specifications

(q) Inspect for stress notches at ends

(r) Perform visual inspections of welds and parent metal for cracks and other defects

(s) Witness non-destructive testing

(t) Determine the acceptance or rejection of welds

(u) Observe any welding used to repair fabrication errors to ensure that the procedure is approved and in accordance with the applicable AWS specifications, that the repair procedure has been submitted and approved where required and that subsequent retesting of the welds is performed.

104B.6 MILL ANALYSIS

104B.6.1 The inspector shall be provided with, if required by the state, the mill certification for all material shipped from the fabrication plant. In addition the inspector shall designate on, or attach to, the mill report the location of material used in the fabrication of primary members.

104B.6.2 Where mill certification are transmitted to the state electronically the inspector shall verify that only accepted material is utilized and shall generate a report showing the location of the primary material within the members being fabricated.

104B.7 RECORDS AND REPORTING

104B.7.1 The shop inspector shall maintain a daily diary for each contract (project) working a given location. The diary, unless specified otherwise, shall be either a permanently bonded book or electronic log with date and time file, of sufficient size to keep complete accurate and legible hand written notes.

104B.7.2 Upon completion of work on the project the diary will be forwarded to the state along with all other documents and records generated by the shop inspector for incorporation into the final record of the project.

104B.7.3 A bi-weekly (or weekly) "status" report shall be prepared by the inspector and forwarded to the state. This report shall list all required information concerning the status of the work performed along with a brief description of the past, either one (1) or two (2) weeks activities in the shop. The inspector shall also include any significant happenings of which the state should be advised. The reports are to be numbered consecutively until completion of the work when the last report will be noted "final."

104B.7.4 Whenever it becomes necessary for the shop inspector to make a formal rejection of a member in the shop the shop inspector shall complete a formal rejection notice and hand deliver it to the appropriate party in the fabricators organization. A copy of the formal rejection notice is to be forwarded to the state within 48 hours of the notice.

104B.8 SAFETY

THE SHOP INSPECTOR SHALL ADHERE TO ALL SAFETY REGULATIONS AND WEAR ALL SAFETY EQUIPMENT THAT ARE SPECIFIED BY THE FABRICATOR FOR USE BY THE SHOP PERSONNEL.

MID-ATLANTIC STATES

STRUCTURAL COMMITTEE

FOR ECONOMICAL FABRICATION

STANDARD 105

ELASTOMERIC

BEARINGS

OCTOBER 1994

References

CONCRETE BRIDGE

ELASTOMERIC BEARING DESIGN EXAMPLE

References:

1. AASHTO Standard Specifications For Highway Bridges 1992 (15th Edition), Section 14. AASHTO

2. "Elastomeric Bearing Pad Design by 1985 AASHTO" by Ronald W. Young, paper IBC 88-17 presented at 5th International Bridge Conference, Pittsburgh, Pennsylvania, June 1988. IBC 88-17

3. FHWA Region 3 SCEF Committee 10 -- Laminated Elastomeric Bearings, General Notes to Designers. GN

4. NCHRP Report 248 (August 1982), "Elastomeric Bearings - Design, Construction, and Materials" by J.F. Stanton and C.W. Roeder. NCHRP 248

References

PROBLEM STATEMENT

Design an elastomeric bearing for 90' P/S I-Beam. The following data are available from the superstructure design:

Span = 90'

Skew = 90° (right or normal structure)

Beam Spacing = 10'-11" = 131"

Live Load = 83.5 Kips [Without Impact]
(HS25 is Design Vehicle) — AASHTO [14.1]

Dead load = 131.0 Kips

P = 131.0 K + 83.5 K = 214.5 Kips

Roadway Slope = -2% — AASHTO [14.2]

BEAM DATA:

Beam Size = 28/78 I-Beam

Bottom flange width = 28"

ELASTOMER DATA:

Hardness = 50 Durometer — GN [10.13]

G = 95 psi to 130 psi — GN [10.14]

References

BEARING DESIGN PROCEDURE

DETERMINE Δ_h:

Δ_h = (Span)(Coef. of Thermal Expansion)(Temp. Range) + (Creep Adjustment/10')(Span) GN [10.4]

Δ_h = (90') (12"/') (0.000006) (70°) + [(1/32)"/10'] (90')

Δ_h = 0.735"

Assume $\Delta_s = \Delta_h$ = 0.735"

As per AASHTO Section 14.2, Δ_h = total horizontal movement of superstructure and, as per GN 10.3,total horizontal movement includes creep andshrinkage for concrete beams. As per AASHTO Section 14.4.1.3, Δ_s shall be taken as the horizontal bridge movement (Δ_h), modified to account for pier flexibility and construction procedures. For this problem , assume no pier flexibility or construction procedure horizontal movement tolerance.

SOLVE FOR h_{rt} (minimum required):

$h_{rt} \geq 2\Delta_s$ = (2)(0.735") = 1.470"

$\therefore$ h_{rt} (minimum required) $\geq$ 1.470" OK

AASHTO [14.4.1.3]

CHOOSE W:

W = 28" (width of bottom flange) - 4" (clearance)

W = 24"

Note: 4" Clearance is based on PADOT Waterproofing Detail at Abutments. This value is used for this example only. W should be chosen as large as practicable, such that it does not adversely effect pedestal size, abutment or pier width, etc.

SOLVE FOR L and $h_{ri\ (interior)}$:

- Allowable Pressure $= \dfrac{GS}{\beta} < 1000\ psi$ — GN [10.6]
- G = 95 psi — GN [10.14]
- β = 1.0 — AASHTO [14.2]
- $S = \dfrac{L\ W}{2h_{ri\ (interior)}\ (L+W)}$ — AASHTO [14.2]
- Design Pressure $= \dfrac{P}{Area}$
- P = 214.5 K
- Area = LW = L (24")

$$\therefore \frac{(95\ psi)\quad L\ (24")}{(1.0)\ 2h_{ri\ (interior)}\ (L+24")} \geq \frac{214.5\ K\ (1000\ \#/K)}{L\ (24")}$$

$$\therefore h_{ri\ (interior)} \leq \frac{(95\ psi)\quad L^2\ (576\ in^2)}{(1.0)2(214{,}500\ \#)(L+24")}$$

- DL Pressure $= \dfrac{DL}{Area} = \dfrac{131\ K}{L\ (24")}$ — GN [10.6]
- L (minimum) $= \dfrac{P}{W(1000\ psi)} = \dfrac{(214.5)(1000\ \#/K)}{(24")(1000\ psi)}$

$= 8.9375" \rightarrow$ Say 9"

References

GN [10.6]

GN [10.14]

AASHTO [14.2]

AASHTO [14.2]

GN [10.6]

References

TABLE 1

L	Maximum $h_{ri(i)}$	DESIGN PRESSURE	DL PRESSURE
9"	0.313"	993 psi	606 psi
10"	0.375"	894 psi	546 psi
11"	0.441"	813 psi	496 psi
12"	0.510"	745 psi	455 psi
13"	0.583"	688 psi	420 psi
14"	0.658"	638 psi	390 psi
15"	0.736"	596 psi	364 psi
16"	0.816"	559 psi	341 psi
17"	0.899"	526 psi	321 psi
18"	0.984"	497 psi	303 psi
19"	1.071"	470 psi	287 psi
20"	1.160"	447 psi	273 psi
21"	1.250"	426 psi	260 psi
22"	1.342"	406 psi	248 psi
23"	1.436"	389 psi	237 psi
24"	1.531"	372 psi	227 psi

$h_{ri(i)} = h_{ri(interior)}$

Procedure for Table 1:

- Choose L, between L (minimum) and W
- Calculate $h_{ri(interior)}$ (maximum)
- Calculate Design Pressure < 1000 psi — GN [10.6]
- Calculate DL Pressure > 200 psi for No Anchorage Required — GN [10.7]

CHOOSE SHIMS (Reinforcement):

SHIMS → Use A570 Grade 36

Use 11 gage shim

Thickness = 0.1196" = h_s

Allowable Stress = 20 Ksi

Resistance = Allowable Stress x h_s

= (20 Ksi) (0.1196")

= 2392 #/in

Maximum $h_{ri(interior)}$ from Table 1 = 1.531"

Applied load = 1700 $h_{ri(interior)}$

= 1700 (1.531")

= 2603 #/in

∴ Resistance = 2392 #/in < 2603 #/in = Applied Load NG

∴ Maximum $h_{ri\ (interior)}$ = 1.407" based on h_s = 0.1196". Thus the maximum L = 22" for this problem.

Note: A thicker shim could be used, if necessary, in order to satisfy the above criteria for any given pad size.

References

AASHTO [14.4.1.6]

GN [10.13]

References

SOLVE FOR ACTUAL h_{rt}:

TABLE $2A_1$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T
9"	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$= 0.350" $h_{ri(c)}$= 0.250"	1.550"	2.03"
11"	3 @ $h_{ri(i)}$= 0.350" $h_{ri(c)}$= 0.250"	1.550"	2.03"
12"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
13"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
14"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
15"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
16"	2 @ $hr_{i(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
17"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
18"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
19"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
20"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
21"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
22"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
23"	N.G.	N.G.	N.G.
24"	N.G.	N.G.	N.G.

$h_{ri(i)} = h_{ri(interior)}$; $h_{ri(c)} = h_{ri(cover)}$

Note: for L = 9", maximum $h_{ri(interior)}$ = 0.313" does not satisfy GN [10.5] since $h_{ri(cover)} \leq h_{ri(interior)}/1.4$ = (0.313")/1.4 = 0.224", but $h_{ri(cover)} \geq$ 0.25".

References

Procedure for Table $2A_1$:

- Select thickness of cover layers ($h_{ri(cover)}$) =0.250"

- Select number and thickness of interior layers such that the thickness is maximized, the number of layers is minimized, and the following equations are satisfied:

$\Sigma\, h_{ri(interior)} + (2)(h_{ri\,(cover)}) \geq h_{rt}$ (minimum required)

and

$h_{ri(interior)} \leq$ Maximum $h_{ri(interior)}$ of Table 1 — GN [10.6]

and

$1/4" = h_{ri(cover)} \leq h_{ri\,(interior)}/1.4$

- Calculate actual h_{rt}

- Calculate actual h_T

$h_T = h_{rt}$ + (number of shims) (h_s)

Note: number of shims = number of interior layers + 1

Now round h_T up to nearest 1/16", and then recompute $h_{ri(interior)}$ and $h_{ri(cover)}$, and compute Actual Volume. See Table $2B_1$.

References

SOLVE FOR ACTUAL h_{rt}:

TABLE $2A_2$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T
9"	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$= 0.350" $h_{ri(c)}$= 0.250"	1.550"	2.03"
11"	2 @ $h_{ri(i)}$= 0.441" $h_{ri(c)}$= 0.294"	1.470"	1.83"
12"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
13"	2 @ $h_{ri(i)}$= 0.485" $h_{ri(c)}$= 0.250"	1.470"	1.83"
14"	1 @ $h_{ri(i)}$= 0.658" $h_{ri(c)}$= 0.406"	1.470"	1.71"
15"	1 @ $h_{ri(i)}$= 0.736" $h_{ri(c)}$= 0.367"	1.470"	1.71"
16"	1 @ $hr_{i(i)}$= 0.816" $h_{ri(c)}$= 0.327"	1.470"	1.71"
17"	1 @ $h_{ri(i)}$= 0.899" $h_{ri(c)}$= 0.286"	1.471"	1.71"
18"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
19"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
20"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
21"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
22"	1 @ $h_{ri(i)}$= 0.970" $h_{ri(c)}$= 0.250"	1.470"	1.71"
23"	N.G.	N.G.	N.G.
24"	N.G.	N.G.	N.G.

$h_{ri(i)} = h_{ri(interior)}$; $h_{ri(c)} = h_{ri(cover)}$

Note: for L = 9", maximum $h_{ri(interior)}$ = 0.313" does not satisfy GN [10.5] since $h_{ri(cover)} \leq h_{ri(interior)}/1.4$ = (0.313")/1.4 = 0.224", but $h_{ri(cover)} \geq$ 0.25".

References

Procedure for Table $2A_2$:

- Select minimum number of and maximum thickness of interior layers such that the following equations are satisfied:

$$\Sigma h_{ri(interior)} + (2)(h_{ri\,(cover)}) \geq h_{rt} \text{ (minimum required)}$$

and

$$h_{ri(interior)} \leq \text{Maximum } h_{ri(interior)} \text{ of Table 1}$$

and

$$1/4" \leq h_{ri(cover)} \leq h_{ri\,(interior)}/1.4$$

GN [10.6]

- Calculate actual h_{rt}
- Calculate actual h_T

$$h_T = h_{rt} + (\text{number of shims})\,(h_s)$$

Note: number of shims = number of interior layers + 1

Now round h_T up to nearest 1/16", and then recompute $h_{ri(interior)}$ and $h_{ri(cover)}$, and compute Actual Volume. See Table $2B_2$.

References

TABLE $2B_1$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$= 0.362" $h_{ri(c)}$= 0.250"	1.585"	2.06"	495.40
11"	3 @ $h_{ri(i)}$= 0.362" $h_{ri(c)}$= 0.250"	1.585"	2.06"	543.84
12"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	541.44
13"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	586.56
14"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	631.68
15"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	676.80
16"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	721.92
17"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	767.04
18"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(c)}$= 0.250"	1.516"	1.88"	812.16
19"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(c)}$= 0.250"	1.511"	1.75"	798.00
20"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(c)}$= 0.250"	1.511"	1.75"	840.00
21"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(c)}$= 0.250"	1.511"	1.75"	882.00
22"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(c)}$= 0.250"	1.511"	1.75"	924.00
23"	N.G.	N.G.	N.G.	N.G.
24"	N.G.	N.G.	N.G.	N.G.

$h_{ri(i)}= h_{ri(interior)}$; $h_{ri(c)}= h_{ri(cover)}$

References

Procedure for Table $2B_1$:

· Round h_T in Table $2A_1$ up to nearest 1/16".

Write h_T to 2 decimal places.

· Calculate required h_{rt}

$h_{rt} = h_T$ - (number of shims) (h_s)

Note: number of shims = number of interior layers (Table $2A_1$) + 1

· Select $h_{ri(interior)}$ and $h_{ri(cover)}$ as per Table $2A_1$, such that

$\Sigma\, h_{ri(interior)} + (2)\,(h_{ri(covers)}) = h_{rt}$ GN [10.6]

and

$1/4" = h_{ri(cover)} \leq h_{ri(interior)} / 1.4$

and

$h_{ri(interior)} \leq$ maximum $h_{ri(interior)}$ of Table 1

· Calculate Actual Volume (in^3)

Volume = W x L x h_T

Note: The most economical bearing is the one with the least volume (i.e. least number of interior layers per L) that satisfies all design criteria (see the following calculations).

References

TABLE $2B_2$

L	Choose $h_{ri(i)}$ & $h_{ri(e)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$= 0.362" $h_{ri(e)}$= 0.250"	1.585"	2.06"	494.40
11"	3 @ $h_{ri(i)}$= 0.362" $h_{ri(e)}$= 0.250"	1.585"	2.06"	543.84
12"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(e)}$= 0.250"	1.516"	1.88"	541.44
13"	2 @ $h_{ri(i)}$= 0.508" $h_{ri(e)}$= 0.250"	1.516"	1.88"	586.56
14"	1 @ $h_{ri(i)}$= 0.658" $h_{ri(e)}$= 0.427"	1.511"	1.75"	588.00
15"	1 @ $h_{ri(i)}$= 0.736" $h_{ri(e)}$= 0.388"	1.511"	1.75"	630.00
16"	1 @ $h_{ri(i)}$= 0.816" $h_{ri(e)}$= 0.348"	1.511"	1.75"	672.00
17"	1 @ $h_{ri(i)}$= 0.899" $h_{ri(e)}$= 0.306"	1.511"	1.75"	714.00
18"	1 @ $h_{ri(i)}$= 0.984" $h_{ri(e)}$= 0.264"	1.511"	1.75"	756.00
19"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(e)}$= 0.250"	1.511"	1.75"	798.00
20"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(e)}$= 0.250"	1.511"	1.75"	840.00
21"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(e)}$= 0.250"	1.511"	1.75"	882.00
22"	1 @ $h_{ri(i)}$= 1.011" $h_{ri(e)}$= 0.250"	1.511"	1.75"	924.00
23"	N.G.	N.G.	N.G.	N.G.
24"	N.G.	N.G.	N.G.	N.G.

$h_{ri(i)} = h_{ri(interior)}$; $h_{ri(c)} = h_{ri(cover)}$

References

Procedure for Table $2B_2$:

· Round h_T in Table $2A_2$ up to nearest 1/16".

Write h_T to 2 decimal places.

· Calculate required h_{rt}

$h_{rt} = h_T$ - (number of shims) (h_s)

Note: number of shims = number of interior layers (Table $2A_2$) + 1

· Select $h_{ri(interior)}$ and $h_{ri(cover)}$ as per Table $2A_2$, such that

$\Sigma h_{ri(interior)} + (2)(h_{ri(covers)}) = h_{rt}$

and

$1/4" \leq h_{ri(cover)} \leq h_{ri(interior)} / 1.4$ GN [10.6]

and

$h_{ri(interior)} \leq$ maximum $h_{ri(interior)}$ of Table 1

· Calculate Actual Volume (in^3)

Volume = W x L x h_T

Note: The most economical bearing is the one with the least volume (i.e. least number of interior layers per L) that satisfies all design criteria (see the following calculations).

References

TABLE 2C
(Summary of least volume from Tables $2B_1$ and $2B_2$)

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$ = 0.362" $h_{ri(c)}$ = 0.250"	1.585"	2.06"	494.40
11"	3 @ $h_{ri(i)}$ = 0.362" $h_{ri(c)}$ =0.250"	1.585"	2.06"	543.84
12"	2 @ $h_{ri(i)}$ = 0.508" $h_{ri(c)}$ = 0.250"	1.516"	1.88"	541.44
13"	2 @ $h_{ri(i)}$ = 0.508" $h_{ri(c)}$ = 0.250"	1.516"	1.88"	586.56
14"	1 @ $h_{ri(i)}$ = .658" $h_{ri(c)}$ = 0.427"	1.511"	1.75"	588.00
15"	1 @ $h_{ri(i)}$ = .736" $h_{ri(c)}$ = 0.388"	1.511"	1.75"	630.00
16"	1 @ $h_{ri(i)}$ = .816" $h_{ri(c)}$ = 0.348"	1.511"	1.75"	672.00
17"	1 @ $h_{ri(i)}$ = .899" $h_{ri(c)}$ = 0.306"	1.511"	1.75"	714.00
18"	1 @ $h_{ri(i)}$ = .984" $h_{ri(c)}$ = 0.264"	1.511"	1.75"	756.00
19"	1 @ $h_{ri(i)}$ = 1.011" $h_{ri(c)}$ = 0.250"	1.511"	1.75"	798.00
20"	1 @ $h_{ri(i)}$ = 1.011" $h_{ri(c)}$ = 0.250"	1.511"	1.75"	840.00
21"	1 @ $h_{ri(i)}$ = 1.011" $h_{ri(c)}$ = 0.250"	1.511"	1.75"	882.00
22"	1 @ $h_{ri(i)}$ = 1.011" $h_{ri(c)}$ = 0.250"	1.511"	1.75"	924.00
23"	N.G.	N.G.	N.G.	N.G.
24"	N.G.	N.G.	N.G.	N.G.

$h_{ri(i)} = h_{ri(interior)}$; $h_{ri(c)} = h_{ri(cover)}$

References

CHECK STABILITY: (GN [10.12])

$W \geq 3h_T$ (AASHTO [14.4.1.5])

$h_T \leq W/3 = (24")/3 = 8.000"$ OK

$L \geq 3h_T = 3\ (2.06") = 6.18"$ OK

Note: see Table 2C for L and h_T values.

DETERMINE COMPRESSIVE STRAIN AND DEFLECTION:

- Compressive Strain = ε_{ci}

$$\varepsilon_{ci} = \left[\frac{P/Area}{2.3\ (S/\beta)^{1.63}}\right]^{\left[\frac{1}{1.15 + 0.0286(S/\beta)}\right]}$$

(IBC 88-17 [EQ. 37])

Note: This equation is used to approximate the AASHTO curve, FIGURE 14.4.1.2A. The actual AASHTO curve may be used if desired.

- Compressive Deflection = Δ_c (AASHTO [14.4.1.2])

$\Delta_{ci(interior)} = \varepsilon_{ci(interior)}\ h_{ri\ (interior)}$

$\Delta_{ci(cover)} = \varepsilon_{ci(cover)}\ h_{ri\ (cover)}$ (AASHTO [14.4.1.2])

- Use $h_{ri(interior)}$ and $h_{ri(cover)}$ from Table 2C.

References

TABLE 3A - INTERIOR LAYER

L	S	ε_{ci}	Δ_{ci}	$(0.07)h_{ri}$
9"	—	—	—	—
10"	9.750	0.0384	0.0139"	0.0253"
11"	10.418	0.0348	0.0126"	0.0253"
12"	7.874	0.0382	0.0194"	0.0356"
13"	8.300	0.0348	0.0177"	0.0356"
14"	6.719	0.0381	0.0251"	0.0461"
15"	6.271	0.0381	0.0280"	0.0515"
16"	5.882	0.0382	0.0311"	0.0571"
17"	5.535	0.0384	0.0345"	0.0629"
18"	5.232	0.0386	0.0380"	0.0689"
19"	5.245	0.0369	0.0373"	0.0708"
20"	5.395	0.0346	0.0350"	0.0708"
21"	5.539	0.0326	0.0330"	0.0708"
22"	5.677	0.0309	0.0312"	0.0708"
23"	—	—	—	—
24"	—	—	—	—

Note: $\beta = 1.0$ — AASHTO [14.2]

Procedure for Table 3A:

- Calculate S — AASHTO [14.4.1.2]
- Calculate ε_{ci}
- Calculate Δ_{ci}
- Check $\Delta_{ci} < (0.07)h_{ri}$ — GN [10.8]

References

TABLE 3B - COVER LAYER

L	S	ε_{ci}	Δ_{ci}	$(0.07)h_{ri}$
9"	_	_	_	_
10"	14.118	0.0378	0.0095"	0.0175"
11"	15.086	0.0344	0.0086"	0.0175"
12"	16.000	0.0317	0.0079"	0.0175"
13"	16.865	0.0295	0.0074"	0.0175"
14"	10.354	0.0355	0.0152"	0.0299"
15"	11.895	0.0310	0.0120"	0.0272"
16"	13.793	0.0275	0.0096"	0.0244"
17"	16.260	0.0249	0.0076"	0.0214"
18"	19.481	0.0232	0.0061"	0.0185"
19"	21.209*	_	_	0.0175"
20"	21.818*	_	_	0.0175
21"	22.400*	_	_	0.0175"
22"	22.957*	_	_	0.0175"
23"	_	_	_	_
24"	_	_	_	_

* = GN [10.5]

Note: $\beta = 1.4$ AASHTO [14.2]

Procedure for Table 3B:

- Calculate S AASHTO [14.4.1.2]
- Calculate ε_{ci}
- Calculate Δ_{ci} GN [10.8]
- Check $\Delta_{ci} < (0.07)h_{ri}$

References

TABLE 3C - TOTAL Δ_c

L	Δ_c
9"	—
10"	0.0607"
11"	0.0550"
12"	0.0546"
13"	0.0502"
14"	0.0555"
15"	0.0520"
16"	0.0504"
17"	0.0497"
18"	0.0502"
19"	0.0373"
20"	0.0350"
21"	0.0330"
22"	0.0312"
23"	—
24"	—

Procedure for Table 3C:

- Total Δ_c = (number of interior layers)
  x Δ_{ci} (Interior Layer)
  + $2\Delta_{ci}$ (Cover Layer)

AASHTO [14.4.1.2]

References

CHECK ROTATION:

- Assume beams are erected level in horizontal direction.

- Assume for this example a construction tolerance of 1/16" per foot parallel to the beam.(Refer to applicable State Specifications.)

  Vertical Deflection = [(1/16")/(12"/')] (1/2) L
  = (1/384) L

  Horizontal Length = (1/2) L

  $\theta_{,x}$ (construction) = TAN^{-1} [(1/384)L/(1/2)L]
  = TAN^{-1} [1/192]
  = 0.0052 Radians

- Assume dead load rotation is taken care of by a combination of camber (see below) and construction tolerances. Thus no check of rotational capacity under dead load only is required. If the dead load rotation is not taken care of by a combination of camber and construction tolerance, i.e. if the top of the bearing is not level and parallel to the bottom of the bearing under full dead load, then the dead load rotation must be checked. To perform this check, calculate Δ_c as per the previous section using P = Dead Load in the equation for ε_{ci} (page 17).

- Assume for this example a construction tolerance of 1/16" per foot perpendicular to the beam.(Refer to applicable State Specifications.)

  Vertical Deflection = [(1/16")/(12"/')] (1/2) W
  = (1/384) W

References

Horizontal Length = (1/2) W

$\theta_{,z}$ (construction) = TAN^{-1} [(1/384)W/(1/2)W]
= TAN^{-1} [1/192]
= 0.0052 Radians

- Determine Slope at Bearings

Grade = -2%

Camber = ±0.00385 Radians

Dead Load Camber = 1.3"
(Calculated by any rational means)

$$\theta_{,x} \text{ (Camber)} = \frac{16}{5}\frac{\text{(Camber)}}{\text{Span}} = \frac{16\ (1.3")}{5(90')(12"/')}$$

= 0.00385 Radians

Note: This formula is based on PADOT's Design Manual Part 4. It is used as an example only. Camber rotation should be calculated by any rational means.

∴ Slope at Bearings = -0.02 Radians
±0.00385 Radians

= -0.01615 Radians
and
= -0.02385 Radians

- Use a beveled sole plate at both bearings.

GN [10.9]

$$\theta_{LL,\,x} = \frac{16}{5}\ \frac{\text{(Deflection)}}{\text{(Span)}}$$

Note: This formula is based on PADOT's Design Manual Part 4. It is used as an example only. Live load rotation should be calculated by any rational means.

References

Assumed maximum live load deflection = 1.0"
(Based on limit of (Span/1000))

$$\theta_{LL,\,x} = \frac{16\,(1.0")}{5\,(90')(12"/')} = 0.00296 \text{ Radians}$$

$\theta_{TL,x} = \theta_{LL,x} + \theta_{,x}$ (construction)

$\theta_{TL,x}$ = 0.00296 Radians + 0.0052 Radians

$\theta_{TL,x}$ = 0.00816 Radians

$\theta_{TL,z} = \theta_{,z}$ (construction)= 0.0052 Radians

$\theta_{TL,x} \leq 2\Delta_c/L$ AASHTO [14.4.1.4]

$\theta_{TL,z} \leq 2\Delta_c/W$

References

TABLE 4

L	$2\Delta_c/L$	$\theta_{TL,x} \leq 2\Delta_c/L$	$2\Delta_c/W$	$\theta_{TL,z} \leq 2\Delta_c/W$
9"	—	—	—	—
10"	0.1214	OK	0.00506	N.G.
11"	0.0100	OK	0.00458	N.G.
12"	0.0091	OK	0.00455	N.G.
13"	***	***	***	***
14"	***	***	***	***
15"	***	***	***	***
16"	***	***	***	***
17"	***	***	***	***
18"	***	***	***	***
19"	***	***	***	***
20"	***	***	***	***
21"	***	***	***	***
22"	***	***	***	***
23"	—	—	—	—
24"	—	—	—	—

GN [10.2]

Note: *** means values did not need to be computed because minimum bearing size was found which satisfied rotation design criteria.

Since all trials were N.G., increment h_{rt} by 1/16" and recompute all values for L = 10", 11", and 12".

Note: The other approach to finding a solution is to try again with a narrower pad, i.e. reduce W, which may result in a more economical design. However, this approach will not be shown for this example.

References

Revised TABLE $2B_1$

L	Choose $h_{ri(i)}$ & $h_{ri(e)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	N.G. $h_{ri(e)}$ = 0.250"	N.G.	2.13"	511.20
11"	3 @ $h_{ri(i)}$ = 0.384" $h_{ri(e)}$ =0.250"	1.652"	2.13"	562.32
12"	N.G. $h_{ri(e)}$ =0.250"	N.G.	1.94"	558.72

Revised TABLE $2B_2$

L	Choose $h_{ri(i)}$ & $h_{ri(e)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$ = 0.375" $h_{ri(e)}$ = 0.264"	1.652"	2.13"	511.20
11"	3 @ $h_{ri(i)}$ = 0.382" $h_{ri(e)}$ =0.250"	1.652"	2.13"	562.32
12"	2 @ $h_{ri(i)}$ = 0.510" $h_{ri(e)}$ = 0.281"	1.581"	1.94"	558.72

References

Revised TABLE 2C

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$ = 0.375" $h_{ri(c)}$ = 0.264"	1.652"	2.13"	511.20
11"	3 @ $h_{ri(i)}$ = 0.382" $h_{ri(c)}$ =0.250"	1.652"	2.13"	562.32
12"	2 @ $h_{ri(i)}$ = 0.510" $h_{ri(c)}$ = 0.281"	1.581"	1.94"	558.72

Revised TABLE 3A - INTERIOR LAYER

L	S	ε_{ci}	Δ_{ci}	$(0.07)h_{ri}$
9"	—	—	—	—
10"	9.387	0.0392	0.0147"	0.0263"
11"	9.873	0.0357	0.0136"	0.0267"
12"	7.843	0.0383	0.0195"	0.0357"

References

Revised TABLE 3B - COVER LAYER

L	S	ε_{ci}	Δ_{ci}	$(0.07)h_{ri}$
9"	—	—	—	—
10"	13.369	0.0388	0.0102"	0.0185"
11"	15.086	0.0344	0.0086"	0.0175"
12"	14.235	0.0332	0.0093"	0.0197"

Revised TABLE 3C - TOTAL Δ_c

L	Δ_c
9"	—
10"	0.0645"
11"	0.0580"
12"	0.0576"

References

Revised TABLE 4

L	$2\Delta_c/L$	$\theta_{TL,x} \leq 2\Delta_c/L$	$2\Delta_c/W$	$\theta_{TL,z} \leq 2\Delta_c/W$
9"	—	—	—	—
10"	0.1290	OK	0.00538	OK
11"	0.0100	OK	0.00458	N.G.
12"	0.0096	OK	0.00480	N.G.

References

CHECK LONG-TERM DEFLECTIONS:

AASHTO [14.4.1.2]

Dead Load Compressive Strain = $\varepsilon_{ci(DL)}$

$$\left[\frac{1}{1.15 + 0.0286(S/\beta)}\right]$$

IBC 88-17 [EQ. 37]

$$\varepsilon_{ci(DL)} = \left[\frac{\text{Dead Load/Area}}{2.3\,(S/\beta)^{1.63}}\right]$$

AASHTO [14.4.1.2]

Note: This equation is used to approximate the AASHTO curve, FIGURE 14.4.1.2A. The actual AASHTO curve may be used if desired.

$\therefore\ \varepsilon_{ci(LL)} = \varepsilon_{ci} - \varepsilon_{ci(DL)}$

Dead Load Compressive Deflection = $\Delta_{c(DL)}$

AASHTO [14.4.1.2]

$\Delta_{ci(DL)}$ (Interior layer) $=(\varepsilon_{ci(DL)})h_{ri(exterior)}$

AASHTO [14.4.1.2]

$\Delta_{ci(DL)}$ (Cover layer) $=(\varepsilon_{ci(DL)})h_{ri(cover)}$

References

STEEL BRIDGE

ELASTOMERIC BEARING DESIGN EXAMPLE

References:

1. AASHTO Standard Specifications For Highway Bridges 1992 (15th Edition), Section 14. — AASHTO

2. "Elastomeric Bearing Pad Design by 1985 AASHTO" by Ronald W. Young, paper IBC 88-17 presented at 5th International Bridge Conference, Pittsburgh, Pennsylvania, June 1988. — IBC 88-17

3. FHWA Region 3 SCEF Committee 10 -- Laminated Elastomeric Bearings, General Notes to Designers. — GN

4. NCHRP report 248 (August 1982), "Elastomeric Bearings - Design, Construction, and Materials" by J.F. Stanton and C.W. Roeder. — NCHRP 248

References

PROBLEM STATEMENT

Design an elastomeric bearing for a 90' Steel Beam. The following data are available from the superstructure design:

Span = 90'

Skew = 90° (right or normal structure)

Beam Spacing = 9'-0" = 108"

Live Load = 72 K [Without Impact] AASHTO [14.1]
(HS25 is Design Vehicle)

Dead load = 90 K

P = 90 K + 72 K = 162 K AASHTO [14.2]

Roadway Slope = 2%

BEAM DATA:

Beam Size = W36x300 Composite

ELASTOMER DATA:

Hardness = 50 Durometer GN [10.13]

G = 95 psi to 130 psi GN [10.14]

References

BEARING DESIGN PROCEDURE

DETERMINE Δ_h:

Δ_h = (Span)(Coefficient of Thermal Expansion) (Temperature Range) — GN [10.4]

Δ_h = (90') (12"/') (0.0000065) (120°)

Δ_h = 0.842"

Assume $\Delta_s = \Delta_h$ = 0.842"

As per AASHTO Section 14.2, Δ_h = total horizontal movement of superstructure. As per AASHTO Section 14.4.1.3, Δ_s shall be taken as the horizontal bridge movement (Δ_h), modified to account for pier flexiblity and construction procedures. For this problem, assume no pier flexiblity or construction procedure horizontal movement tolerance.

SOLVE FOR h_{rt} (minimum required):

$h_{rt} \geq 2\Delta_s$ = (2)(0.842") = 1.684"

$\therefore$ h_{rt} (minimum required) $\geq$ 1.684" OK

AASHTO [14.4.1.3]

CHOOSE W:

W = 16.655" (width of bottom flange)
+ 2.5" (clearance)

W = 19.155"

Note: round W to the nearest inch.

Use: W = 20"

Note: 2.5" Clearance is chosen for example only. This assumed a sole plate attached to the bottom flange, as required (see page 22 and GN 10.8).

References

We should be choosen as large as practicable, such that it does not adversely affect pedestal size, sole plate size, abutment or pier width, etc.

SOLVE FOR L and $h_{ri(interior)}$: GN [10.6]

- Allowable Pressure $= \frac{GS}{\beta} < 1000$ psi GN [10.14]
- G = 95 psi AASHTO [14.2]
- $\beta = 1.0$ AASHTO [14.2]
- $S = \frac{L\ W}{2h_{ri(interior)}\ (L+W)}$
- Design Pressure $= \frac{P}{\text{Area}}$
- P = 162 K
- Area = LW = L (20")

$$\therefore \frac{(95\text{ psi})}{(1.0)} \frac{L\ (20")}{2h_{ri\ (interior)}(L+20")} \geq \frac{162\text{ K }(1000\ \#/\text{K})}{L\ (20")}$$

$$\therefore h_{ri(interior)} \leq \frac{(95\text{ psi})}{(1.0)} \frac{L^2\ (400\text{ in}^2)}{2(162{,}000\ \#)(L + 20")}$$

- DL Pressure $= \frac{DL}{\text{Area}} = \frac{90\text{ K}}{L\ (20")}$
- L (minimum) $= \frac{P}{W(1000\text{ psi})} = \frac{(162\text{ K})(1000\ \#/\text{K})}{(20")(1000\text{ psi})}$ GN [10.6]

  $= 8.10" \rightarrow$ Say 9"

References

TABLE 1

L	Maximum $h_{ri(i)}$	DESIGN PRESSURE	DL PRESSURE
9"	0.327"	900 psi	500 psi
10"	0.391"	810 psi	450 psi
11"	0.458"	737 psi	409 psi
12"	0.528"	675 psi	375 psi
13"	0.601"	623 psi	347 psi
14"	0.676"	579 psi	322 psi
15"	0.754"	540 psi	300 psi
16"	0.834"	507 psi	282 psi
17"	0.916"	477 psi	265 psi
18"	1.000"	450 psi	250 psi
19"	1.086"	426 psi	237 psi
20"	1.173"	405 psi	225 psi

$h_{ri(i)} = h_{ri(interior)}$

Procedure for Table 1:

- Choose L, between L (minimum) and W
- Calculate $h_{ri(interior)}$ (maximum)
- Calculate Design Pressure < 1000 psi — GN [10.6]
- Calculate DL Pressure > 200 psi for No Anchorage Required — GN [10.7]

References

CHOOSE SHIMS (Reinforcement):AASHTO [14.4.1.6]

SHIMS → Use A570 Grade 36

Use 11 gage shim GN [10.13]

Thickness = 0.1196"= h_s

Allowable Stress = 20 Ksi

Resistance = Allowable Stress x h_s

= (20 Ksi) (0.1196")

= 2392 #/in

Maximum $h_{ri(interior)}$ from Table 1 = 1.173"

Applied load = 1700 $h_{ri(interior)}$

= 1700 (1.173")

= 1994 #/in

∴ Resistance = 2392 #/in > 1994 #/in = Applied Load OK

References

SOLVE FOR ACTUAL h_{rt}:

TABLE $2A_1$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T
9"	N.G.	N.G.	N.G.
10"	4 @ $h_{ri(i)}$=0.350" $h_{ri(c)}$= 0.250"	1.900"	2.5"
11"	3 @ $h_{ri(i)}$=0.395" $h_{ri(c)}$=0.250"	1.685"	2.16"
12"	3 @ $h_{ri(i)}$=0.395" $h_{ri(c)}$=0.250"	1.685"	2.16"
13"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
14"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
15"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
16"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
17"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
18"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
19"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
20"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"

$h_{ri(i)}= h_{ri(interior)}$ $h_{ri(c)}= h_{ri(cover)}$

Note: for L=9", maximum $h_{ri(i)}$ = 0.293" does not satisfy GN [10.5], since $h_{ri(c)} \leq h_{ri(i)}/1.4$ = (0.293")/1.4 = 0.209", but $h_{ri(c)} \geq$ 0.25".

References

Procedure for Table $2A_1$:

- Select thickness of cover layers

$(h_{ri(cover)}) = 0.250"$

- Select number and thickness of interior layers such that the thickness is maximized, the number of layers is minimized, and the following equations are satisfied:

$$\Sigma h_{ri(interior)} + (2)(h_{ri(cover)}) \geq h_{rt} \text{ (minimum required)}$$

and

$$h_{ri(interior)} \leq \text{Maximum } h_{ri(interior)} \text{ of Table 1}$$

and

$$1/4" = h_{ri(cover)} \leq h_{ri(interior)} /1.4$$

- Calculate actual h_{rt}

- Calculate actual h_T

$$h_T = h_{rt} + (\text{number of shims})(h_s)$$

GN [10.6]

Note: number of shims = number of interior layers + 1

Now round h_T up to nearest 1/16", and then recompute $h_{ri(interior)}$ and $h_{ri(cover)}$, and compute actual Volume. See Table $2B_1$.

References

SOLVE FOR ACTUAL h_{rt}:

TABLE $2A_2$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T
9"	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$=0.391" $h_{ri(c)}$= 0.256"	1.685"	2.16"
11"	3 @ $h_{ri(i)}$=0.395" $h_{ri(c)}$=0.250"	1.685"	2.16"
12"	2 @ $h_{ri(i)}$=0.528" $h_{ri(c)}$=0.314"	1.684"	2.04"
13"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
14"	2 @ $h_{ri(i)}$=0.592" $h_{ri(c)}$=0.250"	1.684"	2.04"
15"	1 @ $h_{ri(i)}$=0.754" $h_{ri(c)}$=0.465"	1.684"	1.92"
16"	1 @ $h_{ri(i)}$=0.824" $h_{ri(c)}$=0.425"	1.684"	1.92"
17"	1 @ $h_{ri(i)}$=0.916" $h_{ri(c)}$=0.384"	1.684"	1.92"
18"	1 @ $h_{ri(i)}$=1.000" $h_{ri(c)}$=0.342"	1.684"	1.92"
19"	1 @ $h_{ri(i)}$=1.086" $h_{ri(c)}$=0.299"	1.684"	1.92"
20"	1 @ $h_{ri(i)}$=1.173" $h_{ri(c)}$=0.256"	1.685"	1.92"

$h_{ri(i)}$= $h_{ri(interior)}$ $h_{ri(c)}$= $h_{ri(cover)}$

Note: for L=9", maximum $h_{ri(i)}$ = 0.293" does not satisfy GN [10.5], since $h_{ri(c)} \leq h_{ri(i)}$ /1.4 = (0.293")/1.4 = 0.209", but $h_{ri(c)} \geq$ 0.25".

References

Procedure for Table $2A_2$:

- Select minimum number of and maximum thickness of interior layers such that the following equations are satisfied:

$\Sigma\ h_{ri(interior)} + (2)(h_{ri(cover)}) \geq h_{rt}$ (minimum required)

and

$h_{ri(interior)} \leq$ Maximum $h_{ri(interior)}$ of Table 1

and

$1/4" \leq h_{ri(cover)} \leq h_{ri(interior)}/1.4$

- Calculate actual h_{rt}
- Calculate actual h_T

$h_T = h_{rt} +$ (number of shims)(h_s) GN [10.6]

Note: number of shims = number of interior layers + 1

Now round h_T up to nearest 1/16", and then recompute $h_{ri(interior)}$ and $h_{ri(cover)}$, and compute actual Volume. See Table $2B_2$.

References

TABLE $2B_1$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	4 @ $h_{ri(i)}$=0.351" $h_{ri(c)}$=0.250"	1.902"	2.50"	500.00
11"	3 @ $h_{ri(i)}$=0.403" $h_{ri(c)}$=0.250"	1.710"	2.19"	481.80
12"	3 @ $h_{ri(i)}$=0.403" $h_{ri(c)}$=0.250"	1.710"	2.19"	525.60
13"	3 @ $h_{ri(i)}$=0.401" $h_{ri(c)}$=0.250"	1.704"	2.06"	536.38
14"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	577.64
15"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	618.90
16"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	660.16
17"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	701.42
18"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	742.68
19"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	783.94
20"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	825.20

$h_{ri(i)}=h_{ri(interior)}$ $h_{ri(c)}= h_{ri(cover)}$

References

Procedure for Table $2B_1$:

- Round h_T in Table $2A_1$ up to nearest 1/16". Write h_T to 2 decimal places.

- Calculate required h_{rt}

  $h_{rt} = h_T$ - (number of shims)(h_s)

Note: number of shims = number of interior layers (Table $2A_1$) + 1

- Select $h_{ri(interior)}$ and $h_{ri(cover)}$ as per Table $2A_1$ such that

  $\Sigma\, h_{ri(interior)} + (2)(h_{ri(cover)}) = h_{rt}$

  and

  $h_{ri(interior)} \leq$ Maximum $h_{ri(interior)}$ of Table 1

  and

  $1/4" = h_{ri(cover)} < h_{ri(interior)}/1.4$

- Calculate Actual Volume (in^3)

  Volume = W x L x h_T GN [10.6]

Note: The most economical bearing is the one with the least volume (i.e. least number of interior layers per L) that satisfies all design criteria (see the following calculations).

References

TABLE $2B_2$

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$=0.391" $h_{ri(c)}$=0.269"	1.710"	2.19"	438.00
11"	3 @ $h_{ri(i)}$=0.403" $h_{ri(c)}$=0.250"	1.710"	2.19"	481.80
12"	2 @ $h_{ri(i)}$=0.528" $h_{ri(c)}$=0.324"	1.704"	2.06"	494.40
13"	2 @ $h_{ri(i)}$=0.601" $h_{ri(c)}$=0.251"	1.704"	2.06"	535.60
14"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	576.80
15"	1 @ $h_{ri(i)}$=0.754" $h_{ri(c)}$=0.473"	1.699"	1.94"	582.00
16"	1 @ $h_{ri(i)}$=.834" $h_{ri(c)}$=0.433"	1.699"	1.94"	620.80
17"	1 @ $h_{ri(i)}$=0.916" $h_{ri(c)}$=0.392"	1.699"	1.94"	659.60
18"	1 @ $h_{ri(i)}$=1.000" $h_{ri(c)}$=0.350"	1.699"	1.94"	698.40
19"	1 @ $h_{ri(i)}$=1.086" $h_{ri(c)}$=0.307"	1.699"	1.94"	737.20
20"	1 @ $h_{ri(i)}$=1.173" $h_{ri(c)}$=0.263"	1.699"	1.94"	776.00

$h_{ri(i)}$= $h_{ri(interior)}$ $h_{ri(c)}$= $h_{ri(cover)}$

References

Procedure for Table $2B_2$:

- Round h_T in Table $2A_2$ up to nearest 1/16". Write h_T to 2 decimal places.

- Calculate required h_{rt}

  $h_{rt} = h_T$ - (number of shims)(h_s)

Note: number of shims = number of interior layers (Table $2A_2$) + 1

- Select $h_{ri(interior)}$ and $h_{ri(cover)}$ as per Table $2A_2$ such that $\Sigma\, h_{ri(interior)} + (2)(h_{ri(cover)}) = h_{rt}$

  and

  $h_{ri(interior)} \leq$ Maximum $h_{ri(interior)}$ of Table 1

  and

  $1/4" \leq h_{ri(cover)} \leq h_{ri(interior)} / 1.4$

- Calculate Actual Volume (in^3)

  Volume = W x L x h_T

GN [10.6]

Note: The most economical bearing is the one with the least volume (i.e. least number of interior layers per L) that satisfies all design criteria (see the following calculations).

References

TABLE 2C
(Summary of least volume form Tables $2B_1$ and $2B_2$)

L	Choose $h_{ri(i)}$ & $h_{ri(c)}$	Actual h_{rt}	Actual h_T	Actual Volume
9"	N.G.	N.G.	N.G.	N.G.
10"	3 @ $h_{ri(i)}$=0.391" $h_{ri(c)}$=0.269"	1.710"	2.19"	438.00
11"	3 @ $h_{ri(i)}$=0.403" $h_{ri(c)}$=0.250"	1.710"	2.19"	481.80
12"	2 @ $h_{ri(i)}$=0.528" $h_{ri(c)}$=0.324"	1.704"	2.06"	494.40
13"	2 @ $h_{ri(i)}$=0.601" $h_{ri(c)}$=0.251"	1.704"	2.06"	535.60
14"	2 @ $h_{ri(i)}$=0.602" $h_{ri(c)}$=0.250"	1.704"	2.06"	576.80
15"	1 @ $h_{ri(i)}$=0.754" $h_{ri(c)}$=0.473"	1.699"	1.94"	582.00
16"	1 @ $h_{ri(i)}$=.834" $h_{ri(c)}$=0.433"	1.699"	1.94"	620.80
17"	1 @ $h_{ri(i)}$=0.916" $h_{ri(c)}$=0.392"	1.699"	1.94"	659.60
18"	1 @ $h_{ri(i)}$=1.000" $h_{ri(c)}$=0.350"	1.699"	1.94"	698.40
19"	1 @ $h_{ri(i)}$=1.086" $h_{ri(c)}$=0.307"	1.699"	1.94"	737.20
20"	1 @ $h_{ri(i)}$=1.173" $h_{ri(c)}$=0.264"	1.699"	1.94"	776.00

$h_{ri(i)}$=$h_{ri(interior)}$ $h_{ri(c)}$= $h_{ri(cover)}$

References

CHECK STABILITY:

GN [10.12]

$W \geq 3h_T$

AASHTO [14.4.1.5]

$h_T \leq W/3 = (20")/3 = 6.667"$ OK

$L \geq 3h_T = 3(2.188") = 6.564"$ OK

Note: See Table 2C for L and h_T values.

DETERMINE COMPRESSIVE STRAIN AND DEFLECTION:

- Compressive Strain = ε_{ci}

$$\left[\frac{1}{1.15 + 0.0286(S/\beta)}\right]$$

IBC 88-17 [EQ. 37]

$$\varepsilon_{ci} = \left[\frac{P/Area}{2.3\,(S/\beta)^{1.63}}\right]$$

Note: This equation is used to approximate the AASHTO curve, FIGURE 14.4.1.2A. The actual AASHTO curve may be used if desired.

AASHTO [14.4.1.2]

- Compressive Deflection = Δ_c

$\Delta_{ci(interior)} = \varepsilon_{ci(interior)}\, h_{ri(interior)}$

$\Delta_{ci(cover)} = \varepsilon_{ci(cover)}\, h_{ri(cover)}$

AASHTO [14.4.1.2]

- Use $h_{ri(interior)}$ and $h_{ri(cover)}$ from Table 2C.

References

TABLE 3A - INTERIOR LAYER

L	S	ε_{ci}	Δ_{ci}	$(0.07)h_{ri}$
9"	–	–	–	–
10"	8.525	0.0386	0.0151	0.0274
11"	8.805	0.0354	0.0143"	0.0282"
12"	7.102	0.0381	0.0201"	0.0370"
13"	6.555	0.0381	0.0229"	0.0421"
14"	6.840	0.0349	0.0210"	0.0421"
15"	5.684	0.0383	0.0289"	0.0528"
16"	5.329	0.0385	0.0321"	0.0584"
17"	5.016	0.0388	0.0355"	0.0641"
18"	4.737	0.0391	0.0391"	0.0700"
19"	4.486	0.0395	0.0429"	0.0760"
20"	4.263	0.0398	0.0467"	0.0821"

Note: $\beta = 1.0$

Procedure for Table 3A:

- Calculate S
- Calculate ε_{ci} — AASHTO [14.2]
- Calculate Δ_{ci} — AASHTO [14.4.1.2]
- Check $\Delta_{ci} < (0.07)\, h_{ri}$ — GN [10.8]

References

TABLE 3B - COVER LAYER

L	S	ε_{ci}	Δ_{ci}	$(0.07)h_{ri}$
9"	---	---	---	---
10"	12.392	0.0377	0.0101"	0.0188"
11"	14.194	0.0329	0.0082"	0.0175"
12"	11.574	0.0345	0.0112"	0.0227"
13"	15.695	0.0281	0.0071"	0.0176"
14"	16.471	0.0265	0.0066"	0.0175"
15"	9.061	0.0345	0.0163"	0.0331"
16"	10.264	0.0302	0.0131"	0.0303"
17"	11.721	0.0266	0.0104"	0.0274"
18"	13.534	0.0238	0.0083"	0.0245"
19"	15.869	0.0218	0.0067"	0.0215"
20"	18.939	0.0204	0.0054"	0.0185"

* = GN [10.5]

Note: $\beta = 1.4$

Procedure for Table 3B:

- Calculate S — AASHTO [14.2]
- Calculate ε_{ci} — AASHTO [14.4.1.2]
- Calculate Δ_{ci}
- Check $\Delta_{ci} < (0.07)h_{ri}$ — GN [10.8]

References

TABLE 3C - TOTAL Δ_c

L	Δ_c
9"	---
10"	0.0655"
11"	0.0593"
12"	0.0626"
13"	0.0600"
14"	0.0552"
15"	0.0615"
16"	0.0583"
17"	0.0563"
18"	0.0557"
19"	0.0563"
20"	0.0575"

Procedure for Table 3C:

- Total Δ_c = (number of interior layers)
  x Δ_{ci} (Interior Layer)
  + 2Δ_{ci} (Cover Layer)

AASHTO [14.4.1.2]

References

CHECK ROTATION:

- Assume beams are erected level in horizontal direction.
- Assume for this example a construction tolerance of 1/16" per foot parallel to the beam.(Refer to applicable State Specifications.)

Vertical Deflection = [(1/16")/(12"/')] (1/2) L

= (1/384) L

Horizontal Length = (1/2) L

$\theta_{,x}$ (construction) = TAN^{-1} [(1/384)L/(1/2)L]
= TAN^{-1} [1/192]
= 0.0052 Radians

- Assume dead load rotation is taken care of by a combination of camber (see below) and construction tolerances. Thus no check of rotational capacity under dead load only is required. If the dead load only is not taken care of by a combination of cmaber and construction tolerance, i.e. if the top of the bearing is not level and parallel to the bottom of the bearing under full dead load, then the dead load rotation must be checked. To perform this check, calculate Δ_c as per the previous section using P = Dead Load in the equation for ε_{ci} (page 17).

- Assume for this example a construction tolerance of 1/16" per foot perpendicular to the beam.
(Refer to applicable State Specifications.)

Vertical Deflection = [(1/16") / (12"/1)] (1/2)W
= (1/384)W

Horizontal Length = (1/2) W

$\theta_{,z}$ (construction) = TAN^{-1} [(1/384)W / (1/2)W]
= TAN^{-1} [(1/192)]
= 0.0052 Radians.

References

- Grade = 2% (use a beveled sole plate)

$$\theta_{LL,x} = \frac{16}{5}\frac{(\text{Deflection})}{(\text{Span})}$$

GN [10.9]

Note: This formula is based on PADOT's Design Manual Part 4. It is used as an example only. Live load rotation should be calculated by any rational means.

Maximum live load deflection = 0.8"
(Calculated by any rational means.)

$$\theta_{LL,x} = \frac{16\ (0.8")}{5\ (90')(12"/')} = 0.00237 \text{ Radians}$$

$\theta_{TL,x} = \theta_{LL,x} + \theta_x$ (construction)

$\theta_{TL,x} = 0.00237$ Radians + 0.0052 Radians

$\theta_{TL,x} = 0.00757$ Radians

$\theta_{TL,z} = \theta_{,z}$ (construction) = 0.0052 Radians

AASHTO [14.4.1.4]

$\theta_{TL,x} \leq 2\Delta_C/L$

$\theta_{TL,z} \leq 2\Delta_C/W$

References

TABLE 4

L	$2\Delta_c/L$	$\theta_{TL,x} \leq 2\Delta_c/L$	$2\Delta_c/W$	$\theta_{TL,z} \leq 2\Delta_c/W$
9"	---	---	---	---
10"	0.0131"	OK	0.00655"	OK
11"	0.1078"	OK	0.00593"	OK
12"	***	***	***	***
13"	***	***	***	***
14"	***	***	***	***
15"	***	***	***	***
16"	***	***	***	***
17"	***	***	***	***
18"	***	***	***	***
19"	***	***	***	***
20"	***	***	***	***

Note: *** means value did not need to be computed because minimum bearing size was found which satisfied rotation design criteria.

References

CHECK LONG-TERM DEFLECTIONS:

AASHTO [14.4.1.2]

Dead Load Compressive Strain = $\varepsilon_{ci(DL)}$

$$\left[\frac{1}{1.15 + 0.0286(S/\beta)}\right]$$

$$\varepsilon_{ci(DL)} = \left[\frac{\text{Dead Load/Area}}{2.3\,(S/\beta)^{1.63}}\right]$$

IBC 88-17 [EQ. 37]

Note: This equation is used to approximate the AASHTO curve, FIGURE 14.4.1.2A. The actual AASHTO curve may be used if desired.

AASHTO [14.4.1.2]

$\therefore\ \varepsilon_{ci(LL)} = \varepsilon_{ci} - \varepsilon_{ci(DL)}$

Dead Load Compressive Deflection = $\Delta_{c(DL)}$

$\Delta_{ci(DL)}$ (Interior layer) = $(\varepsilon_{ci(DL)})\ h_{ri(exterior)}$

$\Delta_{ci(DL)}$ (Cover layer) = $(\varepsilon_{ci(DL)})\ h_{ri(cover)}$

AASHTO [14.4.1.2]
AASHTO [14.4.1.2]

References

TABLE 5A

L	Interior Layer		Cover Layer	
	$\varepsilon_{ci(DL)}$	$\Delta_{ci(DL)}$	$\varepsilon_{ci(DL)}$	$\Delta_{ci(DL)}$
9"	–	–	–	–
10"	0.0253	0.0099"	0.0248	0.0067"
11"	***	***	***	***
12"	***	***	***	***
13"	***	***	***	***
14"	***	***	***	***
15"	***	***	***	***
16"	***	***	***	***
17"	***	***	***	***
18"	***	***	***	***
19"	***	***	***	***
20"	***	***	***	***

Note: *** means values did not need to be computed computed because minimum bearing size was found which satisfied long-term deflection design criteria. (See Table 5C).

Procedure for Table 5A:

- Calculate $\varepsilon_{ci(DL)}$
- Calculate $\Delta_{ci(DL)}$

$\Delta_{c(DL)} = 2\Delta_{ci(DL)}$ (Cover layer) + $\Sigma\Delta_{ci(DL)}$ (Interior layer)

AASHTO [14.4.1.2]

References

TABLE 5B

L	$\Delta_{c(DL)}$	$\Delta_{c(LL)}$
9"	---	---
10"	0.0431"	0.0224"
11"	***	***
12"	***	***
13"	***	***
14"	***	***
15"	***	***
16"	***	***
17"	***	***
18"	***	***
19"	***	***
20"	***	***

Note: *** means values did not need to be computed because minimum bearing size was found which satisfied long-term deflection design criteria. (See Table 5C).

Procedure for Table 5B:

- See Table 3C for Δ_c
- Calculate $\Delta_{c(DL)}$
- Calculate $\Delta_{c(LL)}$

$$\Delta_{c(LL)} = \Delta_c - \Delta_{c(DL)}$$

References

Elastomer Creep Factor Applied to Dead Load:

Creep Factor = 25%

AASHTO [14.4.1.2]
AASHTO [Table 14.3.1]

$\therefore \Delta_{c(Long\text{-}Term)} = \Delta_c + [\Delta_{c(DL)}$ x (Creep Factor)]

Note: See Table 3C for Δ_c

Appendix D states:

AASHTO [14.4.1.2]
NCHRP 248

Long-term deflections should be accounted for when considering joints and seals; and a maximum relative deflection across a joint of 1/8" is suggested.

$\therefore \Delta_{c(Long\text{-}term)} < 0.125"$

AASHTO [14.4.1.2]

References

TABLE 5C

L	$\Delta_{c(LT)}$	$\Delta_{c(LT)}$<0.125"
9"	---	---
10"	0.0763"	OK
11"	***	***
12"	***	***
13"	***	***
14"	***	***
15"	***	***
16"	***	***
17"	***	***
18"	***	***
19"	***	***
20"	***	***

$\Delta_{c(LT)} = \Delta_{c(\text{Long Term})}$

Note: *** means values did not need to be computed because minimum bearing size was found which satisfied long-term deflection design criteria.

References

BEARING DESIGN SUMMARY:

Select the bearing with the least volume which satisfies all the design criteria.

USE 20" x 10" x 2.19" Thick Bearing with 4 - 11 ga Shims
2 Cover layers ($h_{ri(cover)}$ = 0.269")
3 Interior layers ($h_{ri(interior)}$ = 0.391")

Note: This design is for the expansion bearing. However, it can also be used for the fixed bearing. The design of the fixed bearing is the same as for the expansion bearing, except that the horizontal movement does not control the design (i.e. criteria $h_{rt} \geq 2\Delta_s$ does not apply).

CALCULATE SHEAR FORCE:

$$H = \frac{G\ L\ W\ \Delta_h}{h_{rt}}$$

AASHTO [14.4.1.3]

$$H = \frac{(130psi)(10")(20")(0.842")}{(1.710")(1000\#/K)} = 12.80K$$

AASHTO [14.6.1]

CHECK ANCHORAGE:

(1/5)(Dead Load) > H = 12.80 K

(1/5)(90 K) = 18 K > 12.80 K   OK

∴ Anchorage not required

AASHTO [14.5]

SCEF

Mid-Atlantic States

STRUCTURAL COMMITTEE FOR ECONOMICAL FABRICATION

STANDARD 106

HIGH LOAD MULTI-ROTATIONAL BEARINGS

February. 2000

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C O M M E N T A R Y

106.1 DEFINITION: High Load Multi-Rotational Bearings consist of a rotational element of the Pot-type, Spherical-type or Disc-type when used as a fixed bearing and may, in addition, have sliding surfaces to accommodate translation when used as an expansion bearing and may have guide bars to limit movement in specified directions.

106.2 PURPOSE: This specification was prepared for the broad range of normal applications and the limits of loads, forces and movements stated. The design and manufacture of multi-rotational bearings relies heavily on the principles of engineering mechanics and extensive practical experience in bearing design and manufacture. Therefore, in special cases where structural requirements fall outside the limits of this specification, a bearing manufacturer should be consulted.

Rotational requirements of the bearing, Rb, are determined by:

Rb = Rs + Rc

Where:
- Rb = rotation capacity designed into the bearing
- Rs = anticipated rotation of the structure in service. (Includes live loads, rotations induced by construction/erection sequences)
- Rc = rotation induced in the bearing by construction tolerances, 0.02 radians maximum (see Section 106.3.2.12)

106.3 APPLICATION

106.3.1 General
This section is written to assist bridge design engineers specifying multi-rotational bearings to use the specification that follows. The use of multi-rotational bearings is especially indicated where:

106.3.1.1 Low profile, high load bearings are required.

106.3.1.2 Curved or skewed bridges and other similar structures of complex design are contemplated.

106.3.1.3 Long slender columns or light frames and members exhibit minimum stiffness or rigidity.

106.3.1.4 The direction of rotation varies.

106.3.1.5 The direction of rotation cannot be precisely determined.

106.3.1.6 Settlement of the substructure is anticipated.

106.3.1.7 Self-aligning capabilities are required.

106.3.1.8 Load and rotation eccentricity does not significantly alter the net distribution of stress through the bearing and into the substructure and superstructure.

106.3.1.9 It is desirable to reduce the moment applied to truss or space frame panels.

106.3.1.10 Large movements are anticipated.

106.3.1.11 Economical, long life, zero or low maintenance bearings are desirable.

106.3.2 STRUCTURAL APPLICATION CONSIDERATIONS

106.3.2.1 Vertical and horizontal loads shall be assumed to occur simultaneously. All loads are service loads. Minimum vertical loads are for dead loads and superimposed dead loads. Maximum vertical loads are for dead loads, superimposed dead loads and live loads and impact.

106.3.2.2 The total recommended clearance between all guiding and guided sliding surfaces is 1/l6" (1.6 mm) in order to limit edge stress on guiding interfaces. Avoid specifying total spacing of more than 1/16" (1.6 mm) between guides and guided components where possible.

106.3.2.3 Horizontal loads at each abutment, bent, column, hinge or pier shall be distributed over as few bearings as deemed necessary by the design engineer. Because of fabrication and erection tolerances, it should not be assumed that horizontal forces are equally distributed to all bearings. High horizontal forces (>50% of max. vertical load) should be transmitted through separate devices.

106.3.2.4 Where feasible provide at least two fixed or guided expansion bearings each able to resist all horizontal forces, other than seismic, at each abutment, column, hinge or pier for design redundancy. Horizontal forces from seismic conditions, where minor local yielding is permitted, can be considered as equally shared between all bearings at a given support.

106.3.2.5 Multi-Rotational bearings conforming to the specification should not be used at vertical loads less than 20% of their vertical capacity. Bearings for less than 20% require special design.

106.3.2.6 Special consideration in bearing design shall be given where the ratio of high horizontal to vertical load is anticipated.

106.3.2.7 Frictional resistance of bearing slide surfaces should be neglected when calculating horizontal load capacity.

106.3.2.8 The installed alignment of bearing guiding systems relative to the anticipated movement direction of the structure should be carefully considered to avoid bearing guide system failure. Special studies or designs may be required on curved or skewed structures to ensure correct alignment.

106.3.2.9 The substructure and superstructure should be designed so as to remain rigid under all service conditions in areas around and in contact with the bearings, paying particular attention to the use of stiffeners at extreme points of movement.

106.3.2.10 The substructure and superstructure design should permit bearings to be removed for inspection or rehabilitation by minimum jacking of the structure. Jacking points shall be provided in the structural design.

106.3.2.11 The minimum Structure Rotation, Rs, of bearings covered in this specification is 0.01 radians. Rs comprises live loads and rotations induced by construction/erection sequences.

106.3.2.12 The maximum Construction Rotation, Rc, i.e. rotation induced by construction tolerances, is 0.02 radians: see Section 106.9 "Installation". The designer may elect to specify a smaller Rc than 0.02 radians by changing Section 106.9 but is cautioned to investigate the cost and practicality of the changes contemplated.

106.3.2.13 The coefficient of friction for structure design shall be in accordance with AASHTO, Div'n I, table 14.6.2.5-1
Note: These coefficients of friction are based on the average stress and limits on edge stress on PTFE, out of level installation within the limits of this specification and normal in- service oxidation of the stainless steel mating surface. Abnormal service conditions where accelerated corrosion of the stainless steel mating surface may occur, will require special assessment of the long-term coefficient of friction.

106.3.2.14 Design engineers should not mix pot, spherical or disc multi-rotational bearings at the same expansion joint or bent. The differing deflection characteristics and differing rotation characteristics may result in damage to the bearings and/or structure.

106.3.2.15 Contract drawings and documents should contain a "Bearing Schedule" as shown in Section 106.3.3.

106.3.2.16 Some bearing tests are very costly to perform or cannot be performed because there is no available test equipment in the U.S. The following test requirements should be carefully considered before specifying them:

Vertical loads over 5000 kips (22 240 kN)
Horizontal loads exceeding 500 kips (2 224 kN)
The simultaneous application of horizontal and vertical loads where the horizontal load exceeds 75% of the vertical load.

Tri-axial test loading

The requirement for dynamic rotation of the test bearing while under vertical load.

Coefficient of friction test movements greater than 125 cycles.

106.3.3 BEARING SCHEDULE

106.3.3.1 A schedule of all minimum and maximum vertical and horizontal service loads.

106.3.3.2 Minimum Structure and Construction Rotation requirements.

106.3.3.3 Magnitude and direction of movements at all bearing support joints.

106.3.3.4 Quantity, type (fixed, expansion or guided-expansion).

106.3.3.5 The location of all bearing units.

106.3.3.6 Allowable upper and lower bearing contact pressure.

106.3.3.7 Fixing or anchorage details and/or requirements.

106.3.3.8 Grades, bevels and slopes at all bearings.

106.3.3.9 Allowable coefficient of friction of slide surfaces.

106.3.3.10 Surface coating requirements and the appropriate specifications.

106.3.3.11 Seismic requirements, if any.

106.3.3.12 Uplift details, temporary attachments or other requirements.

106.3.3.13 Dead load and other loads required to design guide bar sliding surfaces. (See Section 106.4.5.3)

106.3.3.14 Dimensional requirements or limitations, if any.

106.3.3.15 Dimensional offsets for expansion bearings, where required.

Note: Design Rotation, Movement and other requirements in the Bearing schedule should only refer to the actual requirements of the Structure where the bearings are to be used. The specification which follows apply very conservative safety factors to the "Design Requirements" specified above.

106.4 DESIGN

106.4.1 General

The work covered by this specification shall consist of design, fabrication and installation of High-Load Multi-Rotational Bearings, including sole and masonry plates, in accordance with the plans and this specification. The High-Load Multi-Rotational bearings may be of any type covered by this specification provided they are supplied by only one manufacturer.

Other high load multi-rotational bearing designs are acceptable provided they are supported by engineering analysis, engineering calculations, data and evidence of acceptable service life for the proposed materials, tests and proven experience for the proposed bearing designs acceptable to the Engineer for the loads, forces, movements and service conditions specified.

Notations

C = clearance in inches (mm) between bearing parts (Figs. 1, 3, 4 & 5)
Dd = diameter in inches (mm) of unconfined elastomeric disc
Dp = diameter in inches (mm) of elastomeric disc and inside diameter of pot bearing (Fig. 1)
Ds = projected diameter in inches (mm) of loaded spherical segment
G = depth of pot bearing in inches (mm) (Fig. 1)
k = depth of chamfer in inches (mm) on pot bearing piston (Fig. 2)
Lh = horizontal design load, in kips, (kN) on bearing
Lv = vertical design load in kips, (kN) on bearing
Rb =minimum design rotation capacity of bearing in radians (Rs+Rc)
Rs = minimum design rotation capacity of structure in radians
Rc = maximum rotation specified under construction tolerances.
Rmax = maximum radius in inches (mm) to prevent unseating of spherical surfaces
S = side of a square pot in inches (mm) (Fig. 1)
t = thickness in inches (mm) of elastomeric disc
w = piston face width in inches (mm) of pot bearing (Fig. 2)

106.4.1.1 Multi-Rotational bearings shall be designed to accommodate the loads, forces and movements specified in the bearing schedule. Particular care shall be taken that all components of the bearings adequately provide for the horizontal loads and forces specified.

106.4.1.2 Maximum design stresses for all bearing components shall not exceed the allowable design stresses of the applicable issue of the AASHTO “Standard Specifications for Highway Bridges” and the applicable sections of this specification.

106.4.1.3 Minimum rotation capacity, Rb, shall be the sum of Rs + Rc.

106.4.1.4 Minimum horizontal fixed, guided and non-guided bearing design capacity shall be 10% of the vertical capacity or as specified in plans.

106.4.1.5 Expansion bearings shall be designed for additional total movement capacity in each direction specified under "Design Movement" in the "Bearing Schedule". The additional total movement capacity shall be 10% of the design movement or 1" (25.4 mm) whichever is greater. Spacing between the guides of the bearing does not require this additional movement capacity.

106.4.1.6 Bearings shall be designed so that all rotational and sliding elements can be replaced with a minimum of jacking movement.

106.4.1.7 All dimensions in this specification are in the customary units of the United States with equivalent metric units shown in parentheses.

106.4.2 Design of Rotational Elements-Pot Bearings (see Fig. 1)

106.4.2.1 Pot

106.4.2.1.1 Pot inside diameter, Dp, shall be the same as the elastomeric disc.

106.4.2.1.2 Depth of pot cavity, G, shall be equal to or greater than:
[(Dp/2) x (Rs + Rc)] + k + t + w + 0.1" (2.5 mm), where
k = 0 for flat sealing rings.
k = 1.7 X ring cross-section diameter for round sealing rings seated 100% in the piston chamfer.
k = 1.2 X ring cross-section diameter for round sealing rings half recessed in the elastomeric disc and half in the piston chamfer.

(See Fig. 2 for "k" dimension details)

106.4.2.1.3 The section thickness of the pot beneath the elastomer shall be in accordance with AASHTO Div'n I, 14.6.4.6. or 14.6.4.8 as appropriate.

106.4.2.1.4 Minimum outer plan dimensions of pots shall be determined by analyzing horizontal loads, internal elastomer pressure and piston force due to friction, in shear, bending and tension. The wall thickness shall be in accordance with AASHTO Div'n 1, 14.6.4.6 or 14.6.4.8 as appropriate.

106.4.2.2 Elastomeric Disc

106.4.2.2.1 Elastomeric discs shall have a minimum thickness t in accordance with AASHTO Div'n I equation 14.6.4.3-1.

106.4.2.2.2 Area of elastomeric disc shall be designed for an average stress not to exceed 3500 psi (24.12Mpa)

106.4.2.2.3 When using flat sealing rings, the upper edge of the disc shall be recessed to receive the rings so that they sit flush with the upper surface of the elastomeric disc. (see Fig. 3)

106.4.2.2.4 The disc shall be lubricated with a silicone compound conforming to the requirements of MIL-S-8660 or other approved equal. PTFE "shear-reducer discs" shall not be used with flat rings.

106.4.2.2.5 Elastomeric discs of natural polyisoprene are preferred in applications where service temperatures are continuously below -20 degrees Fahrenheit (-29 °C) for more than 48 hours.

106.4.2.3 Piston

106.4.3.2.1 The outside diameter of the piston shall be designed in accordance with AASHTO Div'n I, 14.6.4.7.

106.4.2.3.2 Piston thickness shall provide vertical clearance, C between rotating and non-rotating bearings parts no less than 1/8" (3.2 mm) at maximum rotation, see Figs 1 & 3, as follows:
Pots square in plan, C = (Rb X 0.7 X S) + 0.12" (3.2 mm)

Pots round in plan C = (Rb X OD/2) + 0.12" (3.2 mm)

106.4.2.3.3 Piston Face Width, w, is the vertical part of the edge of the piston which contacts the pot wall. (see Fig. 2) When designing pistons for horizontal forces, piston face width, w, shall be designed in accordance with AASHTO Div'n I, equation 14.6.4.8-2, but shall not be less than 1/8" (3.2mm).

106.4.2.3.4 Pistons for round seals shall have the lower corner chamfered at 45 degrees for a depth equal to 1.7 times the diameter of the seal where the seal is wholly within the piston thickness and 1.2 times the diameter where it extends into the elastomer for half its diameter. (see Fig. 2)

106.4.2.4 Elastomer Sealing Rings

106.4.2.4.1 Flat sealing rings shall meet the requirements of AASHTO Div'n I, 14.6.4.5.1. In addition, the maximum gap at the ends of each ring when installed in the pot shall not exceed 0.05" (1.27mm).

106.4.2.4.2 Rings with circular cross-sections shall meet the requirements of AASHTO Div'n I, 14.6.4.5.2. They shall fit the pot snugly so that they are in full contact with the pot wall when installed.

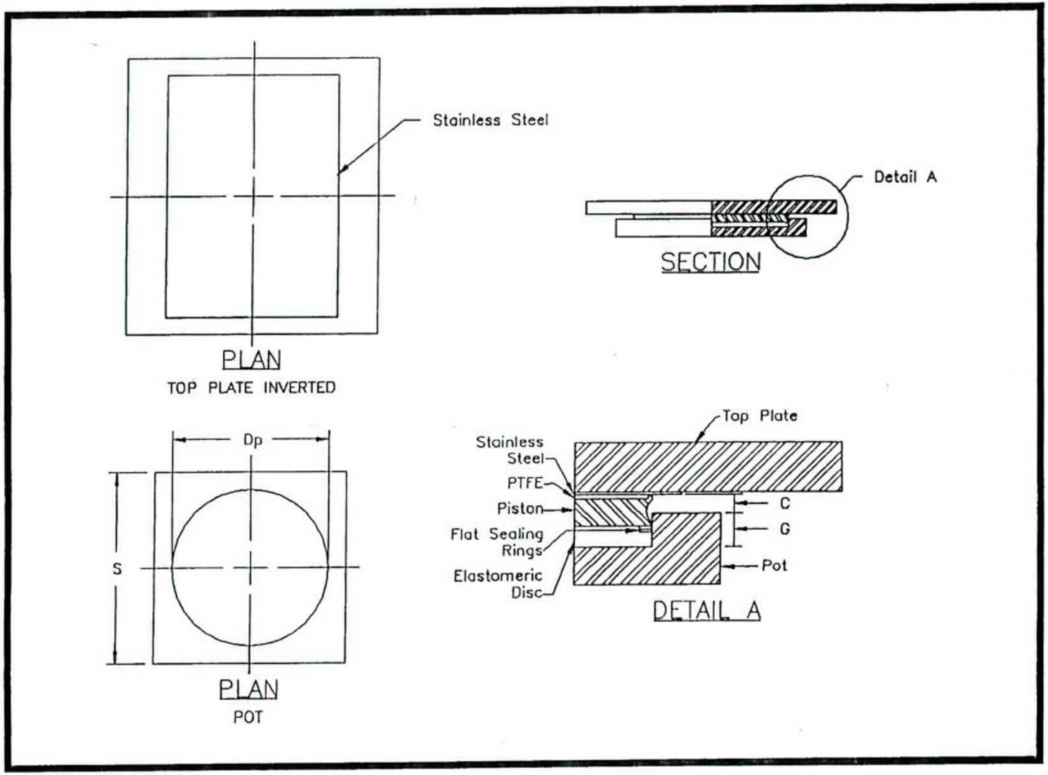

FIGURE 1. POT BEARING WITHOUT GUIDEBARS

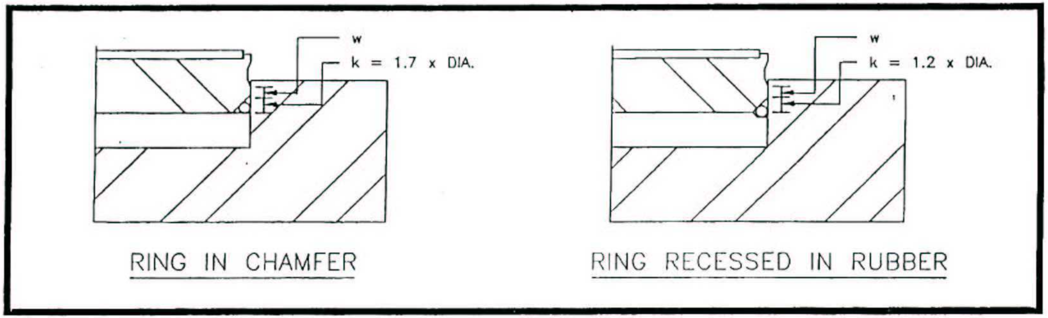

FIGURE 2. ROUND RING SEAL DETAILS

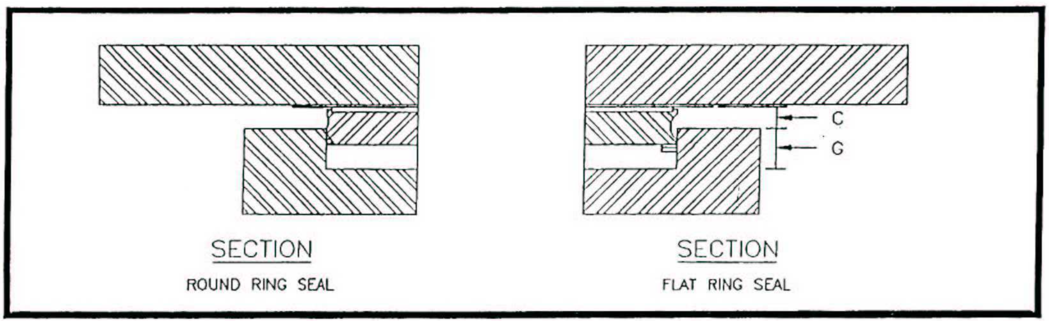

FIGURE 3. POT SEALING RINGS

106.4.3 Design of Rotational Elements Spherical Bearings

106.4.3.1 Rotational Element-Spherical with PTFE/Stainless Steel Surfaces (Fig. 4)

106.4.3.1.1 Concave Element PTFE Surface

106.4.3.1.1.1 Under combinations of horizontal and vertical forces, unseating of the curved surfaces relative to each other shall be prevented by transferring horizontal forces through specifically designed restraints or by control of the radius. In the latter case the radius shall meet the requirements of AASHTO Div'n I, equation 14.6.3.2-2.

106.4.3.1.1.2 Calculations showing the determination of the radius shall be submitted for approval.

106.4.3.1.1.3 The projected area of the PTFE shall be designed for an average stress in accordance with AASHTO Div'n I, table 14.6.2.4-1.

106.4.3.1.1.4 The concave surface shall face down whenever possible.

106.4.3.1.1.5 PTFE fabric in the free state shall be a minimum of 1/l6" (1.6 mm) thick when measured in accordance with ASTM D 1777.

106.4.3.1.1.6 Minimum center thickness of spherical surfaces shall be ¾" (19 mm).

106.4.3.1.1.7 Design of the bearing shall provide vertical clearance, C between rotating and non-rotating bearing
parts no less than 1/8" (3.2 mm) at maximum rotation (see Fig. 4) as follows:
Spherical bearings square in plan, C = (Rb X 0.7 X S) + 0.12" (3.2 mm)
Spherical bearings round in plan, C = (Rb X OD/2) + 0.12" (3.2 mm)

106.4.3.1.2 Convex Element Stainless Steel Surfaces

106.4.3.1.2.1 The convex element shall be designed for rotation, Rb, where Rb = Rs + Rc

106.4.3.1.2.2 The edge thickness shall be a minimum of ¾" (19 mm) for bearings directly on concrete or ½" (12.7 mm) for bearings directly on steel.

106.4.3.1.2.3 The stainless steel surface shall be provided by one of the following means:

a. A cold-formed stainless steel sheet of thickness meeting the requirements of AASHTO Div'n I, 14.6.2.3.2 connected to a structural steel substrate by a continuous weld around the perimeter. The sheet shall be in full contact with the substrate.
b. A solid stainless steel convex element.
c. A stainless steel weld overlay on a structural steel substrate. The minimum overlay thickness shall be 3/32" (2.38 mm).

106.4.3.1.2.4 The surface finish of the stainless steel shall conform to the requirements of AASHTO Div'n I, 14.6.2.2.

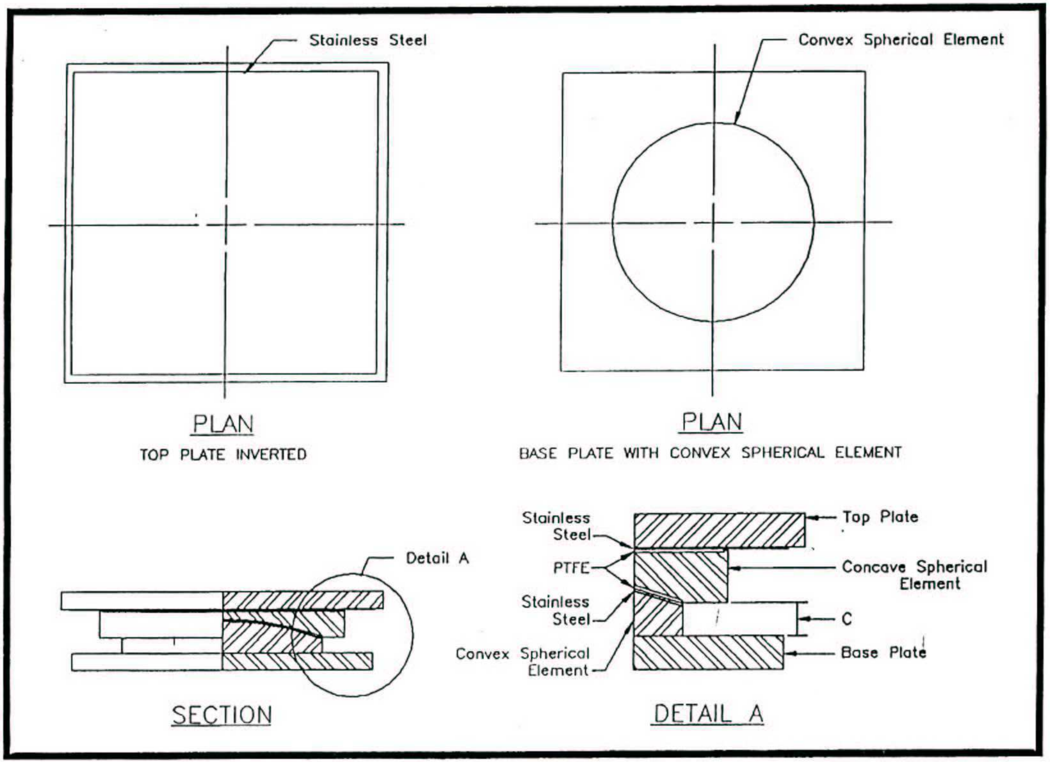

FIGURE 4. SPHERICAL BEARING WITHOUT GUIDEBARS

106.4.3.2 Rotational Elements - Spherical with Bronze/Steel plates

106.4.3.2.1 The concave element may be solid bronze or steel as called for on the plans. The mating convex element shall then be the other of these two materials.

106.4.3.2.2 The spherical radius shall be determined in accordance with AASHTO Div'n I, equation 14.6.3.2-2.

106.4.3.2.3 If required, mechanical safety restraints shall be considered to prevent overturning of the bearing.

106.4.3.2.4 Bearing rotation of Rs + Rc radians shall be considered in the bearing design to prevent overturning or uplift of the bearing.

106.4.3.2.5 Calculations showing the determination of the radius shall be submitted for approval.

106.4.3.2.6 The maximum design compressive stress for the projected area shall be:

ASTM B22 Alloy C90500	2000 psi	(13.8 Mpa)
ASTM B22 Alloy C91100	2500 psi	(17.2 Mpa)
ASTM B22 Alloy C86300	8000 psi	(55.2 Mpa)

106.4.3.2.7 The bearing surfaces shall have lubricant recesses consisting of either concentric rings, with or without central circular recesses with a depth at least equal to the width of the rings or recesses.

106.4.3.2.8 The recesses or rings shall be arranged in a geometric pattern so that adjacent rows overlap in the direction of motion.

106.4.3.2.9 The entire area of all bearing surfaces that have provision for relative motion shall be lubricated by means of the lubricant-filled recesses.

106.4.3.2.10 The lubricant-filled areas shall comprise not less than 25% of the total bearing surface.

106.4.3.2.11 The lubricating compound shall be integrally molded at high pressure and compressed into the rings or recesses and project not less than 0.010" (0.25 mm) above the surrounding bronze plate.

106.4.3.2.12 The minimum thickness at the center of concave plates and at the edge of convex plates shall be ¾" (19 mm).

106.4.3.2.13 The surface finish on the mating surfaces of both bronze and steel plates shall be not more than 125 micro-inch (3.17 µm) rms.

106.4.4 Design of Rotational Elements-Disc Bearings (Fig.5)

106.4.4.1 Disc

106.4.4.1.1 Polyether urethane disc shall be of minimum thickness, t, where

$$t = \frac{\Delta c + [\ (Rs + Rc) \times Dd \times 0.5]}{\epsilon \max}$$

where Δc = deflection due to total compressive load
∈ max = strain due to all effects except long term creep, at maximum vertical stress, and shall be less than 15%

106.4.4.1.2 The area of the disc shall be designed for stress not to exceed:

3700 psi (25.5 MPa) for Polyether Urethane Compound A
5000 psi (34.5 MPa) for Polyether Urethane Compound B

106.4.4.2 Bearing Plates

106.4.4.2.1 The urethane disc shall be held in place by a positive location device as required in AASHTO Div'n I, 14.6.8.1. Limiting rings will only be required for Compound A material.

106.4.4.2.2 The section thickness of the plate beneath the disc shall be: Dd x 0.06 for bearings directly on concrete, Dd x 0.045 for bearings directly on steel masonry plates, but in no case less than ¾" (19 mm) on concrete and ½" (12.7 mm) on steel.

106.4.4.2.3 Design of bearing shall provide vertical clearance, between rotating and non-rotating bearing parts no less than 1/8" (3.2 mm) at maximum rotation (see Fig 5) as follows:

Disc bearings square in plan, C = (Rb x 0.7 X S) + 0.12 (3.2 mm) + 2Δc
Disc bearings round in plan, C = (Rb x OD/2) + 0.12 (3.2 mm) + 2Δc

106.4.4.3 Shear Restriction Mechanism

106.4.4.3.1 The Shear restriction mechanism shall be designed to allow free rotation and withstand the specified horizontal forces.

106.4.4.3.2 The mechanism shall be designed to withstand the design forces on the bearing without exceeding allowable shear of 0.4Fy, bending stress of 0.55 Fy and maximum bearing stress of 0.8Fy not including shear resistance of the disc.

106.4.4.3.3 The shear mechanism shall be connected to the bearing plates by welding, machining out of the solid or other acceptable means.

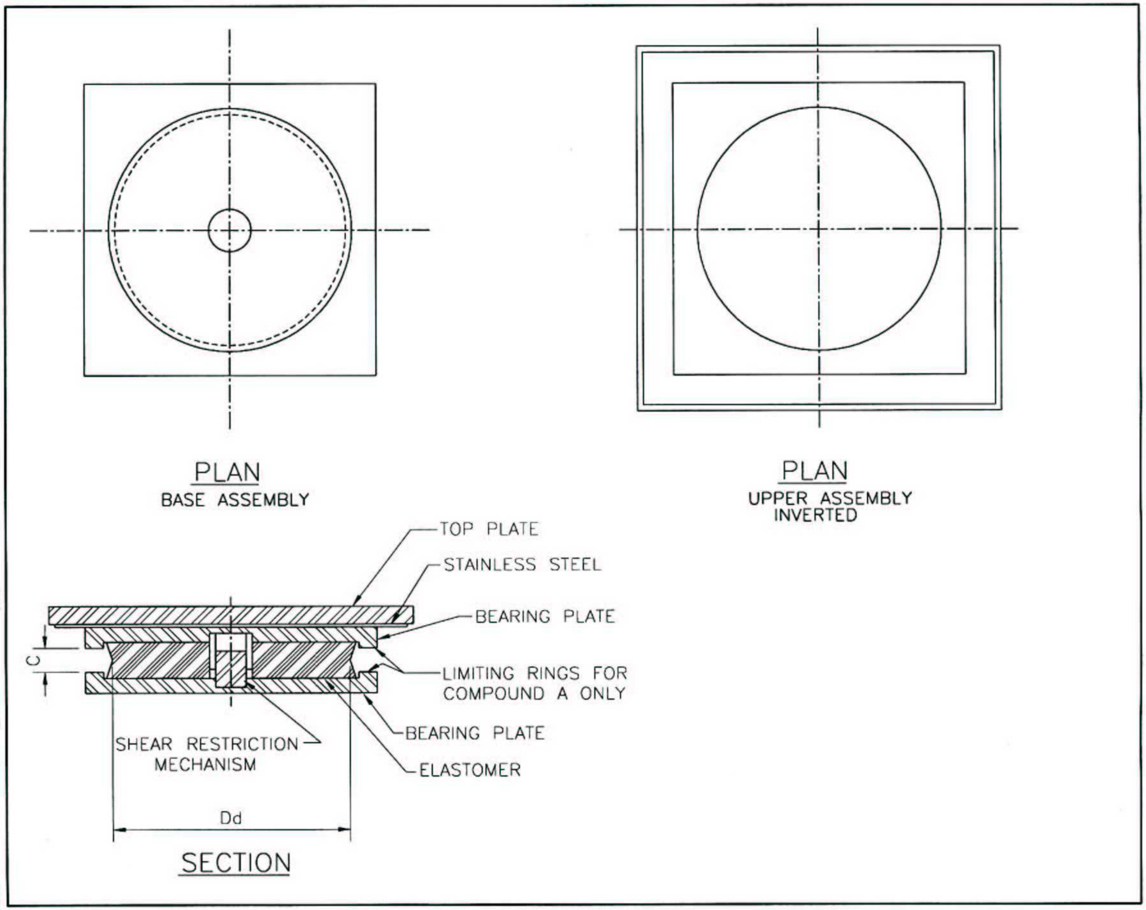

FIGURE 5 NON-GUIDED EXPANSION DISC BEARING

106.4.5 DESIGN OF NON-ROTATIONAL BEARING ELEMENTS

106.4.5.1 PTFE Sliding Surfaces

106.4.5.1.1 PTFE Primary Sliding Surfaces shall be designed for average stress in accordance with AASHTO Div'n I, table 14.6.2.4-1 and 14.6.8.4 as appropriate.

106.4.5.1.2 Thickness of PTFE shall be in accordance with AASHTO Div'n I, 14.6.2.3.1.

106.4.5.1.3 Fabric PTFE shall conform to the requirements of AASHTO Div'n I, 14.6.2.1 Any edges, other than the selvedge shall be oversown or recessed so that no cut fabric edges are exposed.

106.4.5.2 Stainless Steel Sliding Surfaces

106.4.5.2.1 The stainless steel surface shall cover the mating surface in all operating positions and shall conform to the requirements of Section 106.4.1.5.

106.4.5.2.2 Thickness of sheet stainless steel shall conform to the requirements of AASHTO Div'n I, 14.6.2.3.2. It shall be connected to the substrate by a continuous weld around the entire perimeter. The sheet shall be in full contact with the substrate.

106.4.5.2.3 Stainless steel sliding surfaces shall, preferably, be face down.

106.4.5.2.3 Stainless steel welded overlay, when used, shall be a minimum of 3/32" (2.38 mm) thick after welding, grinding and polishing and be produced using Type 309L electrodes.

106.4.5.3 Guide Bars and Central Guide Keys

106.4.5.3.1 Central Guide keys may be made integral by machining from the solid. Where a separate key or guide bar is used they shall be press-fitted in a keyway slot and bolted or welded to resist overturning.

106.4.5.3.2 Guide bars may be integral by machining from the solid or fabricated from bars welded, bolted and/or recessed at the manufacturers option.

106.4.5.3.3 Guide bars and central guide keys shall be designed in accordance with AASHTO Div'n I, 14.6.9.2. If a bolted system is used, it shall be designed in accordance with AASHT0 Div'n I, table 10.32.3B for bearing connections.

106.4.5.3.4 The total clearance between the key/guide bars and guided members shall be in accordance with AASHTO Div'n I, 14.6.9.4.

106.4.5.3.5 Guided members must have their contact area within the guide bars in all operating positions.

106.4.5.3.6 Guiding off the fixed base or any extensions of it where transverse rotation is anticipated shall be avoided.

106.4.6 PTFE on Guiding Surfaces

106.4.6.1 PTFE on guiding surfaces when they are used, shall be designed in accordance with AASHTO Div'n I, 14.6.9.5.2. In addition, it shall be attached as specified in AASHTO Div'n I, 14.6.9.6. If mechanical fastening with screws is specified, there shall be a minimum of two screws. The centerline of the screws shall be located 2 X the nominal screw diameter from the end of the PTFE strip. The top of the screws shall be recessed a minimum of 50% of the amount of protrusion of the PTFE above the guiding surface.

106.4.6.2 PTFE when used on guiding surfaces shall be attached as required in AASHTO Div'n I, 14.6.9.6.

106.4.6.3 Unfilled sheet PTFE used on guide bars shall contain an ultraviolet (UV) inhibitor/screen.

106.4.7 Sole and Masonry Plates

106.4.7.1 For sole plates when bearing on concrete, and masonry plates, the concrete bearing stress on the loaded area shall be designed in accordance with AASHTO Div'n 1, 8.16.7. The Φ factor shall be taken as 0.75.

106.4.7.2 The allowable bending stress in sole and masonry plates shall be 0.63Fy.

106.5 MATERIALS

106.5.1 General. All materials used in the fabrication of bearings covered by this specification shall meet the requirements of the relevant sections of AASHTO Div'n I, Section 14, or Div'n II, Section 18. In addition, the following requirements will apply as stated.

106.5.2 The minimum section thickness for ancillary steel plates (sole plates, masonry plates, load plates and the like) shall be ¾" (19 mm) at the thinnest point.

106.5.3 In self-lubricating bronze bearings, the lubricant shall consist of a combination of solids having non-deteriorating characteristics, as well as lubricating qualities and shall be capable of withstanding long term atmospheric exposure, de-icing materials and water. The use of molybdenum disulfide and other ingredients that may promote electrolytic or chemical action between the bearing elements shall not be allowed. Shellac, tars, asphalt and petroleum solvents shall not be used as binders.

106.5.4 The tolerance on the center-to-center dimensions of holes for sole plates or masonry plates shall be ± 1/8" (3.18 mm)

106.6 CONSTRUCTION

106.6.1 Bearings shall be fabricated in accordance with relevant articles of AASHTO Div'n II, section 18.5.

106.7 TESTING & INSPECTION

106.7.1 General

Tests shall be performed in accordance with the requirements of AASHTO Div'n II, section 18.7. In addition the following items shall be observed.

106.7.1.1 Testing is to be performed at an owner-approved facility.

106.7.1.2 A unit from the lot(s) requiring 5000 kips or greater testing loads shall be tested at 5000 kips; the tests otherwise conforming to the above-indicated AASHTO requirements.

106.7.1.3 Alternatively, if loads required for testing exceed 5000 kips (22 200 kN) then the owner may allow all tests to be conducted on specially fabricated sample bearings provided that:

a. they are designed to the same standards and specification as the larger bearing.
b. they are made from materials similar to the larger bearing.
c. they are produced concurrently with and in the same plant as the larger units and are subject to the same Q.C & Q.A. program.
d. they have a design load capacity of 500 kips (2225 kN) minimum. (sample test bearings need not include sole or masonry plates, or a finish coating).

106.7.2 Sampling

Perform tests on randomly selected samples as required in AASHTO Div'n II, 18.7.1.2, except when specially fabricated sample bearings have been made as in section 106.7.1.3. One bearing per "lot" shall be tested.

106.7.3 Inspection

106.7.3.1 Inspection shall be in accordance with the owner's standard procedures.

106.7.3.2 When bearings are to be inspected on site they shall be inspected within one week of arrival and may not be disassembled except under the supervision of the manufacturer or his representative or with the written approval of the manufacturer. Following inspection the wrapping shall be reapplied and the bearings kept clean until installation.

106.8 PACKING, SHIPPING & STORING

106.8.1 Packing, shipping and storage shall be in accordance with AASHTO Div'n II, 18.8

106.8.2 Marking shall meet the requirements of AASHTO Div'n II, 18.10.2

106.8.3 Removal of sole and top plates of bearings for separate attachment to the structure is not permitted except under the direct supervision of the manufacturer and by permission of the engineer.

106.9 INSTALLATION

106.9.1 Bearings shall be installed in accordance with AASHTO Div'n2, 18.9 and the following requirements

106.9.2 Bearings shall be evenly supported over their upper and lower surfaces under all erection and service conditions.

106.9.3 Bearings shall be lifted by their undersides only or specially designed lifting lugs.

106.9.4 When installing bearings, care shall be taken to avoid damage to and contamination of bearing surfaces.

106.9.5 Bearing straps or retaining clamps shall be left in place as long as possible to ensure parts of bearing are not inadvertently displaced relative to each other. Care must be taken to remove straps or clamps before any normal structural movement takes place, such as post-tensioning, etc.

106.9.6 When bearings will sit directly on concrete with only an elastomeric, preformed fabric pad or lead sheet beneath the bearing, concrete bearing seats shall be prepared in accordance with AASHTO Div'n II, 8.10.5 and bush-hammered or dressed to the correct elevation.

106.9.7 Where grouted bearing seats are used they shall conform to the requirements of AASHTO Div.'n II, 8.14. The grout must be non-shrink type. Grout should be allowed to reach design strength before placing any load on the bearing.

106.9.8 The contractor shall repair any damage to bearing finishes following installation.

106.9.9 Welding procedures shall be established by the contractor to restrict the maximum temperature reached by the bonded PTFE surfaces to a maximum of 300ºF (149ºC) and to restrict the maximum temperature reached by the elastomer (Neoprene or Natural Rubber) to 250ºF (121ºC). Temperatures shall be determined by temperature indicating wax pencils or other suitable means.

106.9.10 Load on the bearings at the time of welding shall be restricted to the dead weight of the beams alone.

106.9.11 Particular care should be exercised to mask and protect the PTFE and polished stainless steel surfaces to protect them from concrete laitence, blast abrasives and paint application during construction.

106.10 DOCUMENTATION

106.10.1 Shop Drawings shall meet the requirements of AASHTO Div'n II, 18.10.1

106.10.2 Certification shall meet the requirements of AASHTO Div'n II, 18.10.3

106.11 MANUFACTURERS QUALIFICATION REQUIREMENTS

106.11.1 General
On any one project, one manufacturer shall furnish all bearings of any given type.

106.11.2 Pre-qualification
Manufacturers may be pre-qualified by the State Materials Bureau or their designated representative.
Pre-qualification requirements shall include (but not be limited to) acceptance of administration procedures, design procedures and personnel qualifications, production equipment and procedures, a written quality control program, welding processes and personnel qualifications, test facilities and experience.

106.11.3 Sub-contracting

106.11.3.1 The primary manufacturer of the bearings shall have full responsibility for the quality control of the complete unit.

106.11.3.2 No more than fifteen percent of any individual bearing of a particular type is sub-contracted and all such sub-contracted work shall be subject to quality control as per section 106.11.2.

106.11.3.3 All sub-contracted work and the facility undertaking such work shall be fully and freely accessible to quality assurance inspection and acceptance as though it were an integral part of the prime manufacturers production and plant.

End of specification.

MID-ATLANTIC STATES

STRUCTURAL COMMITTEE

FOR ECONOMICAL FABRICATION

STANDARD 107

GUIDELINES FOR

METRIC STRUCTURAL PLANS

OCTOBER 1996

107.1 PLAN ITEMS

107.1.1 Plan Sheet Size: All plans shall be prepared using Metric A1 size sheets (841 mm x 594 mm). If A1 sheets are not ready available, English size D sheets (36" x 24") may be used.

107.1.2 Shop Plan Sheet Size: All plans shall be prepared using Metric A1 size sheets (841 mm x 594 mm). If A1 sheets are not readily available, English size D sheets (36" x 24") may be used.

107.1.3 Plan Dimensioning: The following note shall be shown on the front sheet of all structural plans: **All dimensions are in mm unless otherwise noted**. Rules and convention for writing Metric numbers shall be as described in ASTM E380.

107.1.4 Elevation Accuracy: Plan elevations shall be shown in meters, accurate to the millimeter or three decimal places (ex. Elev. 492.543 m). Construction Specification tolerances need to be reviewed and adjusted as necessary.

107.2 MATERIALS

107.2.1 Anchor Bolts: Hard converted Metric bolts should be specified in accordance with ASTM F568. An allowable substitution table may be required until Metric sizes are readily available.

107.2.2 High Strength Bolts: Soft converted Metric bolts, specified in accordance with ASTM A325 or A490, or hard converted Metric bolts, specified in accordance with ASTM A325 or A490 may be used. Installation of hard-converted bolts shall be in accordance with the FHWA Interim guidelines until installation testing is completed. Once the testing is completed and size availability is assured, only hard converted sizes shall be specified.

107.2.3 Reinforcing Steel: Reinforcing steel size shall be in accordance with ASTM standards. An allowable substitution table may be required until Metric sizes are readily available. Specification of a #4 (12 or 13 mm) bar will also be acceptable during the transition from English to Metric.

107.2.4 Prestressed I Beam (AASHTO): Standard AASHTO prestressed beam dimensions shall be soft-converted. A hard conversion with tolerances that will allow the use of the AASHTO standard beams will also be considered acceptable.

107.2.5 Steel Beams: Steel beams shall be called for in accordance with the Metric AISC Manual tables.

107.2.6 Steel Plate and Plate Girders: Steel plates shall be called for in accordance with the Metric AISC Manual tables.

107.2.7 Timber: Timber shall be specified in accordance with Industry Standards.

107.3 SPECIFICATIONS

107.3.1 All specifications for which a Metric equivalent does not exist may be referenced in their current form.

107.4 NOTE

Other items will be added to the guidelines as information becomes available.

ENGLISH
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GENERAL NOTES :

A. PROVIDE MATERIALS AND WORKMANSHIP CONFORMING TO AASHTO, DIVISION II AND AASHTO/AWS D1.5 WELDING CODE.

B. LOCATE ALL INTERMEDIATE STIFFENERS ON OPPOSITE SIDE OF WEB FROM LONGITUDINAL STIFFENER WHEN POSSIBLE.

C. WHEN BEARING STIFFENER IS USED AS A CONNECTION PLATE, WELD TO TOP AND BOTTOM FLANGE.

D. MEMBER, WELD AND PLATE SIZES SHOWN ARE VALID FOR STRAIGHT GIRDERS WITH MAXIMUM GIRDER SPACING OF 10'-0" AND FOR SKEW ANGLES BETWEEN 0° AND 20°. PROVIDE SPECIAL DESIGNS FOR ALL DIAPHRAGM MEMBERS, WELDS AND PLATE SIZES WHEN THE GIRDER SPACING EXCEEDS 10'-0" AND/OR THE SKEW ANGLE EXCEEDS 20°.

E. THE DETAILS SHOWN ARE VALID FOR SKEW ANGLES 0° TO 20°. PROVIDE SPECIAL DETAILS FOR SKEW ANGLES GREATER THAN 20°.

F. FILLET WELD SIZES ARE GOVERNED BY MATERIAL THICKNESS IN ACCORDANCE WITH AASHTO/AWS D1.5.

G. PROVIDE INTERMEDIATE DIAPHRAGMS NORMAL TO THE MAIN MEMBERS FOR SKEWS >20°.

H. THE DIAPHRAGMS SHOWN DO NOT INCLUDE WIND LOAD TRANSFERRED TO THE BEARINGS THROUGH CONNECTIONS.

I. DIAPHRAGMS SHOWN ARE FOR STRAIGHT GIRDERS ONLY.

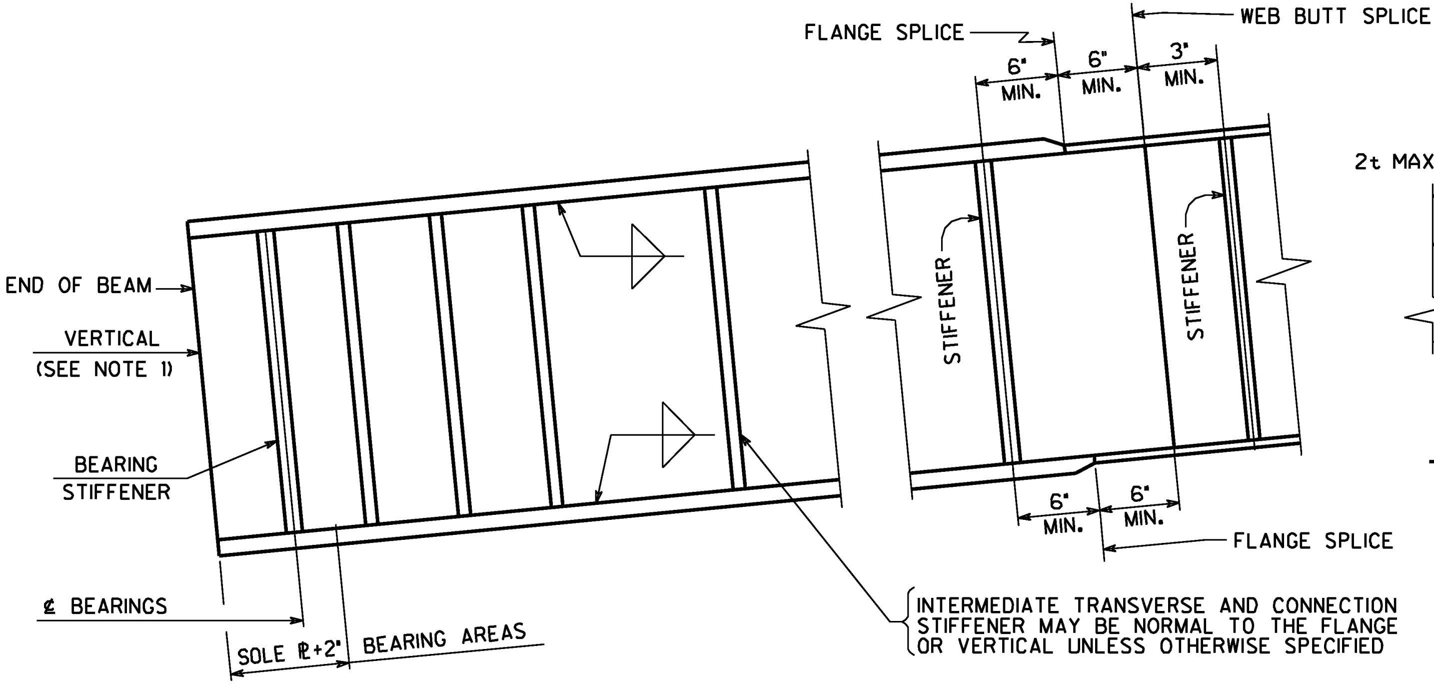
THE FOLLOWING NOTES ARE TO BE USED WHEN REFERENCED ON THE DRAWINGS:

1. UNDER FULL DEAD LOAD, BEAM ENDS AND ALL BEARING STIFFENERS, INCLUDING BEARING STIFFENERS AT PIERS, SHALL BE VERTICAL TO WITHIN APPLICABLE AASHTO/AWS FABRICATION AND CONSTRUCTION TOLERANCES.
2. PERFORM NON-DESTRUCTIVE TESTING ON LONGITUDINAL STIFFENER BUTT WELDS PRIOR TO ATTACHMENT TO GIRDER WEB.
3. USE DETAIL-C AT FIELD SPLICES, SEE SECTION E-E FOR REVERSAL ZONES AT STIFFENERS AND CONNECTION PLATES. DETAILS-A AND B ARE APPLICABLE ONLY IN THE COMPRESSION ZONE. THERE SHALL BE NO CATEGORY D, E, OR E' IN TENSION OR REVERSAL ZONES.
4. SEE DRAWING 202.2 FOR WEB CONNECTION PLATE INSTALLATION DETAILS.
5. MODIFY THE DISTANCE BETWEEN THE BOTTOM GIRDER FLANGE AND THE LOWER DIAPHRAGM COMPONENT WHEN LOWER LATERAL BRACING IS USED. INDICATE MODIFICATIONS ON THE DESIGN DRAWINGS.
6. 1 1/16" DIAMETER HOLE IN CONNECTION PLATE; 15/16" DIAMETER HOLE IN CONNECTING MEMBER FOR 7/8" DIAMETER ASTM A325 BOLTS STD. SIZE HOLES ARE PERMITTED.
7. USE 7/8" DIAMETER ASTM A325 BOLTS HAVING AN UNTHREADED SHANK OF SUFFICIENT LENGTH TO NOT ALLOW ANY THREADS TO EXIST IN THE PLANE BETWEEN THE TWO CONNECTED PARTS (SHEAR PLANE).
8. 1 1/16" DIAMETER HOLE IN BEARING STIFFENERS; 15/16" DIAMETER HOLE IN CONNECTION PLATE FOR 7/8" DIAMETER ASTM A325 BOLTS STD. SIZE HOLES ARE PERMITTED. (NOTE 7 DOES NOT APPLY.)
9. "K" = FLANGE THICKNESS + FILLET, AS INDICATED IN AISC TABLES OF BEAM DIMENSIONS.
10. ALTERNATE INSTALLATION SHOWN FOR 0° TO 20° SKEW CONNECTION PLATES. INDICATING WHICH COMPONENTS ARE WELDED OR BOLTED, MAY BE APPLIED TO ALL OTHER CASES WHERE APPLICABLE.
11. POSITION DIAPHRAGM CONNECTION COMPONENTS SO AS TO CREATE MINIMUM OFFSET FROM ℄ BEARINGS. DIAPHRAGM CONNECTION PLATE MAY BE PLACED BEHIND THE BEARING STIFFENER TO MINIMIZE OFFSET.
12. PROVIDE CONNECTION PLATE ON THE OUTSIDE FACE ALSO FOR TWO OR THREE GIRDER SYSTEMS.
13. PROVIDE WELDING AS SHOWN IN "DETAIL E". THIS DETAIL IS TYPICAL FOR ALL WELDED CONNECTIONS.
14. CHECK ANCHOR BOLT CLEARANCES WHEN STIFFENERS ARE WIDER THAN FLANGE.

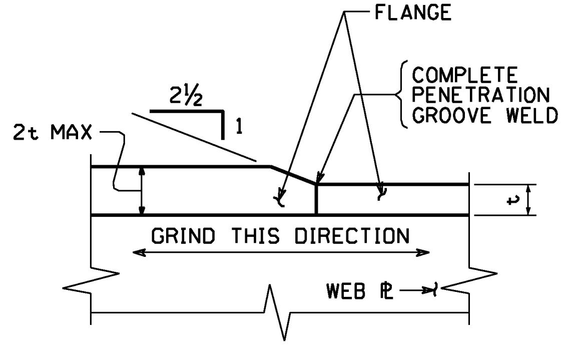
NOTES

MID-ATLANTIC STATES SCEF

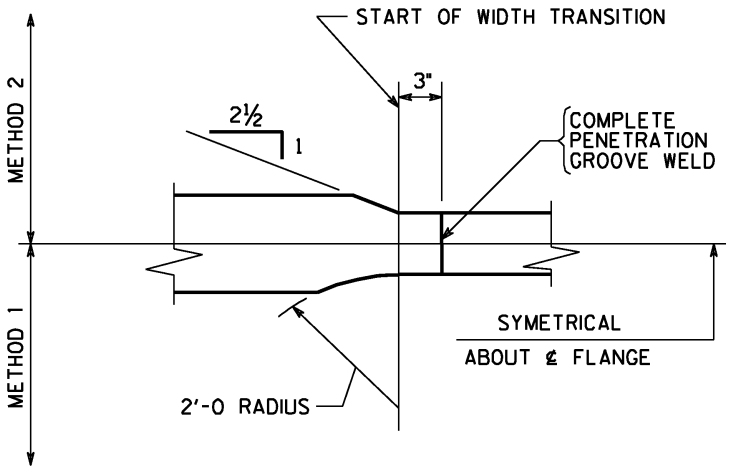
Drawing 201 6-19-00



TYPICAL GIRDER DETAIL

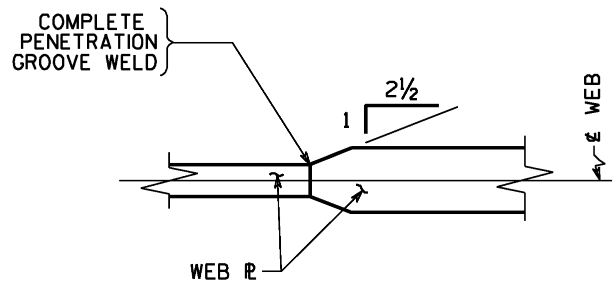


ELEVATION
FLANGE SPLICE DETAILS



FLANGE WIDTH TRANSITION

(MUST USE RADIUS FOR STEEL STRENGTHS ≥ 70KSI)
(PER AWS D1.5-95)

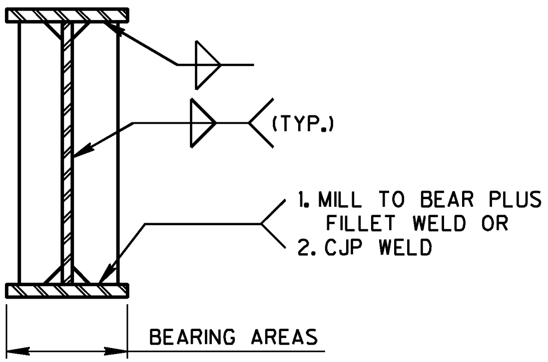


WEB THICKNESS TRANSITION

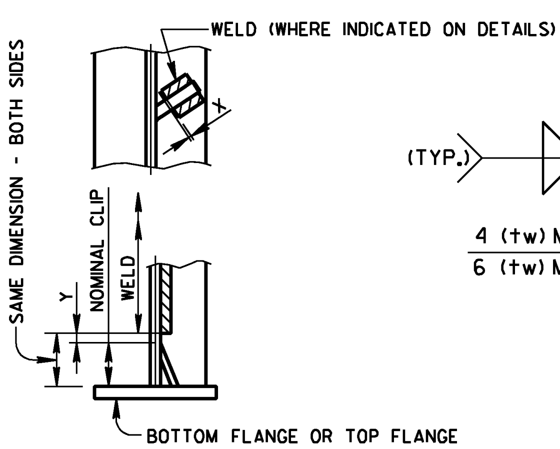
GIRDER WELDED SPLICE DETAILS

MID-ATLANTIC STATES SCEF

Drawing 202.1 6-19-00

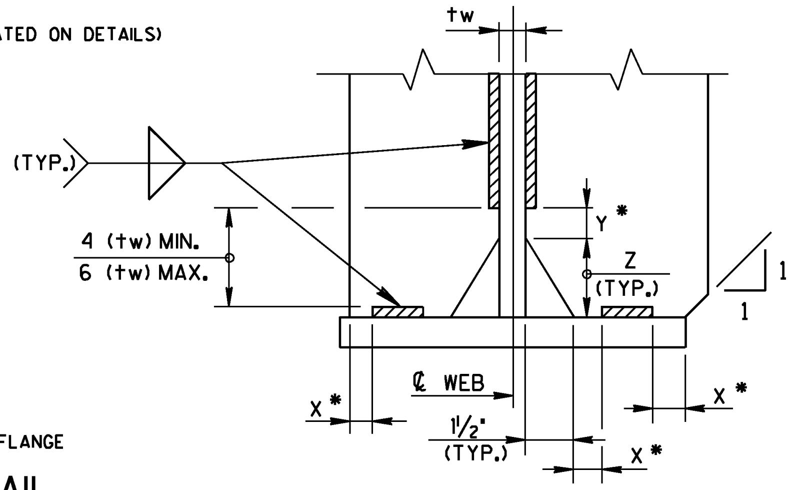


BEARING STIFFENER



STIFFENER WELDING DETAIL

(FOR SKEWED STIFFENERS)



DETAIL @ END OF STIFFENER OR CONNECTION PLATE

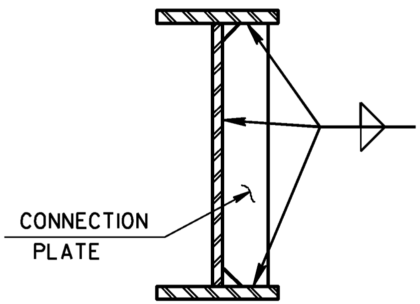
- SHOW STIFFENER PLATE AND FILLET WELD SIZES ON THE PLAN

X = 1/4" ± 1/8"

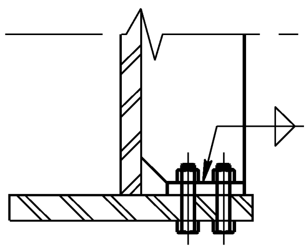
Y = 1/2" ± 1/4"

Z = { 2 1/2" FOR 1/2" WEB; 3" FOR 9/16" WEB; 4" FOR 3/4" WEB }

* 0" FOR GROOVE WELD.



CONNECTION PLATE



ALTERNATE DETAIL @TENSION FLANGE WHERE STRESS RANGE EXCEEDS CATEGORY C

NOTES:

A. STIFFENER SIZE MUST BE SHOWN ON PLANS.

B. FILLET WELD SIZE SHALL BE SHOWN ON PLANS UNLESS MINIMUM WELD SIZE AS PER AASHTO/AWS D1.5 IS TO BE USED.

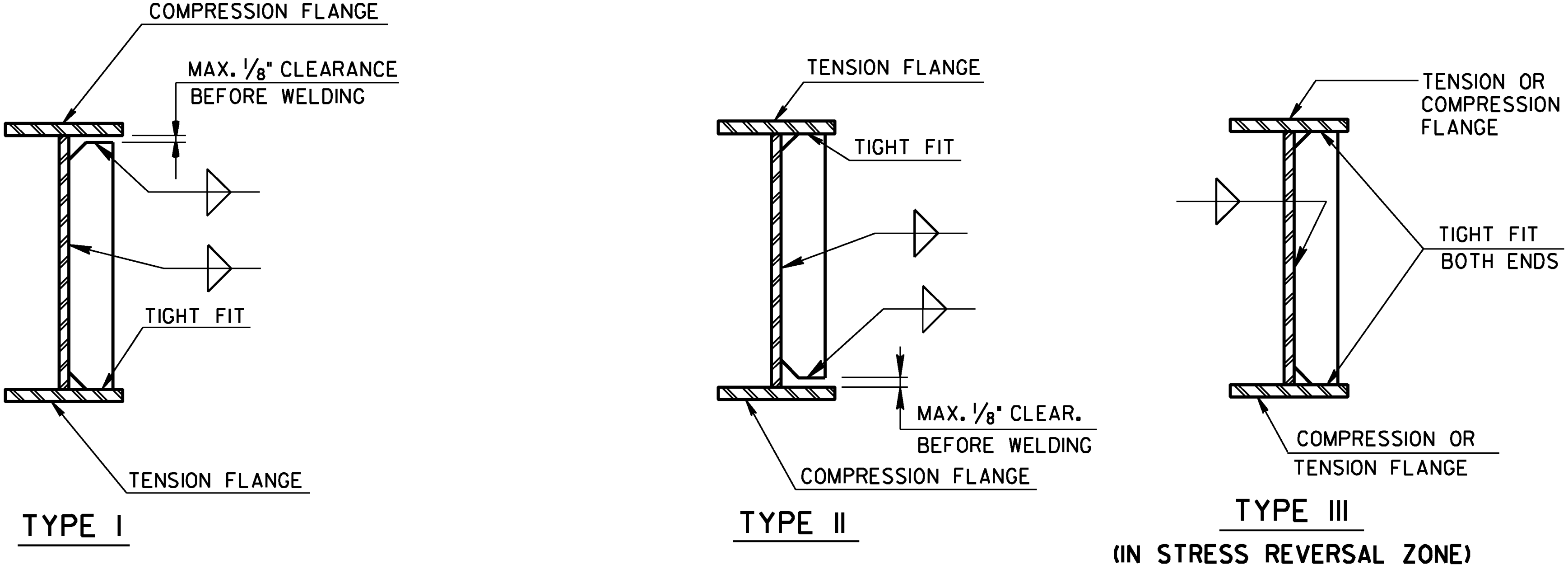
C. IF A BEARING STIFFENER IS USED AS A CONNECTION PLATE FOR CROSS FRAMES FILLET WELDS ARE REQUIRED.

D. WHEN LONGITUDINAL STIFFENERS ARE REQUIRED, PLACE ALL TRANSVERSE STIFFENERS ON ONE SIDE OF WEB AND PLACE THE LONGITUDINAL STIFFENER ON OPPOSITE SIDE.

INTERMEDIATE AND BEARING STIFFENER DETAILS

MID-ATLANTIC STATES SCEF

Drawing 202.2 6-19-00

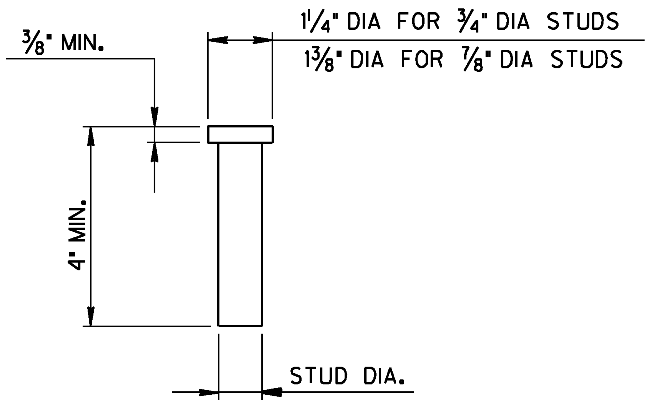


INTERMEDIATE STIFFENER DETAILS

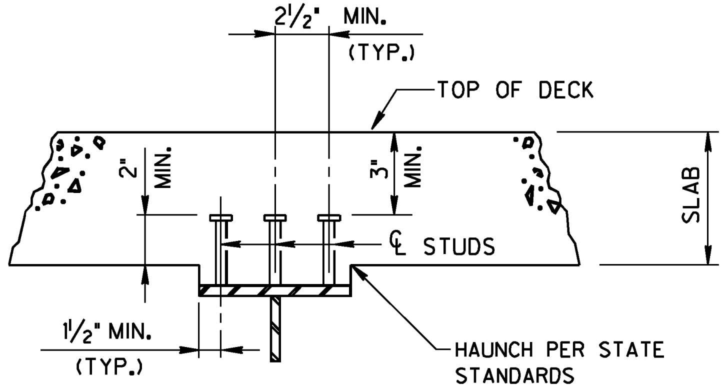
INTERMEDIATE AND BEARING STIFFENER DETAILS

MID-ATLANTIC STATES SCEF

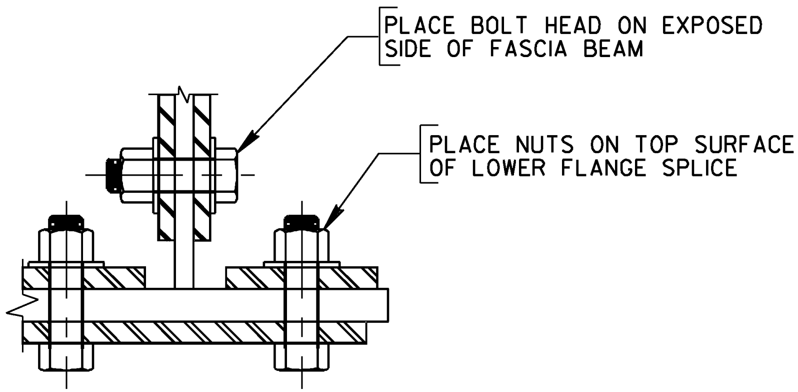
Drawing 202.3 6-19-00



STUD DETAIL



SHEAR CONNECTOR DETAILS

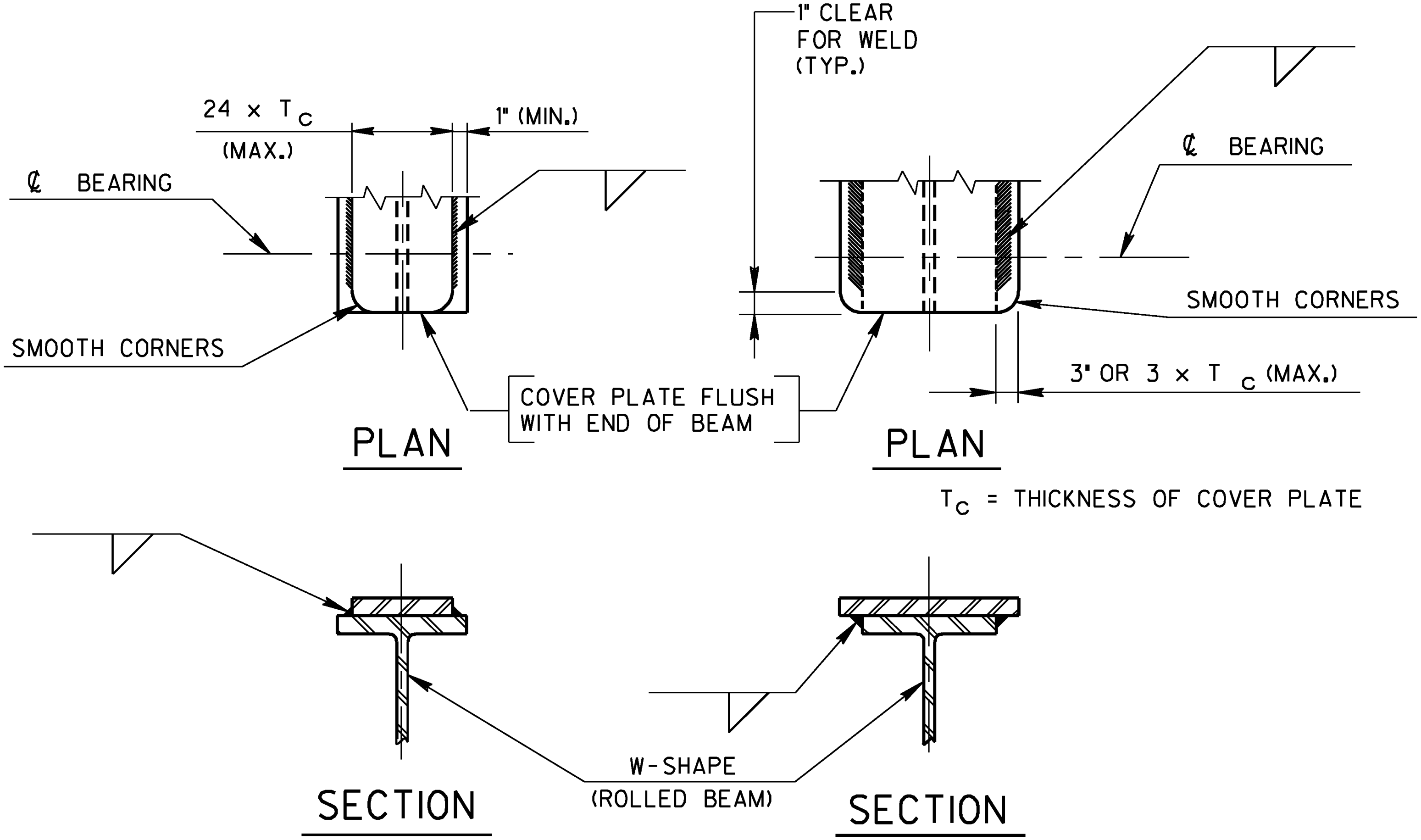


BOLTED SPLICE DETAIL

STUD AND BOLTED SPLICE DETAILS

MID-ATLANTIC STATES SCEF

Drawing 202.4 6-19-00

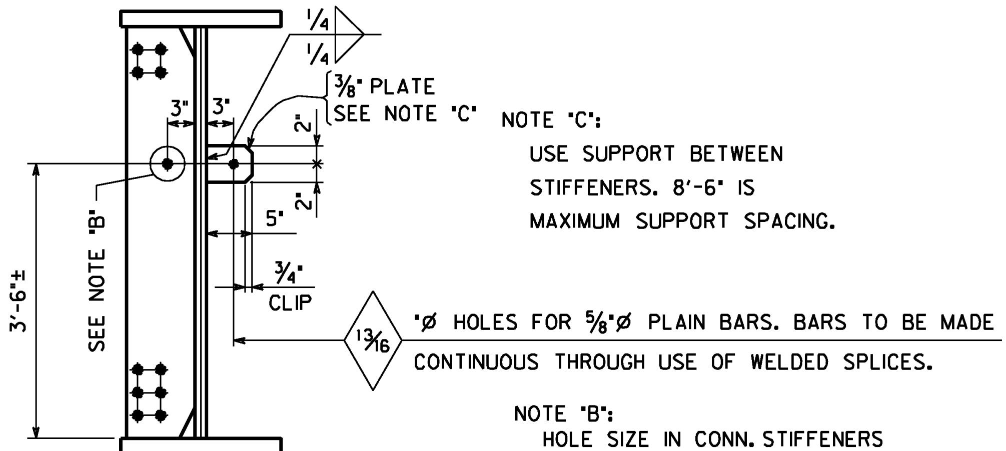


COVER PLATE DETAILS

COVER PLATE DETAILS

MID-ATLANTIC STATES SCEF

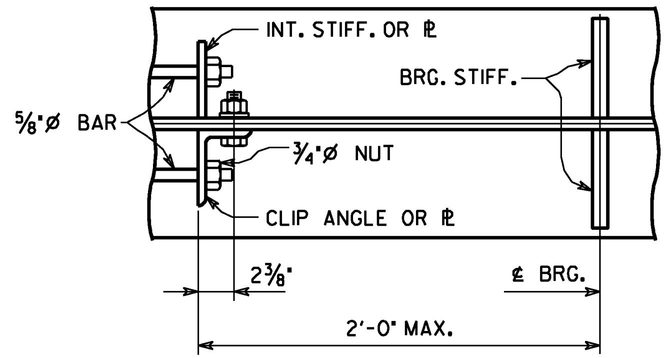
Drawing 202.5 6-19-00



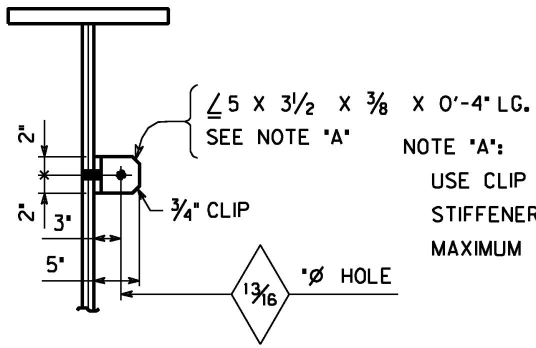
NOTE "C":
USE SUPPORT BETWEEN STIFFENERS. 8'-6" IS MAXIMUM SUPPORT SPACING.

NOTE "B":
HOLE SIZE IN CONN. STIFFENERS MAY BE THE SAME AS OTHER HOLES IN THE STIFFENER (MIN. 13/16 "Ø).

SECTION

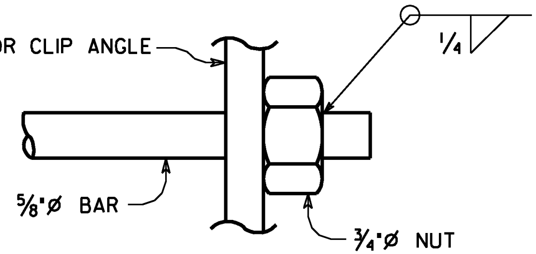


PLAN AT END BEARING

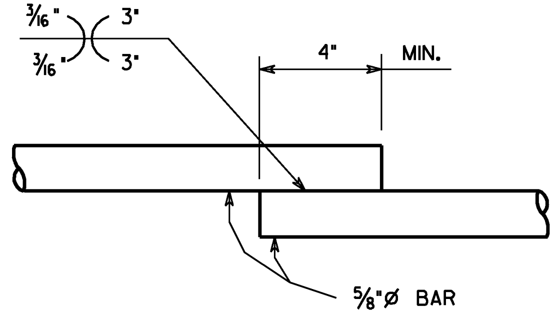


NOTE "A":
USE CLIP ANGLE BETWEEN STIFFENERS. 8'-6" IS MAXIMUM SUPPORT SPACING.

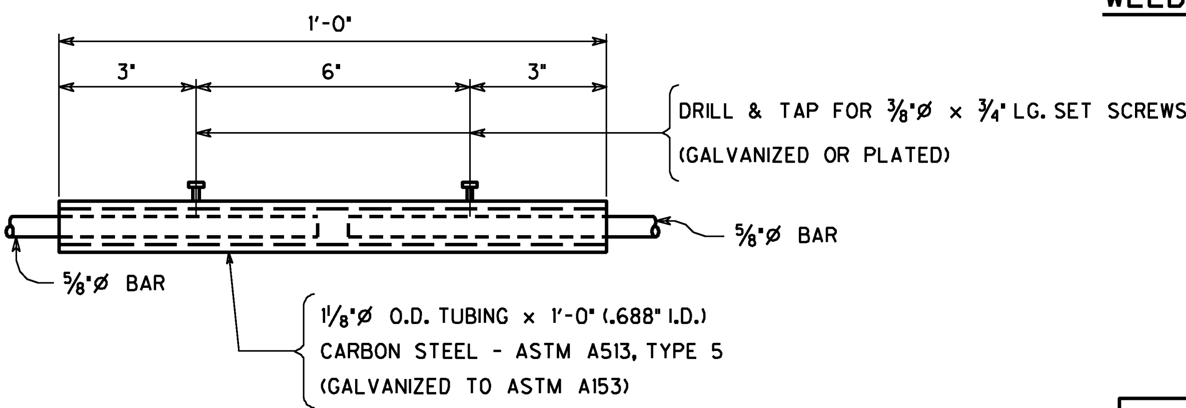
ALTERNATE BOLTED CONN.



END CONNECTION DETAIL



SHOP OR FIELD WELDED SPLICE DETAIL

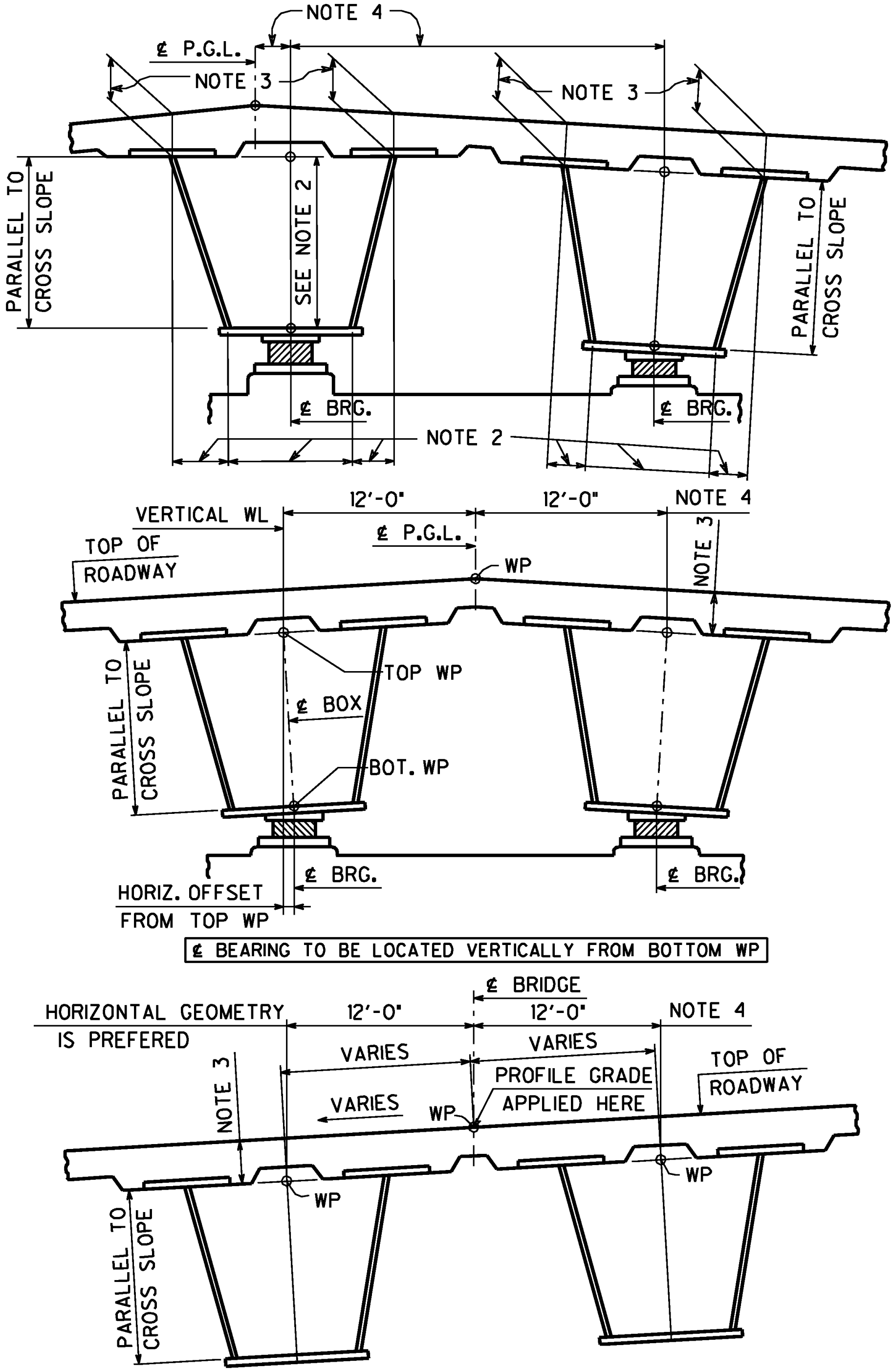


BOLTED SPLICE DETAIL AT MAIN MEMBER FIELD SPLICE

SHOP INSTALLED SAFETY HANDRAIL DETAILS

MID-ATLANTIC STATES SCEF

Drawing 202.6 6-19-00



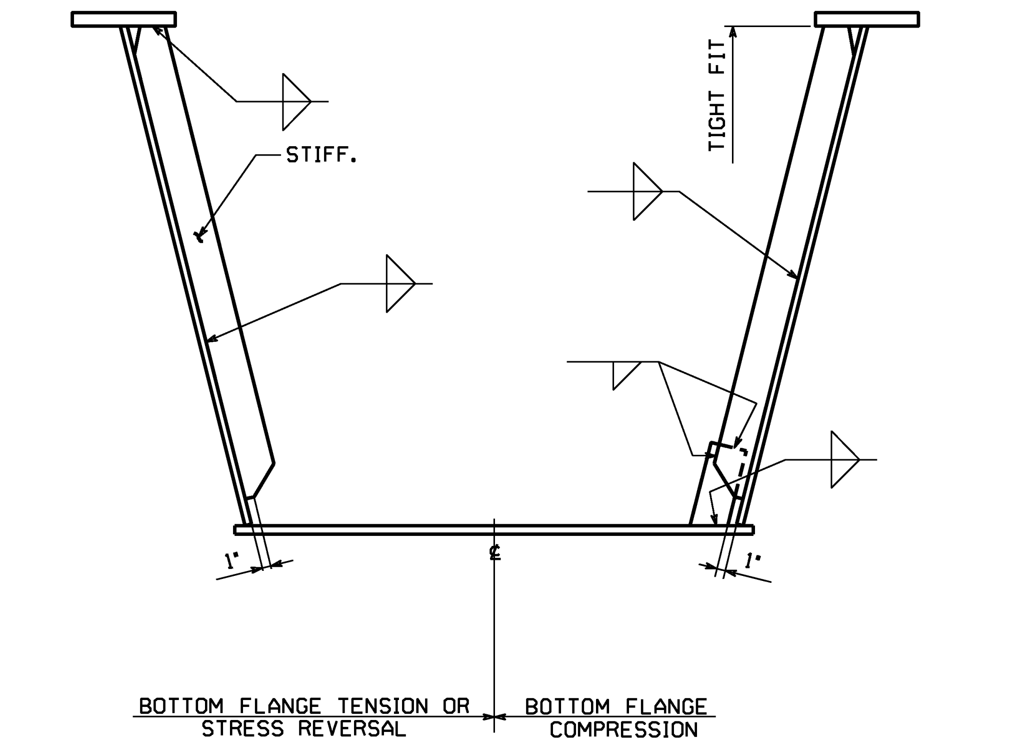
1. ROTATE BOX WITH CROSS SLOPE.
2. MAINTAIN CONSTANT TRAPEZOIDAL SHAPE. (DEPTH MAY VARY WITH HAUNCH)
3. MAINTAIN CONSTANT CONCRETE HAUNCH.
4. HORIZONTAL STATION OFFSETS PREFERRED.
5. FOLLOW CENTERLINE ALIGNMENT EVEN THROUGH A SPIRAL CURVE.

TUB GIRDER (OPEN BOX) CROSS SECTIONAL GEOMETRY

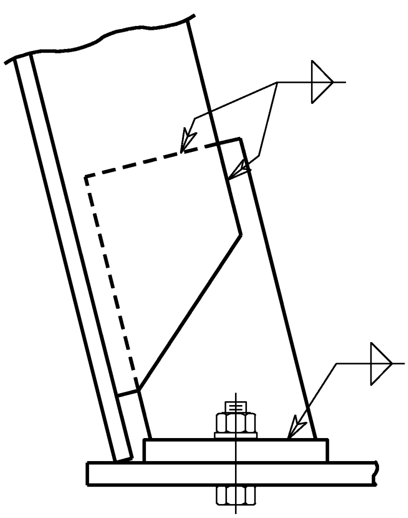
TUB GIRDER (OPEN BOX)

MID-ATLANTIC STATES SCEF

Drawing 202.7.1 6-19-00



TUB GIRDER TRANSVERSE STIFFENER DETAILS

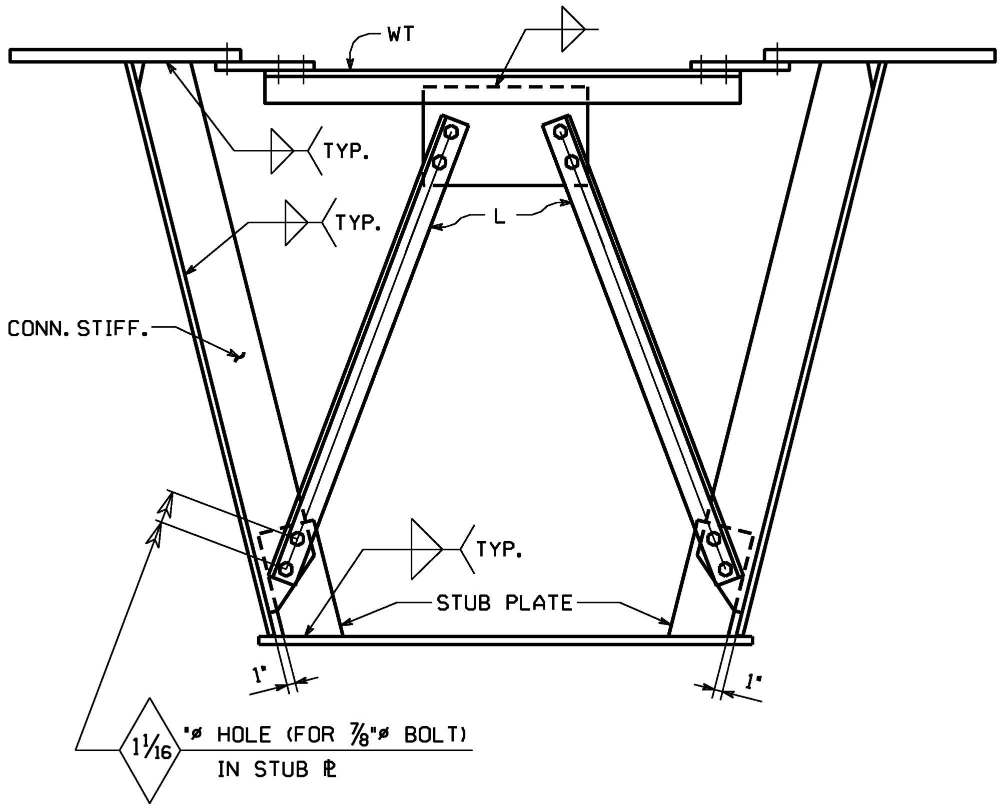


ALTERNATE DETAIL AT TENSION FLANGES

TUB GIRDER (OPEN BOX)

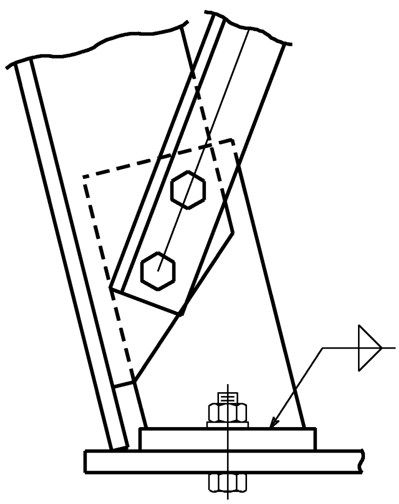
MID-ATLANTIC STATES SCEF

Drawing 202.7.2 6-19-00



BOTTOM FLANGE (COMPRESSION OR TENSION)

INTERIOR CROSSFRAME

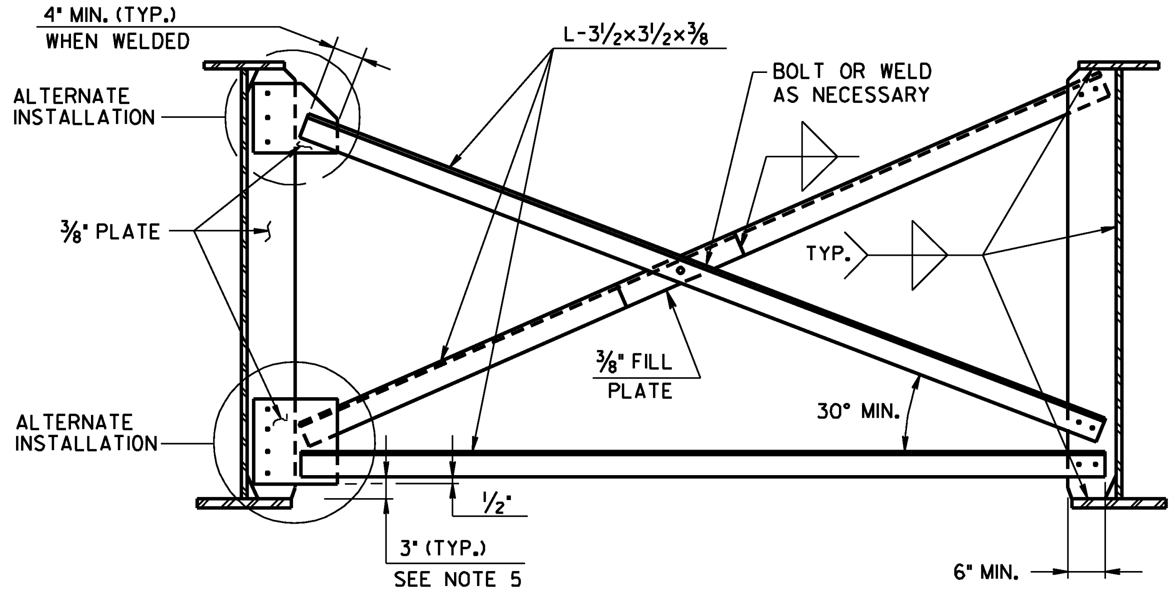


ALTERNATE DETAIL AT TENSION FLANGES

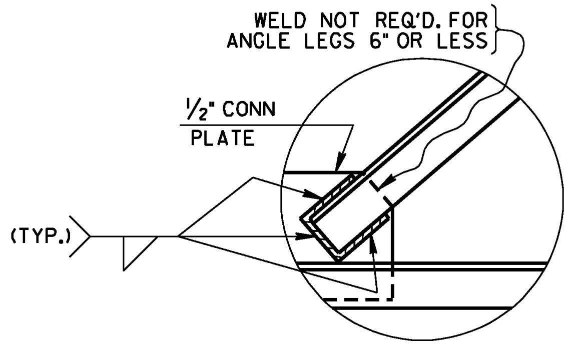
TUB GIRDER (OPEN BOX)

MID-ATLANTIC STATES SCEF

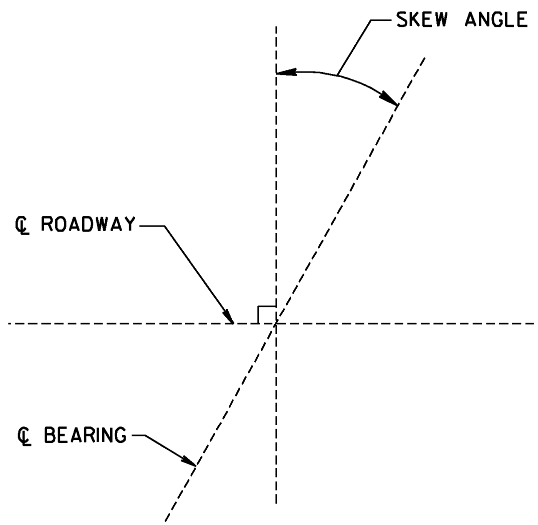
Drawing 202.7.3 6-19-00



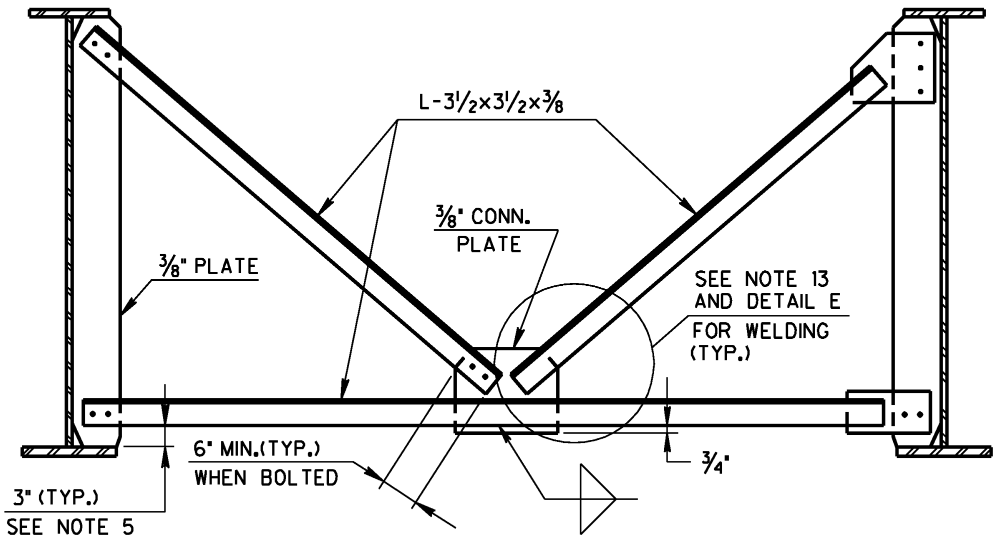
INTERMEDIATE DIAPHRAGM DETAIL



DETAIL E



SKEW ANGLE ORIENTATION

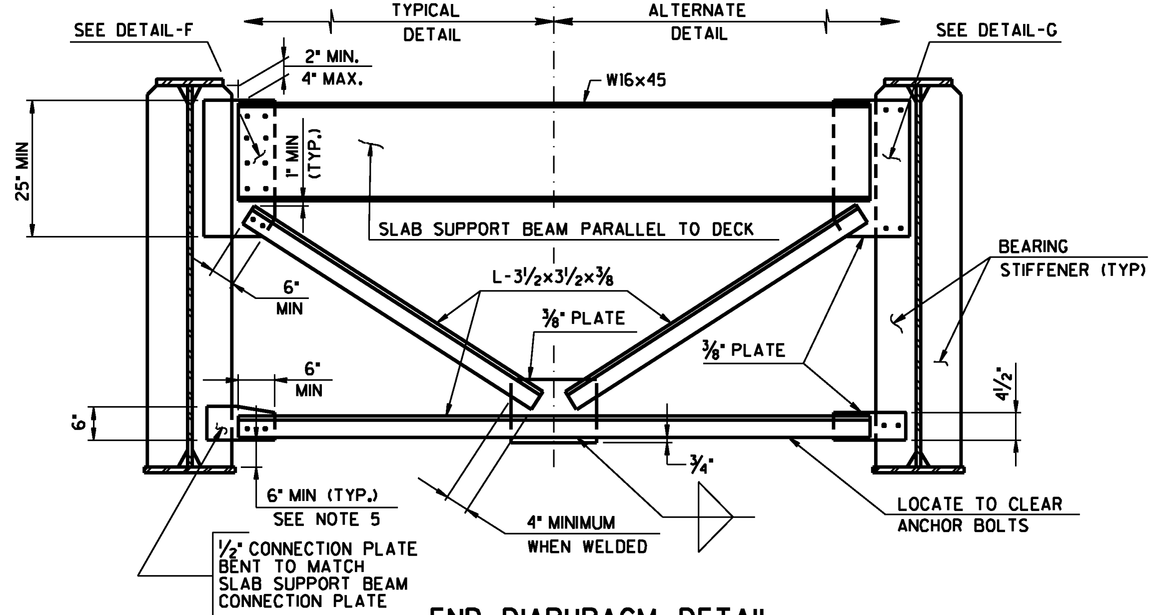


ALTERNATE INTERMEDIATE DIAPHRAGM DETAIL

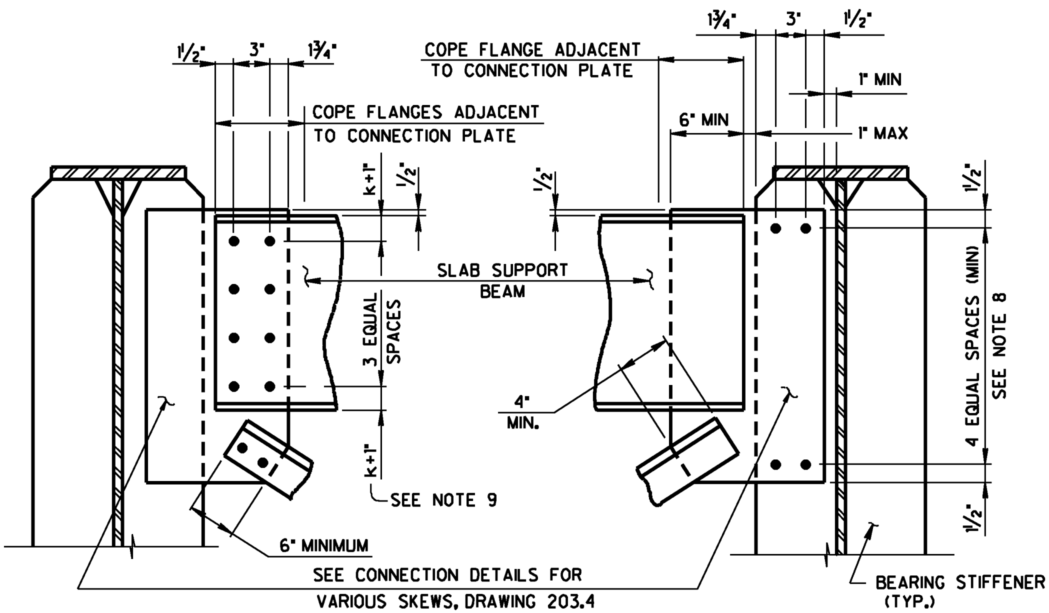
CROSS FRAME DETAILS

MID-ATLANTIC STATES SCEF

Drawing 203.1 6-19-00



END DIAPHRAGM DETAIL



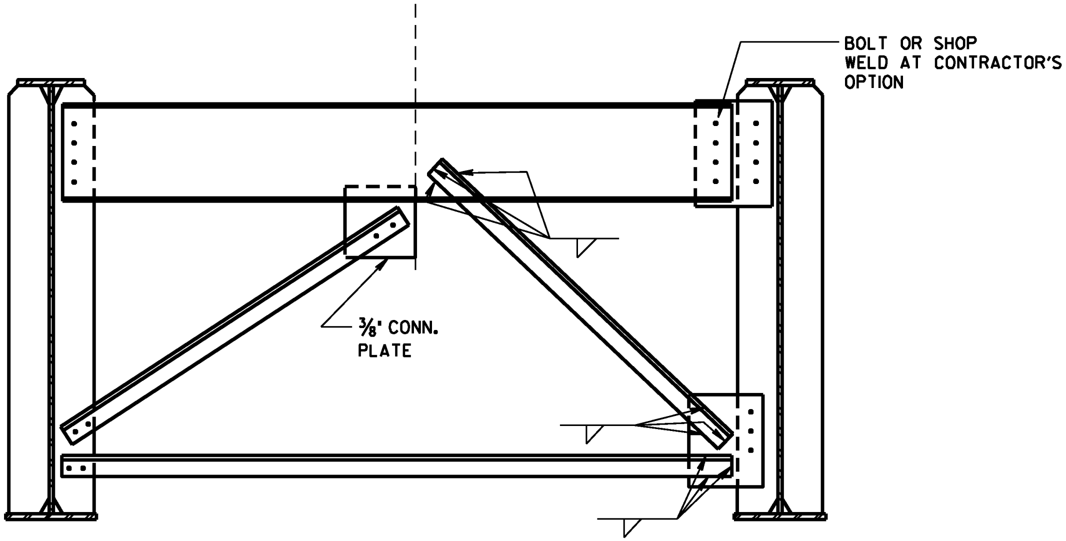
DETAIL-F

DETAIL-G

END CROSS FRAME DETAILS

MID-ATLANTIC STATES SCEF

Drawing 203.2 6-19-00

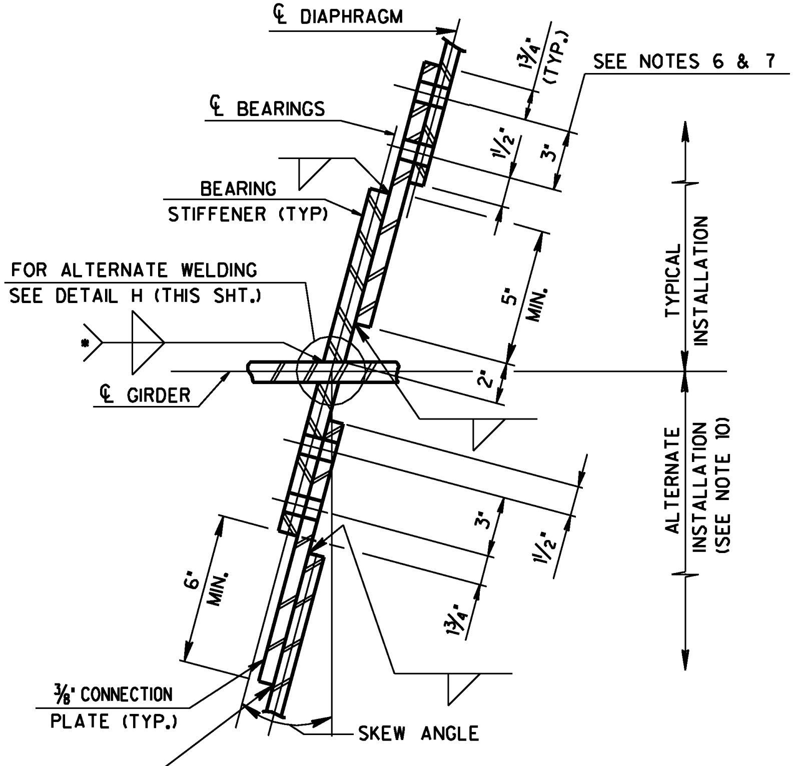


ALTERNATE END DIAPHRAGM DETAIL

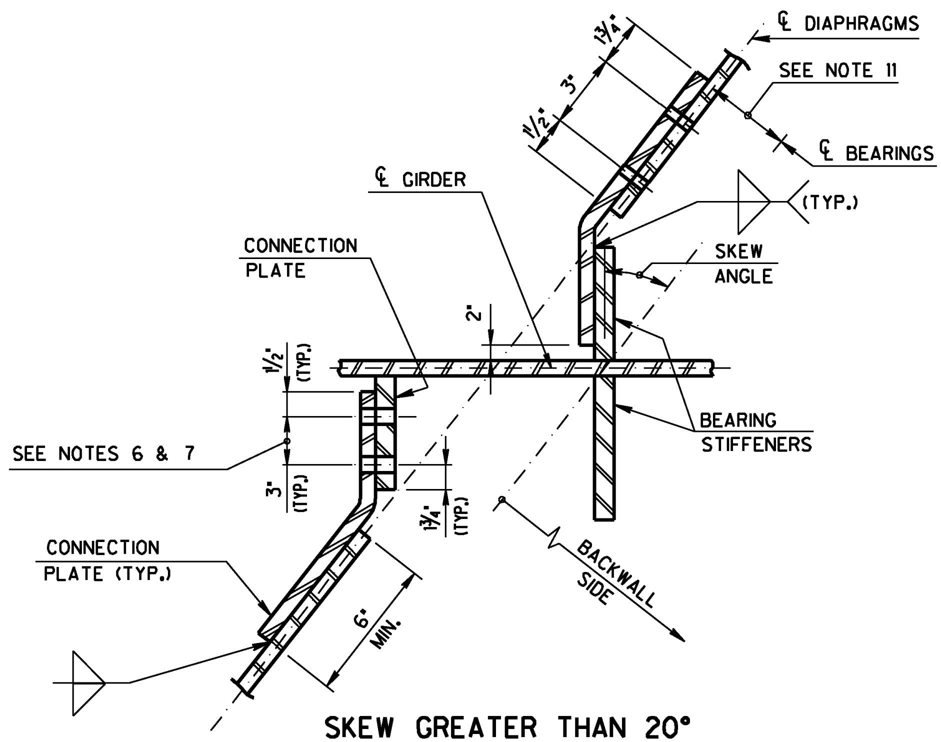
END CROSS FRAME DETAILS

MID-ATLANTIC STATES SCEF

Drawing 203.3 6-19-00

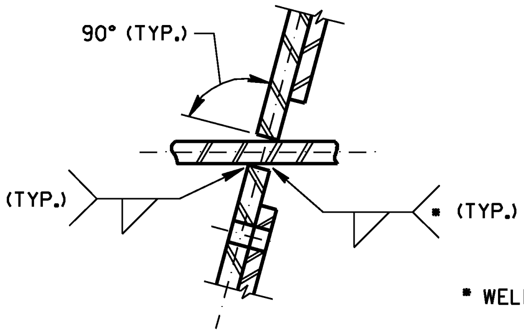


SKEW 0° TO 20°



SKEW GREATER THAN 20°

CONNECTION PLATE DETAILS



DETAIL H

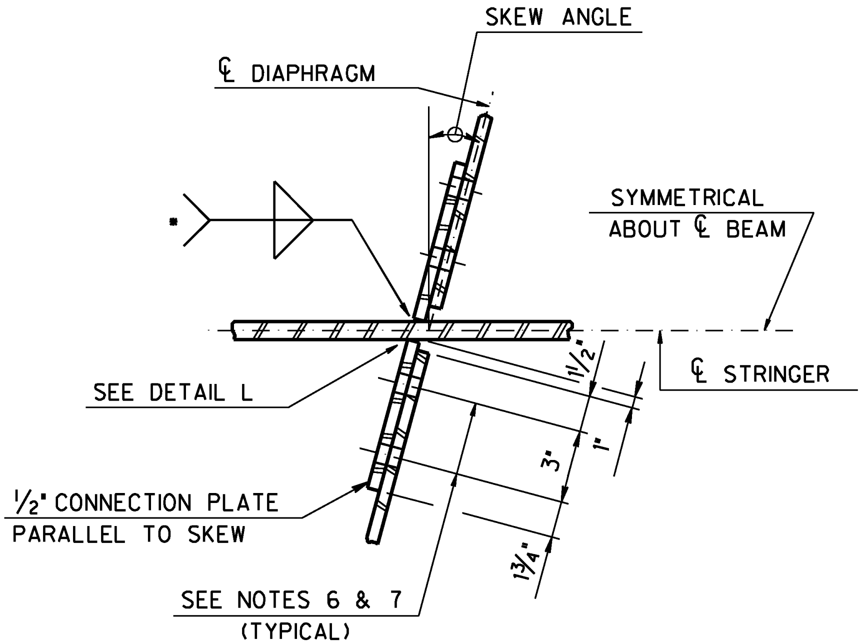
SIMILAR TO NORMAL CONNECTION
EXCEPT AS NOTED

* WELD SIZE MUST BE IN ACCORDANCE WITH AWS D1.5, SECT 2.7

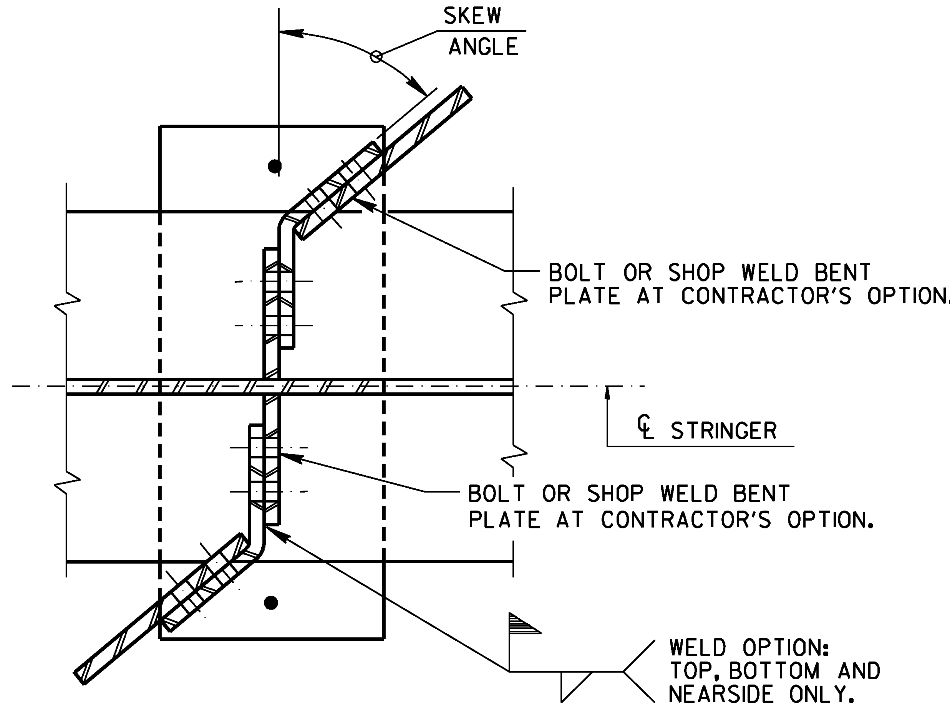
CONNECTION PLATE DETAILS

MID-ATLANTIC STATES SCEF

Drawing 203.4 6-19-00



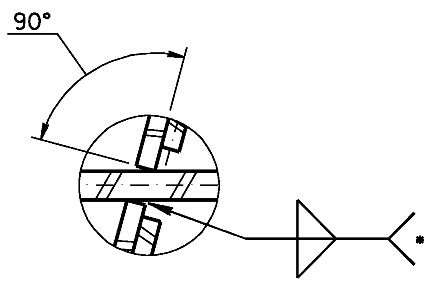
SKEW 0° TO 20°



SKEWS > 20°

CONNECTION PLATE DETAILS

(SEE NOTE 4)



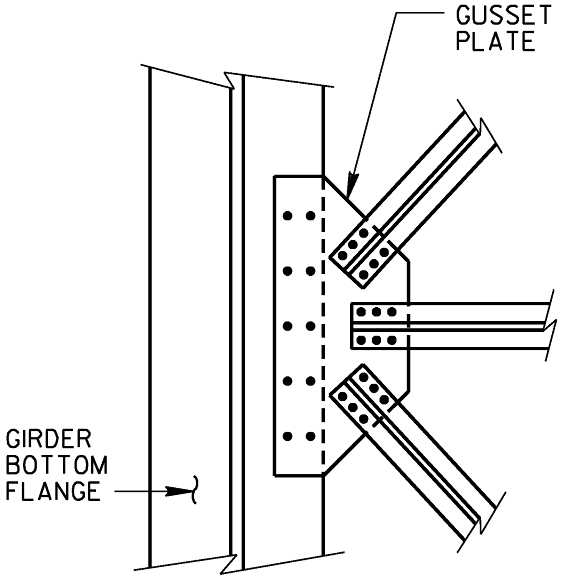
* NOTE:WELD SIZE MUST BE IN ACCORDANCE WITH AWS D1.5, SECT. 27

DETAIL L

CONNECTION PLATE
DETAILS

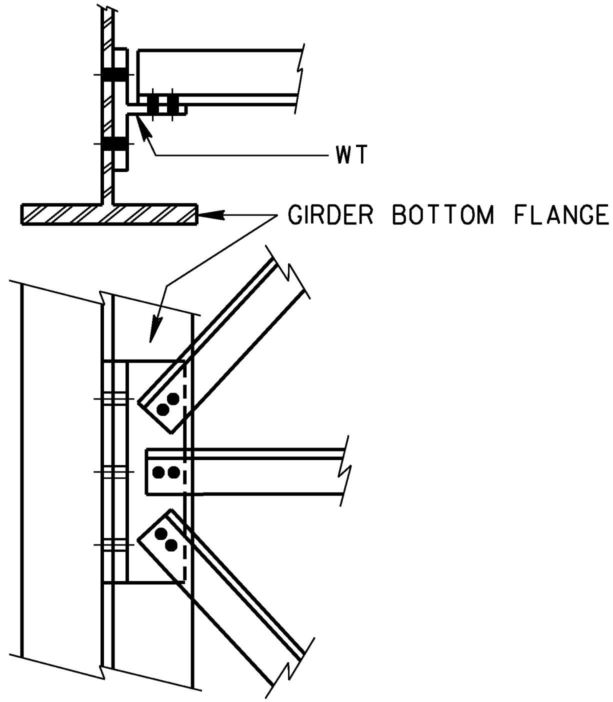
MID-ATLANTIC STATES SCEF

Drawing 203.5 6-19-00



BOLTED ATTACHMENT

(CATEGORY B)



ALTERNATE BOLTED ATTACHMENT

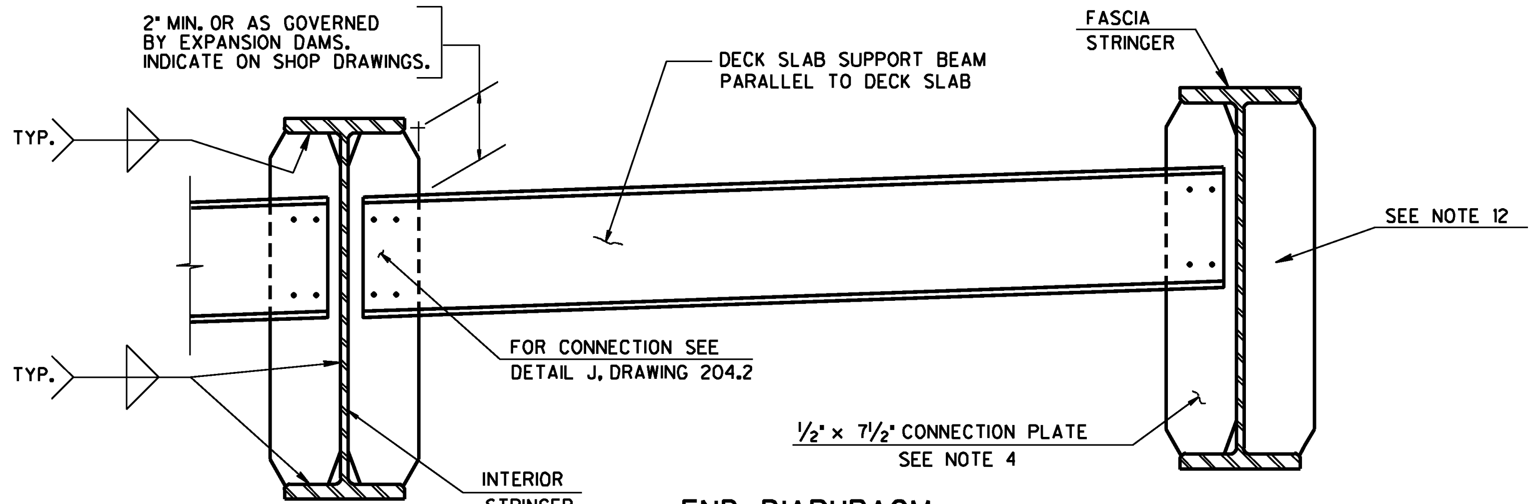
(CATEGORY B)

LATERAL BRACING ATTACHMENTS

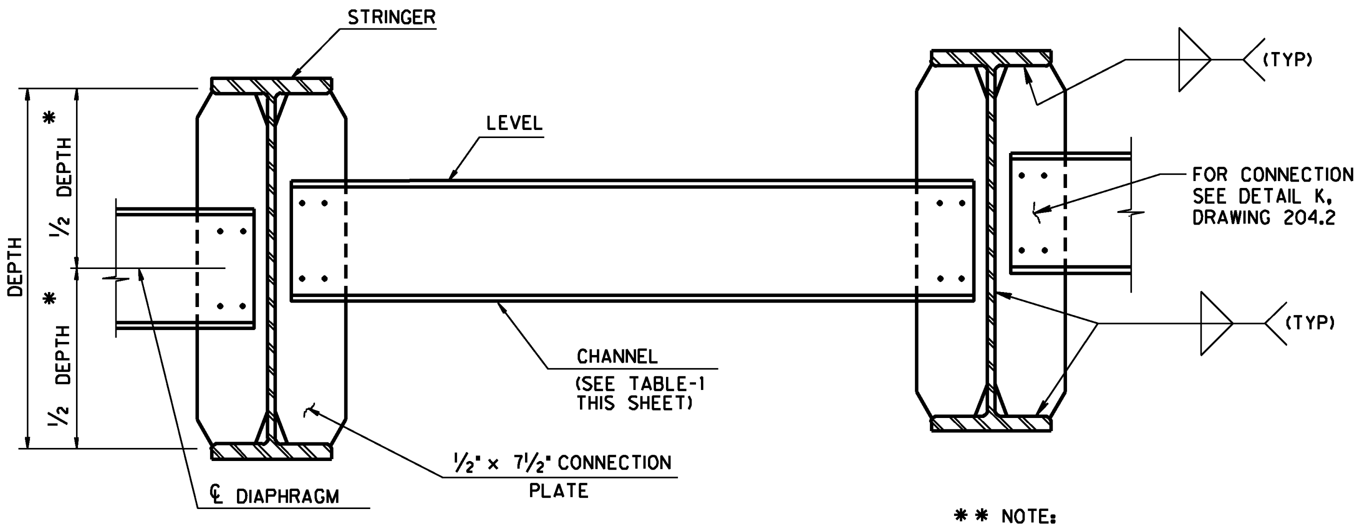
LATERAL BRACING
DETAILS

MID-ATLANTIC STATES SCEF

Drawing 203.6 6-19-00



END DIAPHRAGM
FOR ROLLED SECTIONS



* - WHEREVER POSSIBLE

INTERMEDIATE DIAPHRAGM
FOR ROLLED SECTIONS **

** NOTE:
INTERMEDIATE DIAPHRAGMS
ON DRAWING 203.1 ARE AN
ACCEPTABLE ALTERNATE.

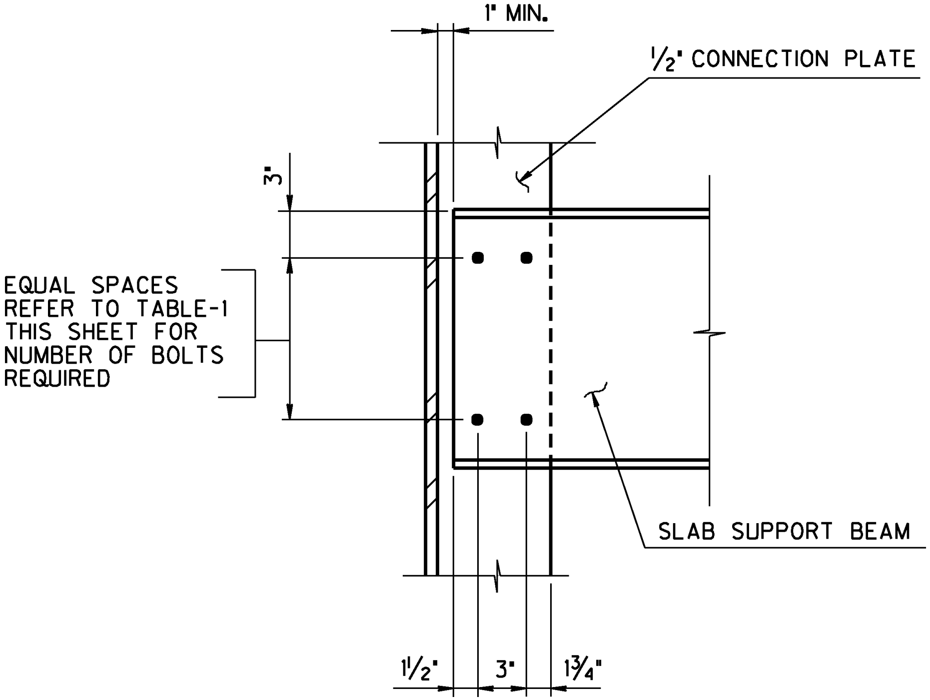
TABLE-1

STRINGER SIZE	DIAPHRAGM SIZE	NO. OF BOLTS
≥ 27" DEPTH	C 15x33.9	8
UP TO 24" DEPTH	C 12x25	6

ROLLED BEAM INTERMEDIATE
DIAPHRAGM DETAILS

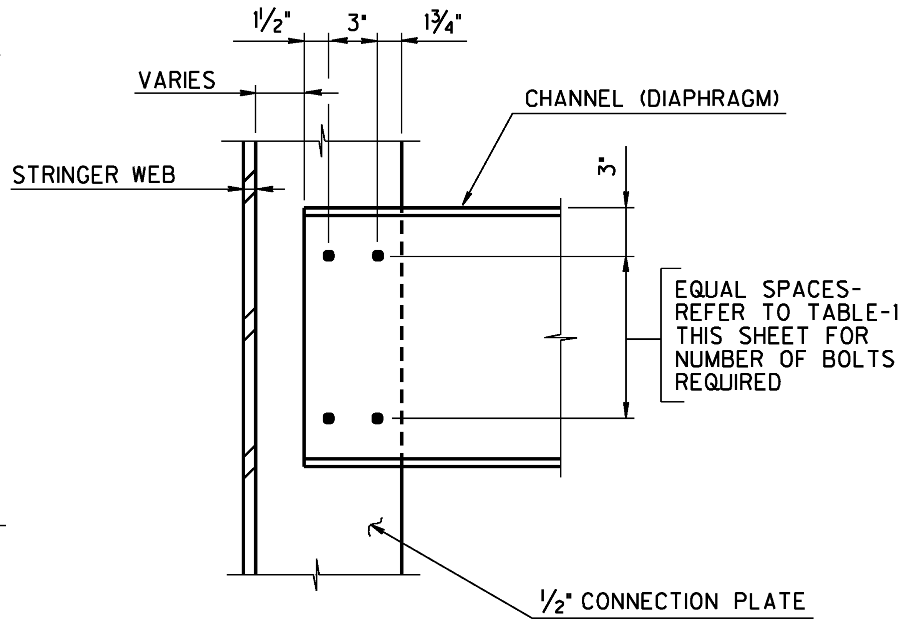
MID-ATLANTIC STATES SCEF

Drawing 204.1 6-19-00



DETAIL-J

END DIAPHRAGM
(SEE NOTE 6, 7 & 9)



DETAIL K

INTERMEDIATE DIAPHRAGM
(SEE NOTE 6)

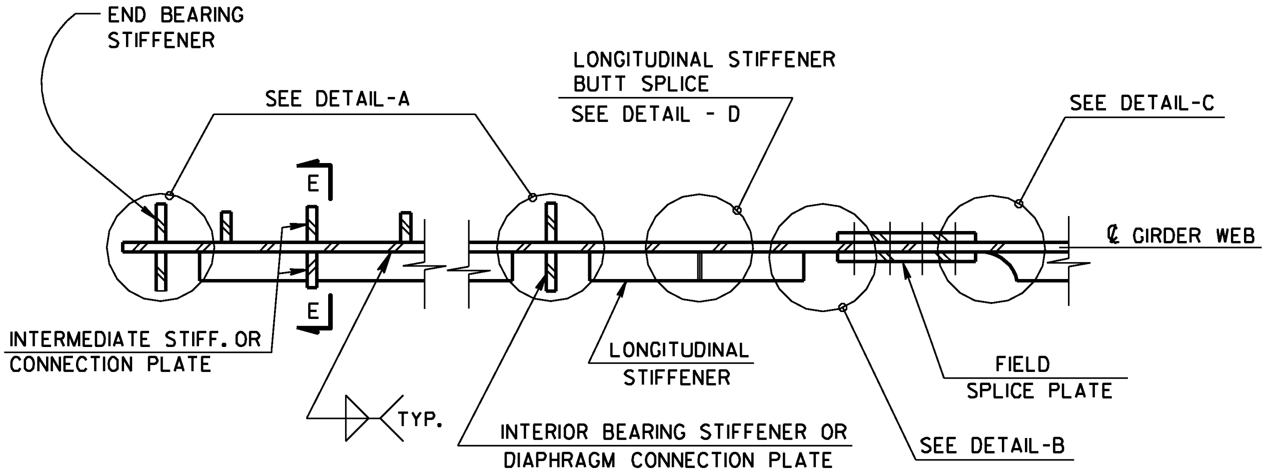
TABLE-1

STRINGER SIZE	DIAPHRAGM SIZE	NO. OF BOLTS
⩾ 27" DEPTH	C 15x33.9	8
UP TO 24" DEPTH	C 12x25	6

ROLLED BEAM INTERMEDIATE DIAPHRAGM DETAILS

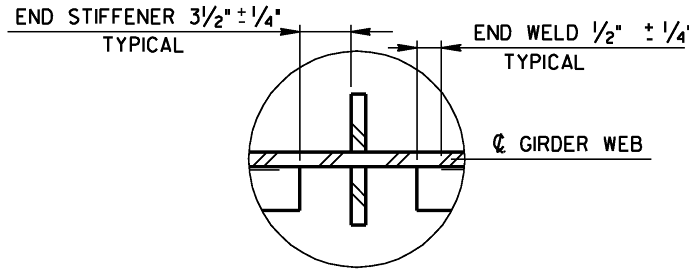
MID-ATLANTIC STATES SCEF

Drawing 204.2 6-19-00



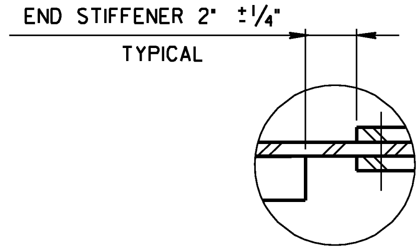
PLAN VIEW

LONGITUDINAL-TRANSVERSE STIFFENER INTERSECTION DETAILS



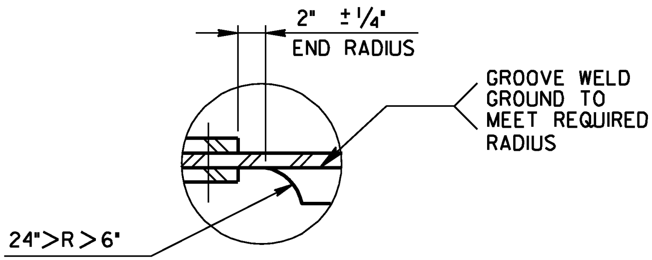
DETAIL-A

(IN COMPRESSION ZONE ONLY)
(AT INT. STIFF. OR CONN. PL.)



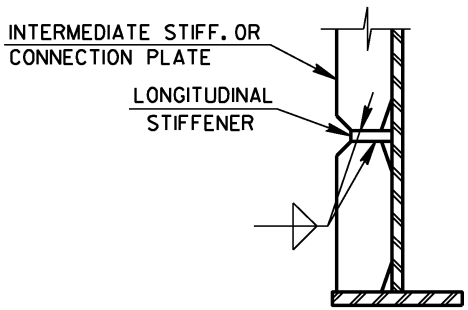
DETAIL-B

(IN COMPRESSION ZONE ONLY)
(AT FIELD SPLICE)



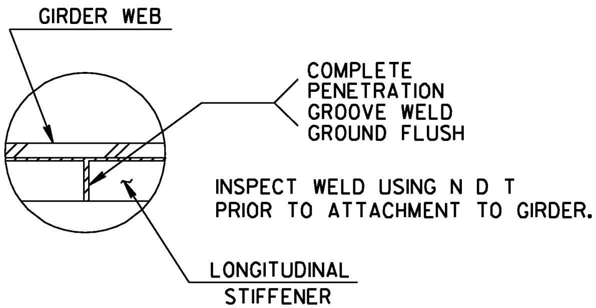
DETAIL-C

(IN TENSION OR REVERSAL ZONE ONLY)
(AT FIELD SPLICE)



SECTION E-E

(IN TENSION OR REVERSAL ZONE ONLY)
(AT INT. STIFF. OR CONN. PL.)



DETAIL-D

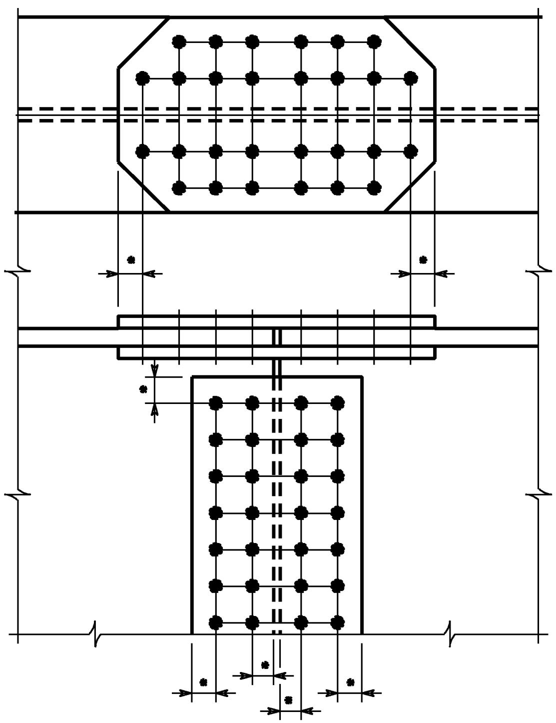
SEE NOTES 2 & 3 FOR ADDITIONAL INFORMATION

LONGITUDINAL / TRANSVERSE STIFFENER INTERSECTION DETAILS

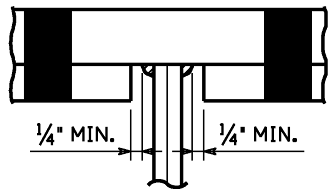
MID-ATLANTIC STATES SCEF

Drawing 205 6-19-00

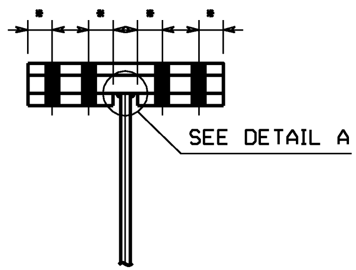
NOTE: EDGES NOTED THUS: • TO BE 1¾" FOR ⅞"ø BOLTS & 2" FOR 1" BOLTS



TYPICAL FIELD SPLICE



DETAIL A

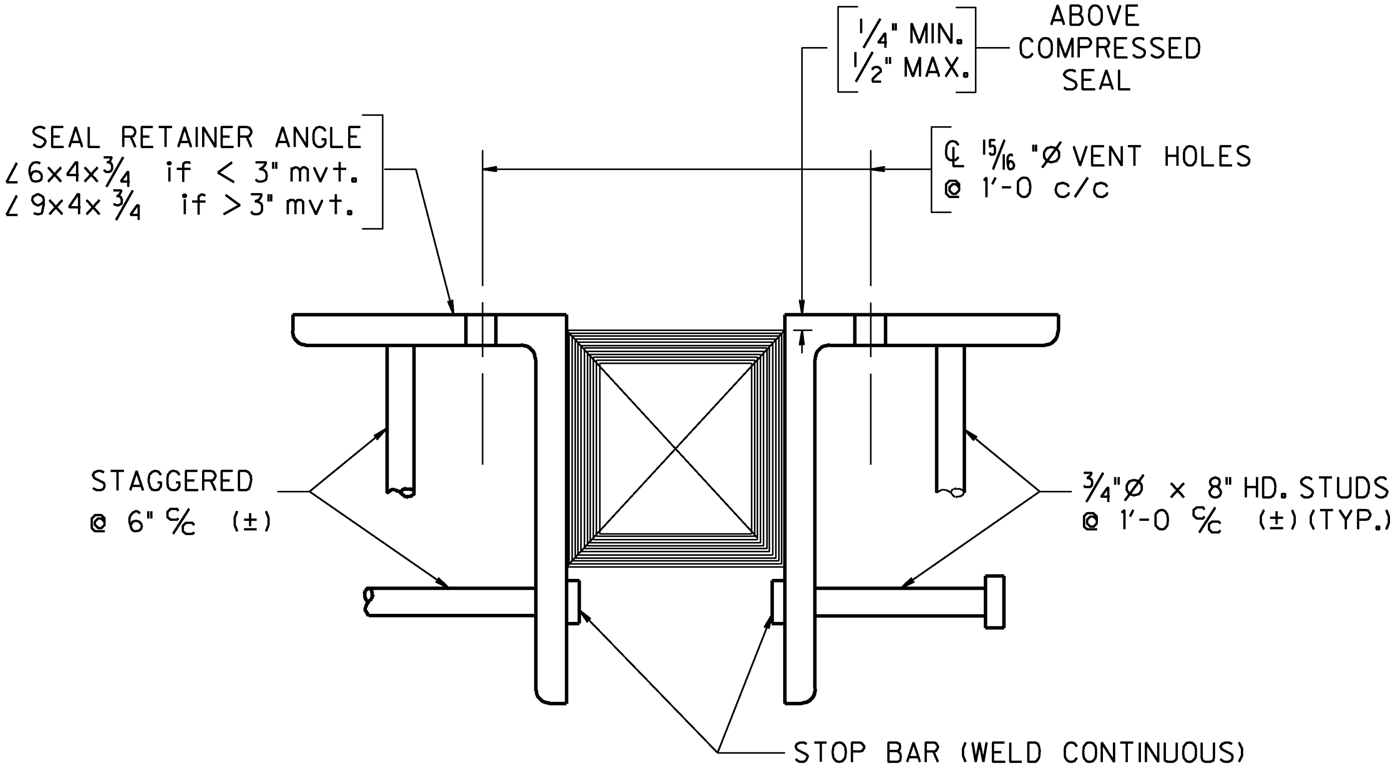


ALL MAIN LOAD CARRYING CONNECTIONS SHOULD BE DESIGNED WITH A MINIMUM OF ⅛" (¼" PREFERRED) ADDITIONAL EDGE DISTANCE BEYOND THE AASHTO MINIMUM REQUIREMENTS. THIS WILL PROVIDE A TOLERANCE FOR PUNCHING, DRILLING & REAMING.

MAIN MEMBER EDGE DISTANCE

MID-ATLANTIC STATES SCEF

Drawing 205.1 6-19-00



NOTES :

1. POSITIVE ANCHORAGE OF ANGLES TO STRINGERS SHOULD BE MADE. STRUCTURAL TEES, ANGLES, OR PLATES CAN BE USED FOR SUCH ANCHORAGE.

2. STUDS SHALL BE WELDED IN ACCORDANCE WITH SECTION 7 OF AASHTO/AWS D 1.5.

COMPRESSION SEAL JOINT
AND
RETAINING ANGLE DETAILS

MID-ATLANTIC STATES SCEF

Drawing 206 6-19-00

GENERAL NOTES: FOR ALL BEARINGS

1. Design is based on AASHTO M183 (ASTM A36) allowable stresses.

2. T_1, T_3, T_S, T_b and y measured at centerline of bearing at 70°F.

3. Fill slots and holes in masonry plate around anchor bolts with an approved non-hardening caulking compound or elastic joint sealer.

4. Steel surfaces of sole plate, rocker plate, web and bearing plate to be a machine finish as shown on the details, measured in accordance with ANSI B46.1. Other steel plate surfaces to be at least 1000 μ inch.

5. Bearing details are satisfactory for the E.Q. requirement for Zone II.

6. Bearings shall be shop assembled and match marked to ensure proper fit if uplift is present.

7. Anchor bolts, when required, shall meet the requirements of M183 and shall have hex-nut and washer. When anchor bolt goes through sole plate, nut is to be 1/4" clear. Burr threads at face of nut.

8. Anchor bolts shall be swedged and may be cast-in-place or grouted in preformed (sleeved or drilled) holes.

9. Sole plate to be beveled or have radius machined to match grade when grade exceeds 3% for low profile fixed bearing or 1% for all other bearings.

10. Steel plates shall meet a flatness requirement of 0.005 inch/inch maximum in direction being measured (width, length and diagonals) but not to exceed 1/8 inch.

11. For painted structures, bearings shall be coated with one shop coat of paint in accordance with project requirements.

12. A leveling pad shall be placed under the masonry plate when required by the contract.

NOTES: EXPANSION BEARING - SHEET 207.2

13. Δ= total longitudinal movement bearing can take. If calculated movement exceeds the limit shown, plate widths may be increased or next higher capacity bearing may be substituted.

14. Surfaces of sole plate and masonry plate in contact with bronze plate to have a machine finish of at least 125 μ inch. These steel surfaces shall not be painted, but shall be coated with a multipurpose grease before shipment. Coating shall be removed with a solvent immediately prior to erection.

15. Self-lubricating bronze bearing plates shall conform to the requirements of AASHTO M107, copper alloy UNS C91100 modified with up to 2 1/2% lead maximum. The sliding surfaces of the plates shall be provided with annular grooves or cylindrical recesses or a combination thereof, which shall be filled with a lubricating compound. The lubricating compound shall be compressed into the recesses under sufficient pressure to form a nonplastic lubricating inset. lubricating inset shall comprise not less than 25% of the total area of the plate. The frictional coefficient shall not exceed 0.10R, when bearing is tested under a load of R and for 1000 cycles. The compound shall be free of any material that could cause abrasive or corrosive action upon the metal surfaces and also shall be able to withstand extremely high pressures and the atmospheric elements over long periods of time.

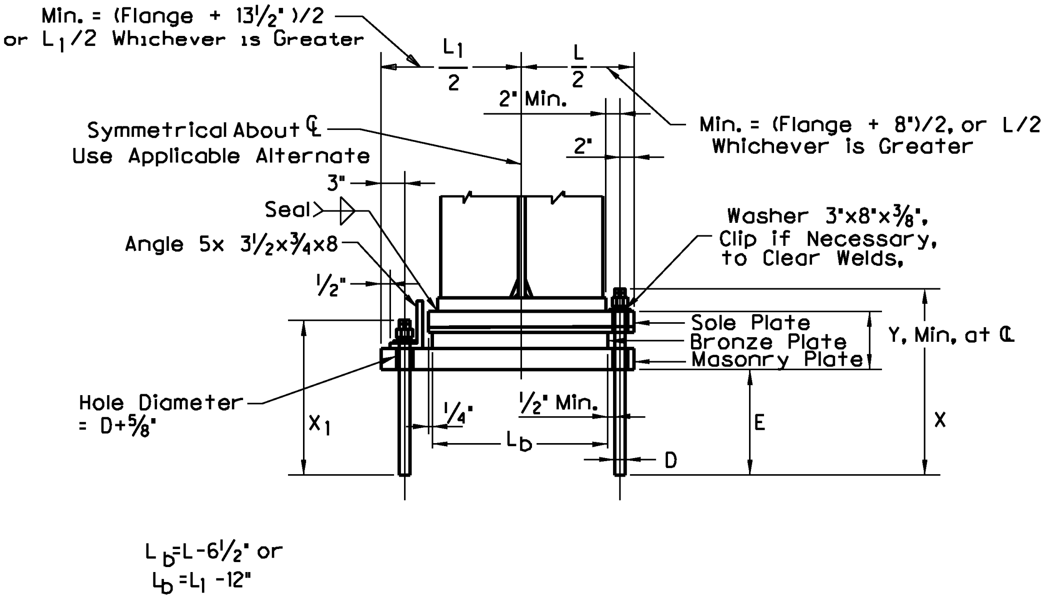
16. All items shall be standard products of the manufacturer of such materials for this application.

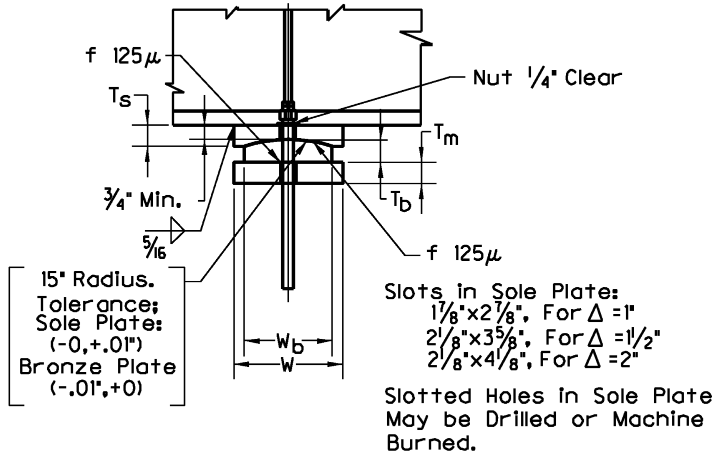
17. Prior to assembly in place, the steel surface which will bear on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer.

BRIDGE BEARING
GENERAL NOTES

MID-ATLANTIC STATES SCEF

Drawing 207.1 6-19-00





R-kips	L"	W"	W_b"	T_s"	T_m"	T_b"	D"	E"	X"	Y"	Δ"	L_1"	X_1"
120	20	10	8	1	2	1½	1¼	12	18¾	4¼	1	25½	17¼
180	22	12	9½	2	2¼	1½	1¼	12	19	4½	1	27½	17½
220	24	12½	10	2¼	2½	1¾	1½	15	22½	5	1½	29½	20¾
260	26	13½	11	2½	2½	2	1½	15	22¾	5¼	1½	31½	20¾
300	28	14	11	2½	2¾	2	1½	15	23	5½	2	33½	21
340	30	14½	11½	2¾	2¾	2	1½	15	23	5½	2	35½	21
400	32	15½	12½	3	3	2¼	1½	15	23½	6	2	37½	21¼

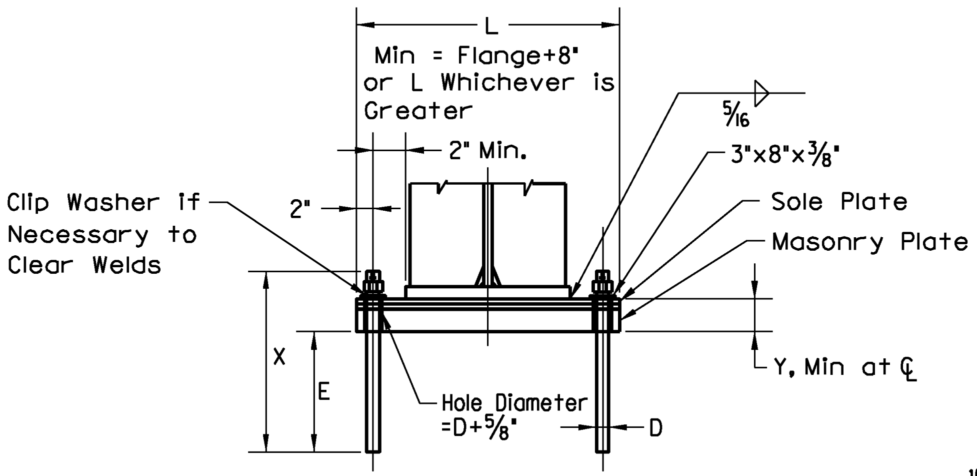
Notes:

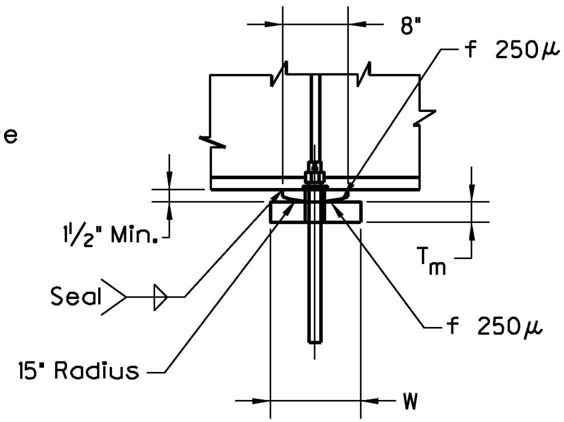
1. See General Notes Sheet 207.1.
2. Anchor bolts through sole plates are necessary only when uplift could occur. When bolts pass through sole plates, extreme care shall be exercised in properly locating anchor bolts.

EXPANSION BEARING
REACTION R - TO 400 KIPS

MID-ATLANTIC STATES SCEF

Drawing 207.2 6-19-00





R-kips	L"	W"	T_m"	D"	E"	X"	Y"
140	20	8	1½	1¼	12	18	3
180	22	9	1¾	1¼	12	18	3¼
220	24	10	2	1½	15	22	3½
260	26	10	2	1½	15	22	3½
300	28	11	2¼	1½	15	22	3¾
340	30	12	2½	1½	15	22	4
400	32	13	2½	1½	15	22	4

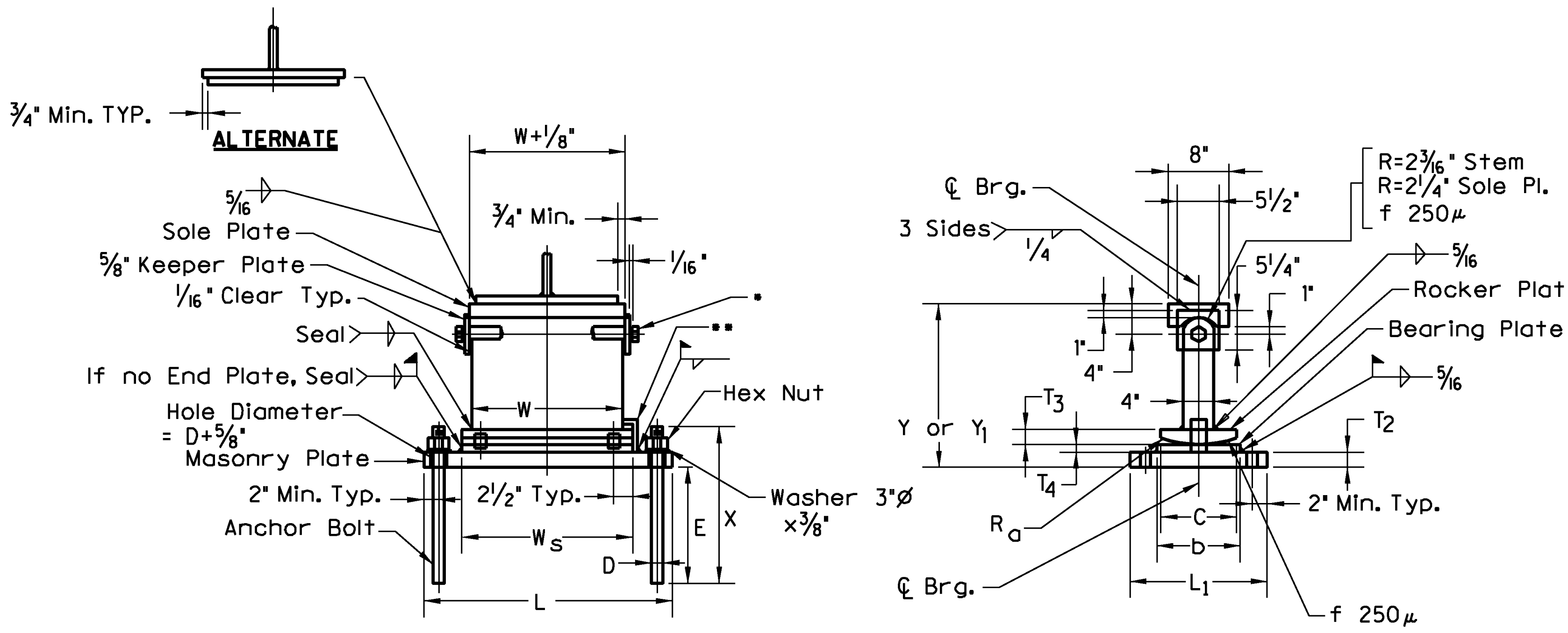
Notes:

1. See General Notes Sheet 207.1.

FIXED BEARING
REACTION R - TO 400 KIPS

MID-ATLANTIC STATES SCEF

Drawing 207.3 6-19-00



* If Uplift is Present 1 1/4"Ø Cap Screw
1 1/2"Ø Hole in Keeper Plate
Drill and Tap Bearing

** End Plate if Uplift is Present

R-kips	L"	L_1"	W_s"	C"	b"	R_a"	T_1"	T_2"	T_3"	T_4"	E"	D"	Δ"	X"	Y"	Y_1"	W"
140	24	13	15 1/2	8	9	7	2 1/2	1 3/8	2	1	12	1 1/4	6	15	12 7/8	13 3/8	13
180	26	13	17 1/2	8	9	8	2 1/2	1 1/2	2	1	12	1 1/4	5 3/4	16	14	14 1/2	15
240	29	13	20 1/2	8	9	9	2 1/2	1 5/8	2	1	15	1 1/2	5 5/8	19	15	15 5/8	18
300	31	14	22 1/2	9	10	10	2 3/4	1 3/4	2	1	15	1 1/2	5 9/16	19 1/4	16 1/2	17	20
360	31	15	22 1/2	9	11	12	3	1 7/8	2	1	15	1 1/2	5 1/4	19 3/8	18 7/8	19 3/8	20
400	31	15	22 1/2	10	11	14	3	2	2	1	15	1 1/2	5 1/4	19 1/2	21	21 1/2	20

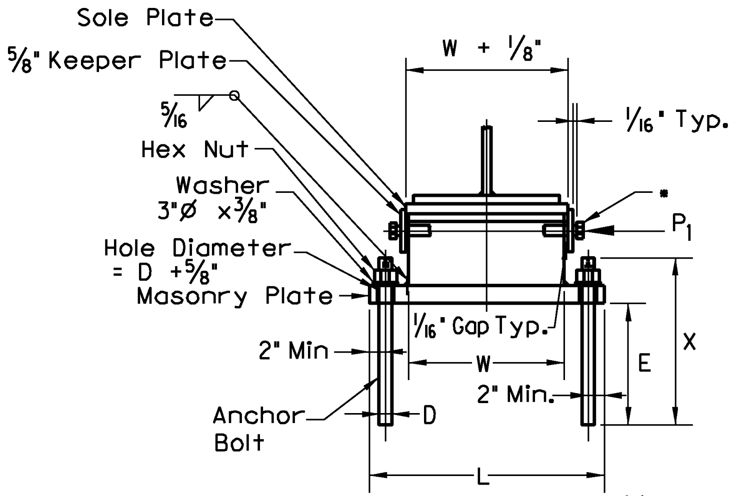
Notes:

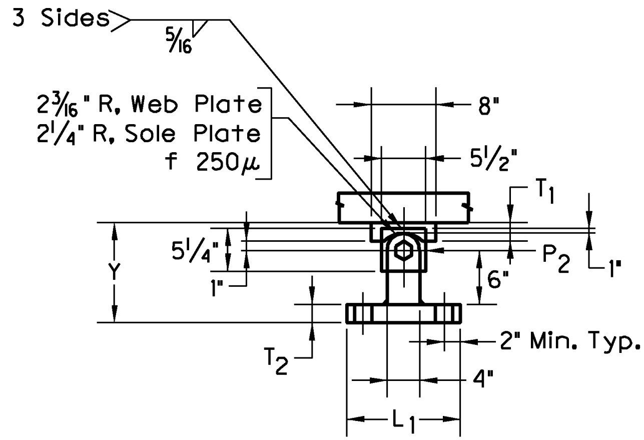
1. See General Notes Sheet 207.1.
2. Y_1, measured at center line of bearing at 70° F, when uplift occurs.
3. Provide cap screw and end plate, only if uplift is present or flood can occur. The detail shown is capable of resisting 30 kips uplift.
4. See Bearing Details, Sheet 207.6, for cap screw, plate and pintle details.

EXPANSION BRG. DETAILS
REACTION R - TO 400 KIPS

MID-ATLANTIC STATES SCEF

Drawing 207.4 6-19-00





* If Uplift is Present 1 1/4"Ø Cap Screw
1 1/2"Ø Hole in Keeper Pl.
Drill and Tap Bearing

R-kips	L"	L_1"	W"	T_1"	T_2"	E"	D"	P_1 - kips	P_2 - kips	X"	Y"
140	22	12	13	2½	1½	12	1¼	63	33	15⅞	11
180	24	12	15	2½	1½	12	1¼	78	38	16	11
240	27	12	18	2½	1¾	15	1½	104	45	19⅛	11¼
300	29	12	20	2¾	1¾	15	1½	123	49	19¼	11½
360	29	13	20	3	2	15	1½	123	49	19⅜	12
400	29	14	20	3	2¼	15	1½	123	49	19½	12¼

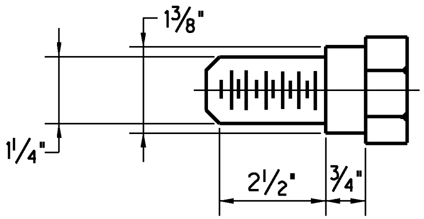
Notes:

1. See General Notes Sheet 207.1.
2. P_1 = Maximum allowable transverse force resisted by welds, uplift is not included.
   P_2 = Maximum allowable longitudinal force resisted by welds, uplift is not included.
3. Provide cap screw only if uplift is present or flood can occur. The detail shown is capable of resisting 30 kips uplift.
4. See Bearing Details, Sheet 207.6, for cap screw detail.

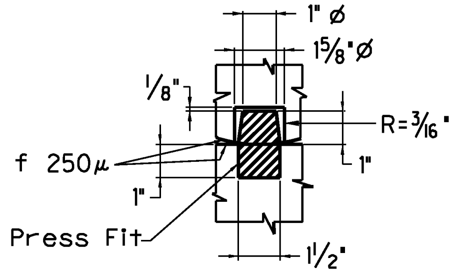
FIXED BRG. DETAILS
REACTION R - TO 400 KIPS

MID-ATLANTIC STATES SCEF

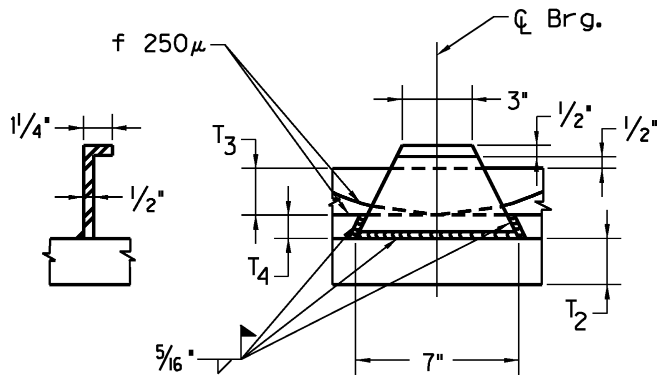
Drawing 207.5 6-19-00



1 1/4"⌀ CAP SCREW DETAIL



PINTLE DETAIL



END PLATE DETAIL

Plate can be made by machining, welding or bending.

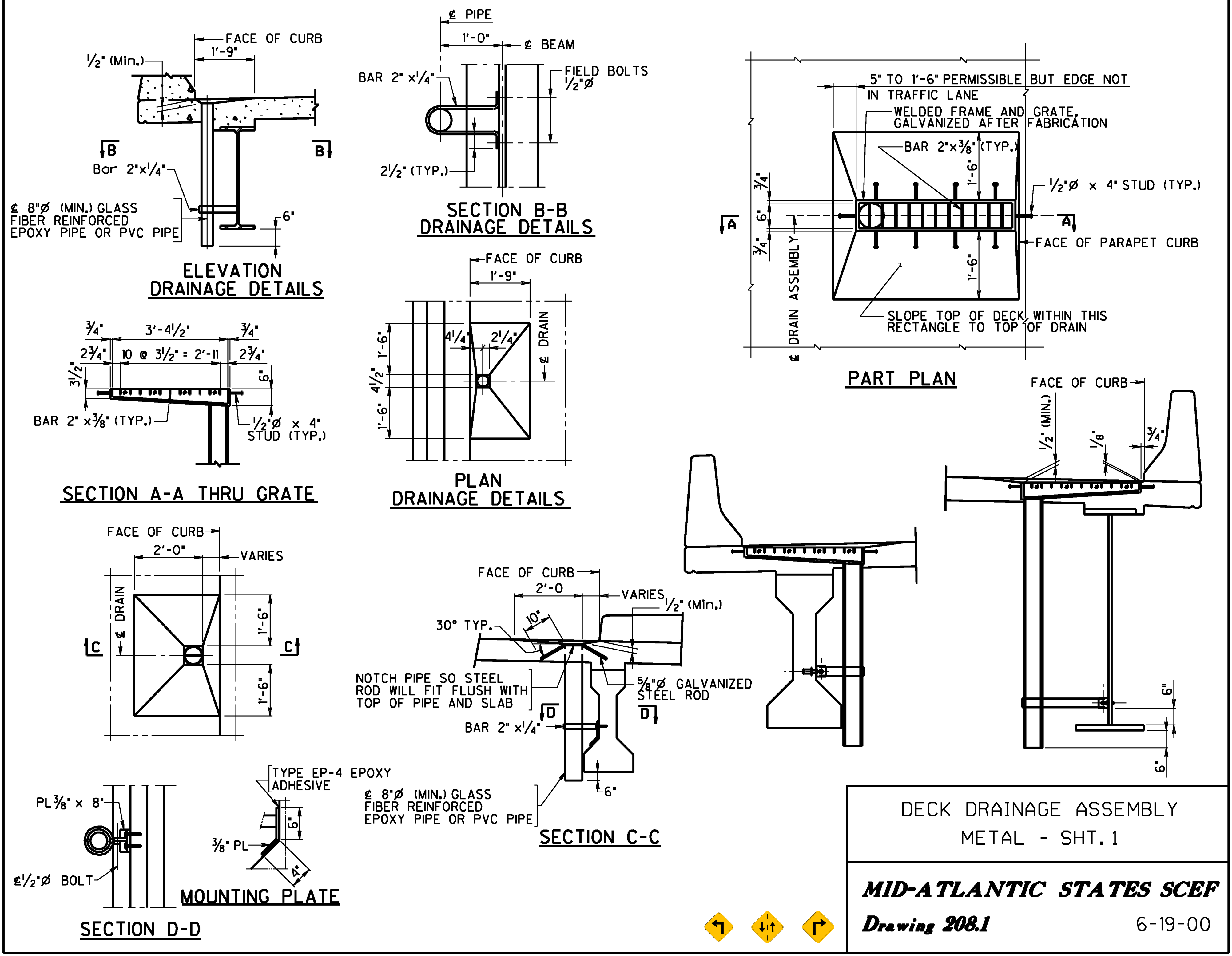
Notes:

1. See General Notes Sheet 207.1.

BEARING DETAILS
REACTION-R TO 400 KIPS

MID-ATLANTIC STATES SCEF

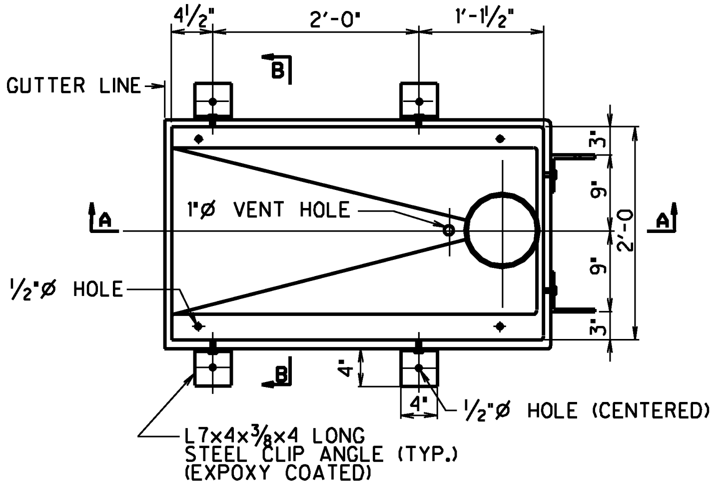
Drawing 207.6 6-19-00



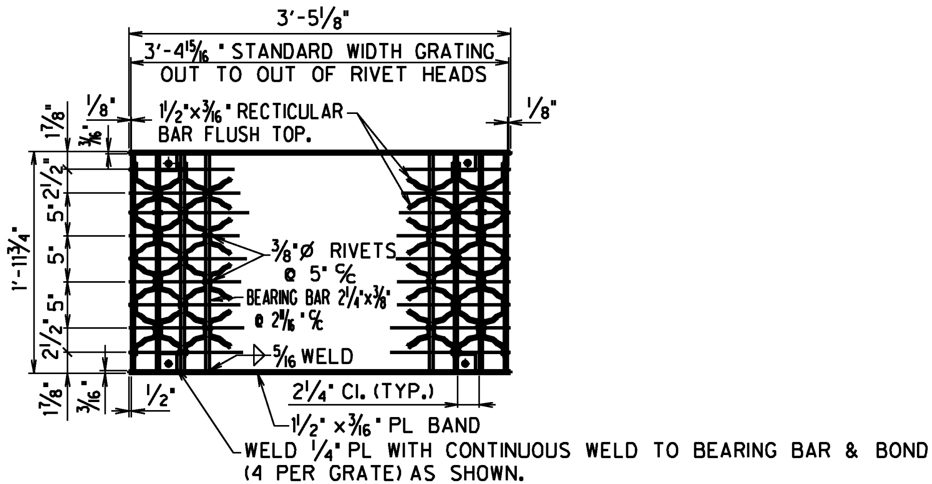
DECK DRAINAGE ASSEMBLY
METAL - SHT. 1

MID-ATLANTIC STATES SCEF

Drawing 208.1 6-19-00



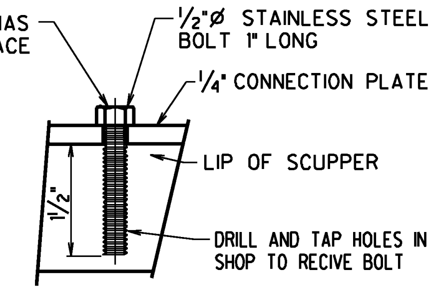
PLAN



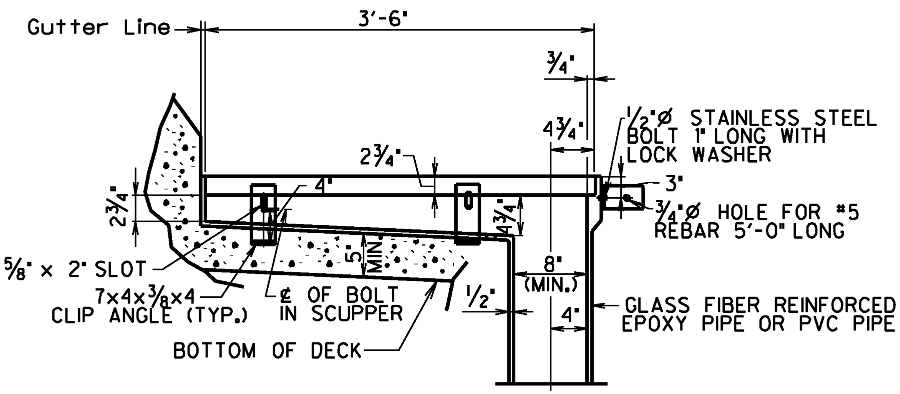
PLAN-SUGGESTED SCUPPER GRATING

NOTE: Scupper Grating shall be designed for HS-25 Loading.

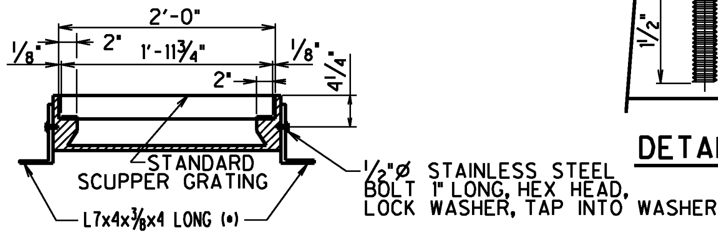
AFTER CONCRETE DECK ID POURED AND INLET HAS BEEN CLEANED, INSERT GRATE AND BOLT IN PLACE



DETAIL A



SECTION A-A



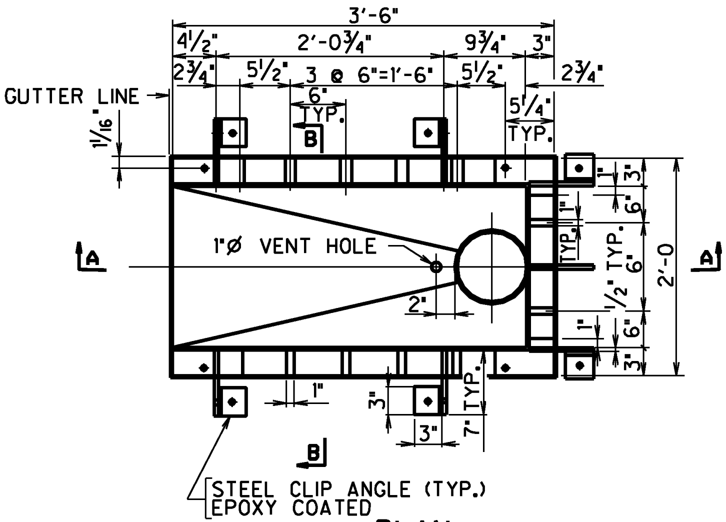
SECTION B-B

(•) CONTRACTOR MAY FURNISH LARGER ANGLES THAN SPECIFIED FOR ADJUSTMENT PURPOSE, PROVIDE THE LOCATION OF SLOT RELATIVE TO TOP OF ANGLE IS MAINTAINED.

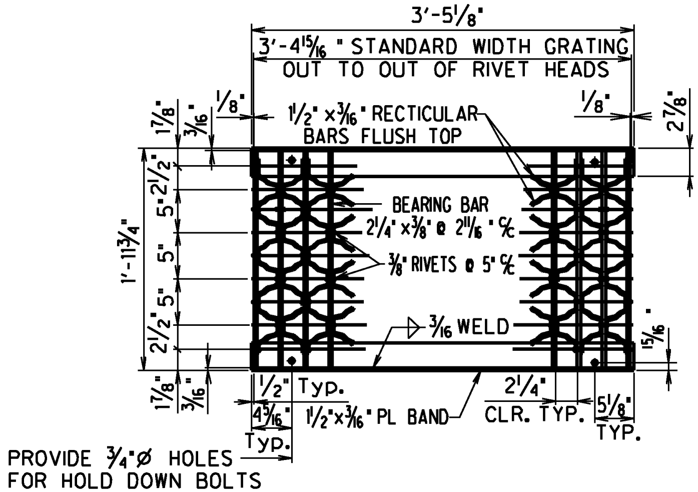
DECK DRAINAGE ASSEMBLY
METAL - SHT. 2

MID-ATLANTIC STATES SCEF

Drawing 208.2 6-19-00

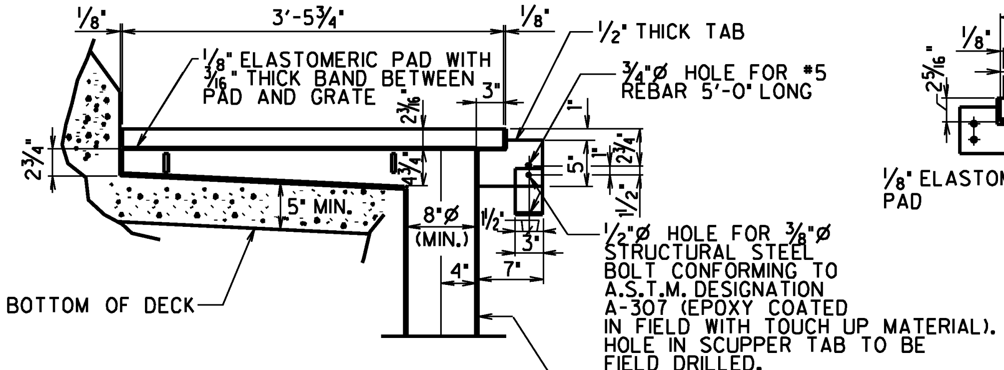


PLAN

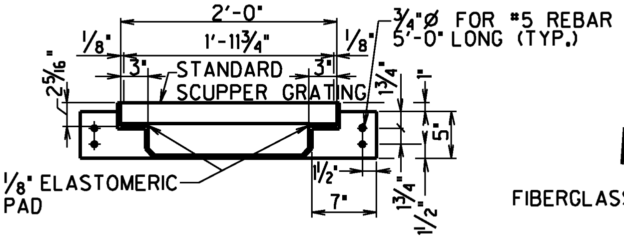


PLAN-SUGGESTED SCUPPER GRATING

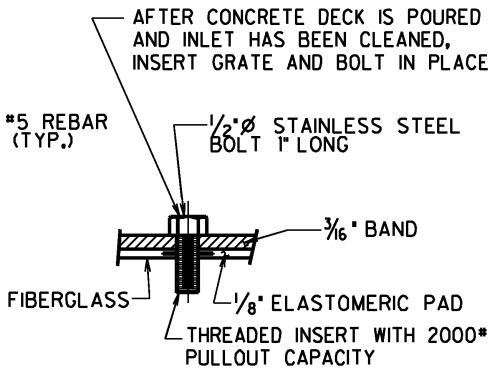
NOTE: Scupper Grating shall be designed for HS-25 Loading.



SECTION A-A



SECTION B-B



DETAIL A

DECK DRAINAGE ASSEMBLY
FIBERGLASS

MID-ATLANTIC STATES SCEF

Drawing 208.3 6-19-00

METRIC
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202.3	INTERMEDIATE & BEARING STIFFENER DETAILS
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208.2	DECK DRAINAGE ASSEMBLY - METAL, SHT. 2
208.3	DECK DRAINAGE ASSEMBLY - FIBERGLASS

GENERAL NOTES :

A. PROVIDE MATERIALS AND WORKMANSHIP CONFORMING TO AASHTO, DIVISION II AND AASHTO/AWS D1.5 WELDING CODE.

B. LOCATE ALL INTERMEDIATE STIFFENERS ON OPPOSITE SIDE OF WEB FROM LONGITUDINAL STIFFENER WHEN POSSIBLE.

C. WHEN BEARING STIFFENER IS USED AS A CONNECTION PLATE, WELD TO TOP AND BOTTOM FLANGE.

D. MEMBER, WELD AND PLATE SIZES SHOWN ARE VALID FOR STRAIGHT GIRDERS WITH MAXIMUM GIRDER SPACING OF 3000 AND FOR SKEW ANGLES BETWEEN 0° AND 20°. PROVIDE SPECIAL DESIGNS FOR ALL DIAPHRAGM MEMBERS, WELDS AND PLATE SIZES WHEN THE GIRDER SPACING EXCEEDS 3000 AND/OR THE SKEW ANGLE EXCEEDS 20°.

E. THE DETAILS SHOWN ARE VALID FOR SKEW ANGLES 0° TO 20°. PROVIDE SPECIAL DETAILS FOR SKEW ANGLES GREATER THAN 20°.

F. FILLET WELD SIZES ARE GOVERNED BY MATERIAL THICKNESS IN ACCORDANCE WITH AASHTO/AWS D1.5.

G. PROVIDE INTERMEDIATE DIAPHRAGMS NORMAL TO THE MAIN MEMBERS FOR SKEWS >20°.

H. THE DIAPHRAGMS SHOWN DO NOT INCLUDE WIND LOAD TRANSFERRED TO THE BEARINGS THROUGH CONNECTIONS.

I. DIAPHRAGMS SHOWN ARE FOR STRAIGHT GIRDERS ONLY.

J. ALL DIMENSIONS SHOWN ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

THE FOLLOWING NOTES ARE TO BE USED WHEN REFERENCED ON THE DRAWINGS:

1. UNDER FULL DEAD LOAD BEAM ENDS AND ALL BEARING STIFFENERS, INCLUDING BEARING STIFFENERS AT PIERS, SHALL BE VERTICAL TO WITHIN APPLICABLE AASHTO/AWS FABRICATION AND CONSTRUCTION TOLERANCES.
2. PERFORM NON-DESTRUCTIVE TESTING ON LONGITUDINAL STIFFENER BUTT WELDS PRIOR TO ATTACHMENT TO GIRDER WEB.
3. USE DETAIL-C AT FIELD SPLICES, SEE SECTION E-E FOR REVERSAL ZONES AT STIFFENERS AND CONNECTION PLATES. DETAILS-A AND B ARE APPLICABLE ONLY IN THE COMPRESSION ZONE. THERE SHALL BE NO CATEGORY D, E, OR E' IN TENSION OR REVERSAL ZONES.
4. SEE DRAWING 202.2 FOR WEB CONNECTION PLATE INSTALLATION DETAILS.
5. MODIFY THE DISTANCE BETWEEN THE BOTTOM GIRDER FLANGE AND THE LOWER DIAPHRAGM COMPONENT WHEN LOWER LATERAL BRACING IS USED. INDICATE MODIFICATIONS ON THE DESIGN DRAWINGS.
6. 27 DIAMETER HOLE IN CONNECTION PLATE; 24 DIAMETER HOLE IN CONNECTING MEMBER FOR 22 DIAMETER ASTM A325 BOLTS, STD. SIZE HOLES ARE PERMITTED.
7. USE 22 DIAMETER ASTM A325 BOLTS HAVING AN UNTHREADED SHANK OF SUFFICIENT LENGTH TO NOT ALLOW ANY THREADS TO EXIST IN THE PLANE BETWEEN THE TWO CONNECTED PARTS (SHEAR PLANE).
8. 27 DIAMETER HOLE IN BEARING STIFFENERS; 24 DIAMETER HOLE IN CONNECTION PLATE FOR 22 DIAMETER ASTM A325 BOLTS STD. SIZE HOLES ARE PERMITTED. (NOTE 7 DOES NOT APPLY.)
9. "K" = FLANGE THICKNESS + FILLET, AS INDICATED IN AISC TABLES OF BEAM DIMENSIONS.
10. ALTERNATE INSTALLATION SHOWN FOR 0° TO 20° SKEW CONNECTION PLATES. INDICATING WHICH COMPONENTS ARE WELDED OR BOLTED, MAY BE APPLIED TO ALL OTHER CASES WHERE APPLICABLE.
11. POSITION DIAPHRAGM CONNECTION COMPONENTS SO AS TO CREATE MINIMUM OFFSET FROM ℄ BEARINGS. DIAPHRAGM CONNECTION PLATE MAY BE PLACED BEHIND THE BEARING STIFFENER TO MINIMIZE OFFSET.
12. PROVIDE CONNECTION PLATE ON THE OUTSIDE FACE ALSO FOR TWO OR THREE GIRDER SYSTEMS.
13. PROVIDE WELDING AS SHOWN IN "DETAIL E". THIS DETAIL IS TYPICAL FOR ALL WELDED CONNECTIONS.
14. CHECK ANCHOR BOLT CLEARANCES WHEN STIFFENERS ARE WIDER THAN FLANGE.

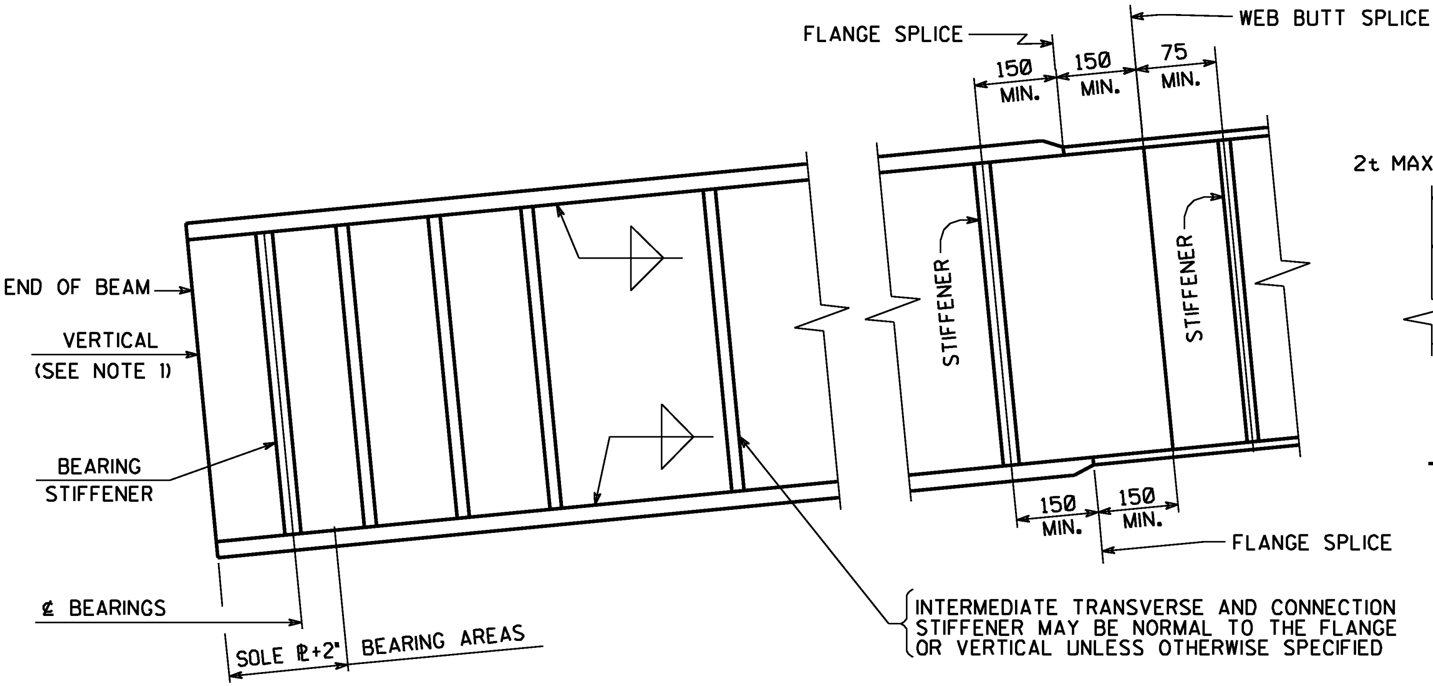
NOTES

METRIC

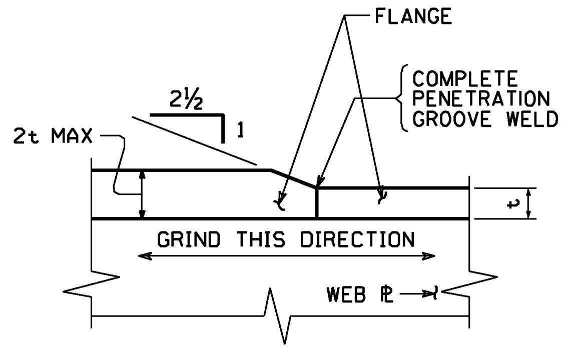
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

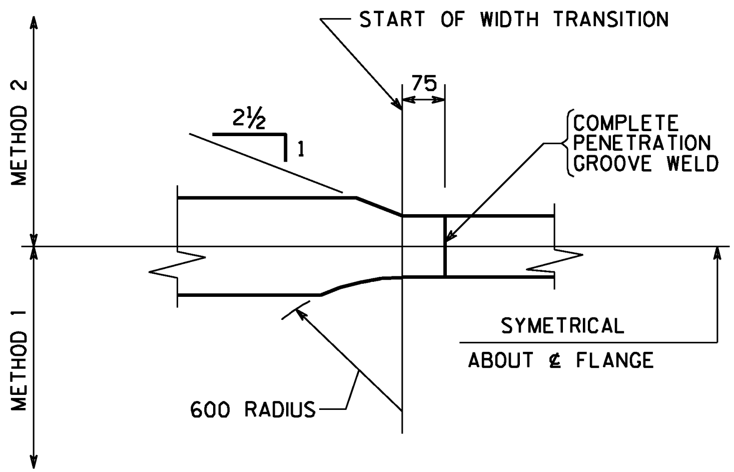
Drawing 201 6-19-00



TYPICAL GIRDER DETAIL

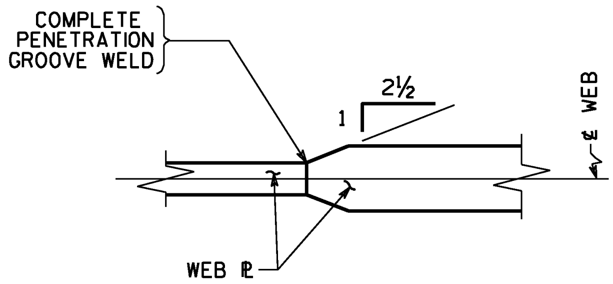


ELEVATION
FLANGE SPLICE DETAILS



FLANGE WIDTH TRANSITION

(MUST USE RADIUS FOR STEEL GRADES ≥ 485)
(PER AWS D1.5-96)



WEB THICKNESS TRANSITION

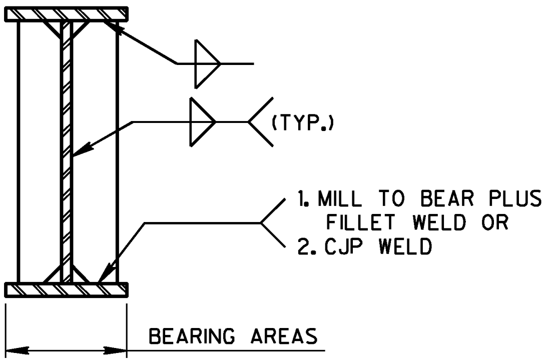
GIRDER WELDED SPLICE DETAILS

METRIC

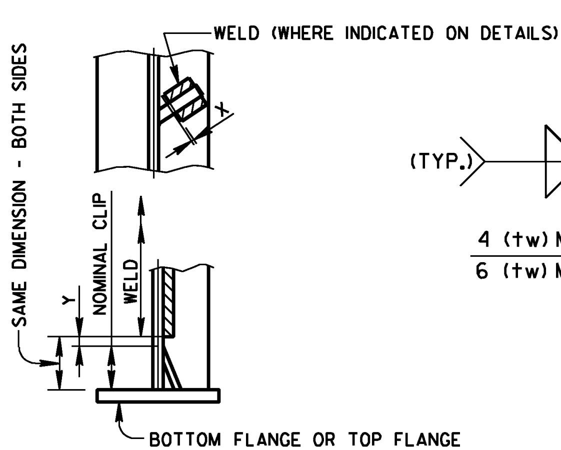
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 202.1 6-19-00

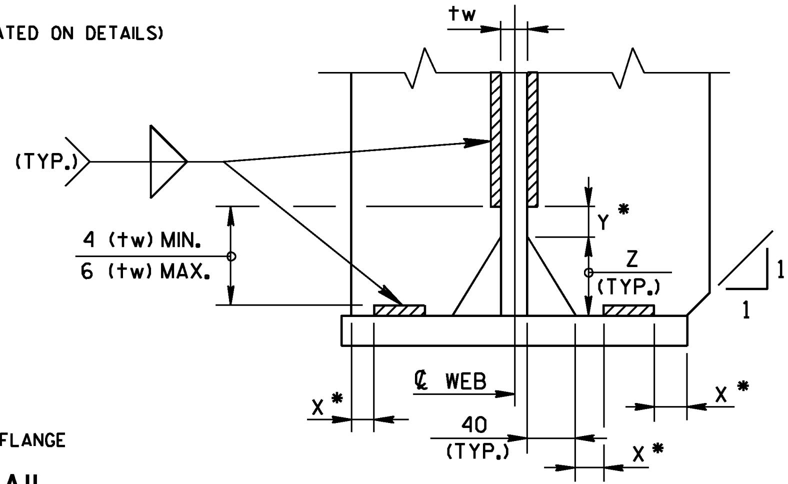


BEARING STIFFENER



STIFFENER WELDING DETAIL

(FOR SKEWED STIFFENERS)



DETAIL @ END OF STIFFENER OR CONNECTION PLATE

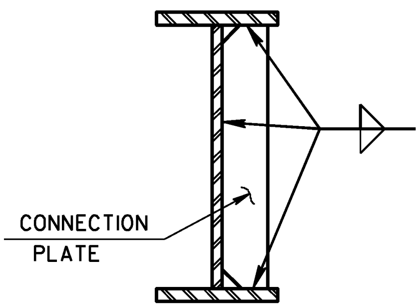
- SHOW STIFFENER PLATE AND FILLET WELD SIZES ON THE PLAN

X = 5 ± 3

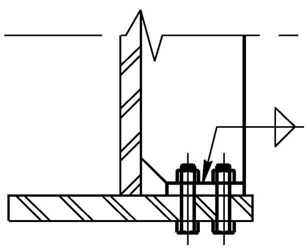
Y = 15 ± 5

Z = { 65 FOR 14 WEB; 75 FOR 16 WEB; 100 FOR 20 WEB }

* 0 FOR GROOVE WELD.



CONNECTION PLATE



ALTERNATE DETAIL @TENSION FLANGE WHERE STRESS RANGE EXCEEDS CATEGORY C

NOTES:

A. STIFFENER SIZE MUST BE SHOWN ON PLANS.

B. FILLET WELD SIZE SHALL BE SHOWN ON PLANS UNLESS MINIMUM WELD SIZE AS PER AASHTO/AWS D1.5 IS TO BE USED.

C. IF A BEARING STIFFENER IS USED AS A CONNECTION PLATE FOR CROSS FRAMES FILLET WELDS ARE REQUIRED.

D. WHEN LONGITUDINAL STIFFENERS ARE REQUIRED, PLACE ALL TRANSVERSE STIFFENERS ON ONE SIDE OF WEB AND PLACE THE LONGITUDINAL STIFFENER ON OPPOSITE SIDE.

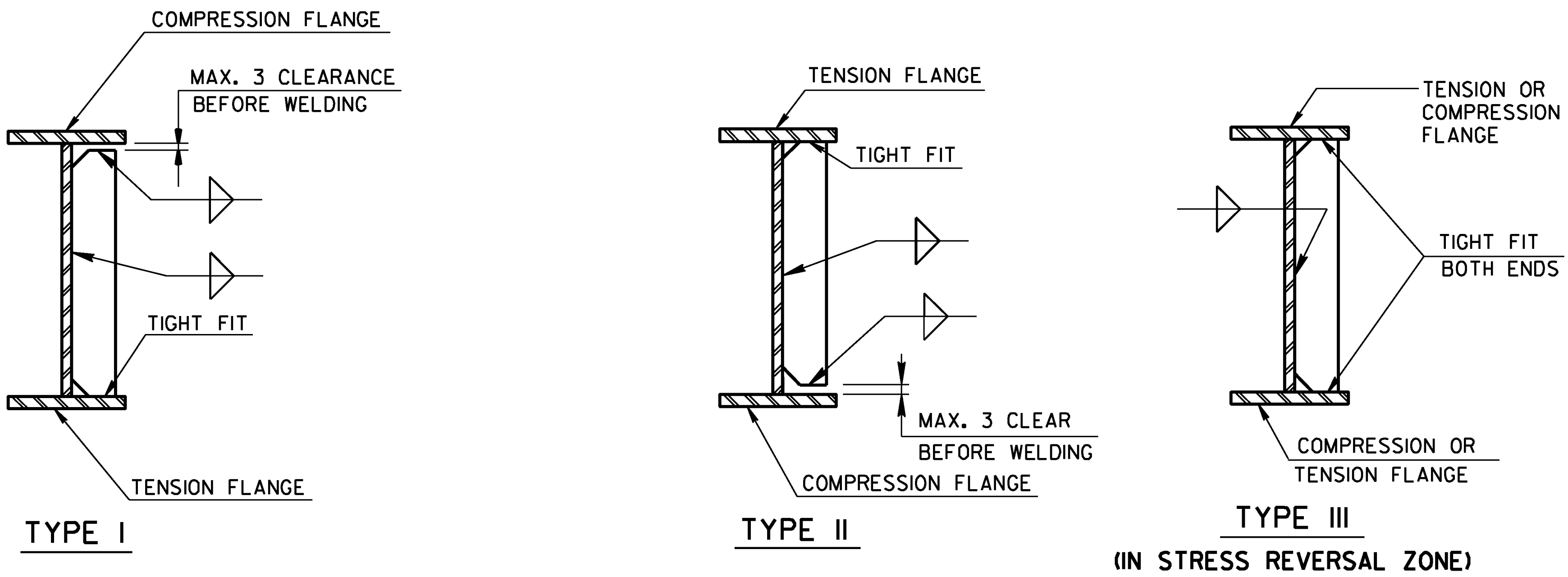
INTERMEDIATE AND BEARING STIFFENER DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 202.2 6-19-00



INTERMEDIATE STIFFENER DETAILS

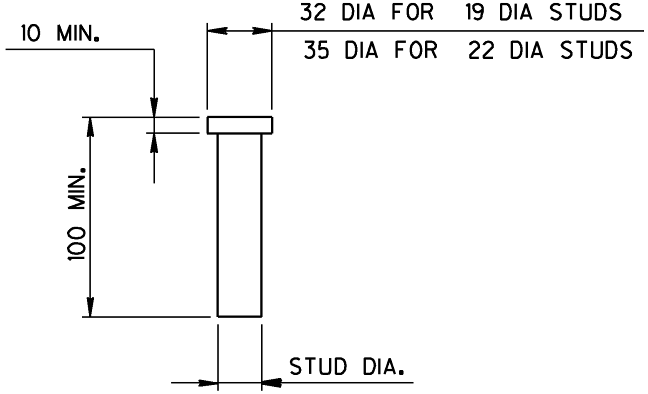
INTERMEDIATE AND BEARING STIFFENER DETAILS

METRIC

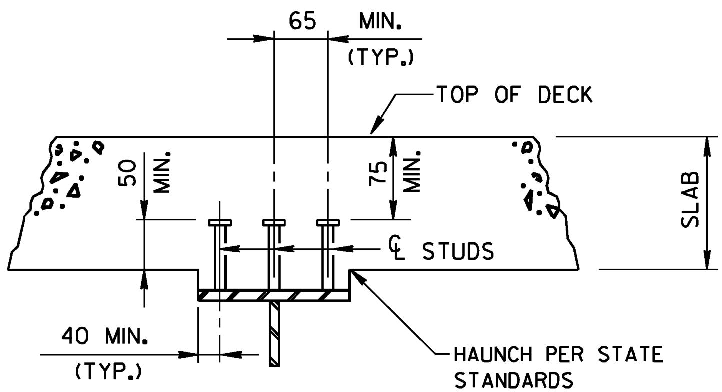
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

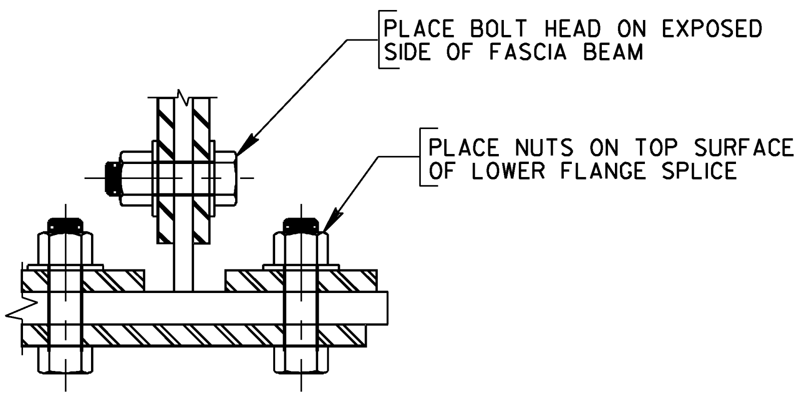
Drawing 202.3 6-19-00



STUD DETAIL



SHEAR CONNECTOR DETAILS



BOLTED SPLICE DETAIL

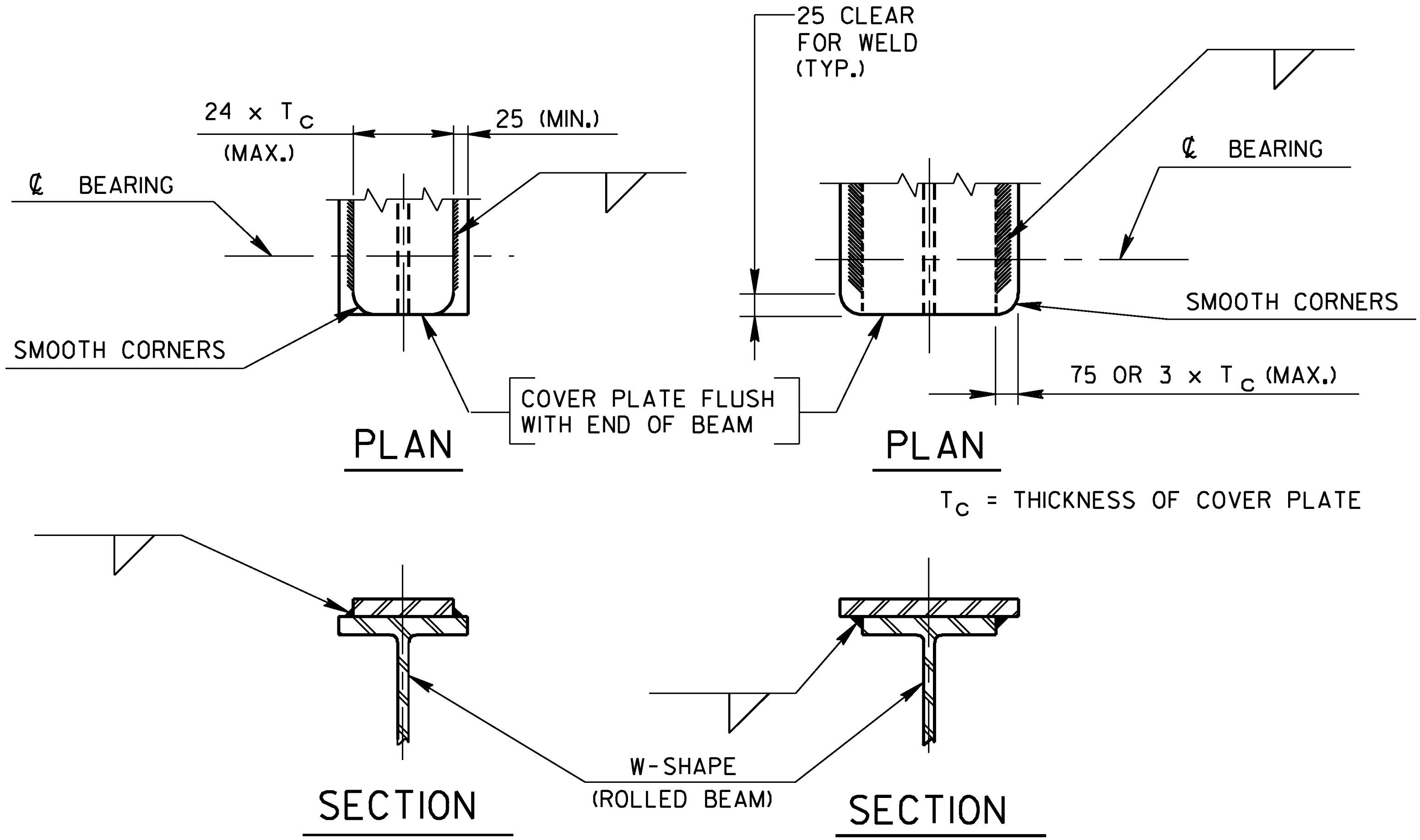
STUD AND BOLTED SPLICE DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 202.4 6-19-00



COVER PLATE DETAILS

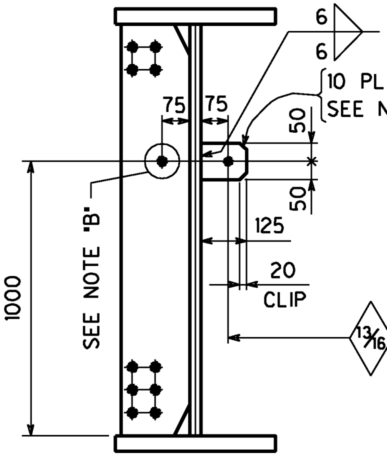
COVER PLATE DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

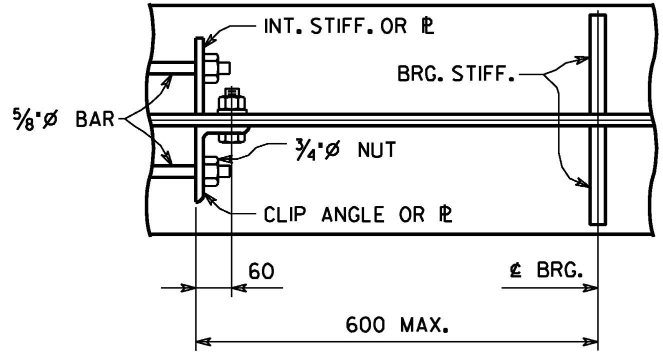
Drawing 202.5 6-19-00



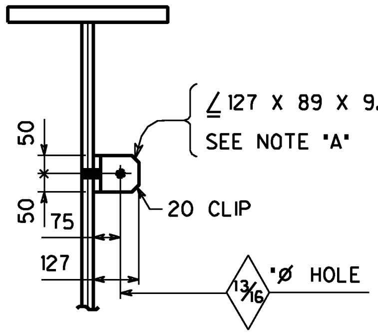
SECTION

NOTE "C":
USE SUPPORT BETWEEN STIFFENERS. 2600 IS MAXIMUM SUPPORT SPACING.

NOTE "B":
HOLE SIZE IN CONN. STIFFENERS MAY BE THE SAME AS OTHER HOLES IN THE STIFFENER (MIN. 13/16"Ø).

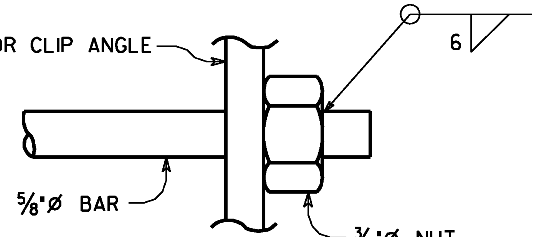


PLAN AT END BEARING

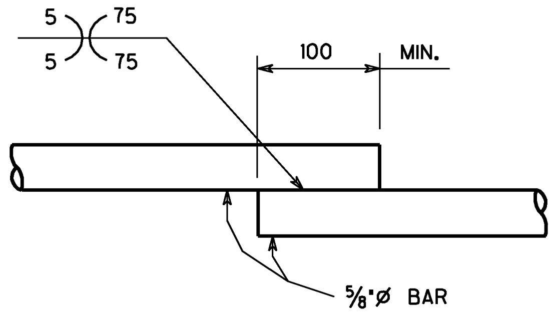


ALTERNATE BOLTED CONN.

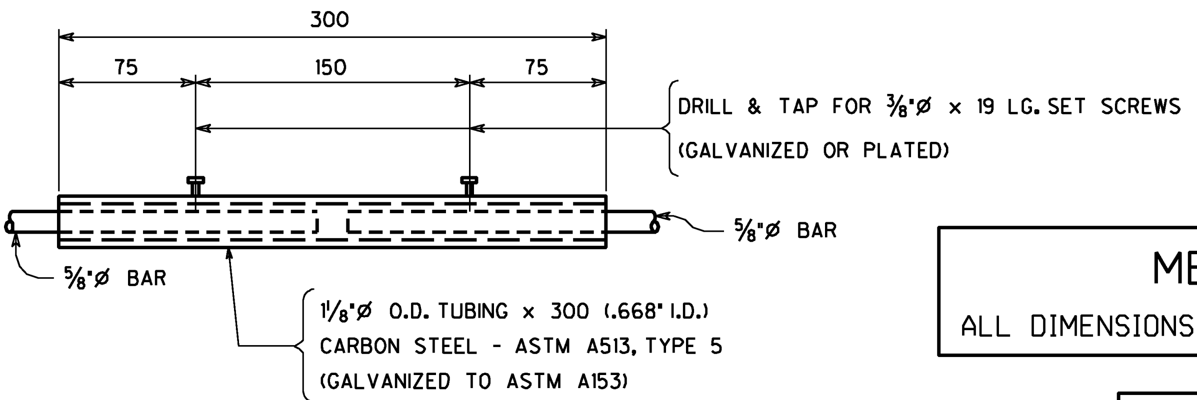
NOTE "A":
USE CLIP ANGLE BETWEEN STIFFENERS. 2600 IS MAXIMUM SUPPORT SPACING.



END CONNECTION DETAIL



SHOP OR FIELD WELDED SPLICE DETAIL



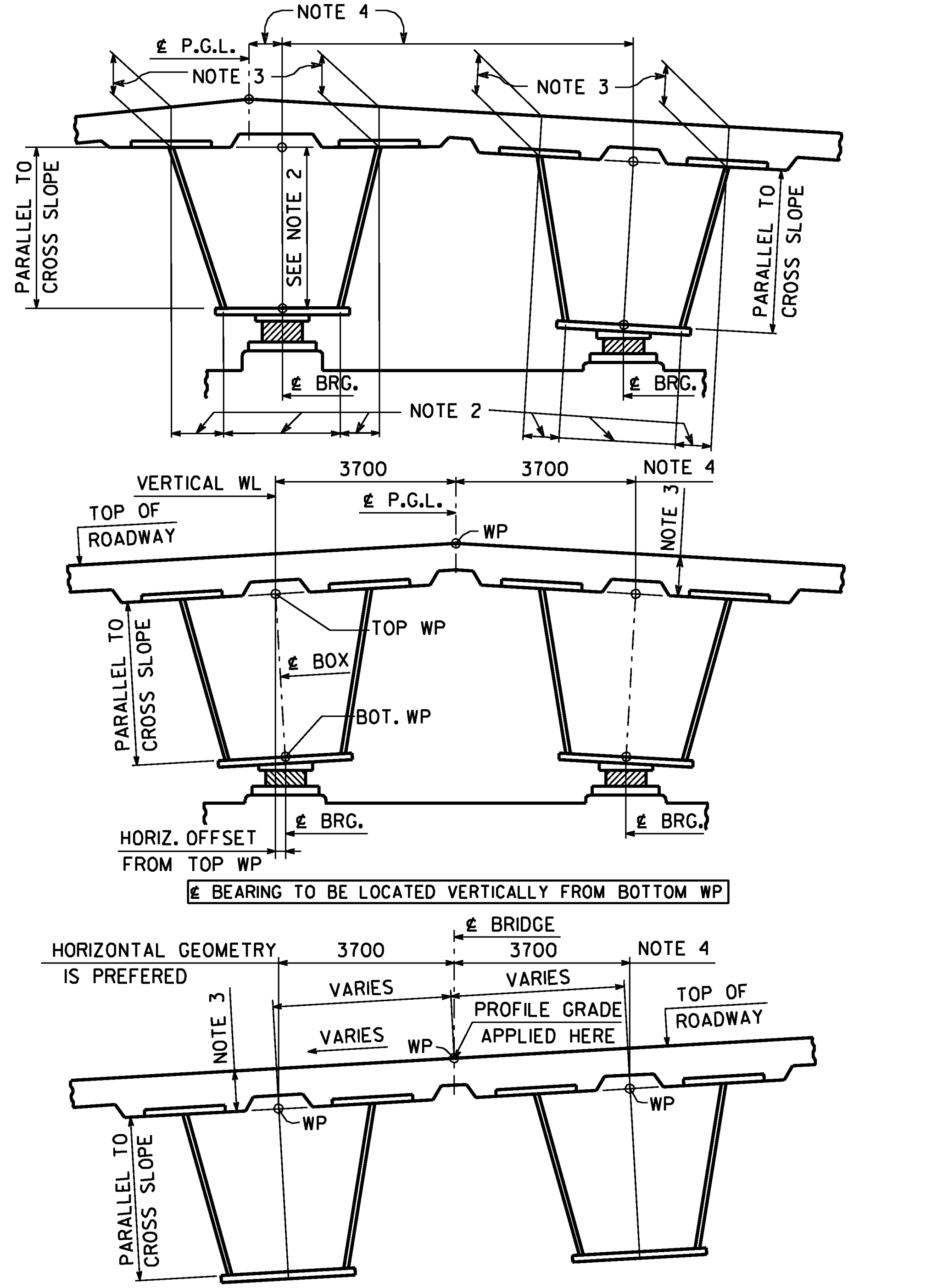
BOLTED SPLICE DETAIL AT MAIN MEMBER FIELD SPLICE

METRIC
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

SHOP INSTALLED SAFETY HANDRAIL DETAILS

MID-ATLANTIC STATES SCEF

Drawing 202.6 6-19-00



1. ROTATE BOX WITH CROSS SLOPE.
2. MAINTAIN CONSTANT TRAPEZOIDAL SHAPE. (DEPTH MAY VARY WITH HAUNCH)
3. MAINTAIN CONSTANT CONCRETE HAUNCH.
4. HORIZONTAL STATION OFFSETS PREFERRED.
5. FOLLOW CENTERLINE ALIGNMENT EVEN THROUGH A SPIRAL CURVE.

TUB GIRDER (OPEN BOX) CROSS SECTIONAL GEOMETRY

TUB GIRDER (OPEN BOX)

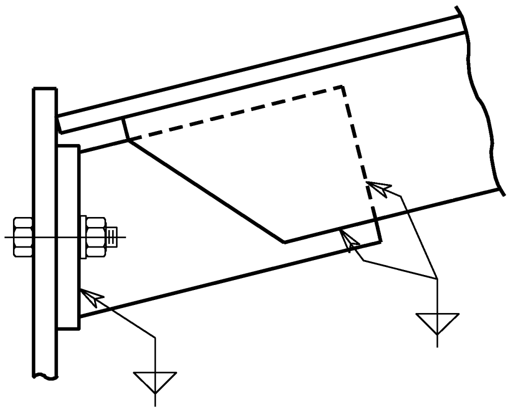
METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

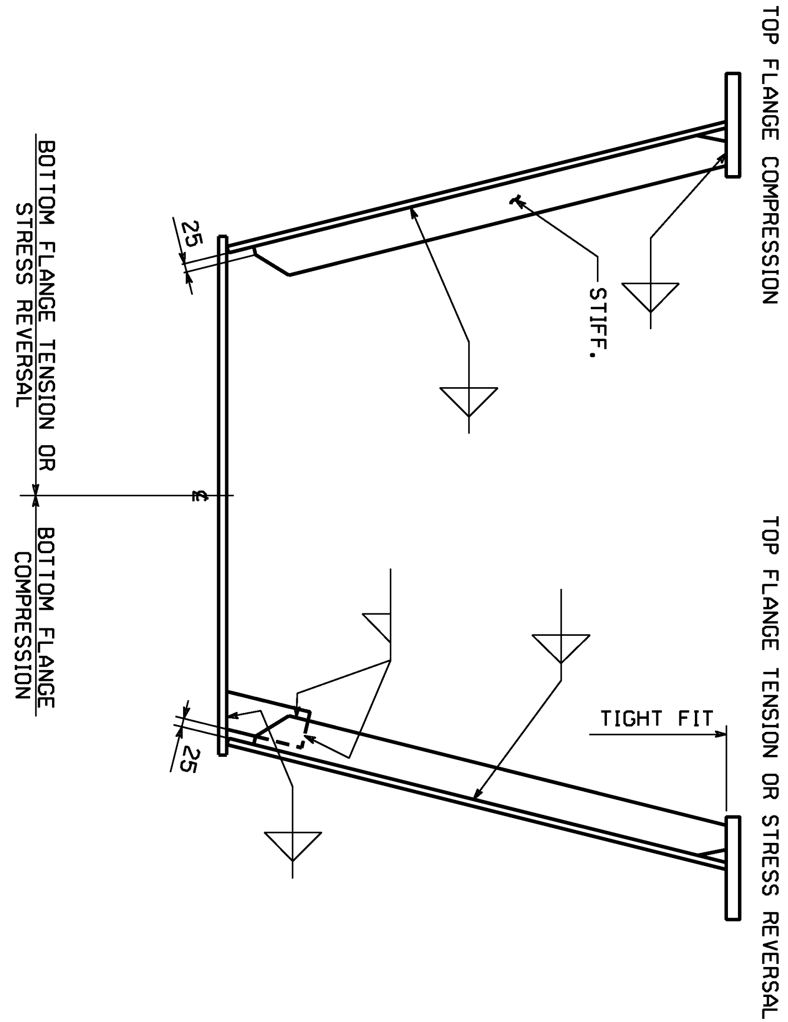
MID-ATLANTIC STATES SCEF

Drawing 202.7.1

6-19-00

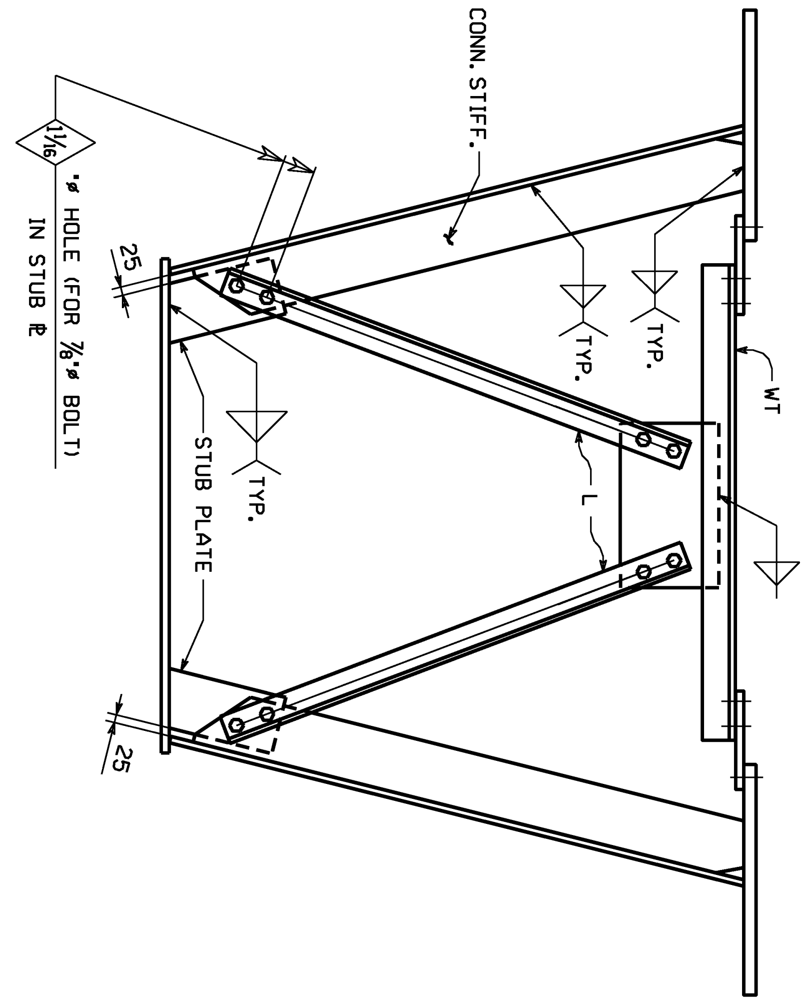


ALTERNATE DETAIL AT TENSION FLANGES

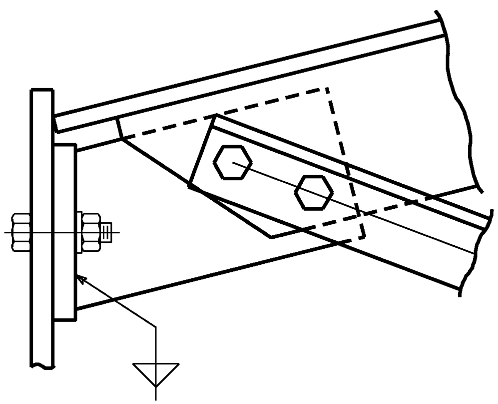


TUB GIRDER TRANSVERSE STIFFENER DETAILS

	TUB GIRDER (OPEN BOX)
METRIC ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)	***MID-ATLANTIC STATES SCEF*** ***Drawing 202.7.2*** 6-19-00



BOTTOM FLANGE (COMPRESSION OR TENSION) INTERIOR CROSSFRAME



ALTERNATE DETAIL AT TENSION FLANGES

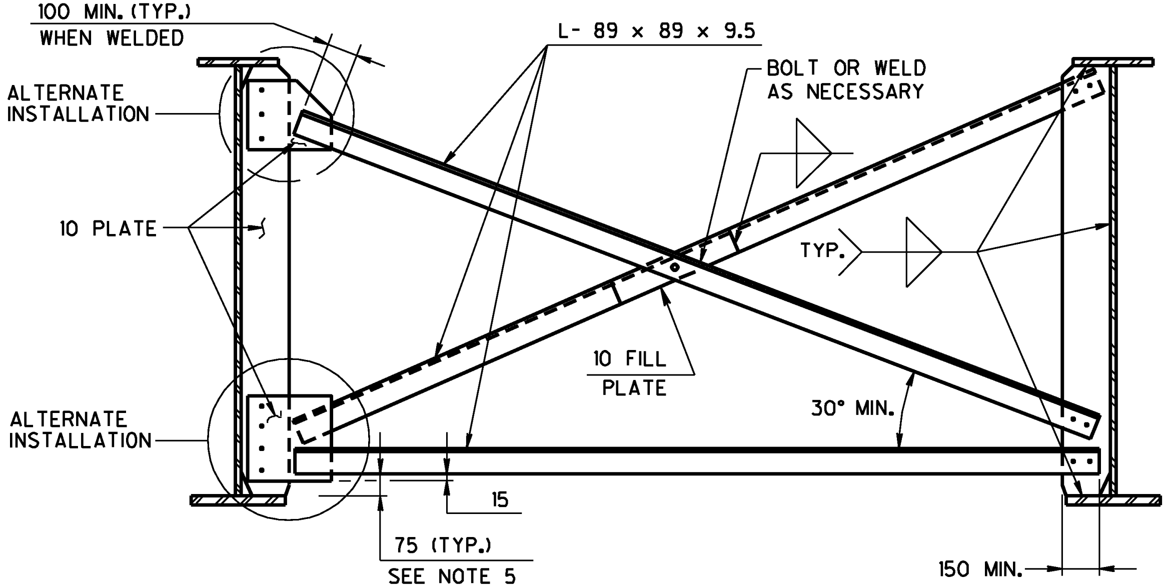
TUB GIRDER (OPEN BOX)

METRIC

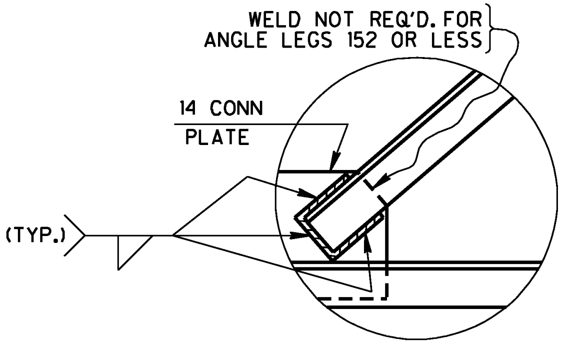
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

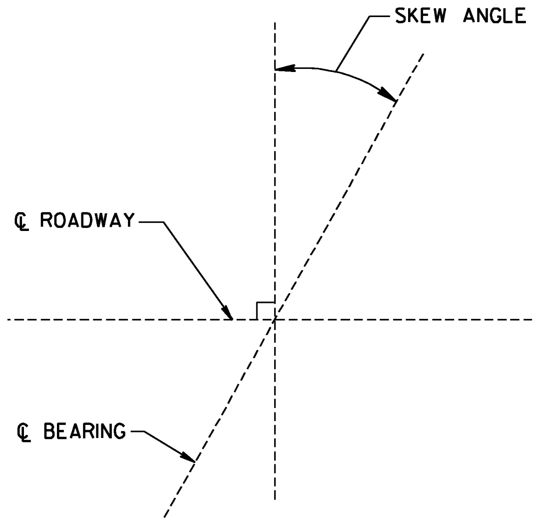
Drawing 202.7.3 6-19-00



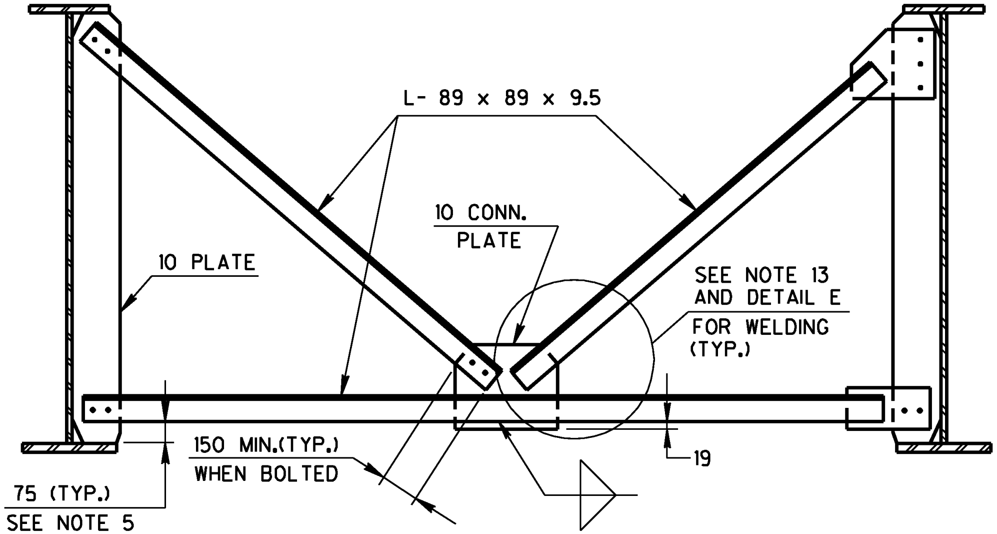
INTERMEDIATE DIAPHRAGM DETAIL



DETAIL E



SKEW ANGLE ORIENTATION



ALTERNATE INTERMEDIATE DIAPHRAGM DETAIL

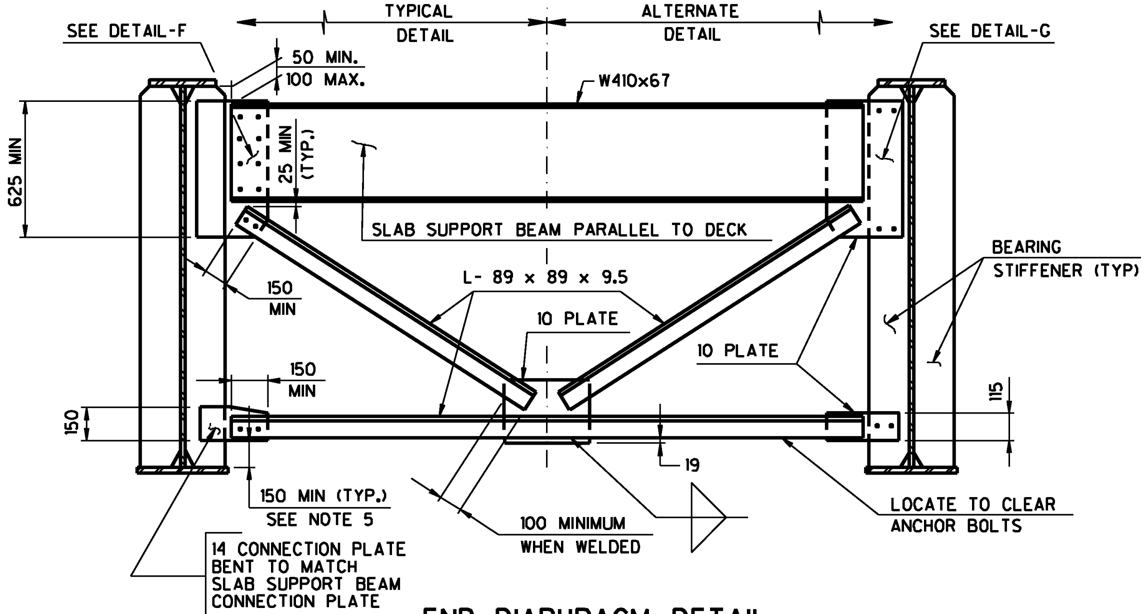
CROSS FRAME DETAILS

METRIC

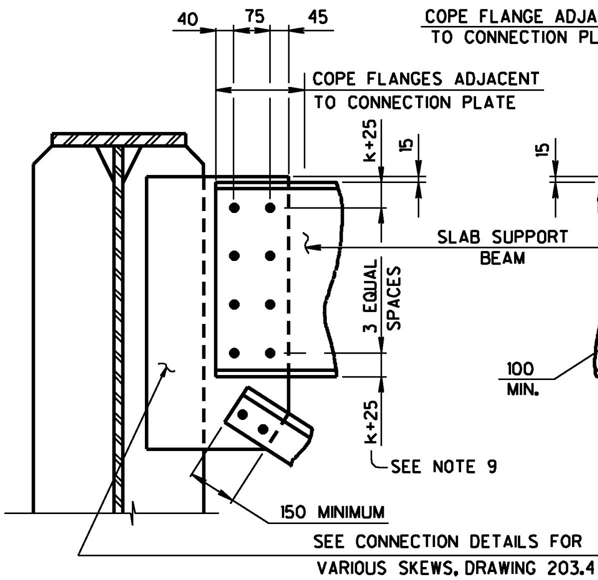
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

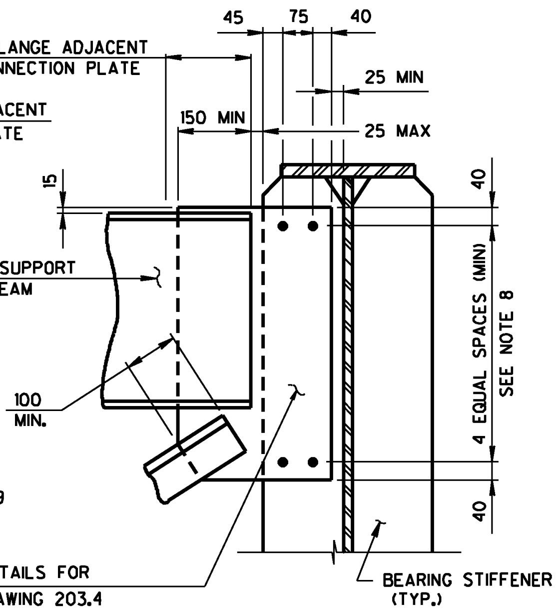
Drawing 203.1 6-19-00



END DIAPHRAGM DETAIL



DETAIL-F



DETAIL-G

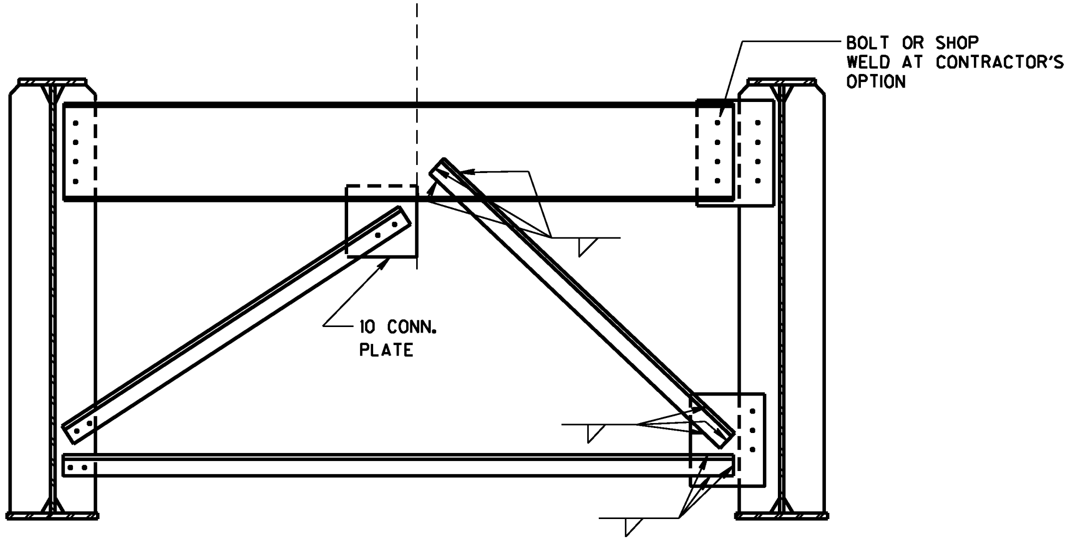
END CROSS FRAME DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 203.2 6-19-00



ALTERNATE END DIAPHRAGM DETAIL

END CROSS FRAME DETAILS

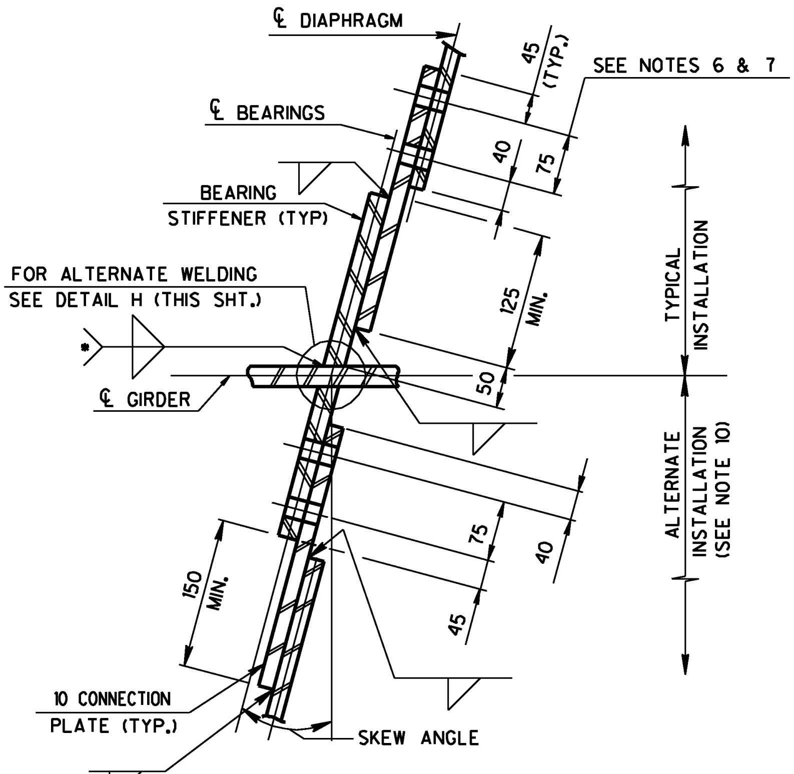
METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

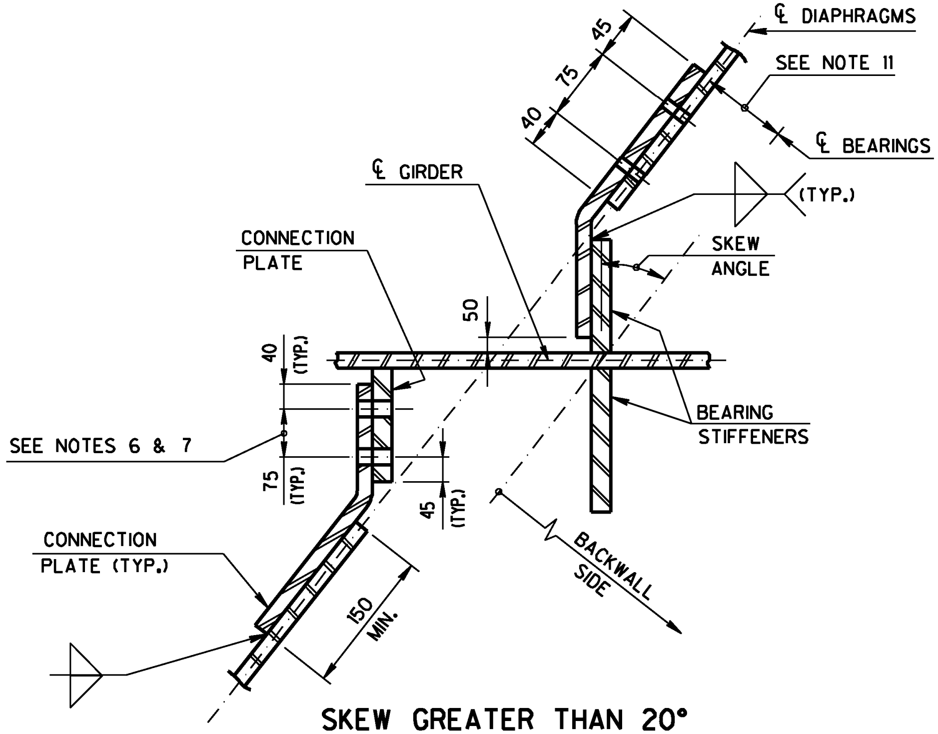
MID-ATLANTIC STATES SCEF

Drawing 203.3

6-19-00

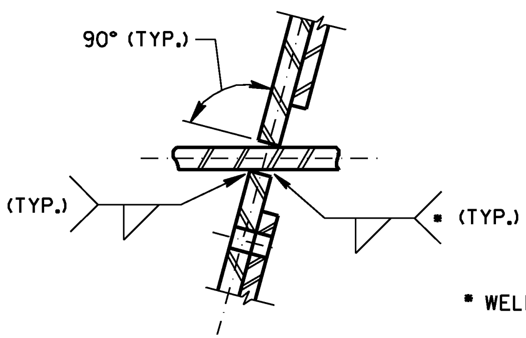


SKEW 0° TO 20°



SKEW GREATER THAN 20°

CONNECTION PLATE DETAILS



* WELD SIZE MUST BE IN ACCORDANCE WITH AWS D1.5, SECT 2.7

DETAIL H

SIMILAR TO NORMAL CONNECTION EXCEPT AS NOTED

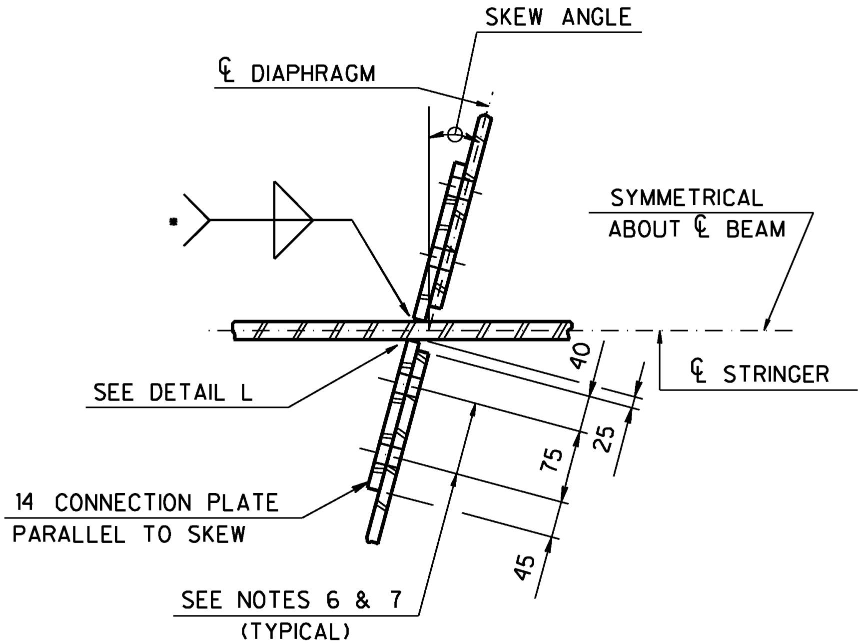
CONNECTION PLATE DETAILS

METRIC

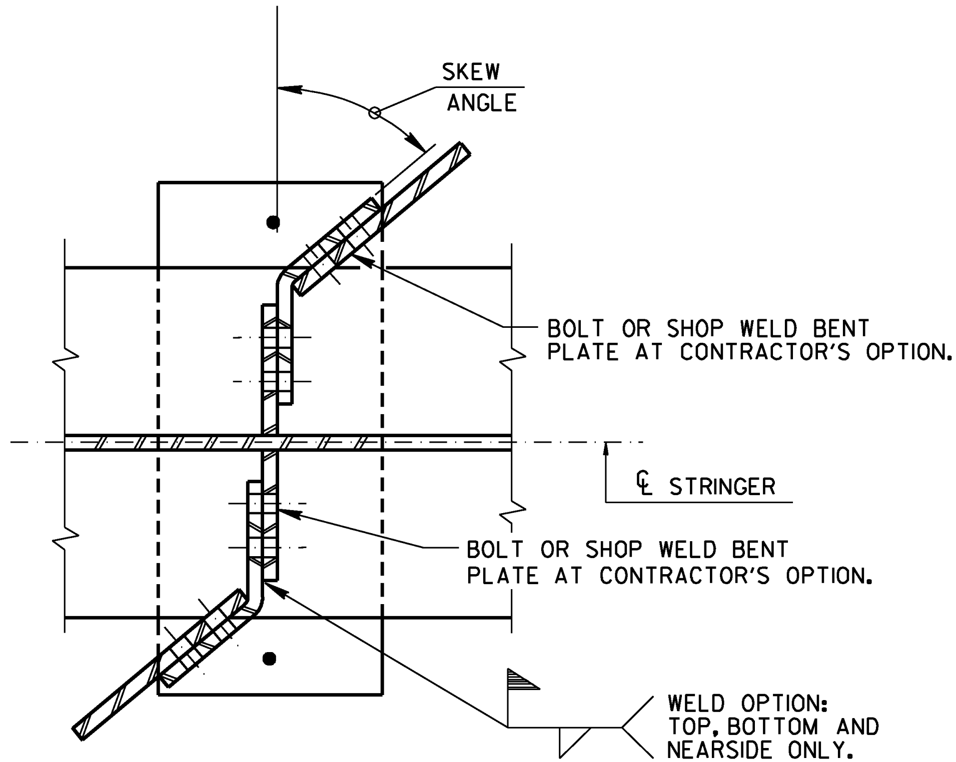
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 203.4 6-19-00



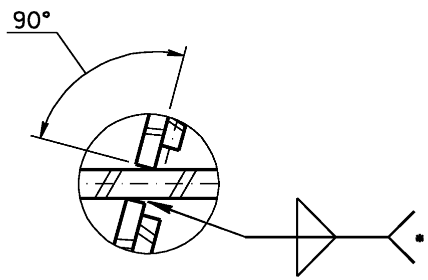
SKEW 0° TO 20°



SKEWS > 20°

CONNECTION PLATE DETAILS

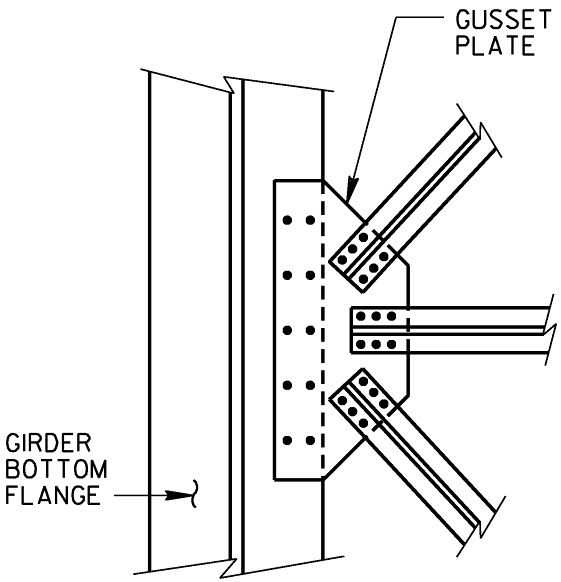
(SEE NOTE 4)



* NOTE:WELD SIZE MUST BE IN ACCORDANCE WITH AWS D1.5, SECT. 27

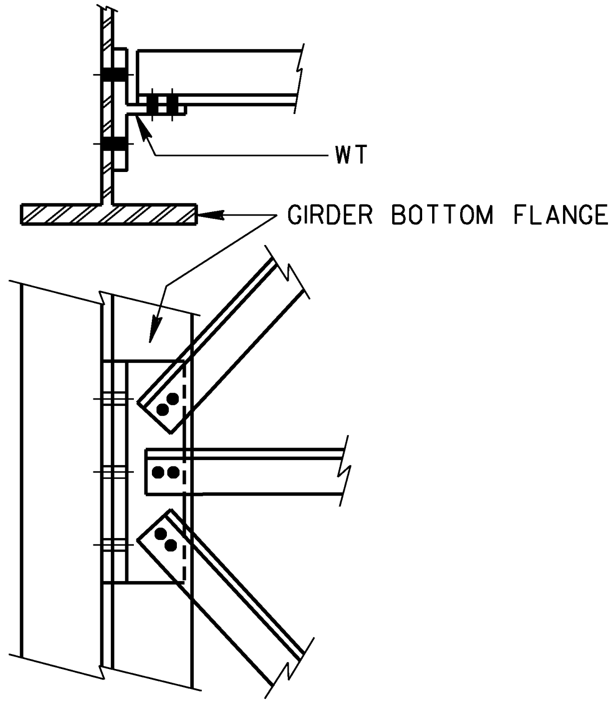
DETAIL L

METRIC ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)	CONNECTION PLATE DETAILS ***MID-ATLANTIC STATES SCEF*** ***Drawing 203.5*** 6-19-00



BOLTED ATTACHMENT

(CATEGORY B)



ALTERNATE BOLTED ATTACHMENT

(CATEGORY B)

LATERAL BRACING ATTACHMENTS

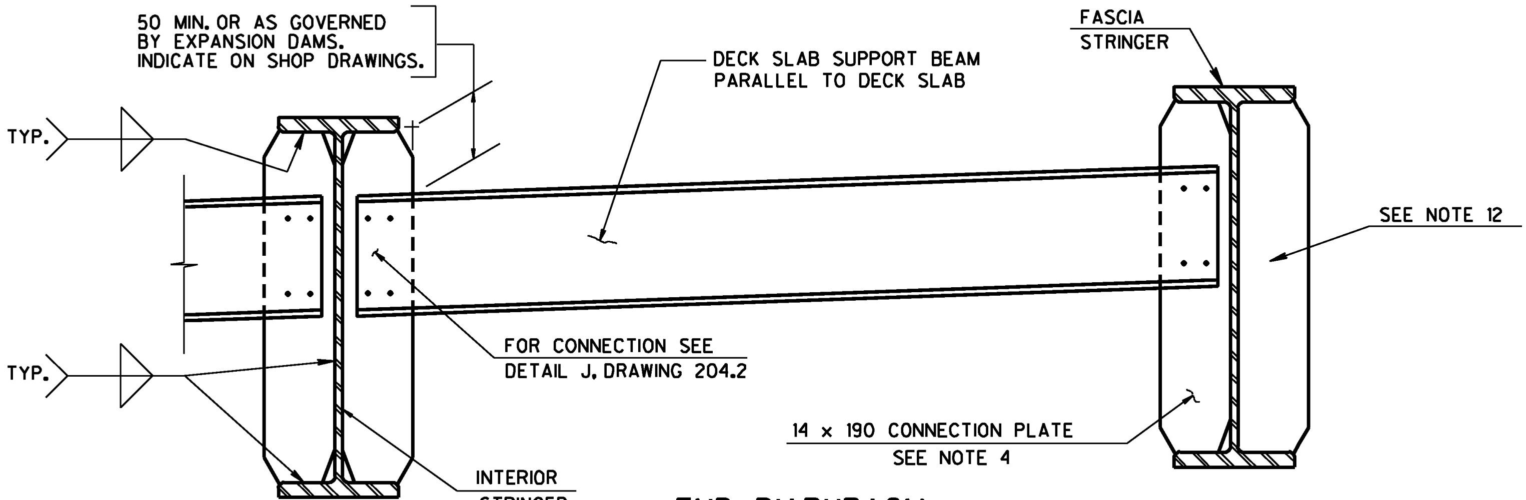
LATERAL BRACING DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

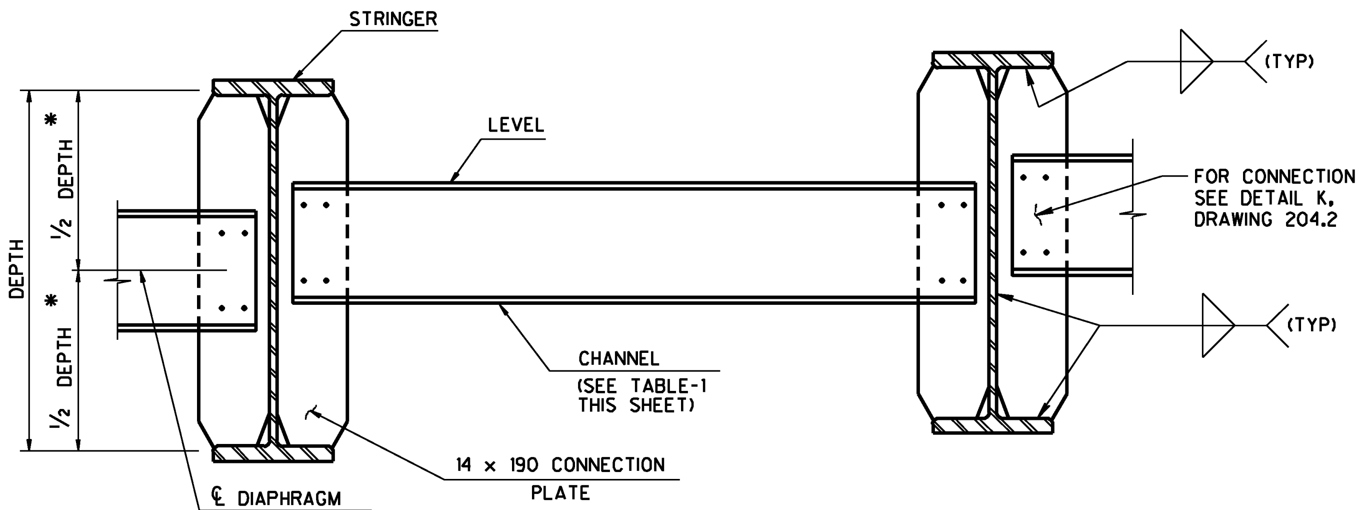
MID-ATLANTIC STATES SCEF

Drawing 203.6 6-19-00



END DIAPHRAGM

FOR ROLLED SECTIONS



✱ - WHEREVER POSSIBLE

INTERMEDIATE DIAPHRAGM

FOR ROLLED SECTIONS ✱✱

✱✱ NOTE:
INTERMEDIATE DIAPHRAGMS
ON DRAWING 203.1 ARE AN
ACCEPTABLE ALTERNATE.

TABLE-1

STRINGER SIZE	DIAPHRAGM SIZE	NO. OF BOLTS
⩾ 675 DEPTH	C 380x50	8
UP TO 600 DEPTH	C 310x37	6

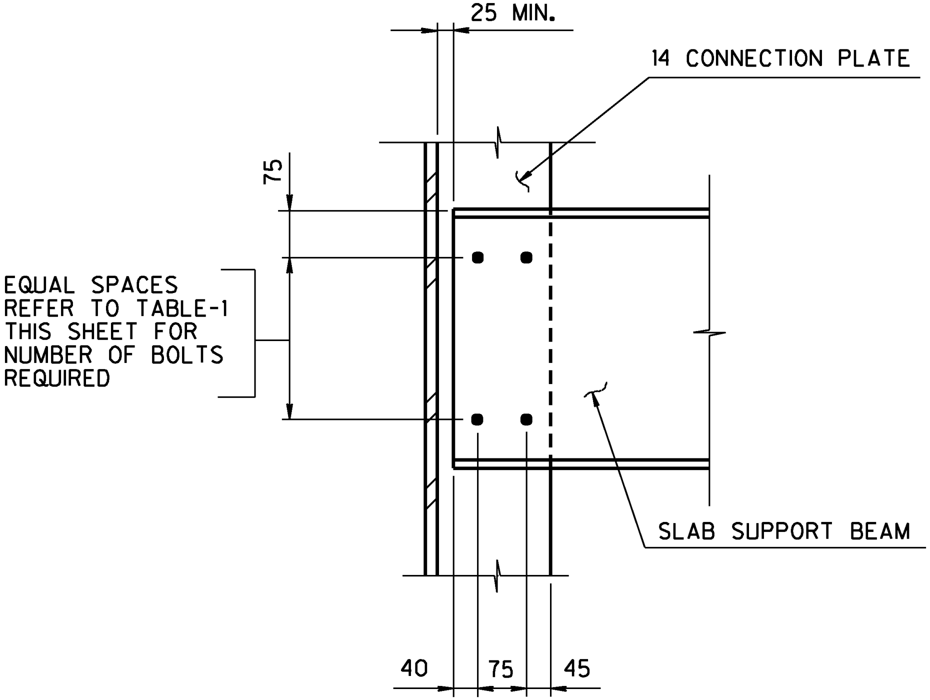
ROLLED BEAM INTERMEDIATE
DIAPHRAGM DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

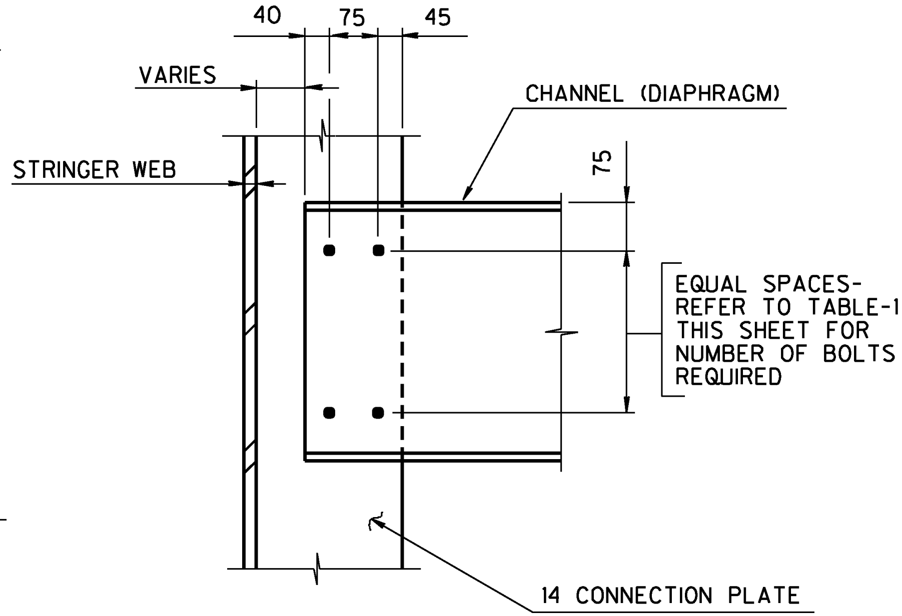
MID-ATLANTIC STATES SCEF

Drawing 204.1 6-19-00



DETAIL-J

END DIAPHRAGM
(SEE NOTE 6, 7 & 9)



DETAIL K

INTERMEDIATE DIAPHRAGM
(SEE NOTE 6)

TABLE-1

STRINGER SIZE	DIAPHRAGM SIZE	NO. OF BOLTS
⩾675 DEPTH	C 380x50	8
UP TO 600 DEPTH	C 310x37	6

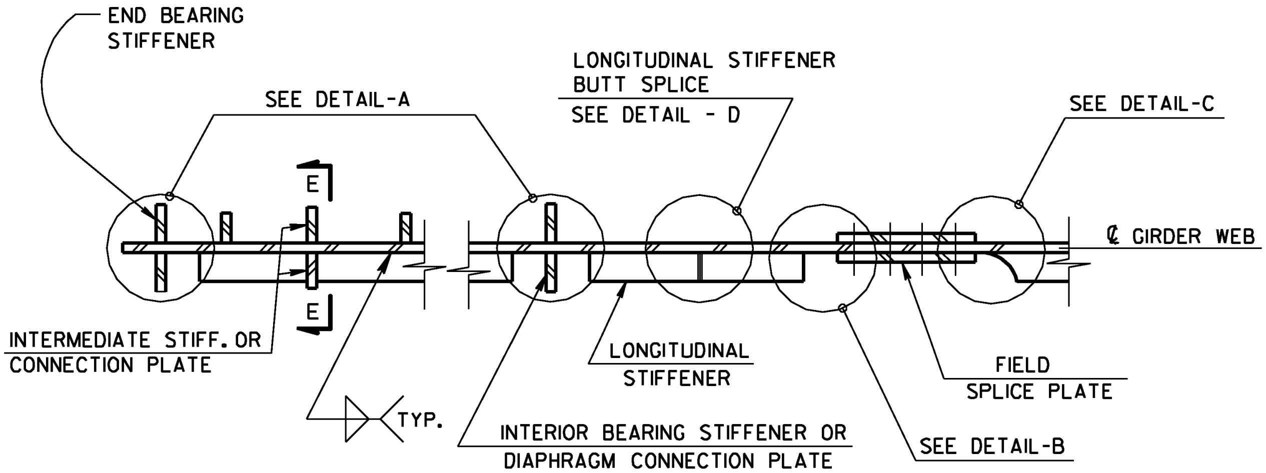
METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

ROLLED BEAM INTERMEDIATE DIAPHRAGM DETAILS

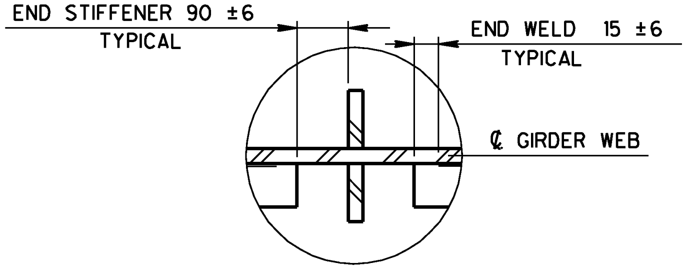
MID-ATLANTIC STATES SCEF

Drawing 204.2 6-19-00



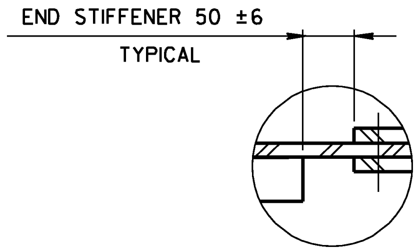
PLAN VIEW

LONGITUDINAL-TRANSVERSE STIFFENER INTERSECTION DETAILS



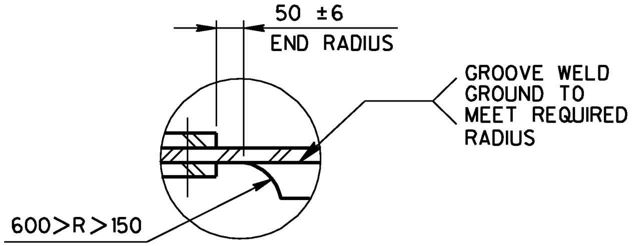
DETAIL-A

(IN COMPRESSION ZONE ONLY)
(AT INT. STIFF. OR CONN. PL.)



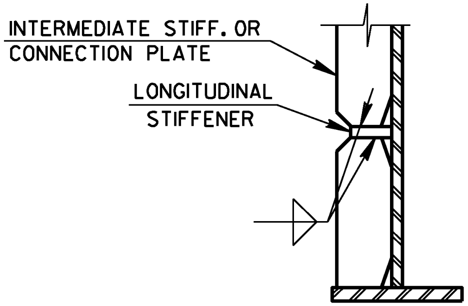
DETAIL-B

(IN COMPRESSION ZONE ONLY)
(AT FIELD SPLICE)



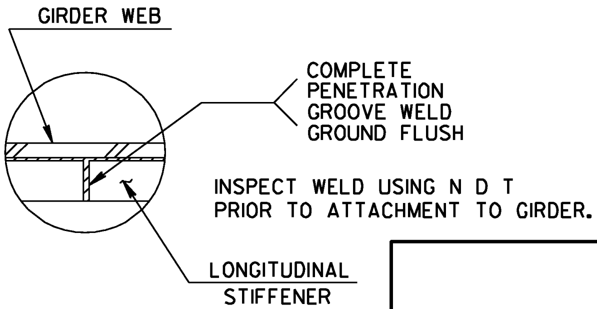
DETAIL-C

(IN TENSION OR REVERSAL ZONE ONLY)
(AT FIELD SPLICE)



SECTION E-E

(IN TENSION OR REVERSAL ZONE ONLY)
(AT INT. STIFF. OR CONN. PL.)



DETAIL-D

SEE NOTES 2 & 3 FOR ADDITIONAL INFORMATION

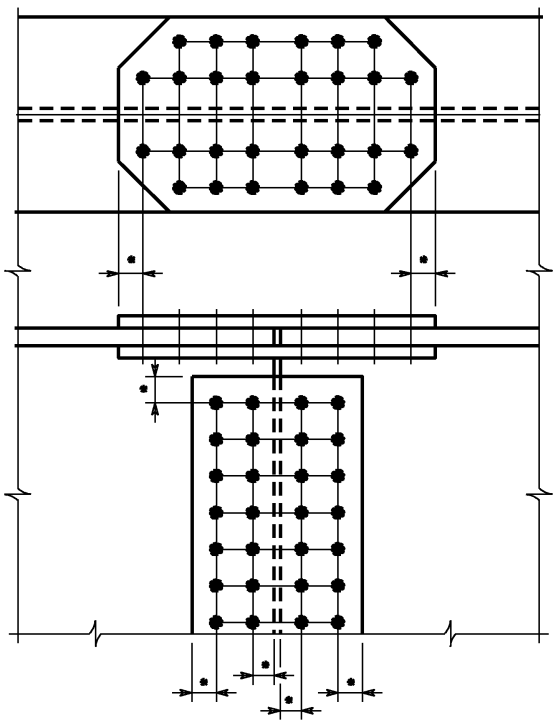
LONGITUDINAL / TRANSVERSE
STIFFENER INTERSECTION
DETAILS

METRIC
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

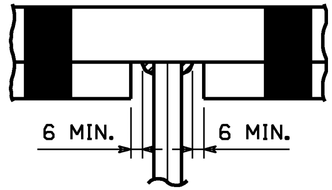
MID-ATLANTIC STATES SCEF

Drawing 205 6-19-00

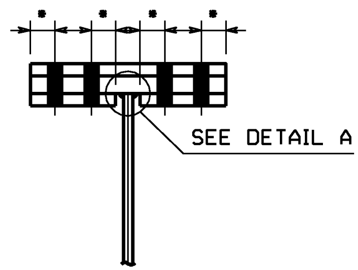
NOTE: EDGES NOTED THUS: • TO BE 45 FOR ⅞"ø BOLTS & 50 FOR 1" BOLTS



TYPICAL FIELD SPLICE



DETAIL A



ALL MAIN LOAD CARRYING CONNECTIONS SHOULD BE DESIGNED WITH A MINIMUM OF 3 (6 PREFERRED) ADDITIONAL EDGE DISTANCE BEYOND THE AASHTO MINIMUM REQUIREMENTS. THIS WILL PROVIDE A TOLERANCE FOR PUNCHING, DRILLING & REAMING.

MAIN MEMBER EDGE DISTANCE

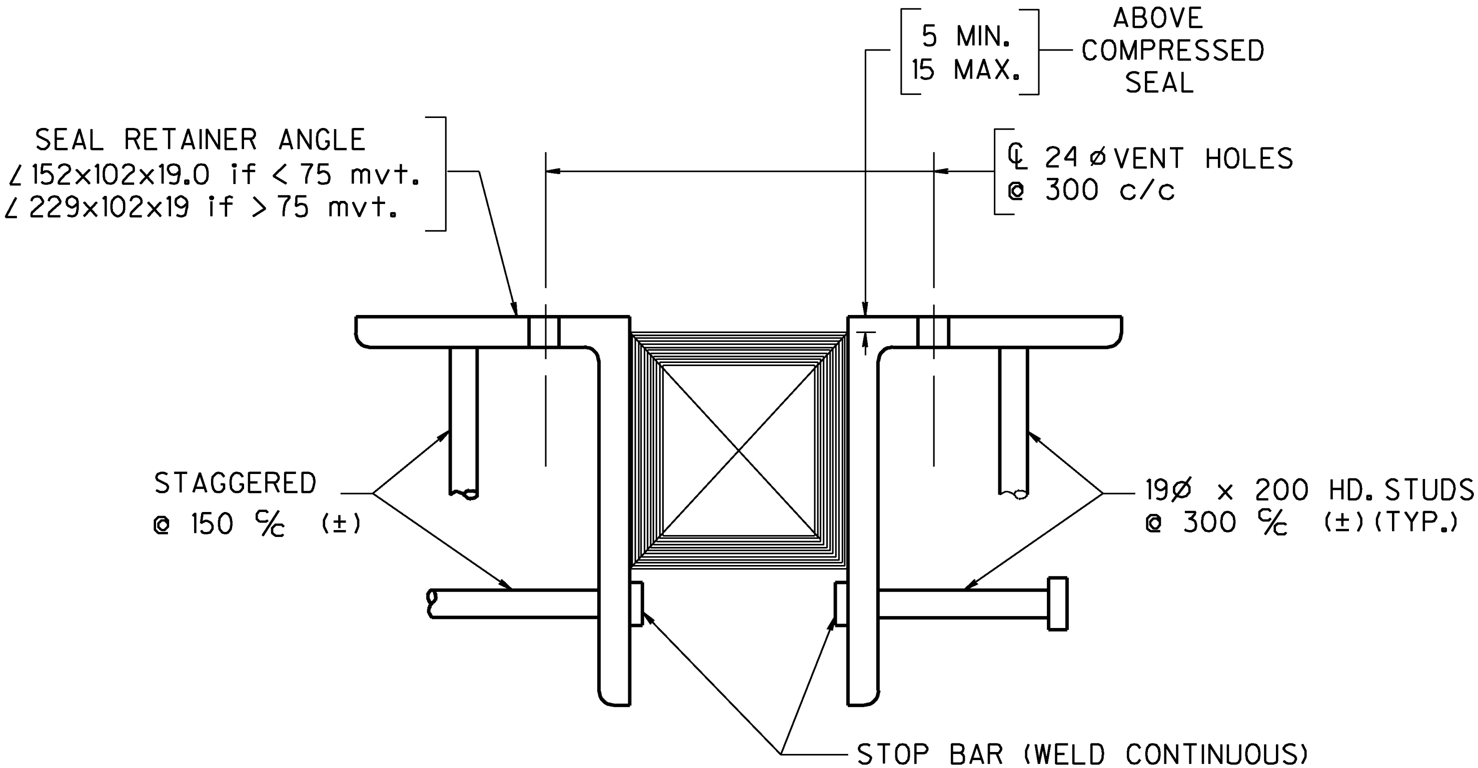
METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 205.1

6-19-00



NOTES :

1. POSITIVE ANCHORAGE OF ANGLES TO STRINGERS SHOULD BE MADE. STRUCTURAL TEES, ANGLES, OR PLATES CAN BE USED FOR SUCH ANCHORAGE.

2. STUDS SHALL BE WELDED IN ACCORDANCE WITH SECTION 7 OF AASHTO/AWS D 1.5.

COMPRESSION SEAL JOINT
AND
RETAINING ANGLE DETAILS

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 206 6-19-00

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

GENERAL NOTES: FOR ALL BEARINGS

1. Design is based on AASHTO M183 (ASTM A36) allowable stresses.

2. T_1, T_3, T_S, T_b and y measured at centerline of bearing at 20°C.

3. Fill slots and holes in masonry plate around anchor bolts with an approved non-hardening caulking compound or elastic joint sealer.

4. Steel surfaces of sole plate, rocker plate, web and bearing plate to be a machine finish as shown on the details, measured in accordance with ANSI B46.1. Other steel plate surfaces to be at least 25μ m.

5. Bearing details are satisfactory for the E.Q. requirement for Zone II.

6. Bearings shall be shop assembled and match marked to ensure proper fit if uplift is present.

7. Anchor bolts, when required, shall meet the requirements of M183 and shall have hex-nut and washer. When anchor bolt goes through sole plate, nut is to be 5 mm clear. Burr threads at face of nut.

8. Anchor bolts shall be swedged and may be cast-in-place or grouted in preformed (sleeved or drilled) holes.

9. Sole plate to be beveled or have radius machined to match grade when grade exceeds 3% for low profile fixed bearing or 1% for all other bearings.

10. Steel plates shall meet a flatness requirement of 0.127 mm/mm maximum in direction being measured (width, length and diagonals) but not to exceed 3 mm.

11. For painted structures, bearings shall be coated with one shop coat of paint in accordance with project requirements.

12. A leveling pad shall be placed under the masonry plate when required by the contract.

NOTES: EXPANSION BEARING - SHEET 207.2

13. Δ= total longitudinal movement bearing can take. If calculated movement exceeds the limit shown, plate widths may be increased or next higher capacity bearing may be substituted.

14. Surfaces of sole plate and masonry plate in contact with bronze plate to have a machine finish of at least 3 μ m. These steel surfaces shall not be painted, but shall be coated with a multipurpose grease before shipment. Coating shall be removed with a solvent immediately prior to erection.

15. Self-lubricating bronze bearing plates shall conform to the requirements of AASHTO M107, copper alloy UNS C91100 modified with up to 2 1/2% lead maximum. The sliding surfaces of the plates shall be provided with annular grooves or cylindrical recesses or a combination thereof, which shall be filled with a lubricating compound. The lubricating compound shall be compressed into the recesses under sufficient pressure to form a nonplastic lubricating inset. lubricating inset shall comprise not less than 25% of the total area of the plate. The frictional coefficient shall not exceed 0.10R, when bearing is tested under a load of R and for 1000 cycles. The compound shall be free of any material that could cause abrasive or corrosive action upon the metal surfaces and also shall be able to withstand extremely high pressures and the atmospheric elements over long periods of time.

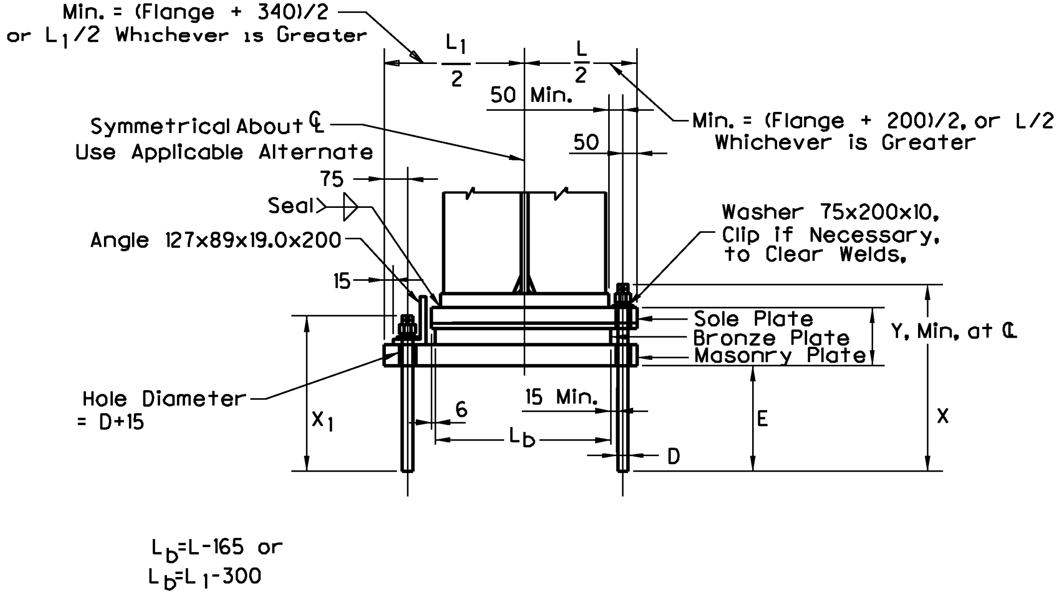
16. All items shall be standard products of the manufacturer of such materials for this application.

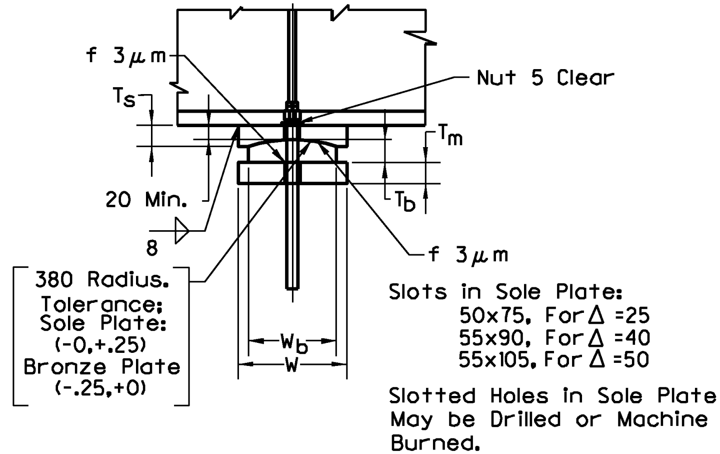
17. Prior to assembly in place, the steel surface which will bear on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer.

BRIDGE BEARING
GENERAL NOTES

MID-ATLANTIC STATES SCEF

Drawing 207.1 6-19-00





R-kg	L	W	W_b	T_s	T_m	T_b	D	E	X	Y	Δ	L_1	X_1
54 430	500	250	200	25	50	40	30	300	475	110	25	640	435
81 650	550	300	240	50	55	40	30	300	475	115	25	690	440
99 790	600	315	250	55	60	45	36	375	565	125	40	740	520
117 930	650	340	275	60	60	50	36	375	570	135	40	790	520
136 080	700	350	275	60	70	50	36	375	575	140	50	840	525
154 220	750	365	290	70	70	50	36	375	575	140	50	890	525
181 440	800	390	315	80	80	55	36	375	590	150	50	940	535

Notes:

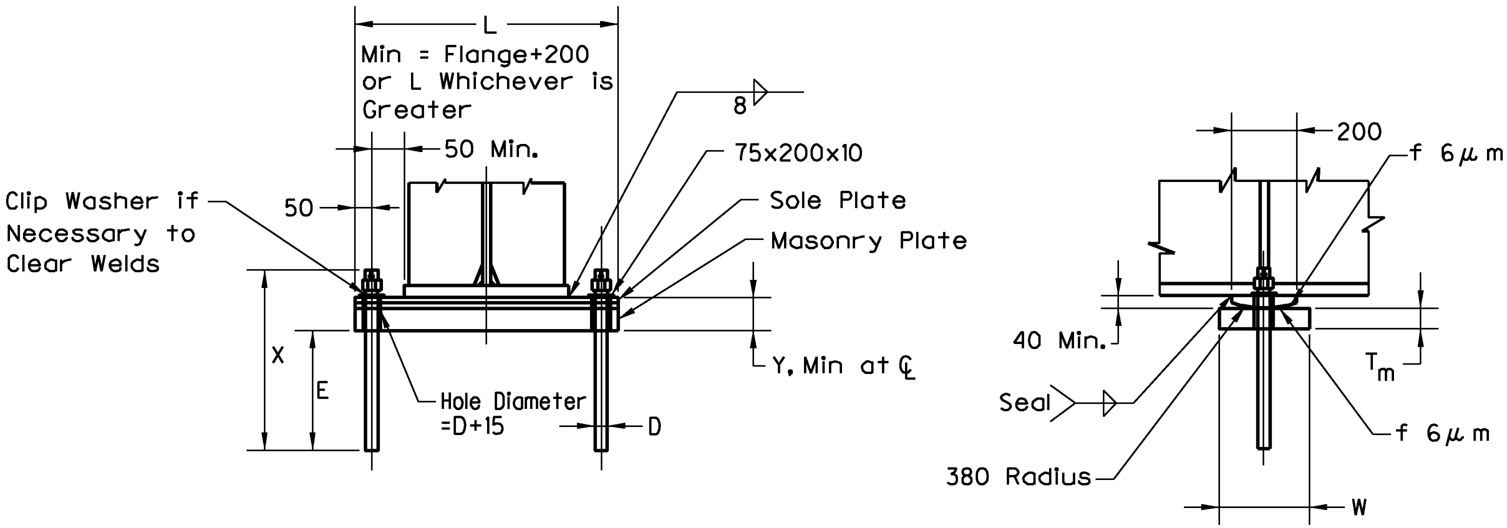
1. See General Notes Sheet 207.1.
2. Anchor bolts through sole plates are necessary only when uplift could occur. When bolts pass through sole plates, extreme care shall be exercised in properly locating anchor bolts.

EXPANSION BEARING
REACTION R - TO 400 KIPS

METRIC
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 207.2 6-19-00



R-kg	L	W	T	D	E	X	Y
63 500	500	200	40	30	300	450	75
81 650	550	225	45	30	300	450	85
99 790	600	250	50	36	375	550	90
117 930	650	250	50	36	375	550	90
136 080	700	275	60	36	375	550	95
154 220	750	300	65	36	375	550	100
181 440	800	325	65	36	375	550	100

Notes:

1. See General Notes Sheet 207.1.

FIXED BEARING
REACTION R - TO 400 KIPS

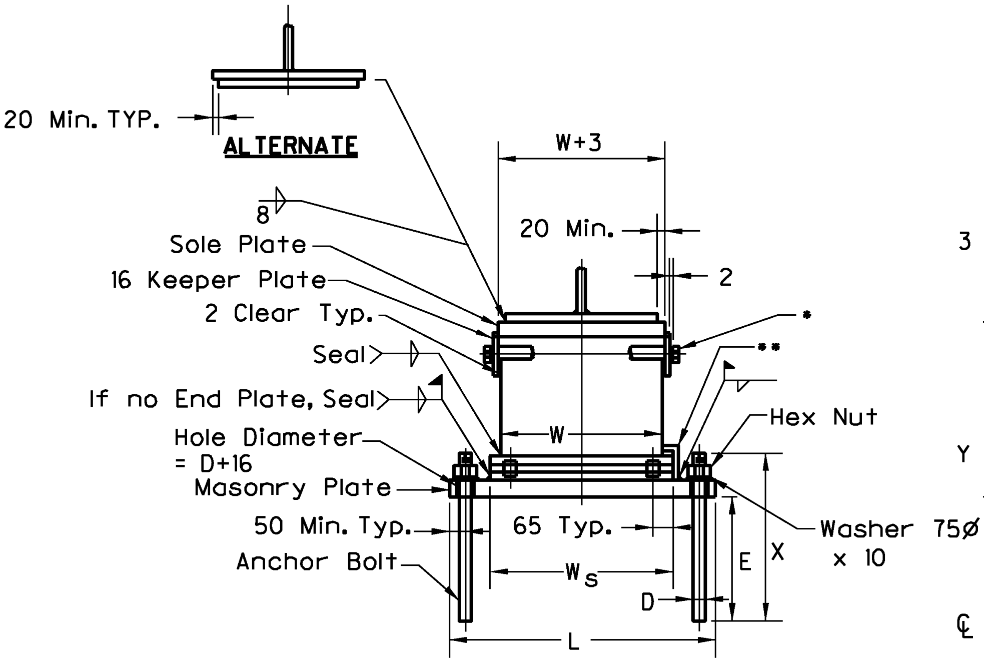
METRIC
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

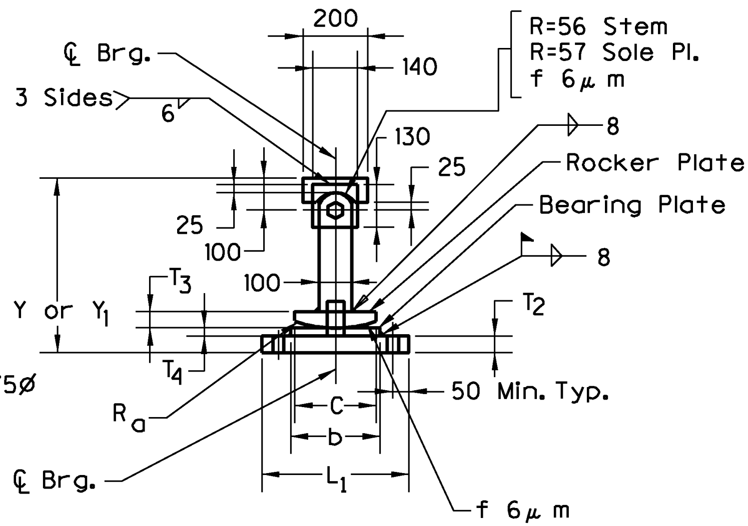
MID-ATLANTIC STATES SCEF

Drawing 207.3 6-19-00

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)





* If Uplift is Present 30Ø Cap Screw
38ø Hole in Keeper Plate
Drill and Tap Bearing

** End Plate if Uplift is Present

R-kg	L	L_1	W_s	C	b	R_a	T_1	T_2	T_3	T_4	E	D	Δ	X	Y	Y_1	W
63 500	600	325	390	200	225	175	60	35	50	25	300	30	150	375	325	340	325
81 650	650	325	440	200	225	200	60	38	50	25	300	30	145	400	350	365	375
108 860	725	325	515	200	225	225	60	40	50	25	375	36	145	475	375	390	450
136 080	775	350	565	225	250	250	70	45	50	25	375	36	140	485	415	425	500
163 290	775	375	565	225	275	300	80	45	50	25	375	36	135	485	475	485	500
181 440	775	375	565	250	275	350	80	50	50	25	375	36	135	490	525	540	500

Notes:

1. See General Notes Sheet 207.1.
2. Y_1, measured at center line of bearing at 20°C, when uplift occurs.
3. Provide cap screw and end plate, only if uplift is present or flood can occur. The detail shown is capable of resisting 136 000 kg uplift.
4. See Bearing Details, Sheet 207.6, for cap screw, plate and pintle details.

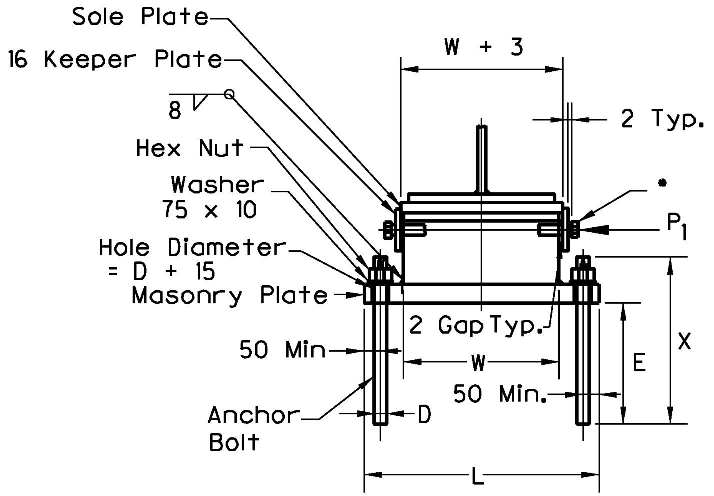
EXPANSION BRG. DETAILS
REACTION R - TO 400 KIPS

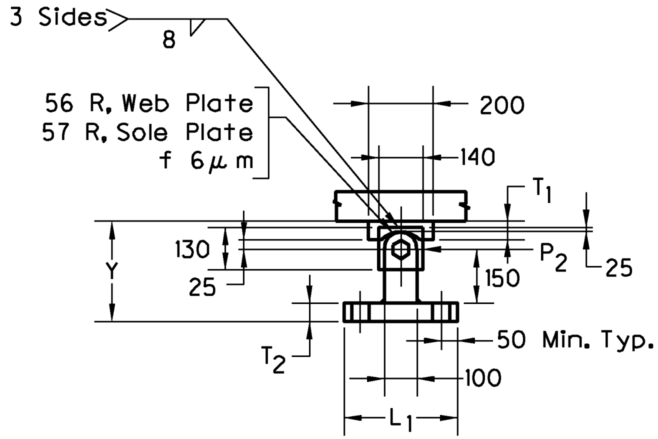
MID-ATLANTIC STATES SCEF

Drawing 207.4 6-19-00

METRIC

ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)





* If Uplift is Present 30Ø Cap Screw
38Ø Hole in Keeper Pl.
Drill and Tap Bearing

R-kg	L	L_1	W	T_1	T_2	E	D	P_1 - kg	P_2 - kg	X	Y
63 500	550	300	325	60	38	300	30	28 580	14 970	400	275
81 650	600	300	375	60	38	300	30	35 380	17 240	400	275
108 860	675	300	450	60	45	375	36	47 170	20 410	480	285
136 080	725	300	500	70	45	375	36	55 790	22 230	485	290
163 290	725	325	500	80	50	375	36	55 790	22 230	485	300
181 440	725	350	500	80	55	375	36	55 790	22 230	490	310

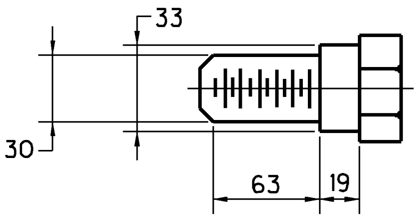
Notes:

1. See General Notes Sheet 207.1.
2. P_1 = Maximum allowable transverse force resisted by welds, uplift is not included.
   P_2 = Maximum allowable longitudinal force resisted by welds, uplift is not included.
3. Provide cap screw only if uplift is present or flood can occur. The detail shown is capable of resisting 136 000 kg uplift.
4. See Bearing Details, Sheet 207.6, for cap screw detail.

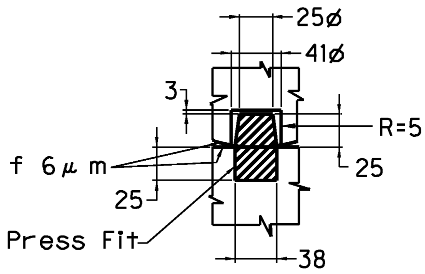
FIXED BRG. DETAILS
REACTION R - TO 400 KIPS

MID-ATLANTIC STATES SCEF

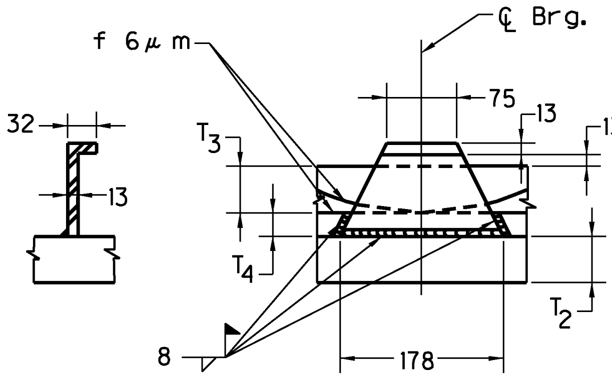
Drawing 207.5 6-19-00



30 ø CAP SCREW DETAIL



PINTLE DETAIL



END PLATE DETAIL

Plate can be made by machining,
welding or bending.

Notes:

1. See General Notes Sheet 207.1.

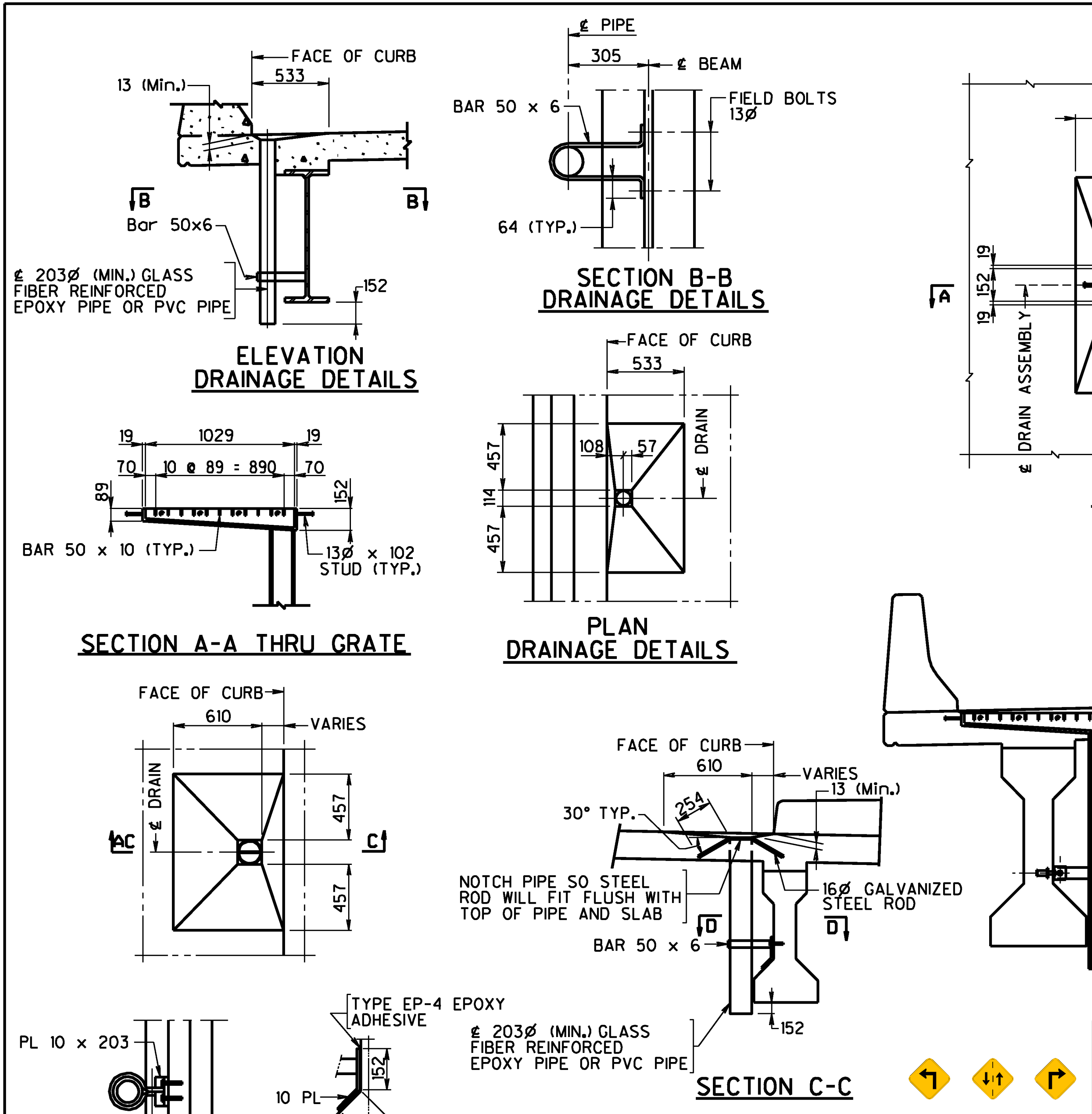
BEARING DETAILS
REACTION-R TO 400 KIPS

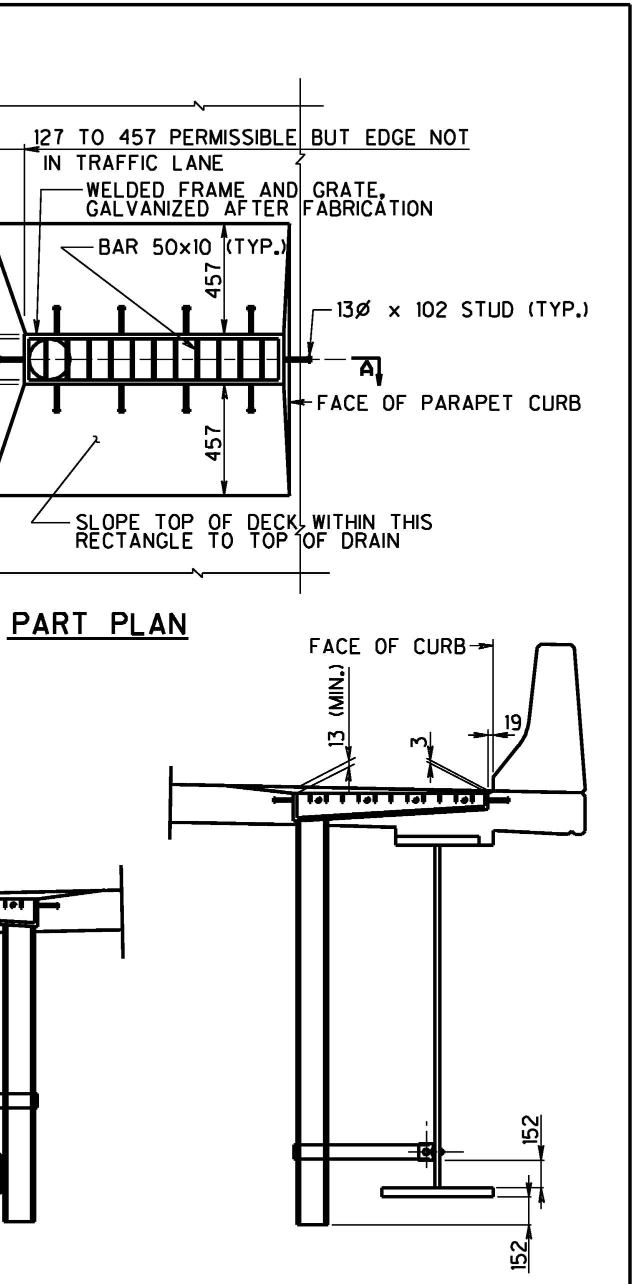
METRIC

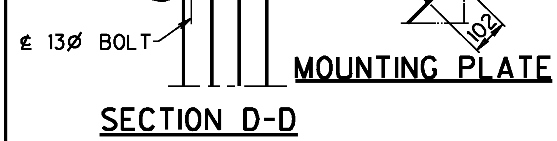
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 207.6 6-19-00







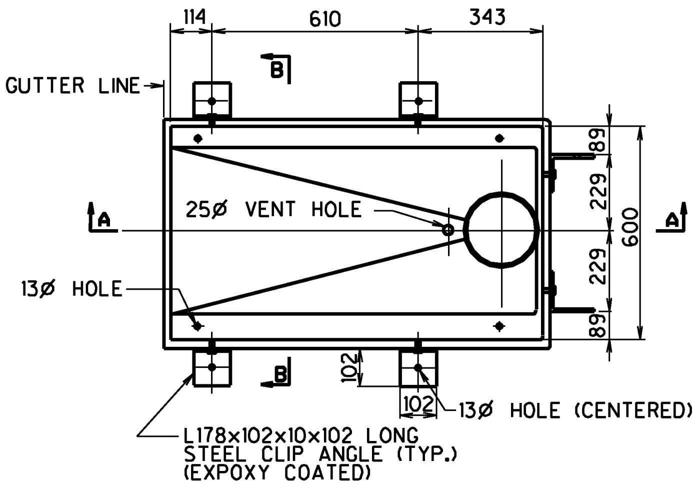
DECK DRAINAGE ASSEMBLY
METAL - SHT. 1

METRIC

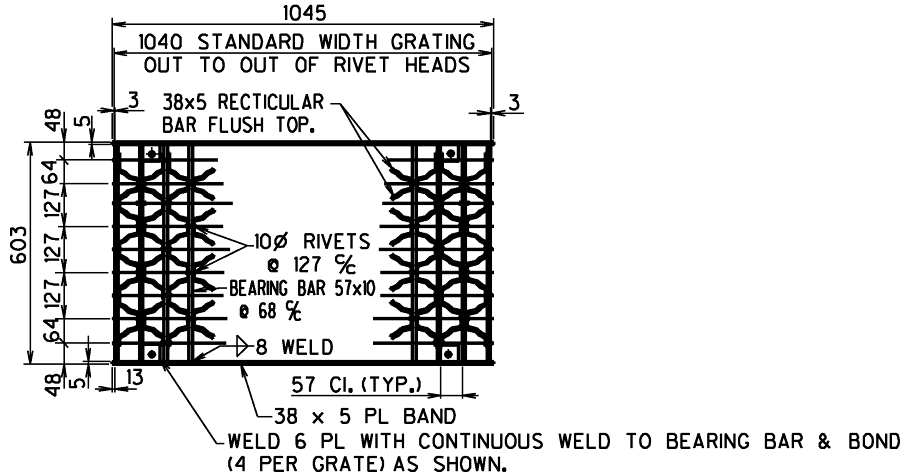
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 208.1 6-19-00

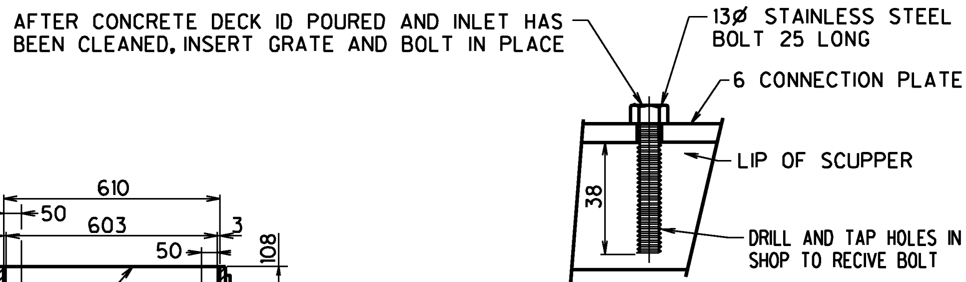


PLAN

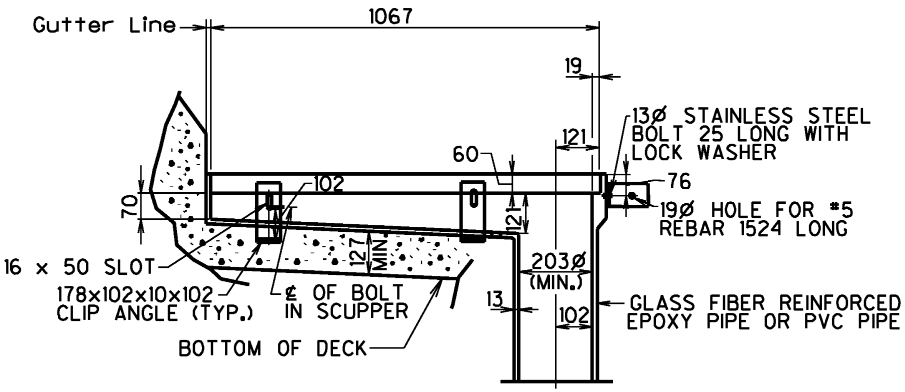


PLAN-SUGGESTED SCUPPER GRATING

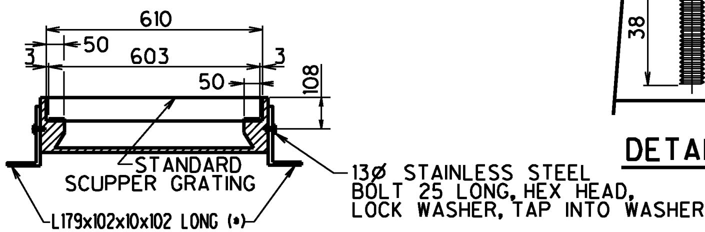
NOTE: Scupper Grating shall be designed for HS-25 Loading.



DETAIL A



SECTION A-A



SECTION B-B

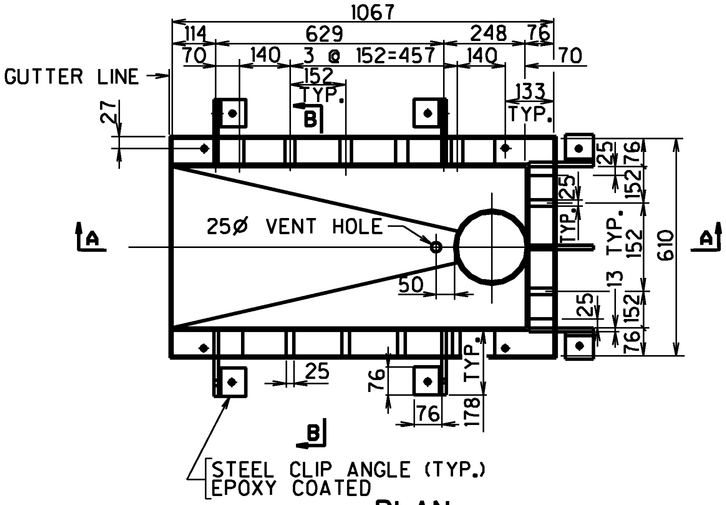
(•) CONTRACTOR MAY FURNISH LARGER ANGLES THAN SPECIFIED FOR ADJUSTMENT PURPOSE, PROVIDE THE LOCATION OF SLOT RELATIVE TO TOP OF ANGLE IS MAINTAINED.

DECK DRAINAGE ASSEMBLY
METAL - SHT. 2

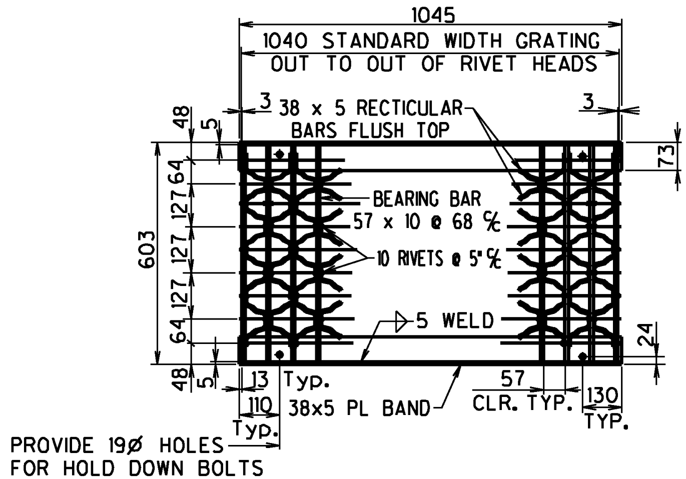
METRIC
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 208.2 6-19-00

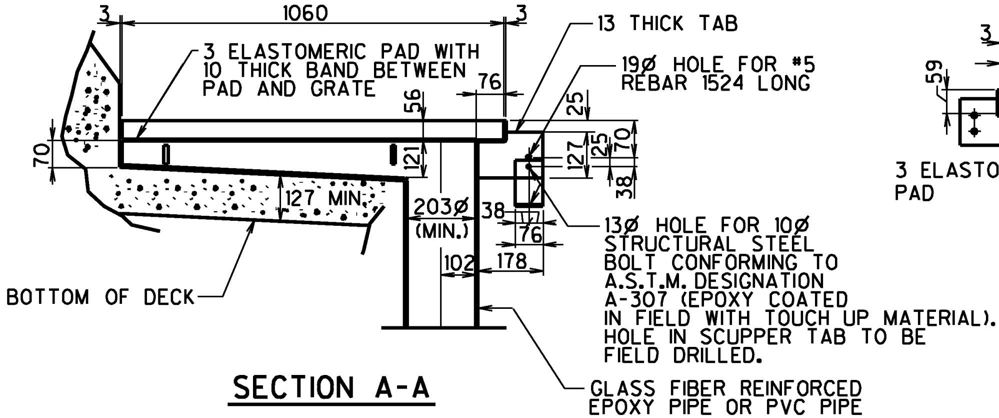


PLAN

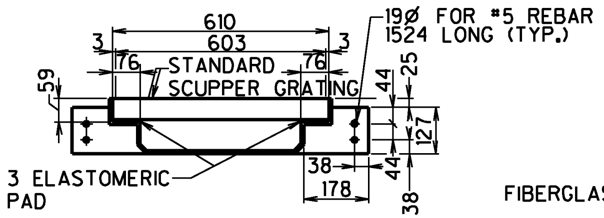


PLAN-SUGGESTED SCUPPER GRATING

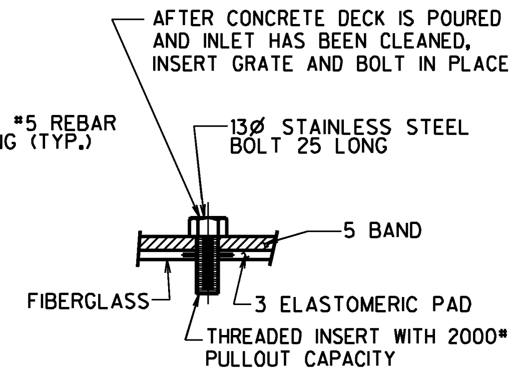
NOTE: Scupper Grating shall be designed
for HS-25 Loading.



SECTION A-A



SECTION B-B



DETAIL A

DECK DRAINAGE ASSEMBLY
FIBERGLASS

METRIC
ALL DIMENSIONS ARE IN MILLIMETERS, (U.N.)

MID-ATLANTIC STATES SCEF

Drawing 208.3 6-19-00