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Bridge Design Manual

M 23-50.03

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1.1.4 Revisions

Bridge Design Manual (BDM) revisions are related to emerging concepts, new state or federal legislation, and comments forwarded to the Bridge Design Office. Some revisions are simple spot changes, while others are major chapter rewrites. The current version of the BDM is available online at: www.wsdot.wa.gov/Publications/Manuals/M23-50.htm.

BDM pages include a revision number and publication date. When a page is revised, the revision number and publication date are revised. Revisions shall be clearly indicated in the text.

The process outlined below is followed for BDM revisions:

1. BDM revisions are prepared, checked and coordinated with BDM chapter authors.
2. BDM revisions are submitted to the Bridge Design Engineer for approval. However, comments related to grammar and clarity can be sent directly to the BDM Coordinator without Bridge Design Engineer approval.
3. After approval from the Bridge Design Engineer, the BDM Coordinator works with WSDOT Engineering Publications to revise the BDM.
4. Revised BDM pages from Engineering Publications are checked for accuracy and corrected if necessary.
5. A Publication Transmittal (DOT Form 761-003A EF) is prepared by Engineering Publications. Publication Transmittals include remarks and instructions for updating the BDM. After the Publications Transmittal has been signed by the State Bridge and Structures Engineer, Engineering Publications will post the complete manual and revision at: <http://www.wsdot.wa.gov/Publications/Manuals/M23-50.htm>.
6. Engineering Publications will coordinate electronic and hard copy distributions.

A BDM Revision QA/QC Worksheet (see Appendix 1.1-A1) shall be prepared to document and track the revision process.

1.2.3 Design Unit Responsibilities and Expertise

The following is an updated summary of the structural design, review and plan preparation responsibilities/expertise within the Bridge Design Section. Contact the Unit Supervisor for the name of the appropriate staff expert for the needed specialty.

Unit Supervisor	Responsibility/Expertise
Mark Anderson	Seismic Design Technical Support Emergency Slide Repairs Retaining Walls (including Structural Earth, Soldier Pile and Tie-Back, Geosynthetic, and Soil Nail) Pre-Approval of Retaining Wall Systems Noise Barrier Walls
Richard Stoddard	Bridge Traffic Barriers and Rail Retrofits Concrete Design Technical Support
Ron Lewis	Coast Guard Permits Special Provisions and Cost Estimates Preliminary Design Falsework, Forming and Temporary Structures Bridge Design Manual Bridge Projects Scheduling
Richard Zeldenrust	Overhead and Bridge-Mounted Sign Structures Light Standard & Traffic Signal Supports Repairs to Damaged Bridges Structural Steel Technical Support
Patrick Clarke	Floating Bridges Bearings and Expansion Joints Technical Support Special Structures
DeWayne Wilson	Bridge Preservation Program (P2 Funds) – Establish needs and priorities (including Seismic, Scour, Deck Overlay, Special Repairs, Painting, Replacement, Misc Structures Programs) Bridge Management System Bridge Engineering Software and CAD Consultant Liaison
Tim Moore	Mega Projects Manager
Paul Kinderman	Bridge Architect

- c. The Unit Supervisor works closely with the design team during the plan review phase. Review efforts should concentrate on reviewing the completed plan details and design calculations for completeness and for agreement with office criteria and office practices. Review the following periodically and at the end of the project:
- (1) Design Criteria
 - Seismic design methodology, acceleration coefficient (“a” value), and any seismic analysis assumptions.
 - Foundation report recommendations, selection of alternates.
 - Deviations from AASHTO, BDM, and proper consideration of any applicable Design Memorandums.
 - (2) Design Time and Budget
- d. Estimate time to complete the project. Plan resource allocation for completing the project to meet the scheduled Ad Date and budget. Monitor monthly time spent on the project.
- At the end of each month, estimate time remaining to complete project, percent completed, and whether project is on or behind schedule.
- Plan and assign workforce to ensure a timely delivery of the project within the estimated time and budget. At monthly supervisors’ scheduling meetings, notify the Bridge Projects Engineer if a project is behind schedule.
- e. Advise Region of any project scope creep and construction cost increases. As a minimum, use quarterly status reports to update Region on project progress.
- f. Use appropriate computer scheduling software or other means to monitor time usage, to allocate resources, and to plan projects.
- g. Review constructability issues. Are there any problems unique to the project?
- h. Review the final plans for the following:
- (1) Scan the job file for unusual items relating to geometrics, hydraulics, geotechnical, environmental, etc.
 - (2) Overall review of sheet #1, the bridge layout for:
 - Consistency — especially for multiple bridge project
 - Missing information
 - (3) Review footing layout for conformance to Bridge Plan and for adequacy of information given. Generally, the field personnel shall be given enough information to “layout” the footings in the field without referring to any other sheets. Plan details shall be clear, precise, and dimensions tied to base references, such as: a survey line or defined centerline of bridge.
 - (4) Review the sequence of the plan sheets. The plan sheets should adhere to the following order: layout, footing layout, substructures, superstructures, miscellaneous details, barriers, and barlist. Also check for appropriateness of the titles.
 - (5) Review overall dimensions and elevations, spot check for compatibility. For example, check compatibility between superstructures and substructure. Also spot check bar marks.
 - (6) Use common sense and experience to review structural dimensions and reinforcement for structural adequacy. When in doubt, question the designer and checker.
- i. Stamp and sign the plans in blue ink.

8. Bridge Design Engineer's Responsibilities

The Bridge Design Engineer is the coach, mentor, and facilitator for the WSDOT QC/QA Bridge Design Procedure. The leadership and support provided by this position is a major influence in assuring bridge design quality for structural designs performed by both WSDOT and consultants. The following summarizes the key responsibilities of the Bridge Design Engineer related to QC/QA:

- a. Prior to the Bridge Design Engineer stamping and signing any plans, he/she shall perform a structural/constructability review of the plans. This is a quality assurance (QA) function as well as meeting the "responsible charge" requirements of state laws relating to Professional Engineers.
- b. Review and approve the Preliminary Bridge Plans. The primary focus for this responsibility is to assure that the most cost-effective and appropriate structure type is selected for a particular bridge site.
- c. Review unique project special provisions and Standard Specification modifications relating to structures.
- d. Facilitate partnerships between WSDOT, consultants, and the construction industry stakeholders to facilitate and improve design quality.
- e. Encourage designer creativity and innovation through forward thinking.
- f. Exercise leadership and direction for maintaining a progressive and up to date Bridge Design Manual.
- g. Create an open and supportive office environment in which Design Section staff are empowered to do high quality structural design work.
- h. Create professional growth opportunities through an office culture where learning is emphasized.
- i. Encourage continuing professional development through training opportunities, attendance at seminars and conferences, formal education opportunities, and technical writing.

9. General Bridge Plan Stamping and Signature Policy

The stamping and signing of bridge plans is the final step in the Bridge QC/QA procedure. It signifies a review of the plans and details by those in responsible charge for the bridge plans. At least one Licensed Structural Engineer shall stamp and sign each contract plan sheet (except the bar list).

For contract plans prepared by a licensed Civil or Licensed Structural Engineer, the Unit Manager and the licensed Civil or Licensed Structural Engineer co-seal and sign the plans, except the bridge layout sheet. The bridge layout sheet is sealed and signed by the State Bridge and Structures Engineer or, in the absence of the State Bridge and Structures Engineer, the Bridge Design Engineer.

For contract plans not prepared by a licensed Civil or Licensed Structural Engineer, the Unit Manager and the Bridge Design Engineer co-seal and sign the plans except the bridge layout sheet. The bridge layout sheet is sealed and signed by the State Bridge and Structures Engineer or, in the absence of the State Bridge and Structures Engineer, the Bridge Design Engineer.

For Non-Standard Retaining Walls and Noise Barrier Walls, Sign Structures, Seismic Retrofits, Expansion Joint and Bearing Modifications, Traffic Barrier and Rail Retrofits, and other special projects, the Unit Manager with either the licensed designer or the Bridge Design Engineer (if the designer is not licensed) co-seal and sign the plans except for the layout sheet. The layout sheets for these plans are sealed and signed by the State Bridge and Structures Engineer, or in the absence of the State Bridge and Structures Engineer, the Bridge Design Engineer.

B. Consultant PS&E — Projects on WSDOT Right of Way

PS&E prepared by consultants will follow a similar QC/QA procedure as that shown above for WSDOT prepared PS&E's and, as a minimum, shall include the following elements:

1. WSDOT Consultant Liaison Engineer's Responsibilities
 - a. Review scope of work.
 - b. Negotiate contract and consultant's Task Assignments.
 - c. Coordinate/Negotiate Changes to Scope of Work.
2. WSDOT Design Reviewer's or Coordinator's Responsibilities
 - a. Early in the project, review consultant's design criteria, and standard details for consistency with WSDOT practices and other bridge designs in project.
 - b. Review the job file as prepared by the Preliminary Plan Engineer.
 - c. Identify resources needed to complete work.
 - d. Initiate a project start-up meeting with the Consultant to discuss design criteria, submittal schedule and expectations, and also to familiarize himself/herself with the Consultant's designers.
 - e. Reach agreement early in the design process regarding structural concepts and design methods to be used.
 - f. Identify who is responsible for what and when all intermediate constructability, Bridge Plans, and Bridge PS&E review submittals are to be made.
 - g. Monitor progress.
 - h. Facilitate communication, including face-to-face meetings.
 - i. Verify that the Consultant's design has been checked by the Consultant's checker at the 100% submittal. The checker's calculations should be included in the designer's calculation set.
 - j. Review consultant's design calculations and plans for completeness and conformance to Bridge Office design practice. The plans shall be checked for constructability, consistency, clarity and compliance. Also, selectively check dimensions and elevations.
 - k. Resolve differences.
3. WSDOT Design Unit Supervisor's Responsibilities
 - a. Encourage and facilitate communication.
 - b. Early involvement to assure that design concepts are appropriate.
 - c. Empower Design Reviewer or Coordinator.

- d. Facilitate resolution of issues beyond authority of WSDOT Reviewer or Coordinator.
 - e. Facilitate face-to-face meetings.
4. WSDOT S&E Engineer's Responsibilities
See Section 12.4.8.
 5. WSDOT Bridge Design Engineer's Responsibilities
 - a. Cursory review of design plans.
 - b. Signature approval of S&E bridge contract package.
- C. Consultant PS&E — Projects on County and City Right of Way
- Counties and cities frequently hire Consultants to design bridges. WSDOT Highways and Local Programs Office determine which projects are to be reviewed by the Bridge and Structures Office. WSDOT Highways and Local Programs send the PS&E to the Bridge Projects Engineer for assignment when a review is required. The Bridge and Structures Office's Consultant Liaison Engineer is not involved.

A WSDOT Design Reviewer or Coordinator will be assigned to the project and will review the project as outlined for Consultant PS&E — Projects on WSDOT Right of Way (see Section 1.3.2.B).

Two sets of plans with the reviewers' comments marked in red should be returned to the Bridge Projects Unit. One set of plans will be returned to Highways and Local Programs. The Bridge Scheduling Engineer will file the other set in the Bridge Projects Unit.

The first review should be made of the Preliminary Plan followed later by review of the PS&E and design calculations. Comments are treated as advisory, although major structural issues must be addressed and corrected. An engineer from the county, city, or consultant may contact the reviewer to discuss the comments.

1.3.3 Design/Check Calculation File

A. File of Calculations

The Bridge and Structures Office maintains a file of all pertinent design/check calculations for documentation and future reference. (See Section 1.3.8 Archiving Design Calculations, Design Files, and S&E Files).

B. Procedures

After an assigned project is completed and the bridge is built, the designer shall turn in a bound file containing the design/check calculations for archiving. The front cover should have a label (See Figure 1.3.8-1).

C. File Inclusions

The following items should be included in the file:

1. Index Sheets

Number all calculation sheets and prepare an index by subject with the corresponding sheet numbers.

List the name of the project, SR Number, designer/checker initials, date (month, day, and year), and Unit Supervisor's initials.

Chapter 2 Preliminary Design

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2.1 Preliminary Studies

2.1.1 Interdisciplinary Design Studies

Region may set up an Interdisciplinary Design Team (IDT) to review the various design alternatives for major projects. The IDT is composed of members from Regions, HQ, outside agencies, and consulting firms. The members have different areas of expertise, contribute ideas, and participate in the selection of design alternatives. This work will often culminate in the publication of an Environmental Impact Statement (EIS).

Bridge designers may be asked to participate either as a support resource or as a member of the IDT.

2.1.2 Value Engineering Studies

Value Engineering (VE) is a review process and analysis of a design project. The VE team seeks to define the most cost-effective means of satisfying the basic function(s) of the project. Usually a VE study takes place before or during the time that the region is working on the design. Occasionally, a VE study examines a project with a completed PS&E. VE studies are normally required for projects with cost overruns.

The VE team is headed by a facilitator and is composed of members with different areas of expertise from Regions, HQ, outside agencies, and consulting firms. The Team Facilitator will lead the team through the VE process. The team will review Region's project as defined by the project's design personnel. The VE team will determine the basic function(s) that are served by the project, brainstorm all possible alternatives to serve the same function(s), evaluate the alternatives for their effectiveness to meet the project's basic functions, determine costs, and prioritize and recommend alternatives. The VE team will prepare a report and present their findings to the region. The Region is then required to investigate and address the VE team's findings in the final design.

Bridge designers may be asked to participate either as a support resource or as a member of the VE team. VE studies usually take place over a three to five day period.

Engineers participating in VE studies and Cost-Risk Assessment meetings shall call the S&E Engineers and double check all costs when providing cost estimates at VE studies and CRA meetings.

2.1.3 Preliminary Recommendations for Bridge Rehabilitation Projects

When the Region starts a bridge rehabilitation project, they will submit a written memo requesting that the Bridge and Structures Office make preliminary project recommendations.

The Bridge and Structures Office will review the as-built plans, load ratings, existing inspection and condition reports prepared by the Bridge Preservation Office (BPO), and schedule a site visit with Region and other stakeholders. Special inspection of certain portions of the structure may be included in the site visit or scheduled later with Region and BPO. The purpose of the inspections is to obtain more detailed information as to the bridge's condition, to obtain dimensions and take photographs of details needed for the project recommendations.

Following the site visit, the next steps are:

- Determine the load capacity of the existing bridge.
- Determine what type of rehabilitation work is needed and time frame required to accomplish the work.

- Determine any special construction staging requirements. Can the bridge be totally shut down for the rehabilitation period? How many lanes will need to be open? Can the work be accomplished during night closures or weekend closures?
- Develop various alternatives and cost estimates for comparison, ranging from “do nothing” to “new replacement”.
- Determine what the remaining life expectancies are for the various rehabilitation alternatives.
- Determine the cost of a new replacement bridge.

Note: The FHWA will not participate in funding the bridge rehabilitation project if the rehabilitation costs exceed 50 percent of the cost for a new bridge replacement.

The Bridge and Structures Office will provide Region with a written report with background information. The Region will be given an opportunity to review the draft report and to provide input prior to finalization.

The Bridge Projects Engineer and Specifications & Estimates Engineers provide bridge scoping cost estimates to Regions for their use in determining budgets during Region's project definition phase. The S&E Engineers will check the Bridge Project Engineer's estimate as well as check each other.

2.1.4 Preliminary Recommendations for New Bridge Projects

The Region will seek assistance from the Bridge and Structures Office when they are preparing a design project requiring new bridges. Similar to the procedures outlined above for rehabilitation projects. The Region will submit a written memo requesting that the bridge office make preliminary project recommendations. The Bridge and Structures Office will provide scope of work, cost estimate(s), and a summary of the preferred alternatives with recommendations. Face to face meetings with the Region project staff are recommended prior to sending a written memo.

The Bridge Projects Engineer and Specifications & Estimates Engineers provide bridge scoping cost estimates to Regions for their use in determining budgets during Region's project definition phase. The S&E Engineers will check the Bridge Project Engineer's estimate as well as check each other.

2.1.5 Type, Size, and Location (TS&L) Reports

The Federal Highway Administration (FHWA) requires that major or unusual bridges must have a Type, Size, and Location (TS&L) report prepared. The report will describe the project, proposed structure(s), cost estimates, other design alternatives considered, and recommendations. The report provides justification for the selection of the preferred alternative. Approval by FHWA of the TS&L study is the basis for advancing the project to the design stage.

The FHWA should be contacted as early as possible in the Project Development stage because the FHWA requires a TS&L study for tunnels, movable bridges, unusual structures, and major structures. Smaller bridges that are unusual or bridge projects for Local Agencies may also require a TS&L study. Other projects, such as long viaducts, may not. Check with the Bridge Projects Engineer to see if a TS&L report is necessary.

The preparation of the TS&L report is the responsibility of the Bridge and Structures Office. The TS&L cannot be submitted to FHWA until after the environmental documents have been submitted. However, TS&L preparation need not wait for environmental document approval, but may begin as soon as the bridge site data is available. See WSDOT *Design Manual* for the type of information required for a bridge site data submittal.

A. TS&L General

The designer should first review the project history in order to become familiar with the project. The environmental and design reports should be reviewed. The bridge site data should be checked so that additional data, maps, or drawings can be requested. A meeting with Region and a site visit should be arranged after reviewing the history of the project.

The Materials Laboratory Geotechnical Services Branch must be contacted early in the TS&L process in order to have foundation information. Specific recommendations on the foundation type must be included in the TS&L report. The Materials Laboratory Geotechnical Services Branch will submit a detailed foundation report for inclusion as an appendix to the TS&L report.

To determine the preferred structural alternative, the designer should:

1. Develop a list of all feasible alternatives. At this stage, the range of alternatives should be kept wide open. Brainstorming with supervisors and other engineers can provide new and innovative solutions.
2. Eliminate the least desirable alternatives by applying the constraints of the project. Question and document the assumptions of any restrictions and constraints. There should be no more than four alternatives at the end of this step.
3. Perform preliminary design calculations for unusual or unique structural problems to verify that the remaining alternatives are feasible.
4. Compare the advantages, disadvantages, and costs of the remaining alternatives to determine the preferred alternative(s).
5. Visit the project site with the Region, Materials Laboratory Geotechnical Services Branch, and HQ Hydraulics staff.

FHWA expects specific information on scour and backwater elevations for the permanent bridge piers, as well as, for any temporary falsework bents placed in the waterway opening.

After the piers have been located, a memo requesting a Hydraulics Report should be sent to the HQ Hydraulics Unit. The HQ Hydraulics Unit will submit a report for inclusion as an appendix to the TS&L report.

The State Bridge and Structures Architect should be consulted early in the TS&L study period. "Notes to the File" should be made documenting the aesthetic requirements and recommendations of the State Bridge and Structures Architect.

Cost backup data is needed for any costs used in the TS&L study. FHWA expects TS&L costs to be based on estimated quantities. This cost data is to be included in an appendix to the TS&L report. The quantities should be compatible with the S&E Engineer's cost breakdown method. The Specifications & Estimates Engineers will check the designer's estimated costs included in TS&L reports. In the case of consultant prepared TS&L reports, the designer shall have the S&E Engineers check the construction costs.

B. TS&L Outline

The TS&L report should describe the project, the proposed structure, and give reasons why the bridge type, size, and location were selected.

1. Cover, Title Sheet, and Index

These should identify the project, owner, location and the contents of the TS&L.

2. Photographs

There should be enough color photographs to provide the look and feel of the bridge site. The prints should be numbered and labeled and the location indicated on a diagram.

3. Introduction

The introduction describes the report, references, and other reports used to prepare the TS&L study. The following reports should be listed, if used.

- Design Reports and Supplements
- Environmental Reports
- Architectural Visual Assessment or Corridor Theme Reports
- Hydraulic Report
- Geotechnical Reports

4. Project Description

The TS&L report clearly defines the project. A vicinity map should be shown. Care should be taken to describe the project adequately but briefly. The project description summarizes the preferred alternative for the project design.

5. Design Criteria

The design criteria identify the AASHTO LRFD Bridge Design Specifications and AASHTO guide specifications that will be used in the bridge design. Sometimes other design criteria or special loadings are used. These criteria should be listed in the TS&L. Some examples in this category might be the temperature loading used for segmental bridges or areas defined as wetlands.

6. Structural Studies

The structural studies section documents how the proposed structure Type, Size, and Location were determined. The following considerations should be addressed.

- Aesthetics
- Cost Estimates
- Geometric constraints
- Project staging and Stage Construction Requirements
- Foundations
- Hydraulics
- Feasibility of construction
- Structural constraints
- Maintenance

This section should describe how each of these factors leads to the preferred alternative. Show how each constraint eliminated or supported the preferred alternatives. Here are some examples. “Prestressed concrete girders could not be used because environmental restrictions required that no permanent piers could be placed in the river. This requires a 230-foot clear span.” “Restrictions on falsework placement forced the use of self supporting precast concrete or steel girders.”

7. Executive Summary

The executive summary should be able to “stand alone” as a separate document. The project and structure descriptions should be given. Show the recommended alternative(s) with costs and include a summary of considerations used to select preferred alternatives or to eliminate other alternatives.

8. Drawings

Preliminary plan drawings of the recommended alternative are included in an appendix. The drawings show the plan, elevation, and typical section. For projects where alternative designs are specified as recommended alternatives, preliminary plan drawings for each of the different structure types shall be included. Supplemental drawings showing special features, such as complex piers, are often included to clearly define the project.

C. Reviews and Submittals

While writing the TS&L report, all major decisions should be discussed with the unit supervisor, who can decide if the Bridge Design Engineer needs to be consulted. A peer review meeting with the Bridge Design Engineer should be scheduled at the 50 percent completion stage. If applicable, the FHWA Bridge Engineer should be invited to provide input.

The final report must be reviewed, approved, and the Preliminary Plan drawings signed by the State Bridge and Structures Architect, the Bridge Projects Engineer, the Bridge Design Engineer, and the Bridge and Structures Engineer. The TS&L study is submitted with a cover letter to FHWA signed by the Bridge and Structures Engineer.

2.2 Preliminary Plan

The Preliminary Plan preparation stage is the most important phase of bridge design because it is the basis for the final design. The Preliminary Plan should completely define the bridge geometry so the final roadway design by the regions and the structural design by the bridge office can take place with minimal revisions.

During the Region's preparation of the highway design, they also begin work on the bridge site data. Region submits the bridge site data to the Bridge and Structures Office, which initiates the start of the Preliminary Plan stage. Information that must be included as part of the bridge site data submittal is described in the *Design Manual* and Appendix 2.2-A1.

2.2.1 Development of the Preliminary Plan

A. Responsibilities

In general, the responsibilities of the designer, checker, detailer, and unit supervisor are described in Section 1.2.2. The Preliminary Plan Design Engineer or the assigned designer is responsible for developing a preliminary plan for the bridge. The preliminary plan must be compatible with the geometric, aesthetic, staging, geotechnical, hydraulic, financial, structural requirements and conditions at the bridge site.

Upon receipt of the bridge site data from the Region, the designer shall review it for completeness and verify that what the project calls for is realistic and structurally feasible. Any omissions or corrections are to be immediately brought to the Region's attention so that revised site data, if required, can be resubmitted to avoid jeopardizing the bridge design schedule.

The Unit Supervisor shall be kept informed of progress on the preliminary plan so that the schedule can be monitored. If problems develop, the Unit Supervisor can request adjustments to the schedule or allocate additional manpower to meet the schedule. The designer must keep the job file up-to-date by documenting all conversations, meetings, requests, questions, and approvals concerning the project. Notes-to-the-designer, and details not shown in the preliminary plan shall be documented in the job file.

The checker shall provide an independent review of the plan, verifying that it is in compliance with the site data as provided by the region and as corrected in the job file. The plan shall be compared against the Preliminary Plan checklist (see Appendix 2.2-A2) to ensure that all necessary information is shown. The checker is to review the plan for consistency with office design practice, detailing practice, and for constructibility.

The preliminary plan shall be drawn using current office CAD equipment and software by the designer or detailer.

B. Site Reconnaissance

The site data submitted by the Region will include photographs and a video of the site. Even for minor projects, this may not be enough information for the designer to work from to develop a preliminary plan. For most bridge projects, site visits are necessary.

Site visits with Region project staff and other project stakeholders, such as, Materials Laboratory Geotechnical Services Branch, HQ Hydraulics, and Region Design should be arranged with the knowledge and approval of the Bridge Projects Engineer.

C. Coordination

The designer is responsible for coordinating the design and review process throughout the project. This includes seeking input from various WSDOT units and outside agencies. The designer should consult with Materials Laboratory Geotechnical Services Branch, HQ Hydraulics, Bridge Preservation Office, and Region design and maintenance, and other resources for their input.

D. Consideration of Alternatives

In the process of developing the Preliminary Plan, the designer should brainstorm, develop, and evaluate various design alternatives. See Section 2.2.3 General Factors for Consideration and how they apply to a particular site. See also Section 2.1.5A. Preliminary design calculations shall be done to verify feasibility of girder span and spacing, falsework span capacity, geometry issues, and construction clearances. Generally, the number of alternatives will usually be limited to only a few for most projects. For some smaller projects and most major projects, design alternatives merit development and close evaluation. The job file should contain reasons for considering and rejecting design alternatives. This provides documentation for the preferred alternative.

E. Designer Recommendation

The designer should be able to make a recommendation for the preferred alternative after a thorough analysis of the needs and limitations of the site, studying all information, and developing and evaluating the design alternatives for the project. At this stage, the designer should discuss the recommendation with the Bridge Projects Engineer.

F. Concept Approval

For some projects, the presentation, in “E” above, to the Bridge Projects Engineer will satisfy the need for concept approval. Large complex projects, projects of unique design, or projects where two or more alternatives appear viable, should be presented to the Bridge Design Engineer for his/her concurrence before plan development is completed. For unique or complex projects a presentation to the Region Project Engineer, and Bridge and Structures Office Peer Review Committee may be appropriate.

2.2.2 Documentation

A. Job File

An official job file is created by the Bridge Scheduling Engineer when a memo transmitting site data from the region is received by the Bridge and Structures Office. This job file serves as a depository for all communications and resource information for the job. Scheduling and time estimates are kept in this file, as well as cost estimates, preliminary quantities, and documentation of all approvals. Records of important telephone conversations and copies of E-mails approving decisions are also kept in the job file.

After completing the Preliminary Plan, the job file continues to serve as a depository for useful communications and documentation for all pertinent project related information and decisions during the design process through and including preparation of the Final Bridge PS&E.

B. Bridge Site Data

All Preliminary Plans are developed from site data submitted by the Region. This submittal will consist of a memorandum IDC, and appropriate attachments as specified by *Design Manual*. When this information is received, it should be reviewed for completeness so that missing or incomplete information can be noted and requested.

C. Request for Preliminary Foundation Data

A request for preliminary foundation data is sent to the Geotechnical Services Branch to solicit any foundation data that is available at the preliminary stage. The Materials Laboratory Geotechnical Services Branch is provided with approximate dimensions for the overall structure length and width, approximate number of intermediate piers (if applicable), and approximate stations for beginning and end of structure on the alignment.

Based on test holes from previous construction in the area, geological maps, and soil surveys. The Materials Laboratory Geotechnical Services Branch responds by memo and a report with an analysis of what foundation conditions are likely to be encountered and what foundation types are best suited for the bridge site.

D. Request for Preliminary Hydraulics Data

A Request for preliminary hydraulics data is sent to the HQ Hydraulics Office to document hydraulic requirements that must be considered in the structure design. The HQ Hydraulics Office is provided a contour plan and other bridge site data.

The Hydraulics Office will send a memo providing the following data: seal vent elevations, normal water, 100-year and 500-year flood elevations and flows (Q), pier configuration, scour depth and minimum footing cover required, ice pressure, minimum waterway channel width, riprap requirements, and minimum clearance required to the 100-year flood elevation.

E. Design Report or Design Summary and Value Engineering Studies

Some bridge construction projects have a Design File Report or Design Summary prepared by the region. This is a document, which includes design considerations and conclusions reached in the development of the project. It defines the scope of work for the project. It serves to document the design standards and applicable deviations for the roadway alignment and geometry. It is also an excellent reference for project history, safety and traffic data, environmental concerns, and other information. If a VE study was done on the bridge, the report will identify alternatives that have been studied and why the recommended alternative was chosen.

F. Other Resources

For some projects, preliminary studies or reports will have been prepared. These resources can provide additional background for the development of the Preliminary Plan.

G. Notes of meetings with Regions and other project stakeholders shall be included in the job file.

2.2.3 General Factors for Consideration

Many factors must be considered in preliminary bridge design. Some of the more common of these are listed in general categories below. These factors will be discussed in appropriate detail in subsequent portions of this manual.

A. Site Requirements

- Topography
- Alignment (tangent, curved, skewed)
- Vertical profile and superelevation
- Highway Class and design speed
- Proposed or existing utilities

B. Safety

Feasibility of falsework (impaired clearance and sight distance, depth requirements, see Section 2.3.10)
Density and speed of traffic
Detours or possible elimination of detours by construction staging
Sight distance
Horizontal clearance to piers
Hazards to pedestrians, bicyclists

C. Economic

Funding classification (federal and state funds, state funds only, local developer funds)
Funding level
Bridge preliminary cost estimate

D. Structural

Limitation on structure depth
Requirements for future widening
Foundation and groundwater conditions
Anticipated settlement
Stage construction
Falsework limitations

E. Environmental

Site conditions (wetlands, environmentally sensitive areas)
EIS requirements
Mitigating measures
Construction access

F. Aesthetic

General appearance
Compatibility with surroundings and adjacent structures
Visual exposure and experience for public

G. Construction

Ease of construction
Falsework clearances and requirements
Erection problems
Hauling difficulties and access to site
Construction season
Time limit for construction

H. Hydraulic

Bridge deck drainage
Stream flow conditions and drift
Passage of flood debris
Scour, effect of pier as an obstruction (shape, width, skew, number of columns)
Bank and pier protection
Consideration of a culvert as an alternate solution
Permit requirements for navigation and stream work limitations

I. Maintenance

Concrete vs. Steel

Expansion joints

Bearings

Deck protective systems

Inspection and Maintenance Access (UBIT clearances) (see Figure 2.3.11-1)

J. Other

Prior commitments made to other agency officials and individuals of the community

Recommendations resulting from preliminary studies

2.2.4 Permits

A. Coast Guard

As outlined in the *Design Manual M 22-01, Additional Data for Waterway Crossings*, the Bridge and Structures Office is responsible for coordinating and applying for Coast Guard permits for bridges over waterways. The Coast Guard Liaison Engineer in the Bridge Projects Unit of the Bridge and Structures Office handles this.

A determination of whether a bridge project requires a Coast Guard permit is typically determined by Region Environmental during the early scoping phase. This scoping is done before the bridge site data is sent to the Bridge & Structures Design Office/Unit.

The Region Design Engineer should request that the Environmental Coordinator consult with the Coast Guard Liaison Engineer prior to sending the bridge site data if possible.

Generally, tidal-influenced waterways and waterways used for commercial navigation will require Coast Guard permits. See the *Design Manual M 22-01*, chapter covering Environmental Permits and Approvals, or *Environmental Procedure Manual M 31-11*, Chapter 520.04 Section 9 Permit – Bridge Work in Navigable Waters, or Chapter 500 Environmental Permitting and PS&E, Table 500-1 for additional information or permit needs and procedures.

For all waterway crossings, the Coast Guard Liaison Engineer is required to initial the Preliminary Plan as to whether a Coast Guard permit or exemption is required. This box regarding Coast Guard permit status is located in the center left margin of the plan. If a permit is required, the permit target date will also be noted. The reduced print, signed by the Coast Guard Liaison Engineer, shall be placed in the job file.

The work on developing the permit application should be started before the bridge site data is complete so that it is ready to be sent to the Coast Guard at least eight months prior to the project ad date. The Coast Guard Liaison Engineer should be given a copy of the preliminary plans from which to develop the Coast Guard Application plan sheets, which become part of the permit.

B. Other

All other permits will be the responsibility of the Region (see the *Design Manual*). The Bridge and Structures Office may be asked to provide information to the Region to assist them in making applications for these permits.

2.2.5 Preliminary Cost Estimate

A preliminary cost estimate should be developed when the bridge type, foundation type, deck area and adjacent retaining walls are determined. At the preliminary stage the cost estimate is based on square-foot costs taken from the BDM Chapter 12 and adjusted for structure specifics. Consult with a Specifications and Estimates Engineer. The preliminary cost estimate is based on recent bidding history on similar structures, degree of difficulty of construction, inflation trends, and length of time until Ad Date, and time for completion of construction. It is considered accurate to within 15%, but is should be accurate enough to preclude a surprise increase at the time of the Engineer's estimate, which is based on completed design quantities. The preliminary cost estimate shall be updated frequently as changes are made to the preliminary plan or new data influences the costs.

After a Preliminary Plan has been developed, but before sending to the Bridge Design Engineer for signature, the Preliminary Plan and cost estimate shall be submitted to one of the Bridge Specifications and Estimates Engineers for review and comment for the structures in the Preliminary Plan. The information presented to the S&E Engineer shall include the complete Preliminary Plan and all backup data previously prepared on costs for the structures (such as preliminary quantity calculations, preliminary foundation type selection, etc.). The S&E Engineer will review the Preliminary Plan, prepare, sign, and date a cost estimate summary sheet, and return the package to the designer. When the Preliminary Plan is presented to the Bridge Design Engineer, the submittal shall include the summary sheet prepared by the S&E Engineer. The summary sheet and backup data will then be placed in the job file. Do not send the summary sheet to the Region.

After submittal of the Preliminary Plan to the Region, the Region shall be notified immediately of any increases in the preliminary cost estimate during the structural design.

2.2.6 Approvals

A. State Bridge and Structures Architect/Specialists

For all preliminary plans, the State Bridge and Structures Architect and appropriate specialists should be aware and involved when the designer is first developing the plan. The State Bridge and Structures Architect and specialists should be given a print of the plan by the designer. This is done prior to checking the preliminary plan. The State Bridge and Structures Architect and specialist will review, approve, sign and date the print. This signed print is placed in the job file. If there are any revisions, which affect the aesthetics of the approved preliminary plan, the State Bridge and Structures Architect should be asked to review and approve, by signature, a print showing the revisions, which change elements of aesthetic significance.

For large, multiple bridge projects, the State Bridge and Structures Architect should be contacted for development of a coordinated architectural concept for the project corridor.

The architectural concept for a project corridor is generally developed in draft form and reviewed with the project stakeholders prior to finalizing. When finalized, it should be signed by the Region Administrator or his/her designee.

Approval from the State Bridge and Structures Architect is required on all retaining walls and noise wall aesthetics including finishes and materials, and configuration.

In order to achieve superstructure type optimization and detailing consistency, the following guidelines shall be used for the preparation of all future Preliminary Plans:

- Preliminary Plans for all steel bridges and structures shall be reviewed by the Steel Specialist.
- Preliminary Plans for all concrete bridges and structures shall be reviewed by the Concrete Specialist.
- Detailing of all Preliminary Plans shall be reviewed by the Preliminary Plans Detailing Specialist.

These individuals shall signify their approval by signing the preliminary plan in the Architect/Specialist block on the first plan sheet, together with the State Bridge and Structures Architect.

B. Bridge Design

The Bridge Projects Engineer signs the preliminary plan after it has been checked and approved by the Architect/Specialists. At this point, it is ready for review, approval, and signing by the Bridge Design Engineer and the Bridge and Structures Engineer.

After the Bridge and Structures Engineer has signed the preliminary plan, it is returned to the designer. The designer places the original signed preliminary plan in the job file and enters the names of the signers in the signature block. This preliminary plan will be sent to region for their review and approval.

The transmittal memo includes the preliminary plan and the WSDOT Form 230-038 “Not Included in Bridge Quantities List” and a brief explanation of the preliminary cost estimate. It is addressed to the Region Administrator/Project Development Engineer from the Bridge and Structures Engineer/Bridge Design Engineer. The memo is reviewed by the Bridge Projects Engineer and is initialed by the Bridge Design Engineer.

The following should be included in the cc distribution list with attachments: FHWA Washington Division Bridge Engineer (when project has Federal Funding), Region Project Engineer, Bridge Projects Engineer, Bridge Design Unit Supervisor, State Geotechnical Engineer, HQ Hydraulics Engineer, Bridge Management Engineer (when it is a replacement) Bridge Preservation Engineer, HQ Bridge Construction Engineer, and Region Traffic Engineer (when ITS is required). The Bridge Scheduling Engineer and the Region and HQ Program Management Engineers should receive a copy of the preliminary plan distribution memo without the attachments.

C. Region

Prior to the completion of the preliminary plan, the designer should meet with the Region to discuss the concept, review the list of items to be included in the “Not Included in Bridge Quantities List” and get their input. (This is a list of non-bridge items that appear on the bridge preliminary plan and eventually on the design plans.)

The Region will review the preliminary plan for compliance and agreement with the original site data. They will work to answer any “*Notes to the Region*” that have been listed on the plan. When this review is complete, the Regional Administrator, or his/her designee, will sign the plan. The Region will send back a print of the signed plan with any comments noted in red (additions) and green (deletions) along with responses to the questions raised in the “*Notes to the Region*”.

D. Railroad

When a railroad is involved with a structure on a Preliminary Plan, the HQ RR Liaison Engineer of the Design Office must be involved during the plan preparation process. A copy of the Preliminary Plan is sent to the HQ RR Liaison Engineer, who then sends a copy to the railroad involved for their comments and approval.

The railroad will respond with approval by letter to the HQ RR Liaison Engineer. A copy of this letter is then routed to the Bridge and Structures Office and then placed in the job file.

For design plans prepared within the Bridge and Structures Office, the Unit Supervisor or lead designer will be responsible for coordinating and providing shoring plans for structures adjacent to railroads. It is recommended that the Construction Support Unit design, prepare, stamp, and sign shoring plans. However, the design unit may elect to design, prepare, stamp, and sign shoring plans.

For consultant prepared design plans, the Unit Supervisor or lead reviewer will be responsible for coordinating and having the consultant design shoring plans for structures adjacent to railroads. The Construction Support Unit has design criteria and sample plan details which can be used by the design units and consultants.

A Construction Support engineer is available to attend design project kick-off meetings if there is a need for railroad shoring plans or other constructability issues associated with the project. Regardless of who prepares the bridge plans, all shoring plans should be reviewed by the Construction Support Unit before they are submitted for railroad review and approval at the 50% Final PS&E stage.

For completed shelf projects, the S&E Engineer will contact the Region Project Engineer and inform the Unit Supervisor or lead reviewer on the need for shoring plans for structures adjacent to railroads. If shoring plans are required, the unit supervisor or lead designer may ask the Construction Support Unit to prepare shoring plans.

At the 50% PS&E plan completion stage or sooner if possible, especially for seismic retrofit project, the S&E Engineer will send four (4) copies of the layout, foundation plan, temporary shoring plans, and appropriate special provision section for structures adjacent to railroads to the HQ RR Liaison Engineer, who will submit this package to the appropriate railroad for review and approval. The shoring plans shall show the pressure loading diagram and calculations to expedite the railroad's review and approval.

2.3 Preliminary Plan Criteria

2.3.1 Highway Crossings

A. General

A highway crossing is defined as a grade separation between two intersecting roadways. Naming convention varies slightly between mainline highway crossings and ramp highway crossings, but essentially, all bridges carry one highway, road, or street over the intersecting highway, road, or street.

1. Mainline highway crossings

Names for mainline highway crossings are defined by the route designation or name of state highway, county road, or city street being carried over another highway, road, or street.

For example, a bridge included as part of an interchange involving I-205 and SR 14 and providing for passage of traffic on I-205 under SR 14 would be named SR 14 Over I-182 (followed by the bridge number).

2. Ramp highway crossings

Names for ramp highway crossings are defined by the state highway route numbers being connected, the directions of travel being connected, and the designation or name of the highway, road, or street being bridged.

For example, a bridge in the Hewitt Avenue Interchange connecting traffic from westbound US 2 to northbound I-5 and passing over Everett Street would be named 2W-5N Ramp Over Everett Street (followed by the bridge number). A bridge connecting traffic from northbound I-5 to westbound SR 518 and passing over northbound I-405 and a ramp connecting southbound I-405 to northbound I-5 would be named 5N-518W Over 405N,405S-5N (followed by the bridge number).

B. Bridge Width

The bridge roadway channelization (configuration of lanes and shoulders) is provided by the region with the Bridge Site Data. For state highways, the roadway geometrics are controlled by the *Design Manual*. For city and county arterials, the roadway geometrics are controlled by Chapter IV of the *Local Agency Guidelines*.

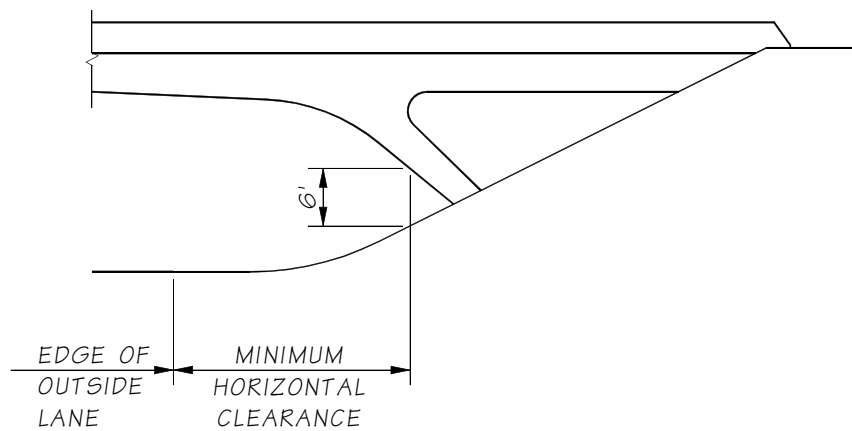
C. Horizontal Clearances

Safety dictates that fixed objects be placed as far from the edge of the roadway as is economically feasible. Criteria for minimum horizontal clearances to bridge piers and retaining walls are outlined in the *Design Manual*. The *Design Manual* outlines clear zone and recovery area requirements for horizontal clearances without guardrail or barrier being required.

Actual horizontal clearances shall be shown in the plan view of the Preliminary Plan (to the nearest 0.1 foot). Minimum horizontal clearances to inclined columns or wall surfaces should be provided at the roadway surface and for a vertical distance of 6 feet above the edge of pavement. When bridge end slopes fall within the recovery area, the minimum horizontal clearance should be provided for a vertical distance of 6 feet above the fill surface. See Figure 2.3.1-1.

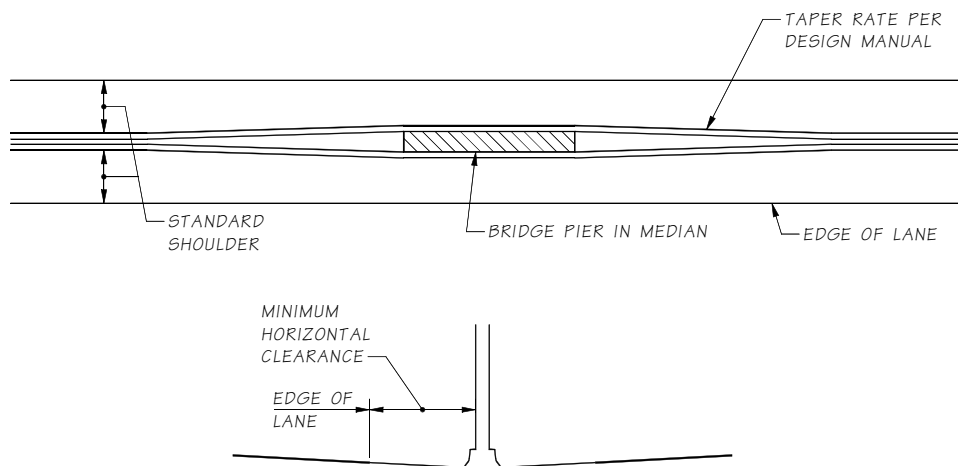
Bridge piers and abutments ideally should be placed such that the minimum clearances can be satisfied. However, if for structural or economic reasons, the best span arrangement requires a pier to be within clear zone or recovery area, and then guardrail or barrier can be used to mitigate the hazard.

There are instances where it may not be possible to provide the minimum horizontal clearance even with guardrail or barrier. An example would be placement of a bridge pier in a narrow median. The required column size may be such that it would infringe on the shoulder of the roadway. In such cases, the barrier safety shape would be incorporated into the shape of the column. Barrier or guardrail would need to taper into the pier at a flare rate satisfying the criteria in the *Design Manual*. See Figure 2.3.1-2. The reduced clearance to the pier would need to be approved by the Region. Horizontal clearances, reduced temporarily for construction, are covered in Section 2.3.9.



Horizontal Clearance to Incline Piers

Figure 2.3.1-1



Bridge Pier in Narrow Median

Figure 2.3.1-2

D. Vertical Clearances

The required minimum vertical clearances are established by the functional classification of the highway and the construction classification of the project. For state highways, this is as outlined in the *Design Manual*. For city and county arterials, this is as outlined in Chapter IV of the *Local Agency Guidelines*.

Actual minimum vertical clearances are shown on the Preliminary Plan (to the nearest 0.1 foot). The approximate location of the minimum vertical clearance is noted in the upper left margin of the plan. For structures crossing divided highways, minimum vertical clearances for both directions are noted.

E. End Slopes

The type and rate of end slope used at bridge sites is dependent on several factors. Soil conditions and stability, right of way availability, fill height or depth of cut, roadway alignment and functional classification, and existing site conditions are important.

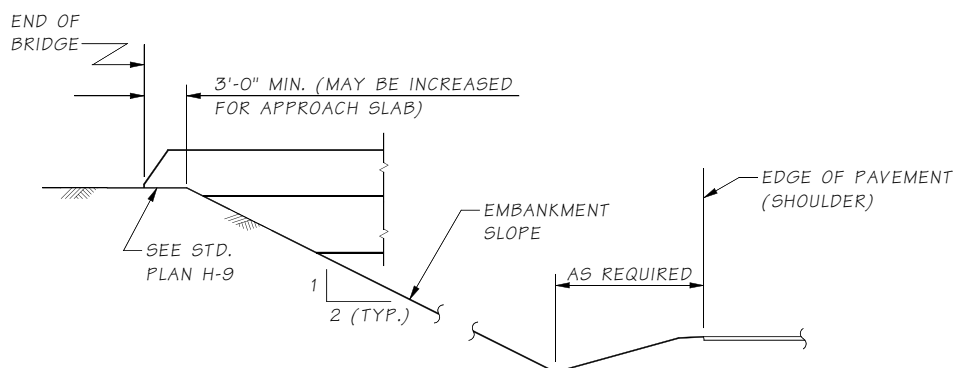
The region should have made a preliminary determination based on these factors during the preparation of the bridge site data. The side slopes noted on the Roadway Section for the roadway should indicate the type and rate of end slope.

The Materials Laboratory Geotechnical Services Branch will recommend the minimum rate of end slope. This should be compared to the rate recommended in the Roadway Section and to existing site conditions (if applicable). The types of end slopes and bridge slope protection are discussed in the *Design Manual*. Examples of slope protection are shown on *Standard Plan D-9*.

F. Determination of Bridge Length

Establishing the location of the end piers for a highway crossing is a function of the profile grade of the overcrossing roadway, the superstructure depth, the minimum vertical and horizontal clearances required for the structure, the profile grade and channelization (including future widening) of the undercrossing roadway, and the type and rate of end slope used.

For the general case of bridges in cut or fill slopes, the control point is where the cut or fill slope plane meets the bottom of roadside ditch or edge of shoulder as applicable. From this point, the fill or cut slope plane is established at the recommended rate up to where the slope plane intersects the grade of the roadway at the shoulder. Following the requirements of Standard Plan H-9, the back of pavement seat, end of wing wall or end of retaining wall can be established at 3 feet behind the slope intersection. See Figure 2.3.1-3



Determination of Bridge Length

Figure 2.3.1-3

For the general case of bridges on wall type abutments or “closed” abutments, the controlling factors are the required horizontal clearance and the size of the abutment. This situation would most likely occur in an urban setting or where right of way or span length is limited.

G. Pedestrian Crossings

Pedestrian crossings follow the same format as highway crossings. Geometric criteria for bicycle and pedestrian facilities are established in the *Design Manual*. Width and clearances would be as established there and as confirmed by region. Minimum vertical clearance over a roadway is given in the *Design Manual*. Unique items to be addressed with pedestrian facilities include ADA requirements, the railing to be used, handrail requirements, overhead enclosure requirements, and profile grade requirements for ramps and stairs.

H. Bridge Redundancy

Design bridges to minimize the risk of catastrophic collapse by using redundant supporting elements (columns and girders).

For substructure design use:

One column minimum for roadways 40 feet wide and under. Two columns minimum for roadways over 40 feet to 60 feet. Three columns minimum for roadways over 60 feet. Collision protection or design for collision loads for piers with one or two columns.

For superstructure design use:

Three girders (webs) minimum for roadways 32 feet and under. Four girders (webs) minimum for roadways over 32 feet. See Appendix 2.3-A2 for details.

Note: Any deviation from the above guidelines shall have a written approval by the Bridge Design Engineer.

2.3.2 Railroad Crossings

A. General

A railroad crossing is defined as a grade separation between an intersecting highway and a railroad. Names for railroad crossings are defined either as railroad over state highway or state highway over railroad. For example, a bridge carrying BNSF railroad tracks over I-5 would be named BNSF Over I-5 (followed by the bridge number) A bridge carrying I-90 over Union Pacific railroad tracks would be named I-90 Over UPRR (followed by the bridge number).

Requirements for highway/railway grade separations may involve negotiations with the railroad company concerning clearances, geometrics, utilities, and maintenance roads. The railroad’s review and approval will be based on the completed Preliminary Plan.

B. Criteria

The initial Preliminary Plan shall be prepared in accordance with the criteria of this section to apply uniformly to all railroads. Variance from these criteria will be negotiated with the railroad, when necessary, after a Preliminary Plan has been provided for their review.

C. Bridge Width

For highway over railway grade separations the provisions of Section 2.3.1 pertaining to bridge width of highway crossings shall apply. Details for railway over highway grade separations will depend on the specific project and the railroad involved.

D. Horizontal Clearances

For railway over highway grade separations, undercrossings, the provisions of Section 2.3.1 pertaining to horizontal clearances for highway crossings shall apply. However, because of the heavy live loading of railroad spans, it is advantageous to reduce the span lengths as much as possible. For railroad undercrossings skewed to the roadway, piers may be placed up to the outside edge of standard shoulders (or 8 feet minimum) if certain conditions are met (known future roadway width requirements, structural requirements, satisfactory aesthetics, satisfactory sight distance, barrier protection requirements, etc.).

For railroad overcrossings, minimum horizontal clearances are as noted below:

	Railroad Alone
Fill Section	14 feet
Cut Section	16 feet

Horizontal clearance shall be measured from the center of the outside track to the face of pier. When the track is on a curve, the minimum horizontal clearance shall be increased at the rate of 1½ inches for each degree of curvature. An additional 8 feet of clearance for off-track equipment shall only be provided when specifically requested by the railroad.

The actual minimum horizontal clearances shall be shown in the Plan view of the Preliminary Plan (to the nearest 0.01 foot).

E. Crash Walls

Crash walls, when required, shall be designed to conform to the criteria of the *AREMA Manual*. To determine when crash walls are required, consult the following:

Union Pacific Railroad, “Guidelines for Design of Highway Separation Structures over Railroad (Overhead Grade Separation)” AREMA Manual WSDOT Railroad Liaison Engineer the Railroad

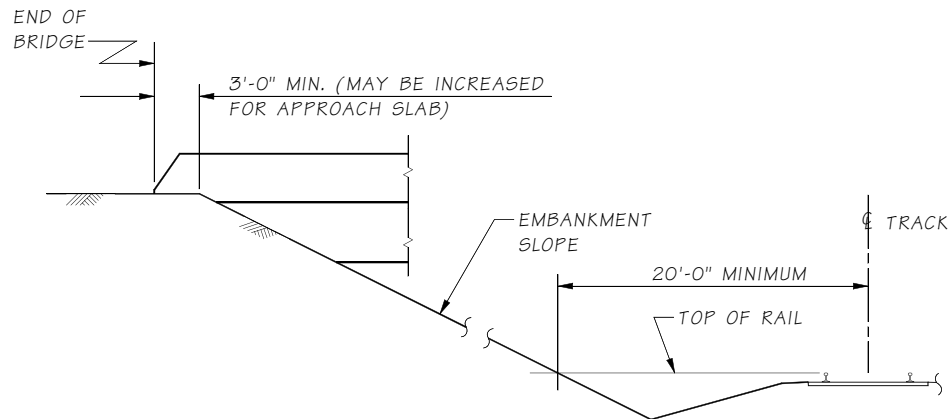
F. Vertical Clearances

For railway over highway grade separations, the provisions of Section 2.3.1 pertaining to vertical clearances of highway crossings shall apply. For highway over railway grade separations, the minimum vertical clearance shall satisfy the requirements of the *Design Manual*.

The actual minimum vertical clearances shall be shown on the Preliminary Plan (to the nearest 0.1 foot). The approximate location of the minimum vertical clearance is noted in the upper left margin of the plan.

G. Determination of Bridge Length

For railway over highway grade separations, the provisions of Section 2.3.1 pertaining to the determination of bridge length shall apply. For highway over railway grade separations, the minimum bridge length shall satisfy the minimum horizontal clearance requirements. The minimum bridge length shall generally satisfy the requirements of Figure 2.3.2-1.



Determination of Bridge Length for a Highway Over Railway Grade Separation

Figure 2.3.2-1

H. Special Considerations

For highway over railway grade separations, the top of footings for bridge piers or retaining walls adjacent to railroad tracks shall be 2 feet or more below the elevation of the top of tie and shall not have less than 2 feet of cover from the finished ground. The footing face shall not be closer than 10 feet to the center of the track. Any cofferdams, footings, excavation, etc., encroaching within 10 feet of the center of the track requires the approval of the railroad.

I. Construction Openings

For railroad clearances, see the WSDOT *Design Manual*. The minimum horizontal construction opening is 9 feet to either side of the centerline of track. The minimum vertical construction opening is 23 feet 6 inches above the top of rail at 6 feet offset from the centerline of track. Falsework openings shall be checked to verify that enough space is available for falsework beams to span the required horizontal distances and still provide the minimum vertical falsework clearance. Minimum vertical openings of less than 23 feet 6 inches shall be coordinated with the HQ Railroad Liaison Engineer.

2.3.3 Water Crossings

A. Bridge Width

The provisions of Section 2.3.1 pertaining to bridge width for highway crossings apply here.

B. Horizontal Clearances

Water crossings over navigable waters requiring clearance for navigation channels shall satisfy the horizontal clearances required by the Coast Guard. Communication with the Coast Guard will be handled through the Coast Guard Liaison Engineer. For bridges over navigable waters, the centerline of the navigation channel and the horizontal clearances (to the nearest 0.1 foot) to the piers or the pier protection shall be shown on the Plan view of the Preliminary Plan. Pier locations shall be reviewed by the HQ Hydraulics unit.

C. Vertical Clearances

Vertical clearances for water crossings must satisfy floodway clearance and, where applicable, navigation clearance.

Bridges over navigable waters must satisfy the vertical clearances required by the Coast Guard. Communication with the Coast Guard will be handled through the Coast Guard Liaison Engineer. The actual minimum vertical clearance (to the nearest 0.1 foot) for the channel span shall be shown on the Preliminary Plan. The approximate location of the minimum vertical clearance shall be noted in the upper left margin of the plan. The clearance shall be shown to the water surface as required by the Coast Guard criteria.

Floodway vertical clearance will need to be discussed with the HQ Hydraulics Office. In accordance with the flood history, nature of the site, character of drift, and other factors, they will determine a minimum vertical clearance for the 100-year flood. The roadway profile and the bridge superstructure depth must accommodate this. The actual minimum vertical clearance to the 100-year flood shall be shown (to the nearest 0.1 foot) on the Preliminary Plan, and the approximate location of the minimum vertical clearance shall be noted in the upper left margin of the plan.

D. End Slopes

The type and rate of end slopes for water crossings is similar to that for highway crossings. Soil conditions and stability, fill height, location of toe of fill, existing channel conditions, flood and scour potential, and environmental concerns are all important.

As with highway crossings, the Region, and Materials Laboratory Geotechnical Services Branch will make preliminary recommendations as to the type and rate of end slope. The HQ Hydraulics Office will also review the Region's recommendation for slope protection.

E. Determination of Bridge Length

Determining the overall length of a water crossing is not as simple and straightforward as for a highway crossing. Floodway requirements and environmental factors have a significant impact on where piers and fill can be placed.

If a water crossing is required to satisfy floodway and environmental concerns, it will be known by the time the Preliminary Plan has been started. Environmental studies and the Design Report prepared by the region will document any restrictions on fill placement, pier arrangement, and overall floodway clearance. The Hydraulics Office will need to review the size, shape, and alignment of all bridge piers in the floodway and the subsequent effect they will have on the base flood elevation. The overall bridge length may need to be increased depending on the span arrangement selected and the change in the flood backwater, or justification will need to be documented.

F. Scour

The HQ Hydraulics Office will indicate the anticipated depth of scour at the bridge piers. They will recommend pier shapes to best streamline flow and reduce the scour forces. They will also recommend measures to protect the piers from scour activity or accumulation of drift (use of deep foundations, minimum cover to top of footing, riprap, pier alignment to stream flow, closure walls between pier columns, etc.).

G. Pier Protection

For bridges over navigable channels, piers adjacent to the channel may require pier protection such as fenders or pile dolphins. The Coast Guard will determine whether pier protection is required. This determination is based on the horizontal clearance provided for the navigation channel and the type of navigation traffic using the channel.

H. Construction Access and Time Restrictions

Water crossings will typically have some sort of construction restrictions associated with them. These must be considered during preliminary plan preparation.

The time period that the Contractor will be allowed to do work within the waterway may be restricted by regulations administered by various agencies. Depending on the time limitations, a bridge with fewer piers or faster pier construction may be more advantageous even if more expensive.

Contractor access to the water may also be restricted. Shore areas supporting certain plant species are sometimes classified as wetlands. A work trestle may be necessary in order to work in or gain access through such areas. Work trestles may also be necessary for bridge removal as well as new bridge construction. Work trestle feasibility, location, staging, deck area and approximate number of piles, and estimated cost need to be determined to inform the Region as part of the bridge preliminary plan.

2.3.4 Bridge Widening

A. Bridge Width

The provisions of Section 2.3.1 pertaining to bridge width for highway crossings shall apply. In most cases, the width to be provided by the widening will be what is called for by the design standards, unless a deviation is approved.

B. Traffic Restrictions

Bridge widenings involve traffic restrictions on the widened bridge and, if applicable, on the lanes below the bridge. The bridge site data submitted by the region should contain information regarding temporary lane widths and staging configurations. This information should be checked to be certain that the existing bridge width, and the bridge roadway width during the intermediate construction stages of the bridge are sufficient for the lane widths, shy distances, temporary barriers, and construction room for the contractor. These temporary lane widths and shy distances are noted on the Preliminary Plan. The temporary lane widths and shy distances on the roadway beneath the bridge being widened should also be checked to ensure adequate clearance is available for any substructure construction.

C. Construction Sequence

A construction sequence shall be developed using the traffic restriction data in the bridge site data. The construction sequence shall take into account the necessary steps for construction of the bridge widening including both the substructure and superstructure. Placement of equipment is critical because of limited access and working space limitations. Space is required for cranes to construct shafts and erect the girders. Consult the Construction Support Unit for crane information, such as: boom angle, capacities, working loads, working radius, and crane footprint. Construction work off of and adjacent to the structure and the requirements of traffic flow on and below the structure shall be taken into account. Generally, cranes are not allowed to lift loads while supported from the existing structure. Checks shall be made to be certain that girder spacing, closure pours, and removal work are all compatible with the traffic arrangements.

Projects with several bridges being widened at the same time should have sequencing that is compatible with the Region's traffic plans during construction and that allow the Contractor room to work. It is important to meet with the Region project staff to assure that the construction staging and channelization of traffic during construction is feasible and minimizes impact to the traveling public.

2.3.5 Detour Structures

A. Bridge Width

The lane widths, shy distances, and overall roadway widths for detour structures are determined by the Region. Review and approval of detour roadway widths is done by the HQ Traffic Office.

B. Live Load

All detour structures shall be designed for 75% of HL 93 live load unless approved otherwise by the Bridge Design Engineer. Construction requirements, such as a year long expected use, and staging are sufficient reasons to justify designing for a higher live load of HL-93. Use of an HL 93 live load shall be approved by the Bridge Design Engineer.

2.3.6 Retaining Walls and Noise Walls

The requirements for Preliminary Plans for retaining walls and noise walls are similar to the requirements for bridges. The plan and elevation views define the overall limits and the geometry of the wall. The section view will show general structural elements that are part of the wall and the surface finish of the wall face.

The most common types of walls are outlined in Chapter 8 of the *Bridge Design Manual* and the *Design Manual*. The Bridge and Structures Office is responsible for Preliminary Plans for all nonstandard walls (retaining walls and noise walls) as spelled out in the *Design Manual*.

2.3.7 Bridge Deck Drainage

The HQ Hydraulics Office provides a review of the Preliminary Plan with respect to the requirements for bridge deck drainage. An 11x17 print shall be provided to the HQ Hydraulics Office for their review as soon as the Preliminary Plan has been developed. The length and width of the structure, profile grade, superelevation diagram, and any other pertinent information (such as locations of drainage off the structure) should be shown on the plan. For work with existing structures, the locations of any and all bridge drains shall be noted.

The HQ Hydraulics Office or the Region Hydraulics staff will determine the type of drains necessary (if any), the location, and spacing requirements. They will furnish any details or modifications required for special drains or special situations.

If low points of sag vertical curves or superelevation crossovers occur within the limits of the bridge, the region should be asked to revise their geometrics to place these features outside the limits of the bridge. If such revisions cannot be made, the HQ Hydraulics Office will provide details to handle drainage with bridge drains on the structure.

2.3.8 Bridge Deck Protective Systems

The Preliminary Plan shall note in the lower left margin the type of deck protective system to be utilized on the bridge. The most commonly used systems are described in Section 5.7.4 of the *Bridge Design Manual*.

New construction will generally be System 1 (2½ inch concrete top cover plus epoxy-coated rebars for the top mat). System 2 (MC overlay) and System 3 (HMA overlay) are to be used on new construction that require overlays and on widenings for major structures. The type of overlay to be used should be noted in the bridge site data submitted by the Region. The bridge condition report will indicate the preference of the Deck Systems Specialist in the Bridge and Structures Office.

2.3.9 Construction Clearances

Most projects involve construction in and around traffic. Both traffic and construction must be accommodated. Construction clearances and working room must be reviewed at the preliminary plan stage to verify bridge constructability.

For construction clearances for roadways, the Region shall supply the necessary traffic staging information with the bridge site data. This includes temporary lane widths and shoulder or shy distances, allowable or necessary alignment shifts, and any special minimum vertical clearances. With this information, the designer can establish the falsework opening or construction opening.

The horizontal dimension of the falsework or construction opening shall be measured normal to the alignment of the road which the falsework spans. The horizontal dimension of the falsework or construction opening shall be the sum of the temporary traffic lane widths and shoulder or shy distances, plus two 2-foot widths for the temporary concrete barriers, plus additional 2 feet shy distances behind the temporary barriers. For multi-span falsework openings, a minimum of 2 feet, and preferably 4 feet, shall be used for the interior support width. This interior support shall also have 2 feet shy on both sides to the two 2-foot wide temporary concrete barriers that will flank the interior support.

The minimum vertical clearance of the construction opening shall normally be 16 feet 6 inches or as specified by the Region. The vertical space available for the falsework must be deep to accommodate the falsework stringers, camber strips, deck, and all deflections. If the necessary depth is greater than the space available, either the minimum vertical clearance for the falsework shall be reduced or the horizontal clearance and span for the falsework shall be reduced, or the profile grade of the structure shall be raised. Any of these alternatives shall be approved by the Region.

Once the construction clearances have been determined the designer should meet with the region to review the construction clearances to ensure compatibility with the construction staging. This review should take place prior to finalizing the preliminary bridge plan.

For railroads see Section 2.3.2H.

2.3.10 Design Guides for Falsework Depth Requirements

Where falsework is required to support construction of cast-in-place superstructure or segmental elements, the designer of the Preliminary Plan shall confirm with the Region the minimum construction opening. See Section 2.3.9

The bridge designer shall consult with the Construction Support Engineer on falsework depth requirements outlined below.

Bridge designers shall evaluate falsework depth requirements based on the following guidelines:

A. Falsework Spans < 36 feet and No Skews

No design is necessary. Provide for minimum vertical clearance and a minimum falsework depth of 4 feet to accommodate:

W36X___ steel beam sections

$\frac{3}{4}$ -inch camber strip

$\frac{5}{8}$ -inch plywood

4x4 joists

6-inch depth for segmental falsework release

B. Falsework Spans > 36 feet or Spans with Skews or Limited Falsework Depth

While the falsework or construction openings are measured normal to the alignment which the falsework spans, the falsework span is measured parallel to the bridge alignment.

The Preliminary Plan designer shall perform preliminary design of the falsework sufficiently to determine its geometric and structural feasibility. Shallow, heavy, close-spaced wide-flange steel beams may be required to meet the span requirements within the available depth. The preliminary design shall be based on design guides in the Standard Specifications 6-02.3(17). Beams shall be designed parallel to the longitudinal axis of the bridge. The falsework span deflection shall be limited according to the Standard Specifications 6-02.3(17)B: generally span/360 for a single concrete placement, such as a slab, and span/500 for successive concrete placement forming a composite structure. This limits the stresses in the new structure from the construction and concrete placement sequences. Beam sizes shall be shown in the final plans (and in the Preliminary Plans as required) with the Contractor having the option of submitting an alternate design. The designer shall verify availability of the beam sizes shown in the plans.

C. Bridge Widening

For bridge widenings where the available depth for the falsework is fixed, designers shall design falsework using shallower and heavier steel beams to fit within the available depth. Beam sizes and details shall be shown in the final plans (and in the Preliminary Plans as required) with the Contractor having the option of using an alternate design. The designer shall verify availability of the beam sizes shown in the plans.

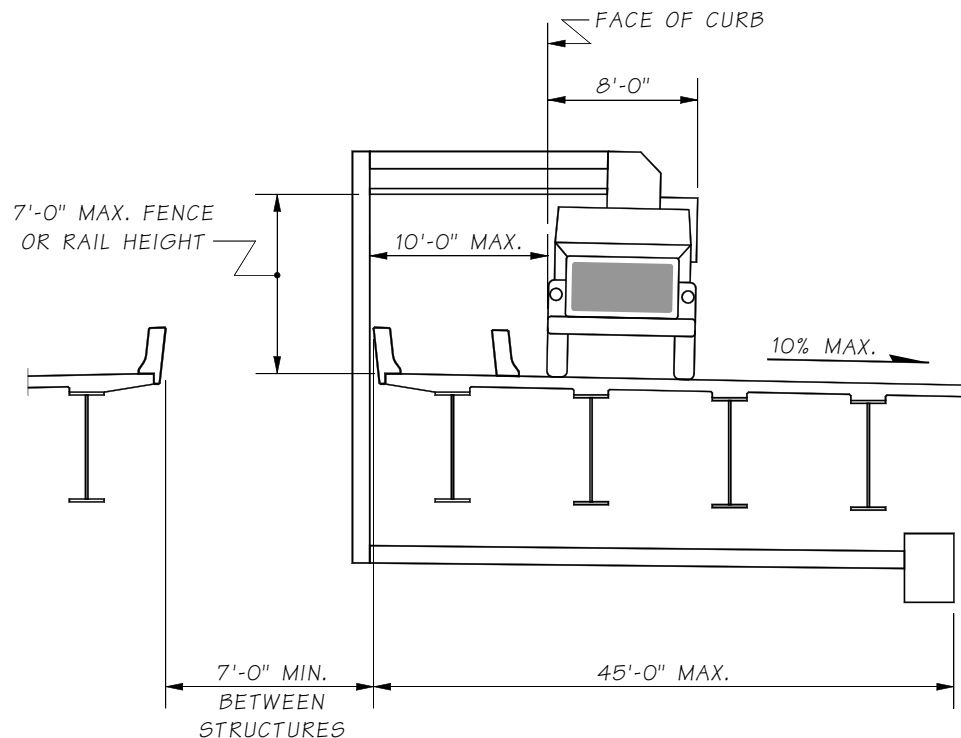
In some cases it may be appropriate to consider a shallower superstructure widening, but with similar stiffness, in order to accommodate the falsework and vertical clearance.

D. Bridge with Skews

Falsework beams shall be laid out and designed for spans parallel to the bridge centerline or perpendicular to the main axis of bending. The centerline of falsework beams shall be located within 2 feet of the bridge girder stems and preferably directly under the stems or webs in accordance with Standard Specification Section 6-02.3(17)E. Falsework beams placed normal to the skew or splayed complicate camber calculations and shall be avoided.

2.3.11 Inspection and Maintenance Access**A. General**

FHWA mandates that bridges be inspected every two years. The BPO inspectors are required to access bridge components to within 3 feet for visual inspection and to access bearings close enough to measure movement. Maintenance personnel need to access damaged members and locations that may collect debris. This is accomplished by using many methods. Safety cables, ladders, bucket trucks, Under Bridge Inspection Truck (UBIT), (see Figure 2.3.11-1), and under bridge travelers are just a few of the most common methods. Preliminary Plan designers need to be aware of these requirements and prepare designs that allow access for bridge inspectors and maintenance personnel throughout the Preliminary Plan and TS&L planning phases.



Limits of Under Bridge Inspection Truck

Figure 2.3.11-1

B. Safety Cables

Safety cables strung on steel plate girders or trusses allow for walking access. Care must be given to the application and location. Built-up plate girder bridges are detailed with a safety cable for inspectors walking the bottom flange. However, when the girders become more than 8 feet deep, the inspection of the top flange and top lateral connections becomes difficult to access. It is not feasible for the inspectors to stand on the bottom flanges when the girders are less than 5 feet deep. On large trusses, large gusset plates (3 feet or more wide) are difficult to circumvent. Tie-off cables are best located on the interior side of the exterior girder of the bridge except at large gusset plates. At these locations, cables or lanyard anchors should be placed on the inside face of the truss so inspectors can utilize bottom lateral gusset plates to stand on while traversing around the main truss gusset plates.

C. Travelers

Under bridge travelers, placed on rails that remain permanently on the bridge, can be considered on large steel structures. This is an expensive option, but it should be evaluated for large bridges with high ADT because access to the bridge would be limited by traffic windows that specify when a lane can be closed. Some bridges are restricted to weekend UBIT inspection for this reason.

D. Abutment Slopes

Slopes in front of abutments shall provide enough overhead clearance to the bottom of the superstructure to access bearings for inspection and possible replacement (usually 3 feet minimum).

2.4 Selection of Structure Type

2.4.1 Bridge Types

See Appendix sheet 2.4-A1 for a bar graph comparing structure type, span range and cost range.

The required superstructure depth is determined during the preliminary plan development process. The AASHTO LRFD Specifications in Table 2.5.2.6.3 show traditional minimum depths for constant depth superstructures. WSDOT has developed superstructure depth-to-span ratios based on past experience.

The AASHTO LRFD Specifications, Section 2.5.2.6.1, states that it is optional to check deflection criteria, except in a few specific cases. The WSDOT criteria is to check the live load deflection for all structures as specified in AASHTO LRFD Specifications, Section 3.6.1.3.2 and 2.5.2.6.2.

The superstructure depth is used to establish the vertical clearance that is available below the superstructure. For preliminary plans, the designer should use the more conservative depth determined from either the AASHTO LRFD criteria or the WSDOT criteria outlined below. In either case, the minimum depth includes the deck thickness. For both simple and continuous spans, the span length is the horizontal distance between centerlines of bearings.

The superstructure depth may be refined during the final design phase. It is assumed that any refinement will result in a reduced superstructure depth so the vertical clearance is not reduced from that shown in the preliminary plan. However, when profile grade limitations restrict superstructure depth, the preliminary plan designer shall investigate and/or work with the structural designer to determine a superstructure type and depth that will fit the requirements.

A. Reinforced Concrete Slab

1. Application

Used for simple and continuous spans up to 60 feet.

2. Characteristics

Design details and falsework relatively simple. Shortest construction time for any cast-in-place structure. Correction for anticipated falsework settlement must be included in the dead load camber curve because of the single concrete placement sequence.

3. Depth/Span Ratios

a. Constant depth

Simple span	$1/22$
Continuous spans	$1/25$

b. Variable depth

Adjust ratios to account for change in relative stiffness of positive and negative moment sections.

B. Reinforced Concrete Tee-Beam

1. Application

This type of Super Structure is not recommended for new bridges. It could only be used for bridge widening and bridges with tight curvature or unusual geometry.

Used for continuous spans 30 feet to 60 feet. Has been used for longer spans with inclined leg piers.

2. Characteristics

Forming and falsework is more complicated than for a concrete slab. Construction time is longer than for a concrete slab.

3. Depth/Span Ratios

a. Constant depth

Simple spans	$1/13$
Continuous spans	$1/15$

b. Variable depth

Adjust ratios to account for change in relative stiffness of positive and negative moment sections.

C. Reinforced Concrete Box Girder

WSDOT restricts the use of Cast-in-place reinforced concrete box girder for bridge superstructure. This type of superstructure may only be used for bridges with tight curvatures or irregular geometry upon Bridge Engineer's approval.

1. Application

This type of Super Structure is not recommended for new bridges. It could only be used for bridge widening and bridges with tight curvature or unusual geometry.

Used for continuous spans 50 feet to 120 feet. Maximum simple span 100 feet to limit excessive dead load deflections.

2. Characteristics

Forming and falsework is somewhat complicated. Construction time is approximately the same as for a tee-beam. High torsional resistance makes it desirable for curved alignments.

3. Depth/Span Ratios*

a. Constant depth

Simple spans	$1/18$
Continuous spans	$1/20$

b. Variable depth

Adjust ratios to account for change in relative stiffness of positive and negative moment sections.

*If the configuration of the exterior web is sloped and curved, a larger depth/span ratio may be necessary.

D. Post-Tensioned Concrete Box Girder

1. Application

Normally used for continuous spans longer than 120 feet or simple spans longer than 100 feet. Should be considered for shorter spans if a shallower structure depth is needed.

2. Characteristics

Construction time is somewhat longer due to post-tensioning operations. High torsional resistance makes it desirable for curved alignments.

3. Depth/Span Ratios*

a. Constant depth

Simple spans	$1/20.5$
Continuous spans	$1/25$

b. Variable depth

Two span structures

At Center of span	$1/25$
At Intermediate pier	$1/12.5$

Multi-span structures

At Center of span	$1/36$
At Intermediate pier	$1/18$

*If the configuration of the exterior web is sloped and curved, a larger depth/span ratio may be necessary.

E. Prestressed Concrete Sections

1. Application

Local precast fabricators have several standard forms available for precast concrete sections based on the WSDOT standard girder series. These are versatile enough to cover a wide variety of span lengths.

WSDOT standard girders are:

- a. WF95G, WF83G, WF74G, WF58G, WF50G, WF42G, W74G, W58G, W50G, and W42G precast, prestressed concrete I-girders requiring a cast-in-place concrete roadway deck used for spans less than 200 feet. The number (eg. 95) specifies the girder depth in inches. WF95PTG, WF83PTG and WF74PTG post-tensioned, precast segmental I-girders with cast-in-place concrete roadway deck use for simple span up to 230 feet, and continuous span up to 250 feet with continuous post-tensioning over the intermediate piers.
- b. U**G* and UF**G* precast, prestressed concrete tub girders requiring a cast-in-place concrete roadway deck are used for spans less than 140 feet. "U" specifies webs without flanges, "UF" specifies webs with flanges, ** specifies the girder depth in inches, and * specifies the bottom flange width in feet. U**G* girders have been precast as shallow as 26 inches.

Post-tensioned, precast, prestressed tub girders with cast-in-place concrete roadway deck are used for simple span up to 160 feet. and continuous span up to 200 feet.

- c. W65DG, W53DG, W41DG, and W35DG precast, prestressed concrete decked bulb tee girders requiring an HMA overlay roadway surface used for span less than 150 feet, with the Average Daily Truck (ADT) limitation of 30,000 or less.
- d. W62BTG, W50BTG, W38BT6, and W32BTG precast, prestressed concrete bulb tee girders requiring a cast-in-place concrete deck for simple spans up to 120 feet.
- e. 12-inch, 18-inch, and 26-inch precast, prestressed slabs requiring 5 inch minimum cast-in-place slab used for spans less than 90 feet.
- f. 26-inch precast, prestressed ribbed girder, deck double tee, used for span less than 60 feet, and double tee members requiring an HMA overlay roadway surface used for span less than 40 feet.

2. Characteristics

Superstructure design is quick for pretensioned girders with proven user-friendly software (PGSuper, PGSplice, and QConBridge)

Construction details and forming are fairly simple. Construction time is less than for a cast-in-place bridge. Little or no falsework is required. Falsework over traffic is usually not required; construction time over existing traffic is reduced.

Precast girders usually require that the bridge roadway superelevation transitions begin and end at or near piers; location of piers should consider this. The Region may be requested to adjust these transition points if possible.

Fully reinforced, composite 8 inch cast-in-place deck slabs continuous over interior piers or reinforced 5 inch cast-in-place deck slabs continuous over interior piers have been used with e. and f.

F. Composite Steel Plate Girder

1. Application

Used for simple spans up to 260 feet and for continuous spans from 120 to 400 feet. Relatively low dead load when compared to a concrete superstructure makes this bridge type an asset in areas where foundation materials are poor.

2. Characteristics

Construction details and forming are fairly simple. Construction time is comparatively short. Shipping and erecting of large sections must be reviewed. Cost of maintenance is higher than for concrete bridges. Current cost information should be considered because of changing steel market conditions.

3. Depth/Span Ratios

a. Constant depth

Simple spans	$1/22$
Continuous spans	$1/25$

b. Variable depth

@ Center of span	$1/40$
@ Intermediate pier	$1/20$

G. Composite Steel Box Girder

1. Use

Used for simple spans up to 260 feet and for continuous spans from 120 to 400 feet. Relatively low dead load when compared to a concrete superstructure makes this bridge type an asset in areas where foundation materials are poor.

2. Characteristics

Construction details and forming are more difficult than for a steel plate girder. Shipping and erecting of large sections must be reviewed. Current cost information should be considered because of changing steel market conditions.

3. Depth/Span Ratios

a. Constant depth

Simple spans	$1/22$
Continuous spans	$1/25$

b. Variable depth

At Center of span	$1/40$
At Intermediate pier	$1/20$

Note: Sloping webs are not used on box girders of variable depth.

H. Steel Truss

1. Application

Used for simple spans up to 300 feet and for continuous spans up to 1,200 feet. Used where vertical clearance requirements dictate a shallow superstructure and long spans or where terrain dictates long spans and construction by cantilever method.

2. Characteristics

Construction details are numerous and can be complex. Cantilever construction method can facilitate construction over inaccessible areas. Through trusses are discouraged because of the resulting restricted horizontal and vertical clearances for the roadway.

3. Depth/Span Ratios

a. Simple spans	$1/6$
b. Continuous spans	
@ Center of span	$1/18$
@ Intermediate pier	$1/9$

I. Segmental Concrete Box Girder

1. Application

Used for continuous spans from 200 to 700 feet. Used where site dictates long spans and construction by cantilever method.

2. Characteristics

Use of travelers for the form apparatus facilitates the cantilever construction method enabling long-span construction without falsework. Precast concrete segments may be used. Tight geometric control is required during construction to ensure proper alignment.

3. Depth/Span Ratios

Variable depth

At Center of span $1/50$ At Intermediate pier $1/20$

J. Railroad Bridges

1. Use

For railway over highway grade separations, most railroad companies prefer simple span steel construction. This is to simplify repair and reconstruction in the event of derailment or some other damage to the structure.

2. Characteristics

The heavier loads of the railroad live load require deeper and stiffer members than for highway bridges. Through girders can be used to reduce overall structure depth if the railroad concurs. Piers should be normal to the railroad to eliminate skew loading effects.

3. Depth/Span Ratios

Constant depth

Simple spans $1/12$ Continuous two span $1/14$ Continuous multi-span $1/15$

K. Timber

1. Use

Generally used for spans under 40 feet. Usually used for detour bridges and other temporary structures. Timber bridges are not recommend for WSDOT Bridges.

2. Characteristics

Excellent for short-term duration as for a detour. Simple design and details.

3. Depth/Span Ratios

Constant depth

Simple span – Timber beam $1/10$ Simple span – Glulam beam $1/12$ Continuous spans $1/14$

L. Other

Bridge types such as cable-stayed, suspension, arch, tied arch, and floating bridges have special and limited applications. The use of these bridge types is generally dictated by site conditions.

Preliminary design studies will generally be done when these types of structures are considered.

2.4.2 Wall Types

Retaining walls, wingwalls, curtain walls, and tall closed abutment walls may be used where required to shorten spans or superstructure length or to reduce the width of approach fills. The process of selecting a type of retaining wall should economically satisfy structural, functional, and aesthetic requirements and other considerations relevant to a specific site. A detailed listing of the common wall types and their characteristics can be found in Chapter 8 of the *Bridge Design Manual*.

2.5 Aesthetic Considerations

2.5.1 General Visual Impact

Bridge, retaining walls and noise walls have a strong visual impact in any landscape. Steps must be taken to assure that even the most basic structure will complement rather than detract from its surroundings. The EIS and bridge site data submitted by the Region should each contain a discussion on the aesthetic importance of the project site. This commentary, together with submitted video and photographs, will help the designer determine the appropriate structure type.

The State Bridge and Structures Architect should be contacted early in the preliminary bridge plan process for input on aesthetics. Normally, a visit to the bridge site with the State Bridge and Structures Architect and Region design personnel should be made.

Aesthetics is a very subjective element that must be factored into the design process in the otherwise very quantitative field of structural engineering. Bridges that are well proportioned structurally using the least material possible are generally well proportioned. However, the details such as pier walls, columns, and crossbeams require special attention to ensure a structure that will enhance the general vicinity.

For large projects incorporating several to many bridges and retaining walls, an architectural theme is frequently developed to bring consistency in structure type, details, and architectural appointments. The preliminary plan designer shall work with the State Bridge and Structures Architect to implement the theme.

2.5.2 End Piers

A. Wingwalls

The size and exposure of the wingwall at the end pier should balance, visually, with the depth and type of superstructure used. For example, a prestressed girder structure fits best visually with a 15-foot wingwall (or curtain wall/retaining wall). However, there are instances where a 20-foot wingwall (or curtain wall/retaining wall) may be used with a prestressed girder (maximizing a span in a remote area, for example or with deep girders where they are proportionally better in appearance). The use of a 20-foot wingwall shall be approved by the Bridge Design Engineer and the State Bridge and Structures Architect.

It is less expensive for bridges of greater than 40 feet of overall width to be designed with wingwalls (or curtain wall/retaining wall) than to use a longer superstructure.

B. Retaining Walls

For structures at sites where profile, right of way, and alignment dictate the use of high exposed wall-type abutments for the end piers, retaining walls that flank the approach roadway can be used to retain the roadway fill and reduce the overall structure length. Stepped walls are often used to break up the height, and allow for landscape planting. A curtain wall runs between the bridge abutment and the heel of the abutment footing. In this way, the joint in the retaining wall stem can coincide with the joint between the abutment footing and the retaining wall footing. This simplifies design and provides a convenient breaking point between design responsibilities if the retaining walls happen to be the responsibility of the Region. The length shown for the curtain wall dimension is an estimated dimension based on experience and preliminary foundation assumptions. It can be revised under design to satisfy the intent of having the wall joint coincide with the end of the abutment footing.

C. Slope Protection

The Region is responsible for making initial recommendations regarding slope protection. It should be compatible with the site and should match what has been used at other bridges in the vicinity. The type selected shall be shown on the Preliminary Plan. It shall be noted on the “Not Included in Bridge Quantities” list.

D. Noise Walls

Approval of the State Bridge and Structures Architect is required for the final selection of noise wall appearance, finish, materials and configuration.

2.5.3 Intermediate Piers

The size, shape, and spacing of the intermediate pier elements must satisfy two criteria. They must be correctly sized and detailed to efficiently handle the structural loads required by the design and shaped to enhance the aesthetics of the structure.

The primary view of the pier must be considered. For structures that cross over another roadway, the primary view will be a section normal to the roadway. This may not always be the same view as shown on the Preliminary Plan as with a skewed structure, for example. This primary view should be the focus of the aesthetic review.

Tapers and flares on columns should be kept simple and structurally functional. Fabrication and constructability of the formwork of the pier must be kept in mind. Crossbeam ends should be carefully reviewed. Skewed bridges and bridges with steep profile grades or those in sharp vertical curves will require special attention to detail.

Column spacing should not be so small as to create a cluttered look. Column spacing should be proportioned to maintain a reasonable crossbeam span balance.

2.5.4 Barrier and Wall Surface Treatments

A. Plain Surface Finish

This finish will normally be used on structures that do not have a high degree of visibility or where existing conditions warrant. A bridge in a remote area or a bridge among several existing bridges all having a plain finish would be examples.

B. Fractured Fin Finish

This finish is the most common and an easy way to add a decorative texture to a structure. Variations on this type of finish can be used for special cases. The specific areas to receive this finish should be reviewed with the State Bridge and Structures Architect.

C. Pigmented Sealer

The use of a pigmented sealer can also be an aesthetic enhancement. The particular hue can be selected to blend with the surrounding terrain. Most commonly, this would be considered in urban areas. The selection should be reviewed with the Bridge Architect and the Region.

D. Architectural Details

Rustication grooves, relief panels, pilasters, and decorative finishes may visually improve appearance at transitions between different structure types such as cast-in-place abutments to structural earth retaining walls. Contact the State Bridge and Structures Architect for guidance.

2.5.5 Superstructure

The horizontal elements of the bridge are perhaps the strongest features. The sizing of the structure depth based on the span/depth ratios in Section 2.4.1, will generally produce a balanced relationship.

Designs rising to the level of "Art" shall be subject to the procedures outlined in the *Design Manual*.

Haunches or rounding of girders at the piers can enhance the structure's appearance. The use of such features should be kept within reason considering fabrication of materials and construction of formwork. The amount of haunch should be carefully reviewed for overall balance from the primary viewing perspective. Haunches are not limited to cast-in-place superstructures, but may be used in special cases on precast, prestressed I girders. They require job-specific forms which increase cost, and standard design software is not directly applicable.

The slab overhang dimension should approach that used for the structure depth. This dimension should be balanced between what looks good for aesthetics and what is possible with a reasonable slab thickness and reinforcement.

For box girders, the exterior webs can be sloped, but vertical webs are preferred. The amount of slope should not exceed 1½: 1 for structural reasons, and should be limited to 4:1 if sloped webs are desired. Sloped webs should only be used in locations of high aesthetic impact.

When using precast, prestressed girders, all spans shall be the same series, unless approved otherwise by the Bridge and Structures Engineer.

2.6 Miscellaneous

2.6.1 Structure Costs

See Section 12.3 for preparing cost estimates for preliminary bridge design.

2.6.2 Handling and Shipping Precast Members and Steel Beams

Bridges utilizing precast concrete beams or steel beams need to have their access routes checked and sites reviewed to be certain that the beams can be transported to the site. It must also be determined that they can be erected once they reach the site.

Both the size and the weight of the beams must be checked. Likely routes to the site must be adequate to handle the truck and trailer hauling the beams. Avoid narrow roads with sharp turns, steep grades, and/or load-rated bridges, which may prevent the beams from reaching the site. The Bridge Preservation Office should be consulted for limitations on hauling lengths and weights.

Generally 200 kips is the maximum weight of a girder that may be hauled by truck. When the weight of a prestressed concrete girder cast in one piece exceeds 160 kips, it may be required to include a post-tensioned 2 or 3-piece option detailed in the contract plans.

The site should be reviewed for adequate space for the contractor to set up the cranes and equipment necessary to pick up and place the girders. The reach and boom angle should be checked and should accommodate standard cranes.

2.6.3 Salvage of Materials

When a bridge is being replaced or widened, the material being removed should be reviewed for anything that WSDOT may want to salvage. Items such as aluminum rail, luminaire poles, sign structures, and steel beams should be identified for possible salvage. The Region should be asked if such items are to be salvaged since they will be responsible for storage and inventory of these items.

2.7 WSDOT Standard Highway Bridge

2.7.1 Design Elements

The following are standard design elements for bridges carrying highway traffic. They are meant to provide a generic base for consistent, clean looking bridges, and to reduce design and construction costs. Modification of some elements may be required, depending on site conditions. This should be determined on a case-by-case basis during the preliminary plan stage of the design process.

A. General

Fractured Fin Finish shall be used on the exterior face of the traffic barrier. All other surfaces shall be Plain Surface Finish.

Exposed faces of wingwalls, columns, and abutments shall be vertical. The exterior face of the traffic barrier and the end of the intermediate pier crossbeam and diaphragm shall have a 1:12 backslope.

B. Substructure

End piers use the following details:

15 feet wingwalls with prestressed girders up to 74 inches in depth or a combination of curtain wall/retaining walls.

Stub abutment wall with vertical face. Footing elevation, pile type (if required), and setback dimension are determined from recommendations in the Materials Laboratory Geotechnical Services Branch Geotechnical Report.

Intermediate piers use the following details:

“Semi-raised” Crossbeams: The crossbeam below the girders is designed for the girder and slab dead load, and construction loads. The crossbeam and the diaphragm together are designed for all live loads and composite dead loads. The minimum depth of the crossbeam shall be 3 feet.

“Raised” Crossbeams: The crossbeam is at the same level as the girders are designed for all dead and live loads. “Raised” crossbeams are only used in conjunction with Prestressed Concrete Tub Girders.

Round Columns: Columns shall be 3 feet to 6 feet in diameter. Dimensions are constant full height with no tapers. Bridges with roadway widths of 40 feet or less will generally be single column piers. Bridges with roadway widths of greater the 40 feet shall have two or more columns, following the criteria established in Section 2.3.1.H. Oval or rectangular column may be used if required for structural performance or bridge visual.

C. Superstructure

Concrete Slab: 7½ inch minimum thickness, with the top and bottom mat being epoxy coated steel reinforcing bars.

Prestressed Girders: Girder spacing will vary depending on roadway width and span length. The slab overhang dimension is approximately half of the girder spacing. Girder spacing typically ranges between 6 feet and 12 feet.

Intermediate Diaphragms: Locate at the midspan for girders up to 80 feet long. Locate at third points for girders between 80 feet and 150 feet long and at quarter points for spans over 150 feet.

End Diaphragms: “End Wall on Girder” type.

Traffic Barrier: “F-shape” or Single-sloped barrier.

Fixed Diaphragm at Inter. Piers: Full or partial width of crossbeam between girders and outside of the exterior girders.

Hinged Diaphragm at Inter. Piers: Partial width of crossbeam between girders. Sloped curtain panel full width of crossbeam outside of exterior girders, fixed to ends of crossbeam.

BP Rail: 3 feet 6 inches overall height for pedestrian traffic. 4 feet 6 inches overall height for bicycle traffic.

Sidewalk: 6-inch height at curb line. Transverse slope of -0.02 feet per foot towards the curb line.

Sidewalk barrier: Inside face is vertical. Outside face slopes 1:12 outward.

The following table provides guidance regarding maximum bridge superstructure length beyond which the use of either intermediate expansion joints or modular expansion joints at the ends is required.

Superstructure Type	Maximum Length (Western WA)		Maximum Length (Eastern WA)	
	Stub Abutment	L-Abutment	Stub Abutment	L-Abutment
Concrete Superstructure				
Prestressed Girders*	450'	900'	450'	900'
PT Spliced Girder **	400'	700' ***	400'	700' ***
CIP-PT Box Girders **	400'	400'	400'	700' ***
Steel Superstructure				
Steel Plate Girder Steel Box Girder	300'	1000'	300'	800'
* Based upon 0.16" creep shortening per 100' of superstructure length, and 0.12" shrinkage shortening per 100' of superstructure length ** Based upon 0.31" creep shortening per 100' of superstructure length, and 0.19" shrinkage shortening per 100' of superstructure length *** Can be increased to 800' if the joint opening at 64F at time of construction is specified in the expansion joint table to be less than the minimum installation width of 1-1/2". This condition is acceptable if the gland is already installed when steel shapes are installed in the blockout. Otherwise (staged construction for example) the gland would need to be installed at temperatures less than 45°F.				

D. Examples

Appendices 2.3-A2-1 and 2.7-A1-1 detail the standard design elements of a standard highway bridge.

The following bridges are good examples of a standard highway bridge. However, they do have some modifications to the standard.

SR 17 Undercrossing 395/110

Contract 3785

Mullenix Road Overcrossing 16/203E&W

Contract 4143

2.7.2 Detailing the Preliminary Plan

The Bridge Preliminary Plan is used and reviewed by the Bridge and Structures Office or consultant who will do the structural design, Region designers and managers, Geotechnical engineers, Hydraulics engineers, Program managers, FHWA engineers and local agency designers and managers. It sometimes is used in public presentation of projects. With such visibility it is important that its detailing is clear, complete, professional, and attractive. The designer, detailer, and checker shall strive for completeness and consistency in information, layout, line style, and fonts. Appendix B contains examples of Preliminary Plans following time-proven format that may be helpful. See also Chapter 11, Detailing Practice.


Typical sheet layout is as follows:


1. Plan and Elevation views. (This sheet ultimately becomes the Layout sheet of the design plan set)
2. Typical Section including details of stage construction.

Superelevation diagrams, tables of existing elevations, Notes to Region, and other miscellaneous details as required shall go on Sheet 2, 3, or 4, as many as are required. See also the Preliminary Plan Checklist for details, dimensions, and notes typically required. The completed plan sheets shall be reviewed for consistency by the Preliminary Plans Detailing Specialist.


2.99 Bibliography

1. Federal Highway Administration (FHWA) publication *Federal Aid Highway Program Manual*.
FHWA Order 5520.1 (dated December 24, 1990) contains the criteria pertaining to Type, Size, and Location studies.
Volume 6, Chapter 6, Section 2, Subsection 1, Attachment 1 (Transmittal 425) contains the criteria pertaining to railroad undercrossings and overcrossings.
2. Washington Utilities and Transportation Commission *Clearance Rules and Regulations Governing Common Carrier Railroads*.
3. American Railway Engineering and Maintenance Association (AREMA) *Manual for Railroad Engineering*. Note: This manual is used as the basic design and geometric criteria by all railroads. Use these criteria unless superseded by FHWA or WSDOT criteria.
4. Washington State Department of Transportation (WSDOT) *Design Manual* (M 22-01).
5. *Local Agency Guidelines* (M 36-63).
6. American Association of State Highway and Transportation Officials *AASHTO LRFD Bridge Design Specification*.
7. The Union Pacific Railroad “*Guidelines for Design of Highway Separation Structures over Railroad (Overhead Grade Separation)*”

 Washington State Department of Transportation		Bridge Site Data General	
Region		Made By	
		Date	
Bridge Information			
SR	Bridge Name	Control Section	Project No.
Highway Section		Section, Township & Range	Datum
Structure width between curbs ?		What are expected foundation conditions?	
Will the structure be widened in a contract subsequent to this contract ? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A Which side and amount ?		When can foundation drilling be accomplished?	
Will the roadway under the structure be widened in the future? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		Is slope protection or riprap required for the bridge end slopes? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Stage construction requirements? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		Are sidewalks to be provided? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A If Yes, which side and width?	
Should the additional clearance for off-track railroad maintenance equipment be provided?		Will sidewalks carry bicycle traffic? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Can a pier be placed in the median? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		Will signs or illumination be attached to the structure? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
What are the required falsework or construction opening dimensions ?		Will utility conduits be incorporated in the bridge? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
Are there detour or shoofly bridge requirements? (If Yes, attach drawings) <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		What do the bridge barriers transition to?	
Can the R/W be adjusted to accommodate toe of approach fills? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		Furnish type and location of existing features within the limits of this project, such as retaining walls, sign support structures, utilities, buildings, powerlines, etc.	
What is the required vertical clearance?			
What is the available depth for superstructure?			
Are overlays planned for a contract subsequent to this contract? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A			
Can profile be revised to provide greater or less clearance? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A If Yes, which line and how much?		Any other data relative to selection of type, including your recommendations?	
Will bridge be constructed before, with or after approach fill? <input type="checkbox"/> Before <input type="checkbox"/> With <input type="checkbox"/> After <input type="checkbox"/> N/A			
Attachments			
<input type="checkbox"/> Vicinity Map			
<input type="checkbox"/> Bridge Site Contour Map			
<input type="checkbox"/> Specific Roadway sections at bridge site and approved roadway sections			
<input type="checkbox"/> Vertical Profile Data			
<input type="checkbox"/> Horizontal Curve Data			
<input type="checkbox"/> Superelevation Transition Diagrams			
<input type="checkbox"/> Tabulated field surveyed and measured stations, offsets, and elevations of existing roadways			
<input type="checkbox"/> Photographs and video tape of structure site, adjacent existing structures and surrounding terrain			
<input type="checkbox"/>			
<input type="checkbox"/>			
DOT Form 235-002 EF Revised 1/2000			

 Washington State Department of Transportation		Bridge Site Data Rehabilitation	
Region		Made By	
		Date	
Bridge Information			
SR	Bridge Name		Project No.
Highway Section		Section, Township & Range	Vertical Datum
Existing roadway width, curb to curb _____		Left of ϕ _____	Right of ϕ _____
Proposed roadway width, curb to curb _____		Left of ϕ _____	Right of ϕ _____
Existing wearing surface (<i>concrete, HMA, HMA w /membrane, MC, epoxy, other</i>) _____		Thickness _____	
Existing drains to be plugged, modified, moved, other? _____			
Proposed overlay (<i>HMA, HMA w /membrane, MC, epoxy</i>) _____		Thickness _____	
Is bridge rail to be modified? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Existing rail type _____			
Proposed rail replacement type _____			
Will terminal design "F" be required? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Will utilities be placed in the new barrier? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Will the structure be overlaid with or after rail replacement? <input type="checkbox"/> With Rail Replacement <input type="checkbox"/> After Rail Replacement			
Condition of existing expansion joints _____			
Existing expansion joints watertight? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Measure width of existing expansion joint, normal to skew.		@ curb line _____ Inch	@ ϕ roadway _____ Inch
		@ curb line _____ Inch	
Estimate structure temperature at time of expansion joint measurement _____			
Type of existing expansion joint _____			
Describe damage, if any, to existing expansion joints _____			
Existing Vertical Clearance _____			
Proposed Vertical Clearance (at curb lines of traffic barrier) _____			
Attachments			
<input type="checkbox"/> Video tape of project			
<input type="checkbox"/> Sketch indicating points at which expansion joint width was measured.			
<input type="checkbox"/> Photographs of existing expansion joints.			
<input type="checkbox"/> Existing deck chloride and delamination data.			
<input type="checkbox"/> Roadway deck elevations at curb lines (10-foot spacing)			

DOT Form 235-002A EF
Revised 5/05

 Washington State Department of Transportation		Bridge Site Data Stream Crossings	
Region _____		Made By _____	
		Date _____	
Bridge Information			
SR _____	Bridge Name _____		Control Section _____
		Project No. _____	
Highway Section _____		Section, Township & Range _____	
		Datum _____	
Name of Stream _____		Tributary of _____	
Elevation of W.S. (@ date of survey) _____		Stream Velocity (fps @ date of survey) _____	
		Depth of Flow (@ date of survey) _____	
Max Highwater Elevation _____		@ Date _____	
Normal Highwater Elevation _____		@ Date _____	
Normal Stage Elevation _____		@ Date _____	
Extreme Low Water Elevation _____		@ Date _____	
Amount and Character of Drift _____			
Streambed Material _____			
Datum (i.e., USC and GS, USGS, etc.) _____			
Manning's "N" Value (Est.) _____			
Attachments			
<input type="checkbox"/> Site Contour Map (See Sect. 7.02.00 Highway Hydraulic Manual)			
<input type="checkbox"/> Highway Alignment and Profile (refer to map and profiles)			
<input type="checkbox"/> Streambed: Profile and Cross Sections (500 ft. upstream and downstream)			
<input type="checkbox"/> Photographs			
<input type="checkbox"/> Character of Stream Banks (i.e., rock, silt, etc.) / Location of Solid Rock			
<input type="checkbox"/> Other Data Relative to Selection of Type and Design of Bridge, Including your Recommendations (i.e., requirements of riprap, permission of piers in channel, etc.)			
<small>DOT Form 235-001 EF Revised 3/97</small>			

Appendix 2.2-A4

Preliminary Plan Checklist

Project _____ SR _____

Prelim. Plan by _____ Check by _____ Date _____

PLAN

- Survey Lines and Station Ticks
- Survey Line Intersection Angles
- Survey Line Intersection Stations
- Survey Line Bearings
- Roadway and Median Widths
- Lane and Shoulder Widths
- Sidewalk Width
- Connection/Widening for Guardrail/Barrier
- Profile Grade and Pivot Point
- Roadway Superelevation Rate (if constant)
- Lane Taper and Channelization Data
- Traffic Arrows
- Mileage to Junctions along Mainline
- Back to Back of Pavement Seats
- Span Lengths
- Lengths of Walls next to/part of Bridge
- Pier Skew Angle
- Bridge Drains, or Inlets off Bridge
- Existing drainage structures
- Existing utilities Type, Size, and Location
- New utilities - Type, Size, and Location
- Luminaires, Junction Boxes, Conduits
- Bridge mounted Signs and Supports
- Contours
- Top of Cut, Toe of Fill
- Bottom of Ditches
- Test Holes (if available)
- Riprap Limits
- Stream Flow Arrow
- R/W Lines and/or Easement Lines
- Points of Minimum Vertical Clearance
- Horizontal Clearance
- Exist. Bridge No. (to be removed, widened)
- Section, Township, Range
- City or Town
- North Arrow
- SR Number
- Bearing of Piers, or note if radial

MISCELLANEOUS

- Structure Type
- Live Loading
- Undercrossing Alignment Profiles/Elevs.
- Superelevation Diagrams
- Curve Data
- Riprap Detail
- Plan Approval Block
- Notes to Region
- Names and Signatures
- Not Included in Bridge Quantities List
- Inspection and Maintenance Access

ELEVATION

- Full Length Reference Elevation Line
- Existing Ground Line x ft. Rt of Survey Line
- End Slope Rate
- Slope Protection
- Pier Stations and Grade Elevations
- Profile Grade Vertical Curves
- BP/Pedestrian Rail
- Barrier/Wall Face Treatment
- Construction/Falsework Openings
- Minimum Vertical Clearances
- Water Surface Elevations and Flow Data
- Riprap
- Seal Vent Elevation
- Datum
- Grade elevations shown are equal to ...
- For Embankment details at bridge ends...
- Indicate F, H, or E at abutments and piers

TYPICAL SECTION

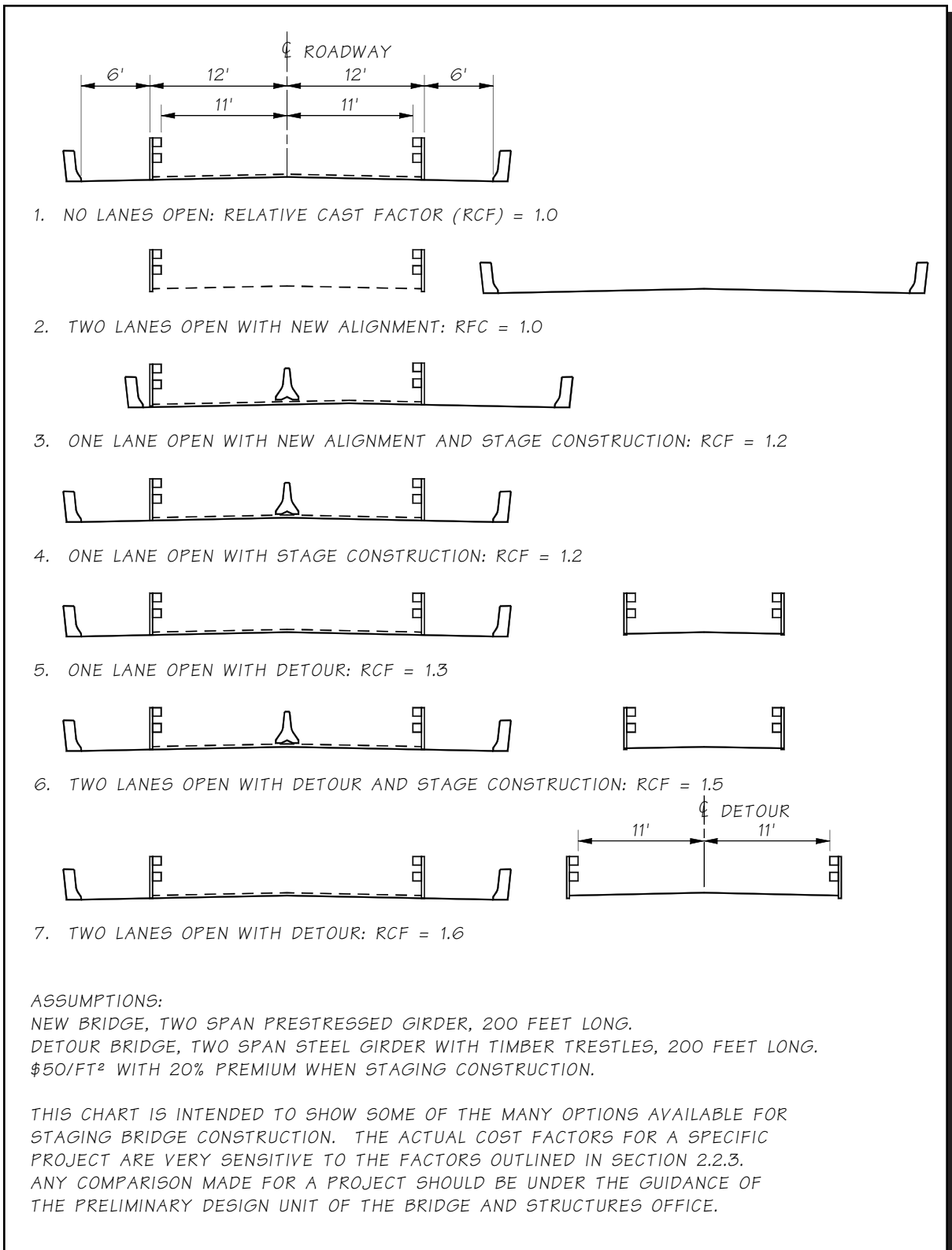
- ___ Bridge Roadway Width
- ___ Lane and Shoulder Widths
- ___ Profile Grade and Pivot Point
- ___ Superelevation Rate
- ___ Survey Line
- ___ Overlay Type and Depth
- ___ Barrier Face Treatment
- ___ Limits of Pigmented Sealer
- ___ BP/Pedestrian Rail dimensions
- ___ Stage Construction, Stage traffic
- ___ Locations of Temporary Concrete Barrier
- ___ Closure Pour
- ___ Structure Depth/Prestressed Girder Type
- ___ Conduits/Utilities in bridge
- ___ Substructure Dimensions

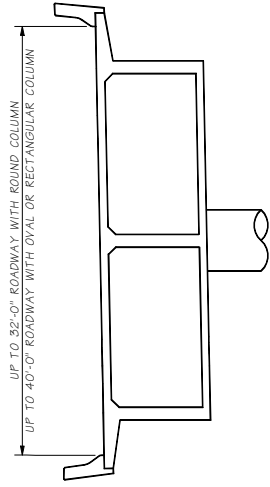
LEFT MARGIN

- ___ Job Number
- ___ Bridge (before/with/after) Approach Fills
- ___ Structure Depth/Prestressed Girder Type
- ___ Deck Protective System
- ___ Coast Guard Permit Status
(Requirement for all water crossing)
- ___ Railroad Agreement Status
- ___ Points of Minimum Vertical Clearance
- ___ Cast-in-Place Concrete Strength

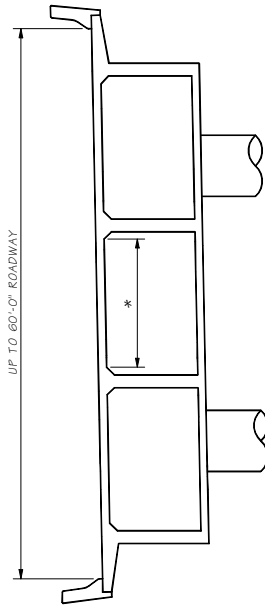
RIGHT MARGIN

- ___ Control Section
- ___ Project Number
- ___ Region
- ___ Highway Section
- ___ SR Number
- ___ Structure Name

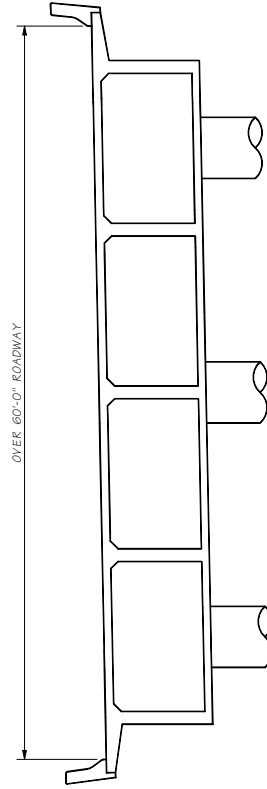




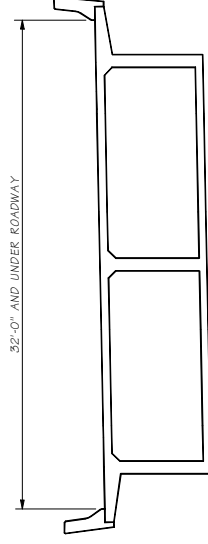
1 COLUMN MINIMUM
 PROVIDE COLLISION PROTECTION
 OR DESIGN FOR COLLISION LOADS.



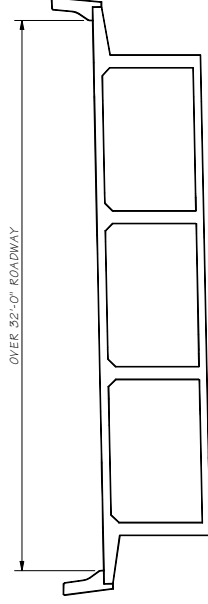
2 COLUMNS MINIMUM
 PROVIDE COLLISION PROTECTION
 OR DESIGN FOR COLLISION LOADS.



3 COLUMNS MINIMUM



3 WEBS MINIMUM



4 WEBS MINIMUM

SUPERSTRUCTURE DESIGN

DESIGN NOTES:

1. USE THE MINIMUM COLUMNS AND WEBS SHOWN TO MEET REDUNDANCY CRITERIA FOR PREVENTING CATASTROPHIC COLLAPSE OF BRIDGES.
 2. DRAWINGS ARE SHOWN FOR CONCRETE BOX GIRDERS BRIDGES, BUT THE COLUMN AND WEB REQUIREMENTS ALSO APPLY TO OTHER BRIDGE TYPES.
- * 8'-0" MAX. IS PREFERRED FOR EASE OF CONSTRUCTION.

SUBSTRUCTURE DESIGN

BRIDGE REDUNDANCY CRITERIA

Bridge Design Engr.	WA1BRIDGE116180M1Cage1pr_21window_files1523421.mxd	STATE	WASH	PROJECT NO.	10	DATE	BY	APPD	REVISION
Supervisor									
Designed By									
Checked By									
Bridge Projects Engr.									
Prelim. Plan By									
Architect/Specifier									

Washington State Department of Transportation

BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

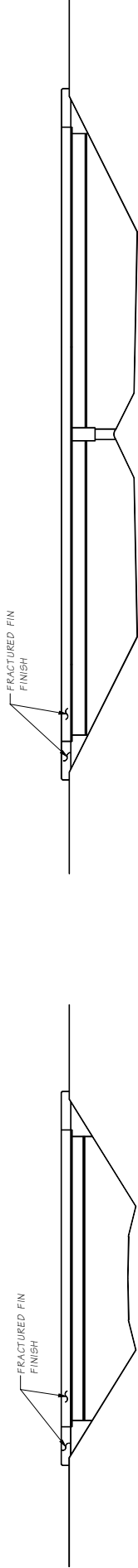
SHEET 10 OF 10

STRUCTURE TYPES	SPAN RANGE, FT.	JULY 2006 COST RANGE \$ / FT ²	SPAN RANGE, FT.
PIPE	1 - 3	30 - 60	
CONCRETE CULVERT	3 - 20	100 - 120	
PLATE ARCH	12 - 20	65 - 80	
REINF. CONCRETE SLAB	20 - 60	90 - 130	
REINF. CONCRETE TEE BEAM	30 - 60	90 - 140	
REINF. CONCRETE BOX GIRDER	50 - 120	180 - 250	
POST-TENSIONED CONC. BOX GIRDER	140 - 200	200 - 300	
SEGMENTAL P.T. BOX GIRDER	200 - 700	250 - 300	
PRESTRESSED CONC. SLAB	15 - 80	100 - 120	
PRESTRESSED CONC. DECK BULB TEE	40 - 160	100 - 145	
PRESTRESSED CONC. GIRDER	50 - 180	130 - 190	
PRESTRESSED TRAPEZOIDAL TUB GIRDER	40 - 140	160 - 200	
PRESTRESSED CONCRETE SPLICED GIRDER	140 - 230	150 - 200	
STEEL ROLLED GIRDER	20 - 70	140 - 160	
STEEL PLATE GIRDER	60 - 400	150 - 220	
STEEL BOX GIRDER	60 - 400	200 - 275	
STEEL TRUSS	300 - 1200	250 - 375	
TIMBER	10 - 20	120 - 140	
GLULAM TIMBER	14 - 40	120 - 140	
CABLE STAY BRIDGE	600 - 1200	500 - 600	
SUSPENSION BRIDGE	600 - 5000	850 - 1200	
FLOATING BRIDGE	600 +	800 - 1000	
ARCH BRIDGE	30 - 400	400 - 450	
MOVEABLE SPAN BRIDGE	200 - 350	1500 - 2000	
TUNNEL	30 +	1500 - 3000	

SPAN RANGE, FT.

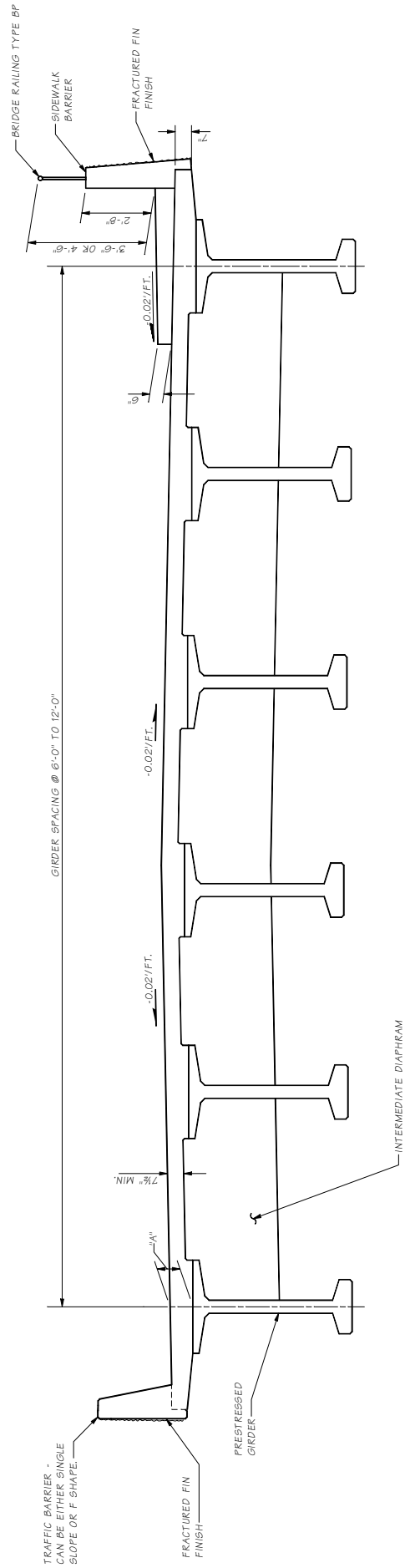
THIS CHART IS INTENDED TO SHOW SOME OF THE MANY OPTIONS AVAILABLE FOR BRIDGE CONSTRUCTION AND THE WIDE RANGE OF COSTS ASSOCIATED WITH THEM. THE ACTUAL COST TO BE USED IN ANY COMPARISON FOR A SPECIFIC PROJECT IS VERY SENSITIVE TO THE FACTORS OUTLINED IN SECTION 2.2.3. ANY COMPARISON MADE FOR A PROJECT SHOULD BE DONE UNDER THE GUIDANCE OF THE PRELIMINARY DESIGN UNIT OF THE BRIDGE AND STRUCTURES OFFICE.

Bridge Design Engr. Supervisor Designed By Checked By Bridge Projects Engr. Trainee/Non By Architect/Specalist	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BRIDGE AND STRUCTURES OFFICE	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION	BRIDGE AND STRUCTURES OFFICE	STATE 10 WASH JOB NUMBER	FEDERAL AID PROJ. NO. DIST. NO.	SHEET NO. OF SHEETS
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ELEVATION
SINGLE SPAN BRIDGE

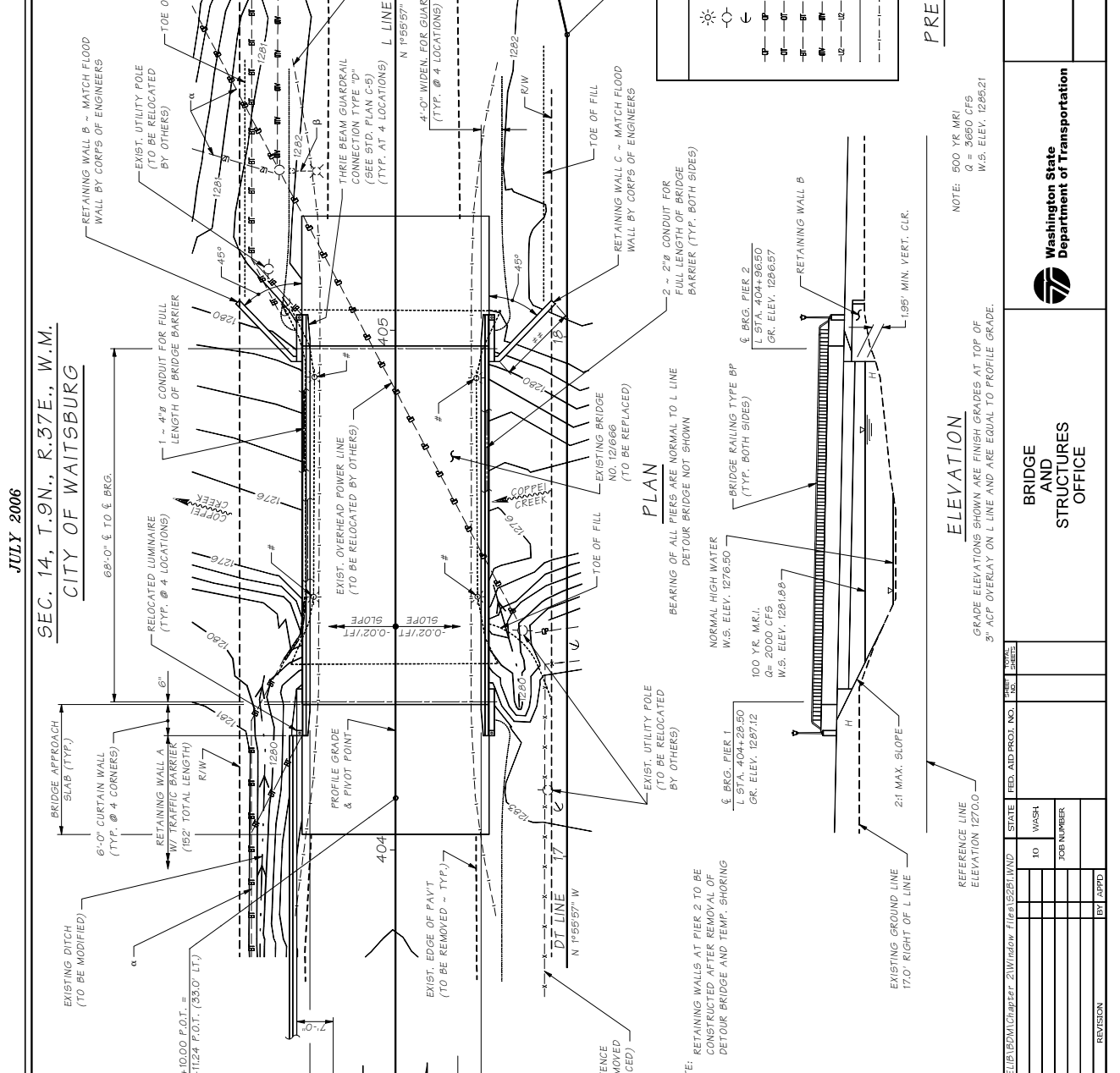
ELEVATION
TWO SPAN BRIDGE



STANDARD SUPERSTRUCTURE ELEMENTS

Bridge Design Engr.	MAURICE GILBERT/MLG/psf/pt/2/1/17/10/06	STATE	WASH	FED. AID PROJ. NO.	SPRINT NO.	TOTAL SHEETS	BRIDGE AND STRUCTURES OFFICE	Washington State Department of Transportation	SHEET	OF	SHEETS
Supervisor											
Checked By											
Drawn By											
Prelims. Plan By											
Architect/Engineer											
DATE											
REVISION											
BY											
APPD.											

SEC. 14, T.9N., R.37E., W.M. CITY OF WAITSBURG



US 12

TO DAYTON 10.0 MILES

TO WALLA WALLA 19.2 MILES

NOTE: RETAINING WALLS AT PIER 2 TO BE CONSTRUCTED AFTER REMOVAL OF DETOUR BRIDGE AND TEMP. SHORING

LEGEND:

- LIGHT POLE - EXISTING
- UTILITY POLE - EXISTING
- POLE ANCHOR - EXISTING
- OVERHEAD POWER - EXISTING
- BURIED TELEPHONE - EXISTING
- OVERHEAD CABLE TV - EXISTING
- 2 OVERHEAD UTILITIES - EXISTING
- TIMBER LIGHT STD. - EXISTING
- GUARDRAIL - EXISTING

PLAN

BEARING OF ALL PIERS ARE NORMAL TO L LINE
DETOUR BRIDGE NOT SHOWN

PRECAST PRESTRESSED SLAB UNITS
LOADING: HL-93

NOTE: 500 YR. MFLI
Q = 5650 CFS
W.S. ELEV. 1286.21

ELEVATION

GRADE ELEVATIONS SHOWN ARE FINISH GRADES AT TOP OF 3" ACP OVERLAY ON L LINE AND ARE EQUAL TO PROFILE GRADE.

BRIDGE AND STRUCTURES OFFICE

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

W.A. BRIDGE (16) (BOM) Chapter 2: W. Widdow (16a) (5/29) WAWD STATE FEED AND PROJ. NO. 10 WASH JOB NUMBER In Plan, Plan D.D. Architect/Specifier

DATE REVISION BY APPD

PLAN APPROVED BY:

BRIDGE AND STRUCTURES ENGINEER

PROJECT SUPERVISOR

DESIGNED BY

CHECKED BY

DEVELOPED BY

BRIDGE PROJECTS ENGR.

In Plan, Plan D.D.

ARCHITECT/SPECIFIER

DATE REVISION BY APPD

JOB NO. SHEET

C.S. 3681 0 PROJ. NO. 1295 0 SOUTH CENTRAL REGION 0 12 0 P 357.04 CITY OF WAITSBURG 0 COPPEL CREEK BRIDGE NO. 12-666 REPLACEMENT

SEC. 14, T.9N., R.37E., W.M.
CITY OF WAITSBURG

COAST GUARD LIAISON
DETOUR BRIDGE W 33X118 GIRDERS
STEEL STRINGER WITH GLULAM DECK
PERMIT TARGET DATE

L STA. 404+10.00 P.O.T. =
DT STA. 17+11.24 P.O.T. (233.0' LT.)

BR. NO. 121666
(TO BE REPLACED)

EXIST. OVERHEAD POWER LINE
(TO BE RELOCATED BY OTHERS)

TEMP. SHORING

404

PT. OF MIN. VERT. CLR.

TEMP. SHORING

L LINE
N 1°55'57" W

DT LINE
N 14°55'12.2" W

DT STA. 18+58.07 A.P. =
L STA. 405+56.85 (33.0' RT.)

RETAINING WALL C
(TO BE CONSTRUCTED
AFTER THE REMOVAL
OF THE DETOUR BRIDGE)

TOP OF TEMP. FILL (TYP. @ 4 CORNERS)

TEMP. CONC. BARRIER (TYP.)

57'-2" EDGE TO EDGE OF DECK

BEARING OF ξ PIERS IS N 70°04'03" E

19°

1282

1277

1280

TO WALLA WALLA
19.2 MILES

A.P.
DT STA. 18+96.60
ELEV. 1281.94

-0.92009 % -0.0040 %

16'-0" ROADWAY

2'-0" SHY LANE

2'-0" SHY LANE

17' SLOPE

1280

EXIST. UTILITY POLE
(TO BE RELOCATED
BY OTHERS)

EXISTING FENCE
(TO BE REMOVED
AND REPLACED)

1280

1277

1280

1282

TEMP. SHORING

TEMP. SHORING

PROFILE GRADE
& PIVOT POINT

TO DAYTON
10.0 MILES

US 12

LEGEND

LIGHT POLE - EXISTING

UTILITY POLE - EXISTING

POLE ANCHOR - EXISTING

OVERHEAD POWER - EXISTING

OVERHEAD TELEPHONE - EXISTING

BURIED TELEPHONE - EXISTING

OVERHEAD CABLE TV - EXISTING

2 OVERHEAD UTILITIES - EXISTING

TIMBER LIGHT STD. - EXISTING

GUARDRAIL - EXISTING

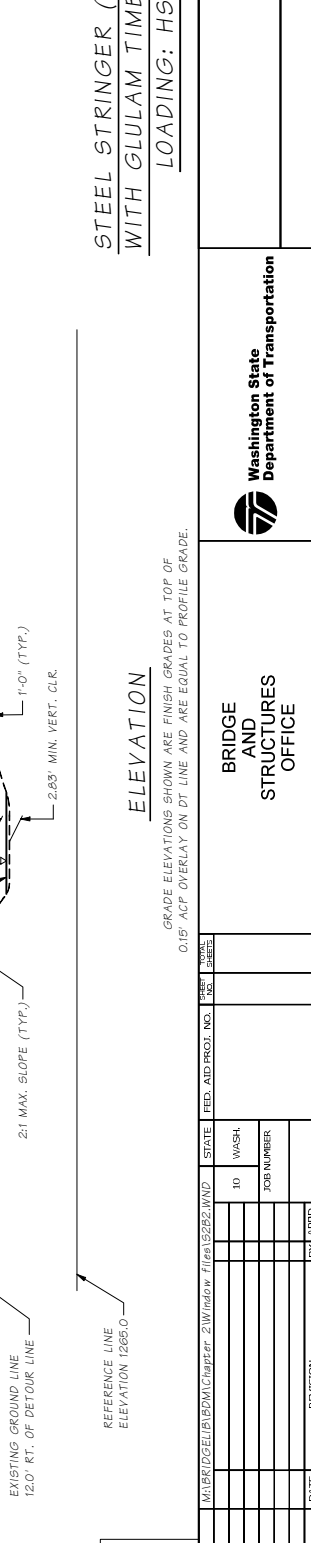
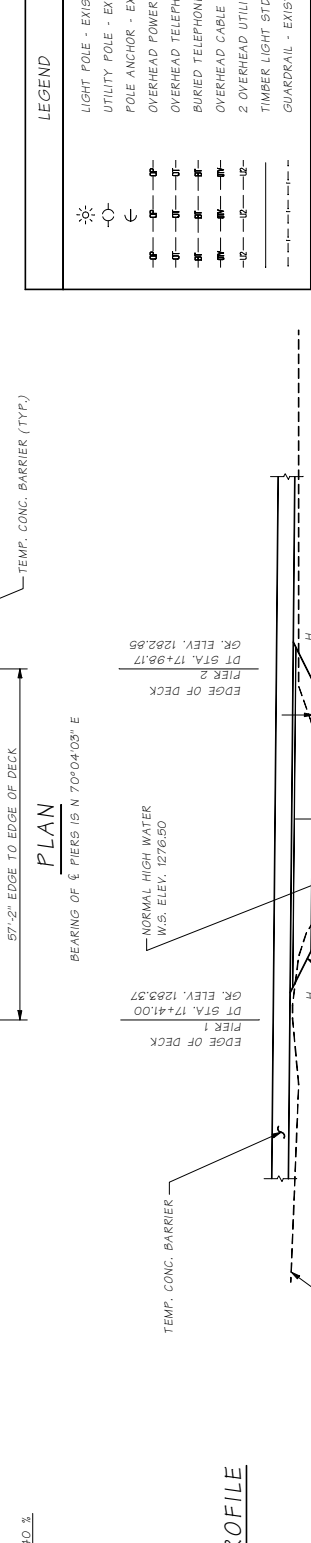
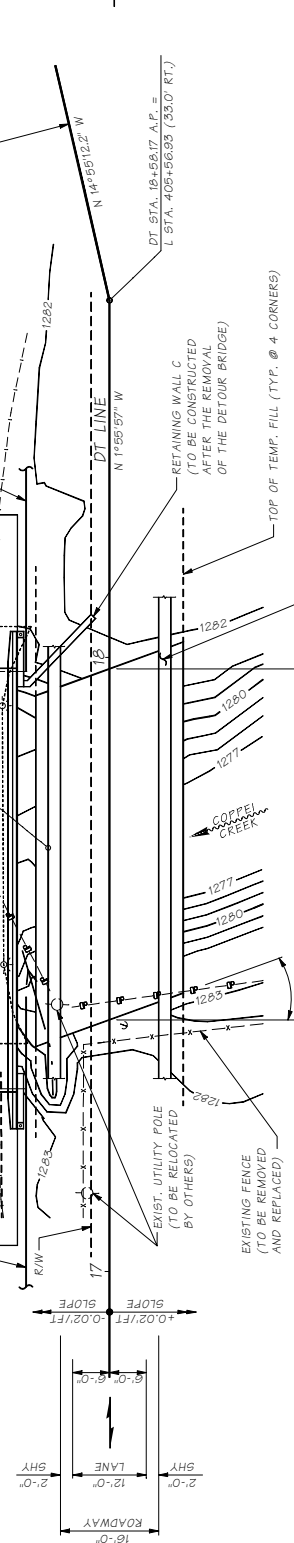
STEEPLE

SPRINT

OF

SHEET

C.S. 3681 0 PROJ. NO. XL1295 0 SOUTH CENTRAL REGION 0 US 12 0 HP 357.04 CITY OF WAITSBURG 0 DETOUR BRIDGE



PLAN APPROVED BY:

BRIDGE AND STRUCTURES ENGINEER

PROJECT PREPARED BY: ENGINEER

BRIDGE DESIGN ENGR.

Supervisor

Checked By

Created By

Bridge Projects Engr.

John M. Ivy

Architect/Specifier

DATE

REVISION

BY

APPD

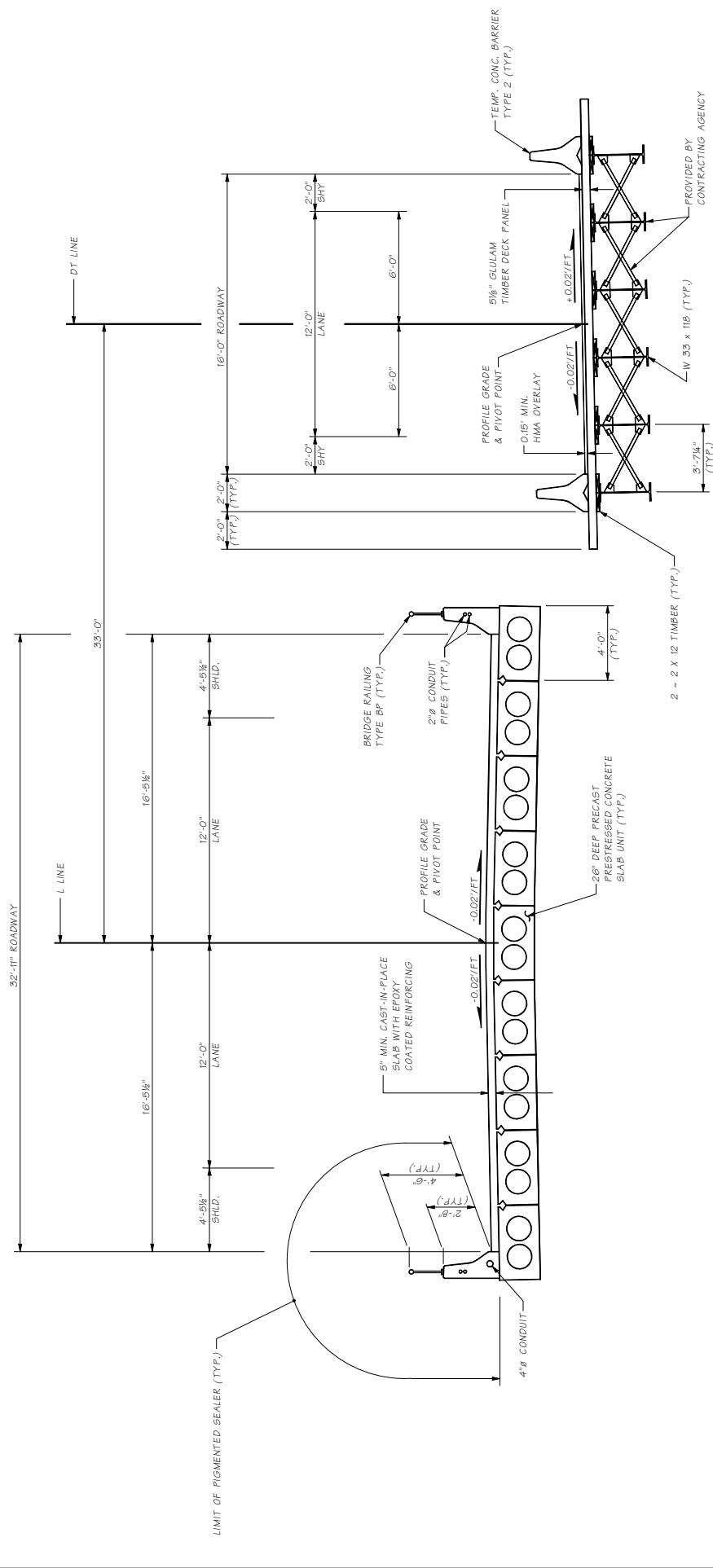
JOB NO. 2-B-2

SHEET NO. 2

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

BRIDGE AND STRUCTURES OFFICE

STEEL STRINGER (W33X118)
WITH GLULAM TIMBER DECK
LOADING: HS-20



JOB NO. SHEET

2-B-3

TYPICAL SECTION
BRIDGE NO. 12/666 & DETOUR BRIDGE
SHOWN NEAR MID SPAN

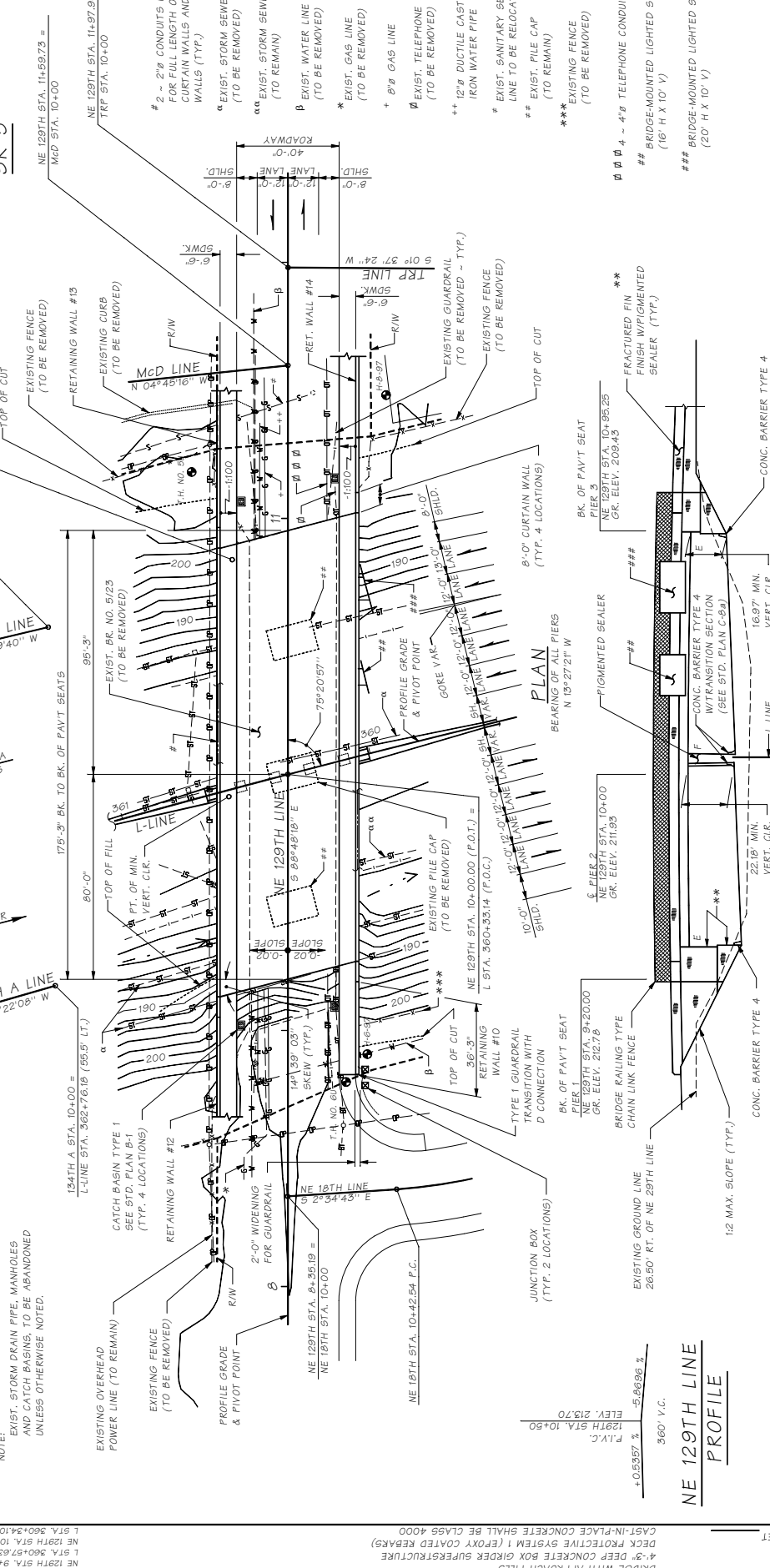
Bridge Design Eng. Supervisor Designed By Checked By Bridge Projects Eng. In-Plant, Plan Dy. Architect/Specifier	WA BRIDGE 16 BDM Chapter 2 Window 1 (16) 5/23 WND	STATE WASH	FEDERAL PROJ. NO. 10	FEDERAL AID PROJ. NO. JOB NUMBER	SHEET NO. 10	TOTAL SHEETS 10	WASHINGTON STATE Department of Transportation	BRIDGE AND STRUCTURES OFFICE	BRIDGE NO. 12/666 & DETOUR BRIDGE	SHEET OF	DATE REVISION	BY APPD	DATE REVISION	PROJECT NO. 12-866 REPLACEMENT

SEC. 26, T.3N., R.1E., W.M.
CLARK COUNTY
SR 5

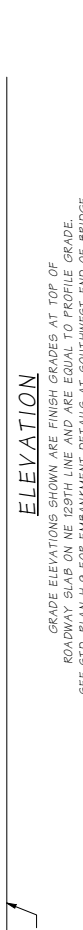


P.I. STATION	Δ	RADIUS	TANGENT	LENGTH	BK. TANGENT BRG.
L 347+80.00	37°42'00"	4580.00'	1967.03'	3020.17'	N 21°44'52" E

NOTE: EXIST. STORM DRAIN PIPE, MANHOLES AND CATCH BASINS TO BE ABANDONED UNLESS OTHERWISE NOTED.



PRECAST POST-TENSIONED
CONCRETE BOX GIRDER
LOADING: HL-93

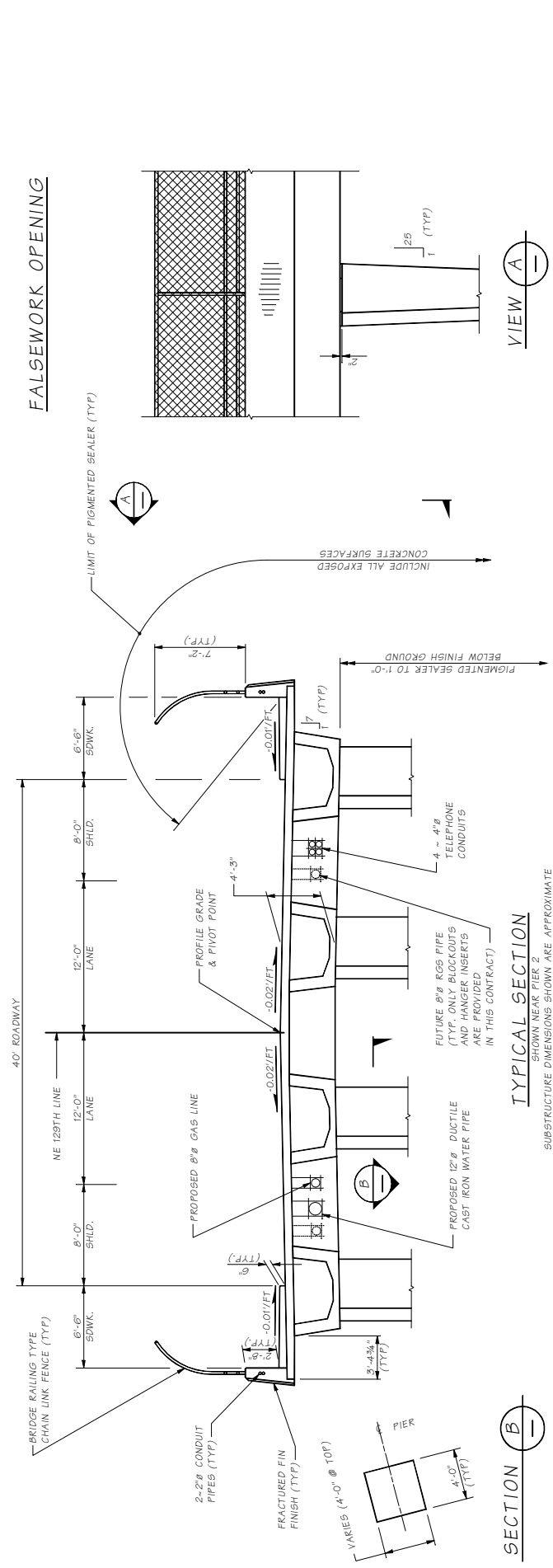
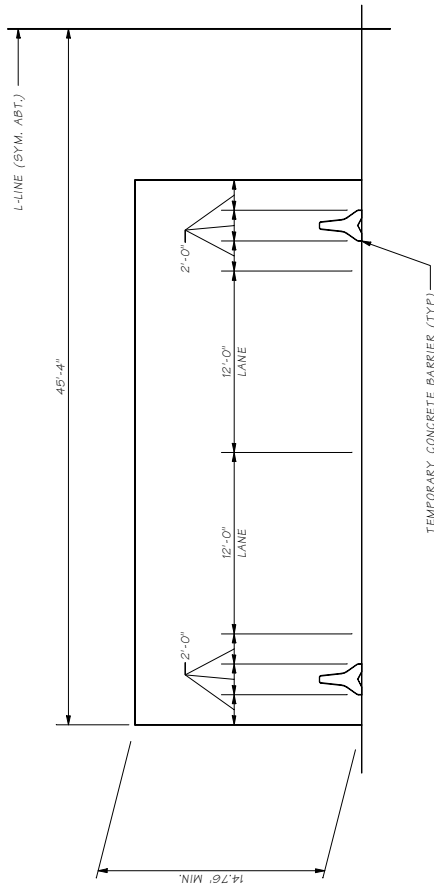


PLAN APPROVED BY:
J. A. W. (Signature)
BRIDGE AND STRUCTURES ENGINEER
Checked By:
Miles Clark
PROJECT DEVELOPMENT ENGINEER

DATUM
N.A.Y.D. OF 1988
GRADE ELEVATIONS SHOWN ARE FINISH GRADES AT TOP OF ROADWAY SLAB ON NE 129TH LINE AND ARE EQUAL TO PROFILE GRADE. SEE STD. PLAN H-9 FOR EMPALEMENT DETAILS AT SOUTHWEST END OF BRIDGE.

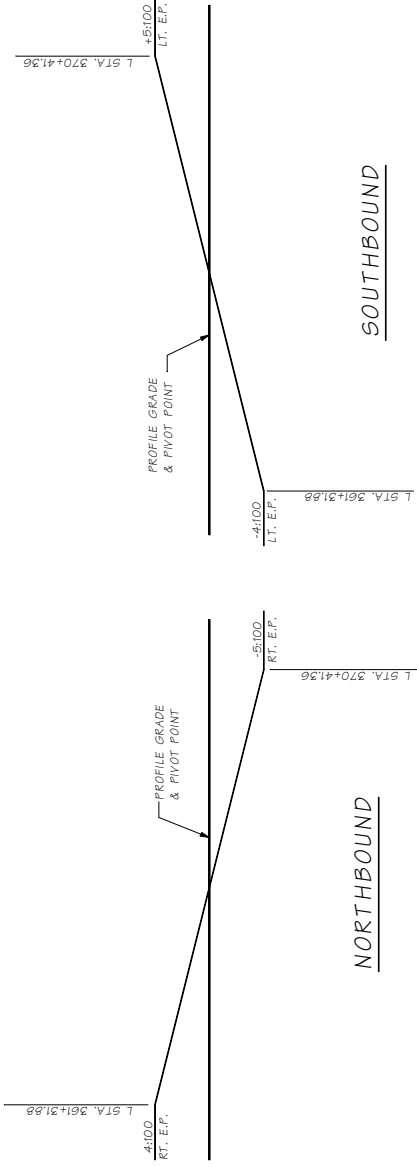
DATE	REVISION	BY	APPD

Washington State Department of Transportation
BRIDGE AND STRUCTURES OFFICE
PRELIMINARY PLAN

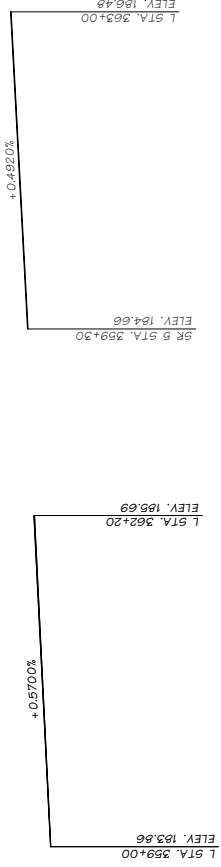


TYPICAL SECTION

Bridge Design Engr.	DATE	REVISION	BY	APPD.
Supervisor				
Designed By				
Checked By				
Detailed By				
Bridge Projects Engr.				
Instrn. Plan By				
Architect/Specifier				
Job No.	10	WASH.		
State				
FED. AID PROJ. NO.				
STATE				
JOB NUMBER				
DATE				
REVISION				
BY				
APPD.				
BRIDGE AND STRUCTURES OFFICE				
Washington State Department of Transportation				
PRELIMINARY PLAN				
SHEET				
OF				
PROJECT				



L-LINE
SUPERELEVATION DIAGRAM



L-LINE NB PROFILE

L-LINE SB PROFILE

9-B-2
SR 5 JOB NO. 7202 SHEET 3 OF 3

Bridge Design Eng.	DATE	REVISION	BY	APPD	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor					WA			
Checked By					10			
Designed By					JOB NUMBER			
Bridge Projects Engr.								
Instr. Plan by								
Architect/Specifier								
					BRIDGE AND STRUCTURES OFFICE			
PRELIMINARY PLAN					PRELIMINARY PLAN			
3 of 3					3 of 3			

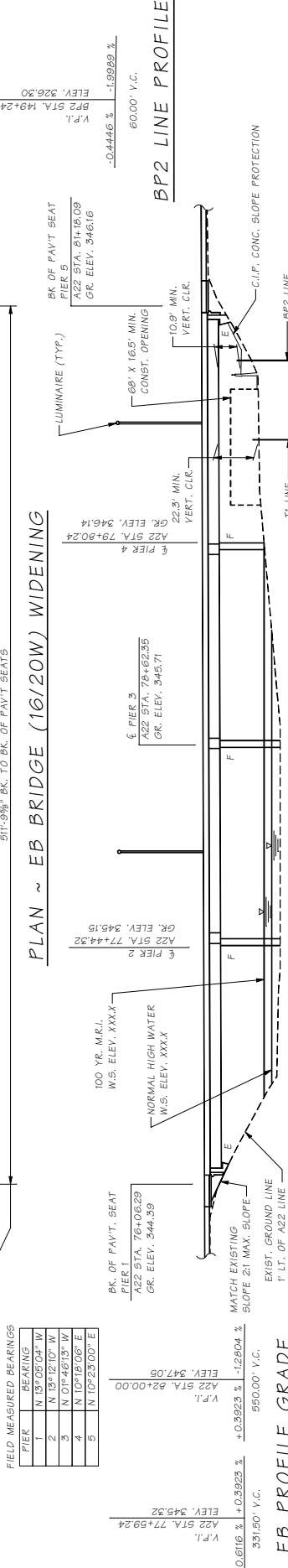
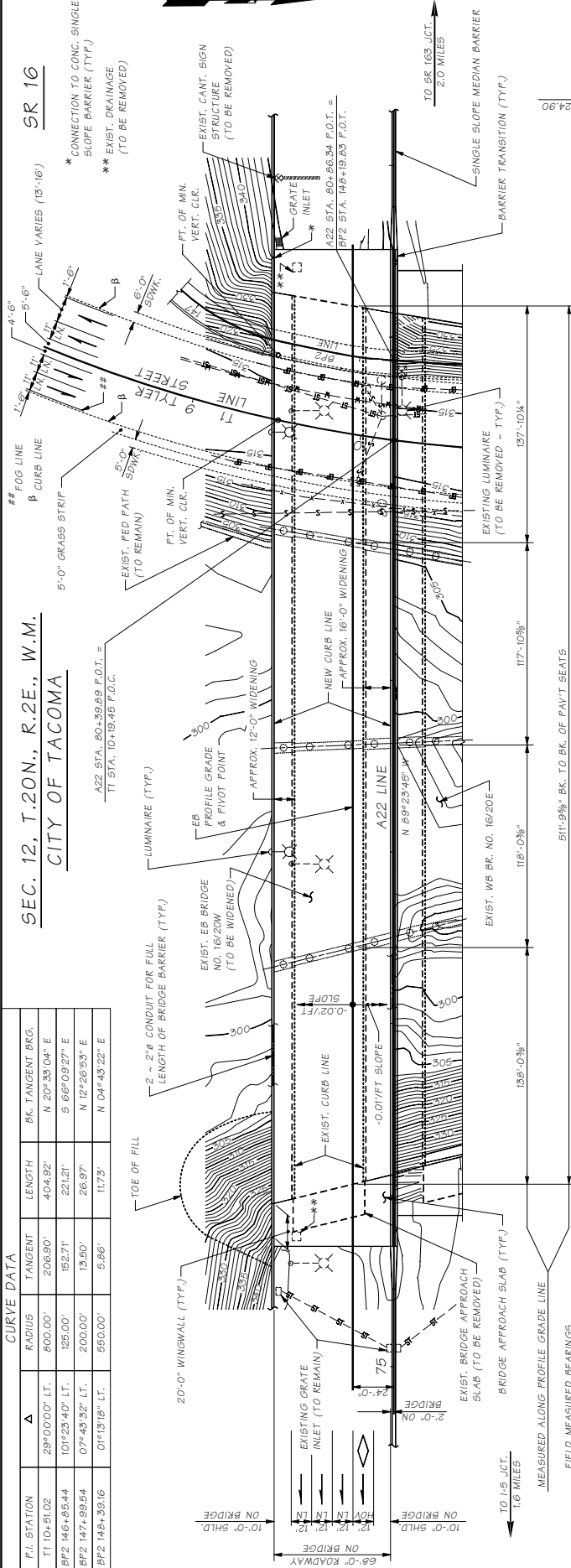
FR Aug 25 11:04:47 2006

C:\9_0602 ~ PROJ. NO. 012687 ~ SOUTHWEST REGION ~ SALMON CREEK TO SR 205 ~ SR 5 ~ NE 129TH ST. BR. NO. 5/23 REPLACEMENT

SEC. 12, T.20N., R.2E., W.M.
CITY OF TACOMA

SR 16

P.I. STATION	Δ	RADIUS	TANGENT	LENGTH	BK. TANGENT BRG.
T1 10+51.02	29°00'00" LT.	800.00'	206.90'	404.92'	N 20°33'04" E
BP2 146+85.44	101°23'40" LT.	125.00'	152.71'	221.21'	S 66°09'27" E
BP2 147+99.54	07°43'32" LT.	200.00'	13.50'	26.97'	N 12°26'53" E
BP2 148+39.16	01°13'18" LT.	550.00'	5.86'	11.73'	N 04°49'22" E



PLAN ~ EB BRIDGE (16/20W) WIDENING
BP2 LINE PROFILE
ELEVATION ~ EB BRIDGE (16/20W) WIDENING
LOADING : HS-25
OR
P.C. GIRDERS (W74G) WIDENING
CONTINUOUS FOR LIVE LOAD
TWO 24 K AXLES @ 4' CTR'S

NOTE: 500 YR MRI W.S. ELEV. XXXX
 SEE STD. PLAN H-9 FOR EMBANKMENT DETAILS AT BRIDGE ENDS.
 GRADE ELEVATIONS SHOWN ARE FINISH GRADES 24'-0" LT. OF A22 LINE AND ARE EQUAL TO THE PROFILE GRADE.

DATUM
 NAVD 1988
 REFERENCE LINE ELEVATION 290.0
 MATCH EXISTING SLOPE 2:1 MAX. SLOPE

FIELD MEASURED BEARINGS

PIER BEARING	1	N 85°12'00" W
	2	N 85°12'00" W
	3	N 07°45'30" W
	4	N 10°18'00" E
	5	N 10°23'00" E

MEASURED ALONG PROFILE GRADE LINE

PIER 1	A22 STA. 82+00.00	ELEV. 347.05
PIER 2	A22 STA. 77+44.32	GR. ELEV. 345.19
PIER 3	A22 STA. 76+02.35	GR. ELEV. 345.71
PIER 4	A22 STA. 79+80.24	GR. ELEV. 346.14
PIER 5	A22 STA. 81+18.09	GR. ELEV. 346.16
V.P. 1	A22 STA. 82+00.00	ELEV. 347.05
V.P. 2	A22 STA. 77+44.32	ELEV. 345.19
V.P. 3	A22 STA. 76+02.35	GR. ELEV. 345.71
V.P. 4	A22 STA. 79+80.24	GR. ELEV. 346.14
V.P. 5	A22 STA. 81+18.09	GR. ELEV. 346.16
V.P. 6	A22 STA. 82+00.00	ELEV. 347.05

FIELD APPROVED BY: _____
 BRIDGE AND STRUCTURES ENGINEER
PROJECT SUPERVISOR: _____
 PROJECT SUPERVISOR
DESIGNED BY: _____
CHECKED BY: _____
DATE: _____

Washington State Department of Transportation

BRIDGE AND STRUCTURES OFFICE

Architect/Engineer

 DATE: _____

Architect/Engineer

 DATE: _____

JOB NO. _____ SHEET _____

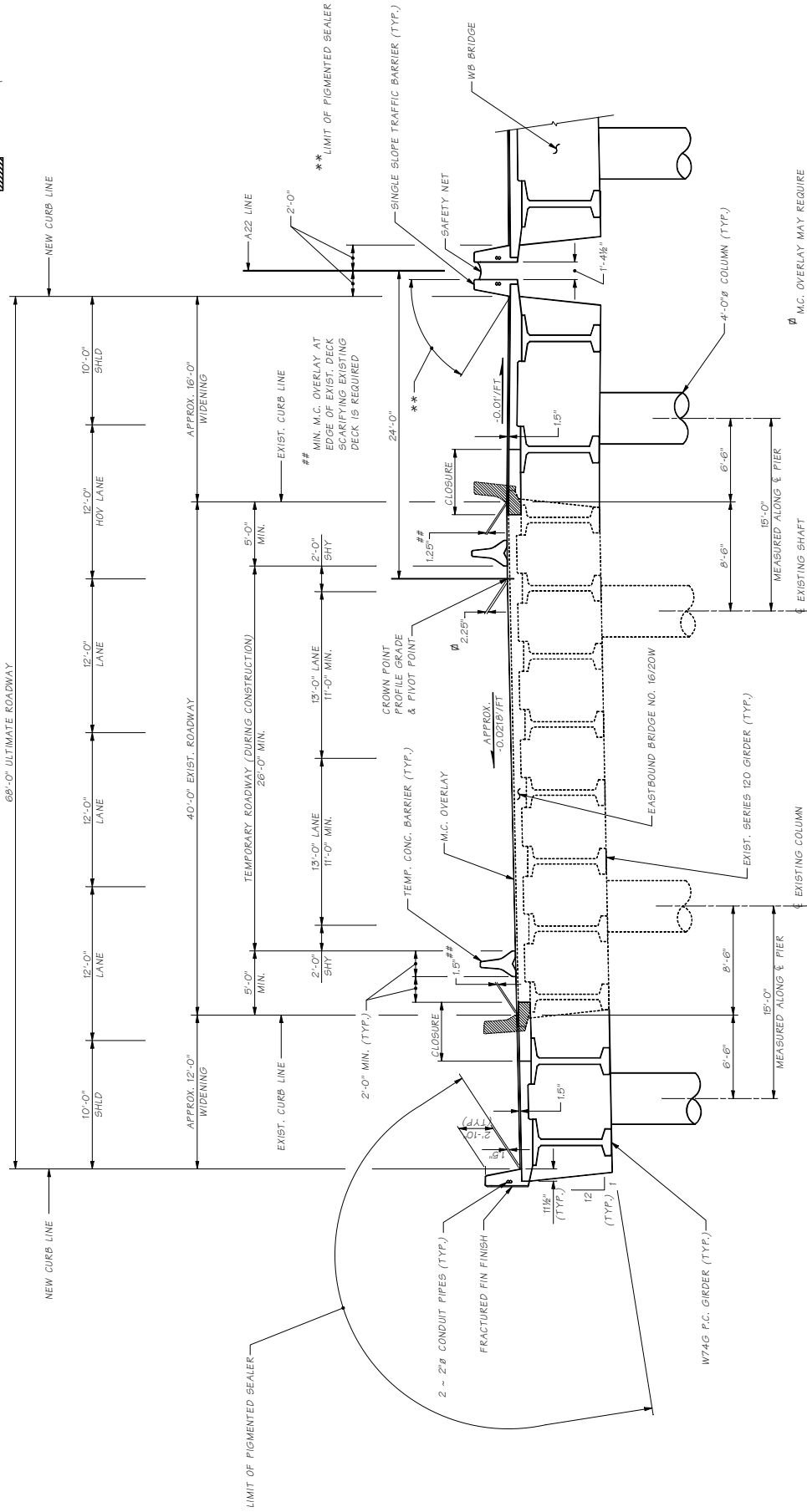
W74G P.C. GIRDERS
 "A" DIMENSION = 118' (PRELIMINARY - NOT FOR DESIGN)
 CAST-IN-PLACE CONC. SHALL BE 4000 PSI
 DECK PROTECTIVE SYSTEM (EPOXY COATED REBAR)

PERMIT TARGET DATE _____

FRI Aug 25 11:04:41 2006

C.S. 2784 D PROJ. NO. X1788 D OLYMPIA REGION D SR 16 D UNION AVE. TO PEARL ST. D SHAKLE LAKE NORTH BRIDGE NO. 16-28U WIDENING

HATCH AREA (TO BE REMOVED ~ TYP.)



TYPICAL SECTION ~ EB BRIDGE

SHOWN NEAR INTERMEDIATE PIER 3
SUBSTRUCTURE DIMENSIONS ARE APPROXIMATE
HORIZONTAL DIMENSIONS MEASURED PERPENDICULAR TO A22 LINE (UNLESS OTHERWISE NOTED)

Bridge Design Firm: MALBRIDGE CONSULTANTS, Inc. 15225 WINDY HILL RD. #100 WASH DC 20042 State: WASH Job Number: _____ Date: _____ Revision: _____ By: JSPD		FEDERAL PROJECT NO.: _____ STATE: _____ COUNTY: _____ JOB NUMBER: _____ DATE: _____ REVISION: _____		BRIDGE AND STRUCTURES OFFICE Washington State Department of Transportation		PRELIMINARY PLAN	
SHEET NO. 2-B-8				SHEET 2 OF 2			

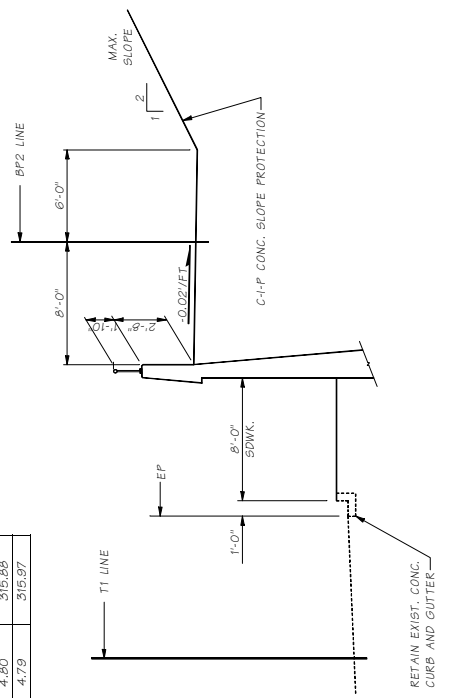
C.S. 2784 PROJ. NO. K1208 LYRIC REGION SR 16 UNION AVE. TO PEARL ST. SNAKE LAKE NORTH BRIDGE NO. 16/20W WIDENING

EXISTING EB BRIDGE ELEVATIONS

AS2 STA.	LT. OFFSET	ELEVATION	LT. OFFSET	ELEVATION
75+99.05			57.84	343.56
76+00.00			57.85	343.57
76+07.79	17.85	344.40		
76+10.00	17.85	344.41	57.87	343.64
76+20.00	17.85	344.45	57.89	343.70
76+30.00	17.91	344.50	57.87	343.75
76+40.00	17.92	344.55	57.85	343.79
76+50.00	17.91	344.61	57.83	343.84
76+60.00	17.89	344.66	57.84	343.90
76+70.00	17.89	344.72	57.85	343.96
76+80.00	17.90	344.77	57.87	344.02
76+90.00	17.90	344.82	57.85	344.08
77+00.00	17.90	344.88	57.84	344.14
77+10.00	17.91	344.93	57.83	344.20
77+20.00	17.91	344.99	57.83	344.25
77+30.00	17.91	345.04	57.84	344.30
77+40.00	17.90	345.09	57.85	344.35
77+50.00	17.89	345.14	57.85	344.40
77+60.00	17.89	345.19	57.82	344.44
77+70.00	17.89	345.24	57.80	344.48
77+80.00	17.89	345.29	57.79	344.52
77+90.00	17.89	345.33	57.80	344.56
78+00.00	17.89	345.38	57.80	344.60
78+10.00	17.88	345.42	57.81	344.64
78+20.00	17.88	345.47	57.82	344.69
78+30.00	17.88	345.51	57.82	344.74
78+40.00	17.89	345.54	57.83	344.78
78+50.00	17.89	345.58	57.84	344.80
78+60.00	17.89	345.62	57.85	344.82
78+70.00	17.89	345.67	57.86	344.85
78+80.00	17.88	345.71	57.86	344.90
78+90.00	17.87	345.76	57.85	344.96
79+00.00	17.88	345.80	57.84	345.02
79+10.00	17.88	345.85	57.84	345.07
79+20.00	17.89	345.90	57.84	345.11
79+30.00	17.89	345.94	57.83	345.15
79+40.00	17.90	345.97	57.83	345.19
79+50.00	17.90	346.01	57.83	345.23
79+60.00	17.90	346.04	57.84	345.26
79+70.00	17.90	346.07	57.84	345.30
79+80.00	17.90	346.09	57.85	345.32
80+00.00	17.90	346.11	57.86	345.35
80+10.00	17.90	346.13	57.84	345.39
80+20.00	17.90	346.14	57.82	345.41
80+30.00	17.91	346.13	57.80	345.42
80+40.00	17.91	346.12	57.82	345.42
80+50.00	17.92	346.11	57.83	345.43
80+60.00	17.92	346.11	57.85	345.43
80+70.00	17.91	346.13	57.85	345.42
80+80.00	17.90	346.14	57.84	345.41
80+90.00	17.90	346.14	57.84	345.40
81+00.00	17.90	346.13	57.82	345.38
81+10.00	17.91	346.12	57.80	345.37
81+17.04	17.91	346.11	57.78	345.36
81+20.00			57.77	345.36
81+23.91			57.77	345.36

TYLER STREET ROADWAY ELEVATIONS

LT. OFFSET	ELEVATION	RT. OFFSET	ELEVATION	LT. OFFSET	ELEVATION	RT. OFFSET	ELEVATION
27.07	315.93	27.09	315.92	4.93	315.50	4.63	315.54
27.06	314.98	27.09	314.96	4.94	315.44	4.63	315.48
27.05	314.93	27.10	314.90	4.94	315.37	4.63	315.42
27.05	314.88	27.12	314.86	4.94	315.33	4.65	315.38
27.05	314.83	27.15	314.84	4.93	315.32	4.71	315.37
27.04	314.78	27.15	314.82	4.92	315.30	4.76	315.36
27.04	314.74	27.16	314.79	4.91	315.29	4.82	315.35
27.04	314.69	27.18	314.77	4.90	315.27	4.88	315.34
27.04	314.65	27.20	314.75	4.90	315.26	4.93	315.33
27.01	314.62						
27.01	314.59						
27.15	314.55	27.21	314.75	4.93	315.25	4.97	315.32
27.81	314.61	27.20	314.77	4.98	315.26	4.95	315.35
28.36	314.64	27.22	314.80	4.96	315.29	4.92	315.38
28.91	314.68	27.24	314.83	4.93	315.33	4.90	315.41
29.47	314.71	27.25	314.87	4.90	315.36	4.88	315.44
30.02	314.74	27.27	314.90	4.88	315.40	4.85	315.46
30.58	314.77	27.28	314.93	4.85	315.44	4.83	315.50
31.13	314.80	27.26	314.92	4.82	315.47	4.83	315.54
31.68	314.86	27.23	315.04	4.82	315.52	4.83	315.59
32.22	314.91	27.20	315.10	4.84	315.57	4.83	315.64
32.77	314.97	27.17	315.15	4.85	315.62	4.82	315.69
33.32	315.02	27.15	315.21	4.86	315.67	4.82	315.74
33.86	315.08	27.15	315.26	4.88	315.72	4.82	315.80
34.41	315.13	27.16	315.32	4.89	315.78	4.80	315.86
34.94	315.18	27.16	315.37	4.89	315.85	4.79	315.97



BP2 LINE UNDER EB BRIDGE (16/20W)

BRIDGE DESIGN ENGR.	WA18R0818/8/04/Chapter_2/Window_1/ra15289/WAD	STATE	10	WASH	DATE	REVISION	BY	APPD.
SUPERVISOR								
DESIGNED BY								
CHECKED BY								
DESIGNED BY								
IN CHARGE								
ARCHITECT/SPECIALIST								

Washington State Department of Transportation
BRIDGE AND STRUCTURES OFFICE

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9.1 Expansion Joints

9.1.1 General Considerations

All bridges must accommodate, in some manner, environmentally and self-imposed phenomena that tend to make structures move in various ways. These movements come from several primary sources: thermal variations, concrete shrinkage, creep effects from prestressing, and elastic post-tensioning shortening. With the exception of elastic post-tensioning shortening, which generally occurs before expansion devices are installed, movements from these primary phenomena are explicitly calculated for expansion joint selection and design. Other movement inducing phenomena include live loading (vertical and horizontal braking), wind, seismic events, and foundation settlement. Movements associated with these phenomena are generally either not calculated or not included in total movement calculations for purposes of determining expansion joint movement capacity.

With respect to seismic movements, it is assumed that some expansion joint damage may occur, that this damage is tolerable, and that it will be subsequently repaired. In cases where seismic isolation bearings are used, the expansion joints must accommodate seismic movements in order to allow the isolation bearings to function properly.

Expansion joints must accommodate cyclic and long-term structure movements in such a way as to minimize imposition of secondary stresses in the structure. Expansion joint devices must prevent water, salt, and debris infiltration to substructure elements below. Additionally, an expansion joint device must provide a relatively smooth riding surface over a long service life.

Expansion joint devices are highly susceptible to vehicular impact that results as a consequence of their inherent discontinuity. Additionally, expansion joints have often been relegated a lower level of importance by both designers and contractors. Many of the maintenance problems associated with in-service bridges relate to expansion joints.

One solution to potential maintenance problems associated with expansion joints is to use construction procedures that eliminate the joints from the bridge deck. The two most commonly used methods are called integral and semi-integral construction. These two terms are sometimes collectively referred to as jointless bridge construction. In integral construction, concrete end diaphragms are cast monolithically with both the bridge deck and supporting pile substructure. In order to minimize secondary stresses induced in the superstructure, steel piles are generally used in their weak axis orientation relative to the direction of bridge movement. In semi-integral construction, concrete end diaphragms are cast monolithically with the bridge deck. Supporting girders rest on elastomeric bearings within an L-type abutment. Longer semi-integral bridges generally have reinforced concrete approach slabs at their ends. Approach slab anchors, in conjunction with a compression seal device, connect the monolithic end diaphragm to the approach slab. Longitudinal movements are accommodated by diaphragm movement relative to the approach slab, but at the same time resisted by soil passive pressure against the end diaphragm.

Obviously, bridges cannot be built incrementally longer without eventually requiring expansion joint devices. The incidence of approach pavement distress problems increases markedly with increased movement that must be accommodated by the end diaphragm pressing against the backfill. Approach pavement distress includes pavement and backfill settlement and broken approach slab anchors.

Washington State Department of Transportation (WSDOT) has implemented jointless bridge design by using semi-integral construction. Office policy for concrete and steel bridge design is as follows:

- A. Concrete Bridges: Semi-integral design is used for prestressed concrete girder bridges under 450 feet long and for post-tensioned spliced concrete girder and cast-in-place post-tensioned concrete box girder bridges under 400 feet long. Use L-type abutments with expansion joints at the bridge ends where bridge length exceeds these values. In situations where bridge skew angles exceed 30 degrees, consult the Bearing and Expansion Joint Specialist and the Bridge Design Engineer for recommendations and approval.
- B. Steel Bridges: Use L-type abutments with expansion joints at the ends for multiple-span bridges. *Semi-integral* construction may be used in lieu of expansion joints for single span bridges under 300 feet with the approval of the Bridge Design Engineer. In situations where the bridge skew exceeds 30 degrees, consult the Bearing and Expansion Joint Specialist and the Bridge Design Engineer for recommendations and approval.

In all instances, the use of intermediate expansion joints should be avoided wherever possible. The following table provides guidance regarding maximum bridge superstructure length beyond which the use of either intermediate expansion joints or modular expansion joints at the ends is required.

Superstructure Type	Maximum Length (western WA)		Maximum Length (eastern WA)	
	Semi-Integral	L-Abutment	Semi-Integral	L-Abutment
Concrete Superstructure				
Prestressed girder*	450 ft.	900 ft.	450 ft.	<u>900 ft.</u>
P.T. spliced girder**	400 ft.	700 ft.***	400 ft.	<u>700 ft.***</u>
C.I.P. - P.T. box girder	400 ft.	700 ft.***	400 ft.	<u>700 ft.***</u>
Steel Superstructure				
Plate girder Box girder	300 ft.	1,000 ft.	300 ft.	<u>800 ft.</u>
<p>* Based upon 0.16 in. creep shortening per 100 ft. of superstructure length and 0.12 in. shrinkage shortening per 100 ft. of superstructure length</p> <p>** Based upon 0.31 in. creep shortening per 100 ft. of superstructure length and 0.19 in. shrinkage shortening per 100 ft. of superstructure length</p> <p>*** Can be increased to 800 ft. if the joint opening at 64° F at time of construction is specified in the expansion joint table to be less than the minimum installation width of 1½ in. This condition is acceptable if the gland is already installed when steel shapes are placed in the blockout. Otherwise (for example, staged construction) the gland would need to be installed at temperature less than 45° F.</p>				

Because the movement restriction imposed by a bearing must be compatible with the movements allowed by the adjacent expansion joint, expansion joints and bearings must be designed interdependently and in conjunction with the anticipated behavior of the overall structure.

A plethora of manufactured devices exists to accommodate a wide range of expansion joint total movements. Expansion joints can be broadly classified into three categories based upon their total movement range as follows:

Small Movement Joints	Total Movement Range < <u>1¾ in.</u>
Medium Movement Joints	<u>1¾ in.</u> < Total Movement Range < <u>5 in.</u>
Large Movement Joints	Total Movement Range > <u>5 in.</u>

9.1.2 General Design Criteria

Expansion joints must be sized to accommodate the movements of several primary phenomena imposed upon the bridge following installation of its expansion joint devices. Concrete shrinkage, thermal variation, and long-term creep are the three most common primary sources of movement. Calculation of the movements associated with each of these phenomena must include the effects of superstructure type, tributary length, fixity condition between superstructure and substructure, and pier flexibilities.

A. Shrinkage Effects

Accurate calculation of shrinkage as a function of time requires that average ambient humidity, volume-to-surface ratios, and curing methods be taken in consideration as summarized in LRFD Article 5.4.2.3.3. Because expansion joint devices are generally installed in their respective blockouts at least 30 to 60 days following concrete deck placement, they must accommodate only the shrinkage that occurs from that time onward. For most situations, that shrinkage strain can be assumed to be 0.0002 for normal weight concrete in an unrestrained condition. This value must be corrected for restraint conditions imposed by various superstructure types.

$$\Delta_{\text{shrink}} = \beta \cdot \mu \cdot L_{\text{trib}}$$

where

- L_{trib} = tributary length of the structure subject to shrinkage
- β = ultimate shrinkage strain after expansion joint installation; estimated as 0.0002 in lieu of more refined calculations
- μ = restraint factor accounting for the restraining effect imposed by superstructure elements installed before the concrete slab is cast
 - = 0.0 for steel girders, 0.5 for precast prestressed concrete girders, 0.8 for concrete box girders and T-beams, 1.0 for concrete flat slabs

B. Thermal Effects

Bridges are subject to all modes of heat transfer: radiation, convection, and conduction. Each mode affects the thermal gradients generated in a bridge superstructure differently. Climatic influences vary geographically resulting in different seasonal and diurnal average temperature variations. Additionally, different types of construction have different thermal “inertia” properties. For example, a massive concrete box girder bridge will be much slower to respond to an imposed thermal stimulus, particularly a diurnal variation, than would a steel plate girder bridge composed of many relatively thin steel elements.

Variation in the superstructure average temperature produces elongation or shortening. Therefore, thermal movement range is calculated using the maximum and minimum anticipated bridge superstructure average temperatures anticipated during the structure’s lifetime. The considerations in the preceding paragraph have led to the following maximum and minimum anticipated bridge superstructure average temperature guidelines for design in Washington State:

Concrete Bridges:	0° F to 100° F
Steel Bridges (<u>eastern</u> Washington)	-30° F to 120° F
Steel Bridges (<u>western</u> Washington)	0° F to 120° F

Total thermal movement range is then calculated as:

$$\Delta_{\text{temp}} = \alpha \cdot L_{\text{trib}} \cdot \delta T$$

where

L_{trib} = tributary length of the structure subject to thermal variation

α = coefficient of thermal expansion; 0.000006 in./in./°F for concrete and 0.0000065 in./in./°F for steel

δT = bridge superstructure average temperature range as a function of bridge type and location

In accordance with WSDOT Standard Specifications, contract drawings state dimensions at a normal temperature of 64° F unless specifically noted otherwise. Construction and fabrication activities at average temperatures other than 64° F require the Contractor or fabricator to adjust lengths of structural elements and concrete forms accordingly.

Some expansion joint devices are installed in pre-formed concrete blockouts some time after the completion of the bridge deck. The expansion joint device must be cast into its respective breakout with a gap setting corresponding to the ambient superstructure average temperature at the time the blockouts are filled with concrete. In order to accomplish this, expansion device gap settings must be specified on the contract drawings as a function of superstructure ambient average temperature. Generally, these settings are specified for temperatures of 40° F, 64° F, and 80° F.

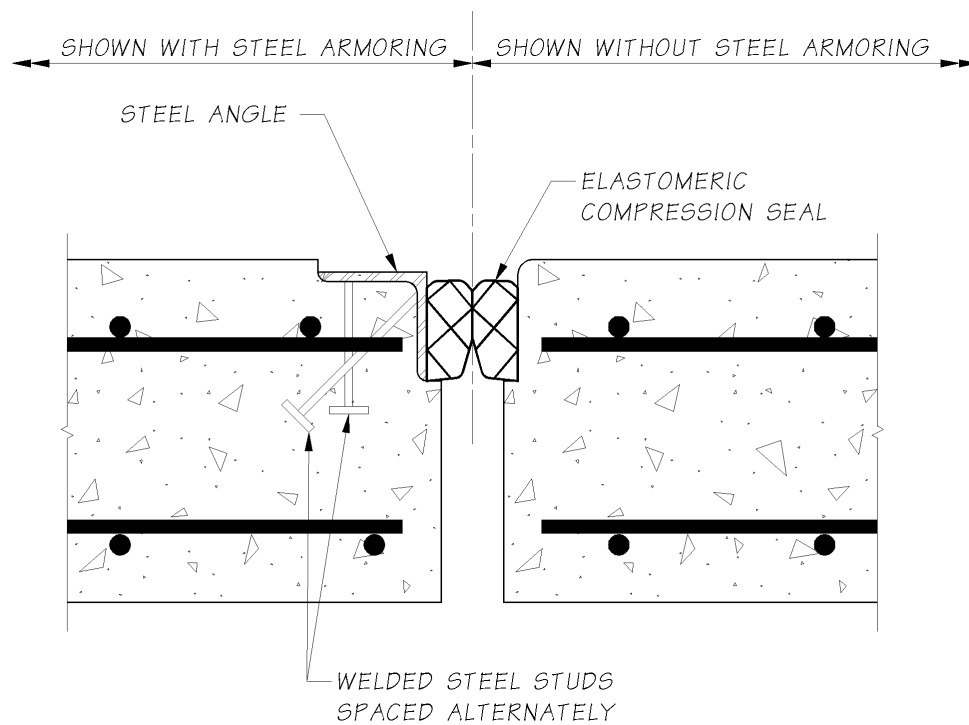
9.1.3 Small Movement Range Joints

Elastomeric compression seals, poured sealants, asphaltic plugs, pre-formed closed cell foam, epoxy-bonded elastomeric glands, steel sliding plates, and bolt-down elastomeric panels have all been used in the past for accommodating small movement ranges. The current policy is to use compression seals and rapid-cure silicone sealants almost exclusively.

A. Compression Seals

Compression seals are continuous manufactured elastomeric elements, typically with extruded internal web systems, installed within an expansion joint gap to effectively seal the joint against water and debris infiltration. Compression seals are held in place by mobilizing friction against adjacent vertical joint faces. Design philosophy requires that they be sized and installed to always be in a state of compression.

Compression seals can be installed against smooth vertical concrete faces or against steel armoring. When installed against concrete, special concrete nosing material having enhanced impact resistance is typically used. Polymer concrete, polyester concrete, and elastomeric concrete have been used with varying degrees of successful performance. Consult the Bearing and Expansion Joint Specialist for current policy.



Compression Seal Joint

Figure 9.1.3-1

In design calculations, the minimum and maximum compressed widths of the seal are generally set at 40 percent and 85 percent of the uncompressed width. These measurements are perpendicular to the joint axis. It is generally assumed that the compressed seal width at the normal construction temperature of 64° F is 60 percent of its uncompressed width. For skewed joints, bridge deck movement must be separated into components perpendicular to and parallel to the joint axis. Shear displacement of the compression seal should be limited to a specified percentage of its uncompressed width, usually set at about 22 percent. Additionally, the expansion gap width should be set so that the compression seal can be replaced over a reasonably wide range of construction temperatures. Manufacturers' catalogues generally specify the minimum expansion gap widths into which specific size compression seals can be installed. The expansion gap width should be specified on the contract drawings as a function of the superstructure average temperature.

Compression seal movement design relationships can be expressed as:

$$\Delta_{\text{temp-normal}} = \Delta_{\text{temp}} \cdot \cos \theta \text{ [thermal movement normal to joint]}$$

$$\Delta_{\text{temp-parallel}} = \Delta_{\text{temp}} \cdot \sin \theta \text{ [thermal movement parallel to joint]}$$

$$\Delta_{\text{shrink-normal}} = \Delta_{\text{shrink}} \cdot \cos \theta \text{ [shrinkage movement normal to joint]}$$

$$\Delta_{\text{shrink-parallel}} = \Delta_{\text{shrink}} \cdot \sin \theta \text{ [shrinkage movement parallel to joint]}$$

$$W_{\text{min}} = W_{\text{install}} - [(T_{\text{max}} - T_{\text{install}})/(T_{\text{max}} - T_{\text{min}})] \cdot \Delta_{\text{temp-normal}} > 0.40 \cdot W$$

$$W_{\text{max}} = W_{\text{install}} + [(T_{\text{install}} - T_{\text{min}})/(T_{\text{max}} - T_{\text{min}})] \cdot \Delta_{\text{temp-normal}} + \Delta_{\text{shrink-normal}} < 0.85 \cdot W$$

where θ = skew angle of the expansion joint, measured with respect to a line perpendicular to the bridge longitudinal axis

- W = uncompressed width of the compression seal
 W_{install} = expansion gap width at installation
 T_{install} = superstructure temperature at installation
 W_{min} = minimum expansion gap width
 W_{max} = maximum expansion gap width
 T_{min} = minimum superstructure average temperature
 T_{max} = maximum superstructure average temperature

Algebraic manipulation yields:

$$W > (\Delta_{\text{temp-normal}} + \Delta_{\text{shrink-normal}})/0.45$$

$$W > (\Delta_{\text{temp-parallel}} + \Delta_{\text{shrink-parallel}})/0.22$$

Now, assuming $W_{\text{install}} = 0.6 \cdot W$,

$$W_{\text{max}} = 0.6 \cdot W + [(T_{\text{install}} - T_{\text{min}})/(T_{\text{max}} - T_{\text{min}})] \cdot \Delta_{\text{temp-normal}} + \Delta_{\text{shrink-normal}} < 0.85 \cdot W$$

Rearranging yields:

$$W > 4 \cdot [(T_{\text{install}} - T_{\text{min}})/(T_{\text{max}} - T_{\text{min}})] \cdot \Delta_{\text{temp-normal}} + \Delta_{\text{shrink-normal}}$$

Design Example:

Given: A reinforced concrete box girder bridge has a total length of 200 ft. A compression seal expansion joint at each abutment will accommodate half of the total bridge movement. The abutments and expansion joints are skewed 15°. Bridge superstructure average temperatures are expected to range between 0° F and 100° F.

Find: Required compression seal size and construction gap widths at 40° F, 64° F, and 80° F.

Solution:

Step 1: Calculate temperature and shrinkage movement.

$$\text{Temperature: } \Delta_{\text{temp}} = \frac{1}{2}(.000006)(100^\circ\text{F})(200')(12''/') = 0.72''$$

$$\text{Shrinkage: } \Delta_{\text{shrink}} = \frac{1}{2}(.0002)(0.8)(200')(12''/') = \underline{0.19''}$$

$$\text{Total deck movement at the joint:} = 0.91''$$

$$\Delta_{\text{temp-normal}} + \Delta_{\text{shrink-normal}} = (0.91'')(\cos 15^\circ) = 0.88''$$

$$\Delta_{\text{temp-parallel}} + \Delta_{\text{shrink-parallel}} = (0.91'')(\sin 15^\circ) = 0.24''$$

Step 2: Determine compression seal width required.

$$W > 0.88''/0.45 = 1.96''$$

$$W > 0.24''/0.22 = 1.07''$$

$$W > 4[(64^\circ\text{F} - 0^\circ\text{F})/(100^\circ\text{F} - 0^\circ\text{F}) \cdot (0.72'') + 0.19''](\cos 15^\circ) = 2.51''$$

→ Use a 3" compression seal

Step 3: Evaluate construction gap widths for various temperatures for a 3 in. compression seal.

$$\text{Construction width at } 64^\circ\text{F} = 0.6(3'') = 1.80''$$

$$\text{Construction width at } 40^\circ\text{F} = 1.80'' + [(64^\circ - 40^\circ)/(100^\circ + 0^\circ)] \cdot (0.72'') \cdot (\cos 15^\circ) = 1.97''$$

$$\text{Construction width at } 80^\circ\text{F} = 1.80'' - [(80^\circ - 64^\circ)/(100^\circ + 0^\circ)] \cdot (0.72'') \cdot (\cos 15^\circ) = 1.69''$$

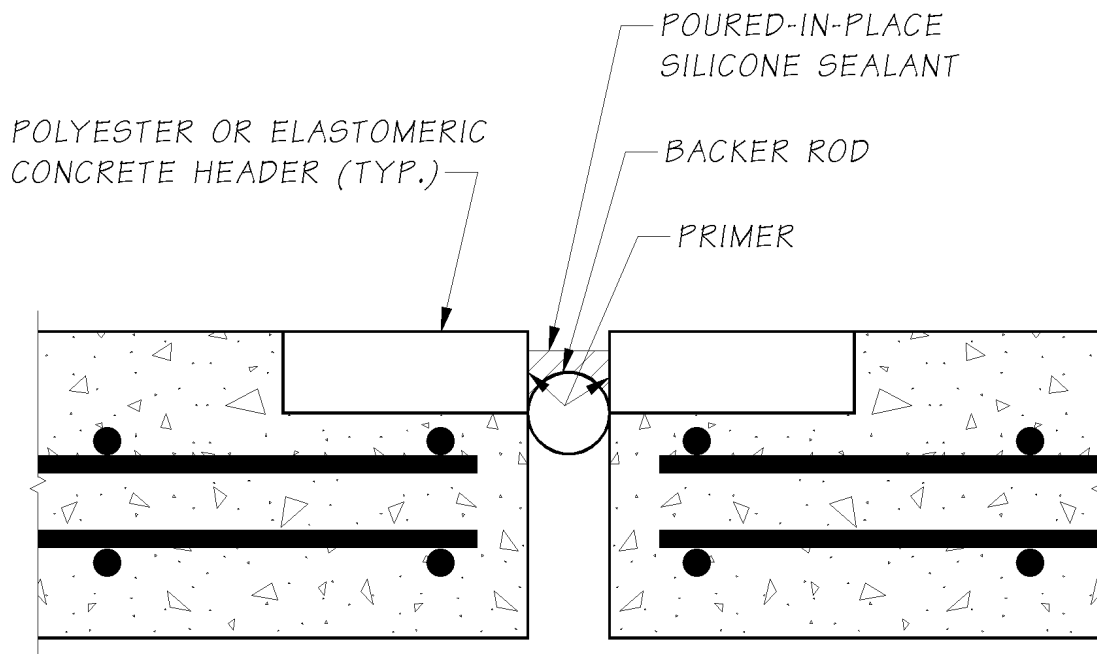
Conclusion: Use a 3 in. compression seal. Construction gap widths for installation at temperatures of 40° F, 64° F, and 80° F are 2 in., 1-13/16 in., and 1-11/16 in. respectively.

B. Rapid-Cure Silicone Sealants

Durable low-modulus poured sealants provide watertight expansion joint seals in both new construction and rehabilitation projects. Most silicone sealants possess good elastic performance over a wide range of temperatures while demonstrating high levels of resistance to ultraviolet and ozone degradation. Other desirable properties include self-leveling and self-bonding characteristics.

Rapid-cure silicone sealants are particularly good candidates for rehabilitation in situations where significant traffic disruption consequential to extended traffic lane closure is unacceptable. Additionally, unlike compression seals, rapid-cure silicone sealants do not require straight, parallel substrate surfaces in order to create a watertight seal.

Rapid-cure silicone sealants can be installed against either concrete or steel. It is extremely critical that concrete or steel substrates be thoroughly cleaned before the sealant is installed. Some manufacturers require application of specific primers onto substrate surfaces prior to sealant installation in order to enhance bonding. Consult the Bearing and Expansion Joint Specialist for specifics.



Rapid-cure Silicone Sealants Joint

Figure 9.1.3-2

Rapid-cure silicone sealants should be designed based upon the manufacturer's recommendations. Maximum and minimum working widths of the poured sealant joint are generally recommended as a percentage of the sealant width at installation. Depending upon the manufacturer, these joints can accommodate tensile movements of up to 100 percent and compressive movements of up to 50 percent of the sealant width at installation. A minimum recess is typically required between the top of the roadway surface and the top of the sealant surface. This recess is critical in assuring that tires will not contact the top surface of the sealant and initiate its debonding from substrate material.

Design Example:

Given: An existing 25-year old 160 ft. long single span prestressed concrete girder bridge is scheduled for a concrete overlay. The existing compression seals at each non-skewed abutment are in poor condition, although the existing concrete edges on each side of each expansion joint are in relatively good condition. The expansion gaps at these abutments are 1 in. wide at a normal temperature of 64° F. Assume that each expansion joint will accommodate half of the total bridge movement. Bridge superstructure average temperatures are expected to range between 0° F and 100° F.

Find: Determine the feasibility of reusing the existing 1 in. expansion gaps for a rapid cure silicone sealant system retrofit. Assume that the sealant will be installed at an average superstructure temperature between 40° F and 80° F. Manufacturer's recommendations state that Sealant A can accommodate 100 percent tension and 50 percent compression and that Sealant B can accommodate 50 percent tension and 50 percent compression.

Solution:

Step 1: Calculate future temperature, shrinkage, and creep movements.

$$\text{Temperature: } \Delta_{\text{temp}} = \frac{1}{2} (.000006)(100^{\circ}\text{F})(160')(12''/') = 0.58''$$

$$\text{Shrinkage: } \Delta_{\text{shrink}} = 0 \text{ (Essentially all shrinkage has already occurred.)}$$

$$\text{Creep: } \Delta_{\text{creep}} = 0 \text{ (Essentially all creep has already occurred.)}$$

Step 2: Calculate existing expansion gap widths at average superstructure temperatures of 40° F and 80° F. These are estimated extreme sealant installation temperatures.

$$G_{40^{\circ}\text{F}} = 1.00'' + [(64^{\circ}\text{F} - 40^{\circ}\text{F}) / (100^{\circ}\text{F} - 0^{\circ}\text{F})] \cdot (.58'') = 1.14''$$

$$G_{80^{\circ}\text{F}} = 1.00'' - [(80^{\circ}\text{F} - 64^{\circ}\text{F}) / (100^{\circ}\text{F} - 0^{\circ}\text{F})] \cdot (.58'') = 0.91''$$

Step 3: Check sealant capacity if installed at 40° F.

$$\begin{aligned} \text{Closing movement} &= [(100^{\circ}\text{F} - 40^{\circ}\text{F}) / (100^{\circ}\text{F} - 0^{\circ}\text{F})] \cdot (.58'') = 0.35'' \\ &0.35'' / 1.14'' = 0.31 < 0.50 \text{ Sealants A and B} \end{aligned}$$

$$\begin{aligned} \text{Opening movement} &= [(40^{\circ}\text{F} - 0^{\circ}\text{F}) / (100^{\circ}\text{F} - 0^{\circ}\text{F})] \cdot (.58'') = 0.23'' \\ &0.23'' / 1.14'' = 0.20 < 1.00 \text{ Sealant A} < 0.50 \text{ Sealant B} \end{aligned}$$

Step 4: Check sealant capacity if installed at 80° F.

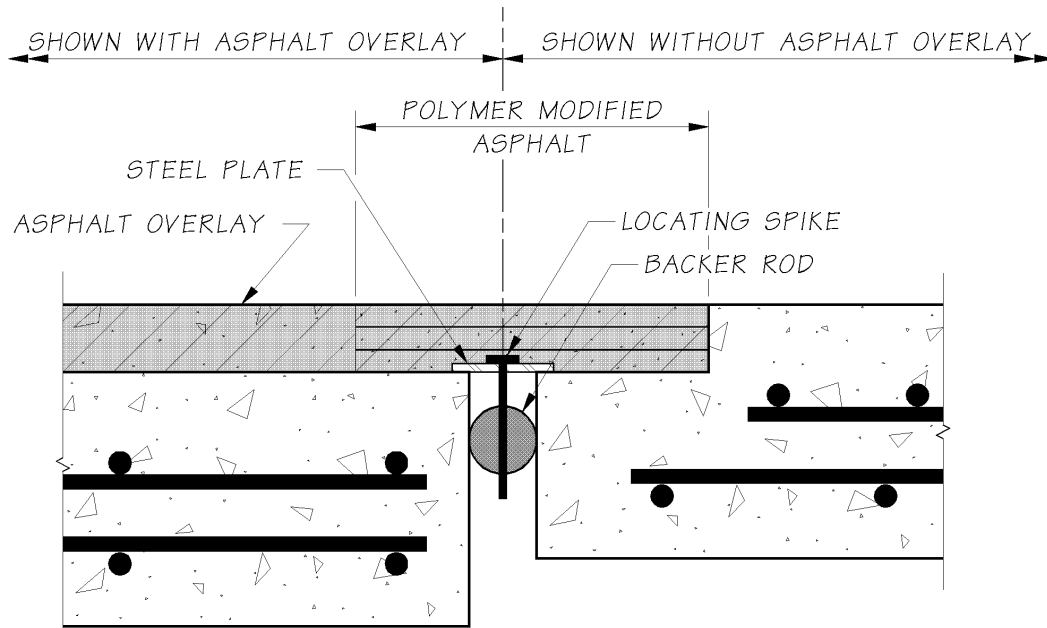
$$\begin{aligned} \text{Closing movement} &= [(100^{\circ}\text{F} - 80^{\circ}\text{F}) / (100^{\circ}\text{F} - 0^{\circ}\text{F})] \cdot (.58'') = 0.12'' \\ &0.12'' / 0.91'' = 0.13 < 0.50 \text{ Sealants A and B} \end{aligned}$$

$$\begin{aligned} \text{Opening movement} &= [(80^{\circ}\text{F} - 0^{\circ}\text{F}) / (100^{\circ}\text{F} - 0^{\circ}\text{F})] \cdot (.58'') = 0.46'' \\ &0.46'' / 0.91'' = 0.50 < 1.00 \text{ Sealant A} \\ &= 0.50 \text{ Sealant B} \end{aligned}$$

Conclusion: The existing 1 in. expansion gap is acceptable for installation of a rapid cure silicone sealant system. Note that Sealant B would reach its design opening limit at 0° F if it were installed at a superstructure average temperature of 80° F. Expansion gap widths at temperatures other than the normal temperature are generally not specified on rapid cure silicone sealant retrofit plans.

C. Asphaltic Plug Joints

Asphaltic plug joints consist of a flexible polymer modified asphalt installed in a preformed block out atop a steel plate and backer rod. In theory, asphaltic plug joints provided a seamless smooth riding surface. However, when subjected to high traffic counts, heavy trucks, or substantial acceleration/deceleration traction, the polymer modified asphalt tends to creep, migrating out of the block outs. As a consequence, we no longer specify the use of asphaltic plug joints.



Asphaltic Plug Joint

Figure 9.1.3-3

D. Headers

Expansion joint headers for new construction are generally the same Class 4000D structural concrete as used for the bridge deck and cast integrally with the deck.

Expansion joint headers installed as part of a rehabilitative and/or overlay project are constructed differently.

Being a flexible material, hot mix asphalt (HMA) cannot provide rigid lateral support to an elastomeric compression seal or a rapid cure silicone sealant bead. Therefore, rigid concrete headers must be constructed on each side of such an expansion joint when an HMA overlay is installed atop an existing concrete deck. These headers provide a rigid lateral support to the expansion joint device and serve as a transition between the HMA overlay material and the expansion joint itself.

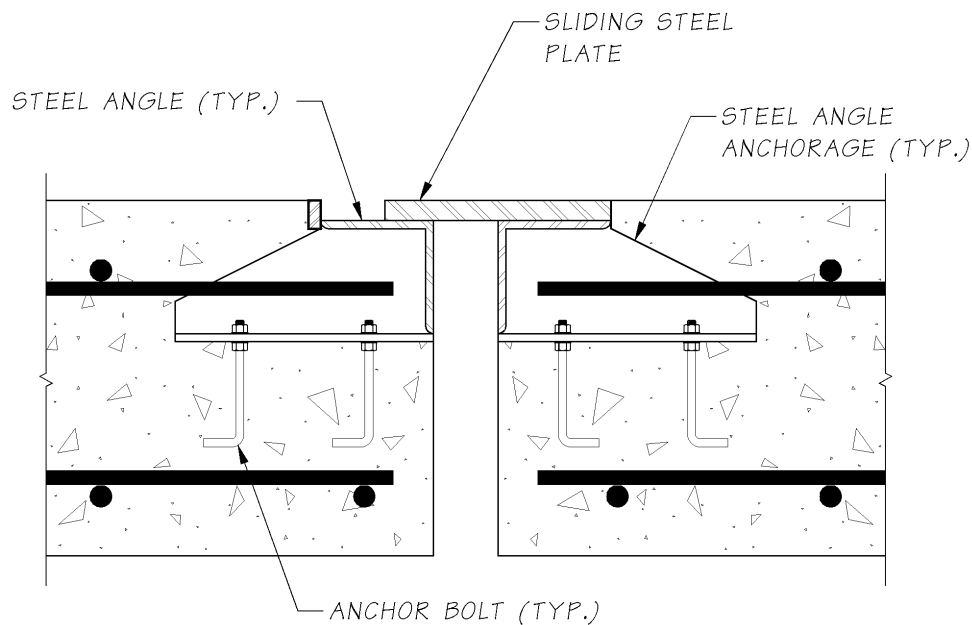
WSDOT allows either polyester concrete or elastomeric concrete for expansion joint headers. These two materials, which provide enhanced durability to impact in regard to other concrete mixes, shall be specified as alternates in the contract documents. Bridge Special Provisions (BSP)02206.GB6 and BSP023006.GB6 specify the material and construction requirements for polyester concrete. Bridge Special Provisions BSP02207.GB6 and BSP023007.GB6 specify the material and construction requirements for elastomeric concrete.

Modified concrete overlay (MCO) material can provide rigid side support for an elastomeric compression seal or a rapid cure silicone sealant bead without the need for separately constructed elastomeric concrete or polyester concrete headers. This alternative approach requires the approval of the Bearing and Expansion Joint Specialist. Such modified concrete overlay headers may utilize welded wire fabric as reinforcement. Contract 7108 which includes Bridges No. 90/565N&S and 90/566N&S is an example. BSP02313410.GB6 specifies the construction requirements for this approach, including the requirement for a temporary form to keep the joint open during placement of the MCO.

9.1.4 Medium Movement Range Joints

A. Steel Sliding Plate Joints

Two overlapping steel plates, one attached to the superstructure on each side of the joint, can be used to provide a smooth riding surface across an expansion joint. Unfortunately, steel sliding plates do not generally provide an effective barrier against intrusion of water and deicing chemicals into the joint and onto substructure elements. Consequently, these joints have been supplanted by newer systems, such as strip seals, with improved resistance to water penetration.



Steel Sliding Plate Joint

Figure 9.1.4-1

Before the advent of more modern systems, steel sliding plates were specified extensively. Their limited use today includes the following specific applications: 1) high pedestrian use sidewalks, 2) modular expansion joint upturns at traffic barriers, and 3) roadway applications involving unusual movements (translation and large rotations) not readily accommodated by modular expansion joints. In these applications, the sliding plates are generally galvanized or painted to provide corrosion resistance.

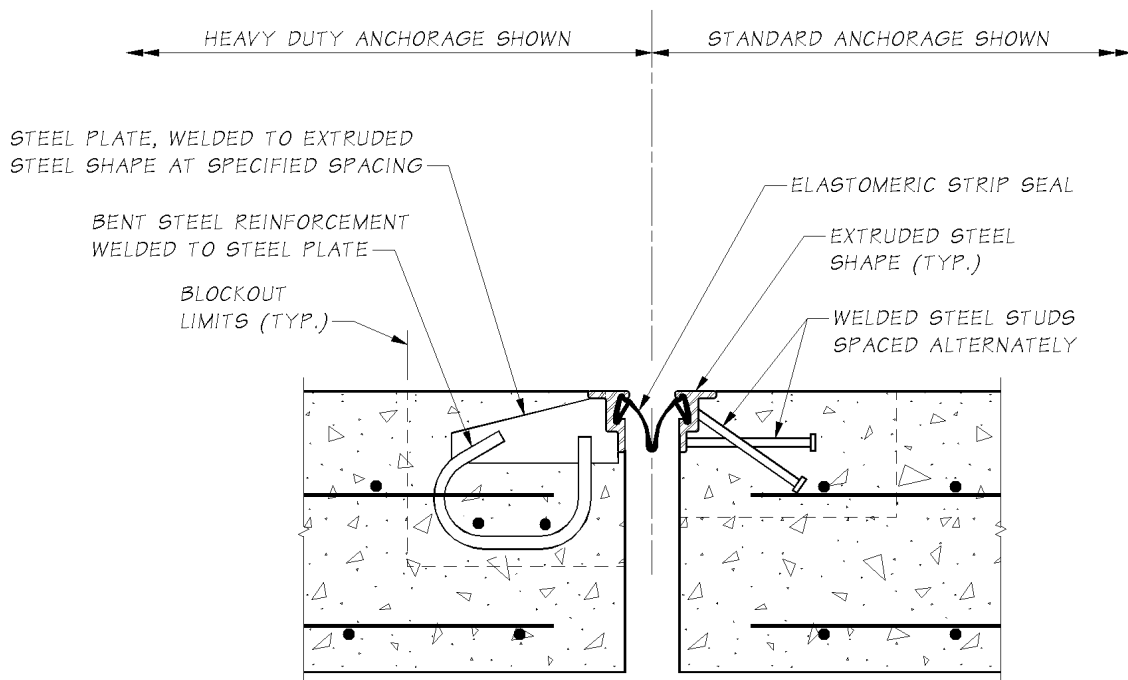
Repeated impact and corrosion have deteriorated many existing roadway sliding steel plate systems. In many instances, the anchorages connecting the sliding plate to the concrete deck have broken. When the integrity of the anchorages has been compromised, the steel sliding plates must generally be removed in their entirety and replaced with a new, watertight system. Where the integrity of the anchorages has not been compromised, sliding plates can often be retrofitted with poured sealants or elastomeric strip seals.

B. Strip Seal Joints

An elastomeric strip seal system consists of a preformed elastomeric gland mechanically locked into metallic edge rails generally embedded into the concrete deck on each side of an expansion joint gap. Unfolding of the elastomeric gland accommodates movement. Steel studs are generally welded to the steel extrusions constituting the edge rails to facilitate anchorage to the concrete deck. Damaged or worn glands can be replaced with minimal traffic disruption.

The metal edge rails effectively armor the edges of the expansion joint, obviating the need for a special impact resistant concrete, usually required at compression seal and poured sealant joints. The designer must select either the standard or special anchorage. The special anchorage incorporates steel reinforcement bar loops welded to intermittent steel plates, which in turn are welded to the extrusion. The special anchorage is generally used for very high traffic volumes or in applications subject to snowplow hits. In applications subject to snowplow hits and concomitant damage, the intermittent steel plates can be detailed to protrude slightly above the roadway surface in order to launch the snowplow blade and prevent it from catching on the forward extrusion.

The special anchorage requires a 9 in. deep block out, as opposed to 7 in. deep for the standard anchorage. The standard anchorage is acceptable for high traffic volume expansion joint replacement projects where block out depth limitations exist.



Strip Seal Joint

Figure 9.1.4-2

Design Example:

Given: A steel plate girder bridge has a total length of 600 ft. It is symmetrical and has a strip seal expansion joint at each end. These expansion joints are skewed 10°. Interior piers provide negligible restraint against longitudinal translation. Bridge superstructure average temperatures are expected to range between -30° F and 120° F during the life of the bridge. Assume a normal installation temperature of 64° F.

Find: Required Type A and Type B strip seal sizes and construction gap widths at 40° F, 64° F, and 80° F. Type A strip seals have a $\frac{1}{2}$ in. gap at full closure. Type B strip seals are able to fully close, leaving no gap.

Solution:

Step 1: Calculate temperature and shrinkage movement.

$$\text{Temperature: } \Delta_{\text{temp}} = \frac{1}{2}(.0000065)(150^{\circ}\text{ F})(600')(12''/') = 3.51''$$

$$\text{Shrinkage: } \Delta_{\text{shrink}} = 0.0 \text{ (no shrinkage; } \mu = 0.0 \text{ for steel bridge)}$$

$$\text{Total deck movement at each joint: } = 3.51''$$

$$\begin{aligned} \Delta_{\text{temp-normal-closing}} &= (120^{\circ}\text{ F} - 64^{\circ}\text{ F}) / (120^{\circ}\text{ F} + 30^{\circ}\text{ F})(3.51'')(\cos 10^{\circ}) \\ &= 1.29'' \end{aligned}$$

$$\begin{aligned} \Delta_{\text{temp-normal-opening}} &= (64^{\circ}\text{ F} + 30^{\circ}\text{ F}) / (120^{\circ}\text{ F} + 30^{\circ}\text{ F})(3.51'')(\cos 10^{\circ}) \\ &= 2.17'' \end{aligned}$$

Step 2: Determine strip seal size required. Assume a minimum construction gap width of 1½" at 64° F.

Type A: Construction gap width of 1½" at 64° F will not accommodate 1.29" closing with a ½" gap at full closure. Therefore, minimum construction gap width at 64° F must be 1.29" + 0.50" = 1.79"

$$\text{Size required} = 1.79'' + 2.17'' = 3.96'' \rightarrow \text{Use 4'' strip seal}$$

Type B: Construction width of 1½" at 64° F is adequate.

$$\text{Size required} = 1.50'' + 2.17'' = 3.67'' \rightarrow \text{Use 4'' strip seal}$$

Step 3: Evaluate construction gap widths for various temperatures for a 4" strip seal.

Type A: Required construction gap width at 64° F = 0.50" + 1.29" = 1.79"

$$\text{Construction gap width at } 40^{\circ}\text{ F} = 1.79'' + (64^{\circ}\text{ F} - 40^{\circ}\text{ F}) / (64^{\circ}\text{ F} + 30^{\circ}\text{ F}) \cdot (2.17'') = 2.34''$$

$$\text{Construction gap width at } 80^{\circ}\text{ F} = 1.79'' - (80^{\circ}\text{ F} - 64^{\circ}\text{ F}) / (120^{\circ}\text{ F} - 64^{\circ}\text{ F}) \cdot (1.29'') = 1.42''$$

Type B: Construction gap width of 1½" at 64°F is adequate.

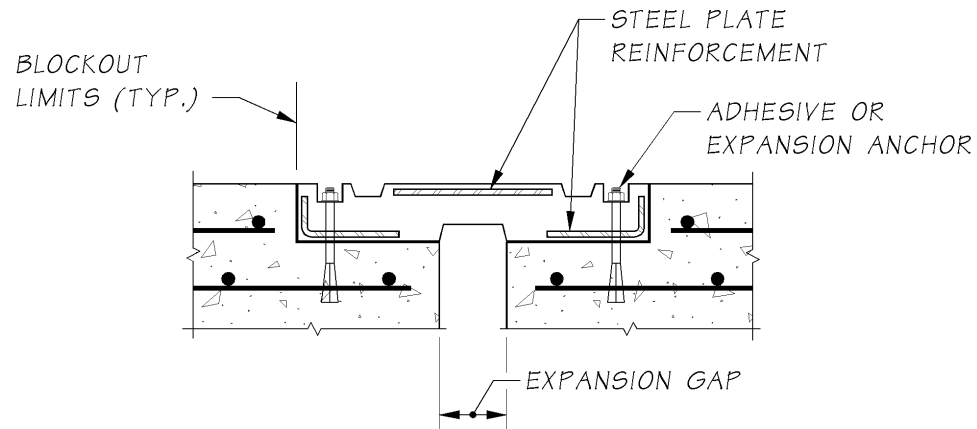
$$\text{Construction gap width at } 40^{\circ}\text{ F} = 1.50'' + (64^{\circ}\text{ F} - 40^{\circ}\text{ F}) / (64^{\circ}\text{ F} + 30^{\circ}\text{ F}) \cdot (2.17'') = 2.05''$$

$$\text{Construction gap width at } 80^{\circ}\text{ F} = 1.50'' - (80^{\circ}\text{ F} - 64^{\circ}\text{ F}) / (120^{\circ}\text{ F} - 64^{\circ}\text{ F}) \cdot (1.29'') = 1.13''$$

Conclusion: Use a 4 in. strip seal. Construction gap widths for installation at superstructure average temperatures of 40° F, 64° F, and 80° F are 2-5/16", 1-13/16", and 1-7/16" for Type A and 2-1/16", 1½", and 1⅝" for Type B. (Note that slightly larger gap settings could be specified for the 4" Type B strip seal in order to permit the elastomeric glands to be replaced at lower temperatures at the expense of ride smoothness across the joint.)

C. Bolt-down Panel Joints

Bolt-down panel joints, sometimes referred to as expansion dams, are preformed elastomeric panels internally reinforced with steel plates. Bridging across expansion gaps, these panels are bolted into formed block outs in the concrete deck with either adhesive or expansive anchors. Expansion is accompanied by stress and strain across the width of the bolt-down panel between anchor bolts.



Bolt-down Panel Joint

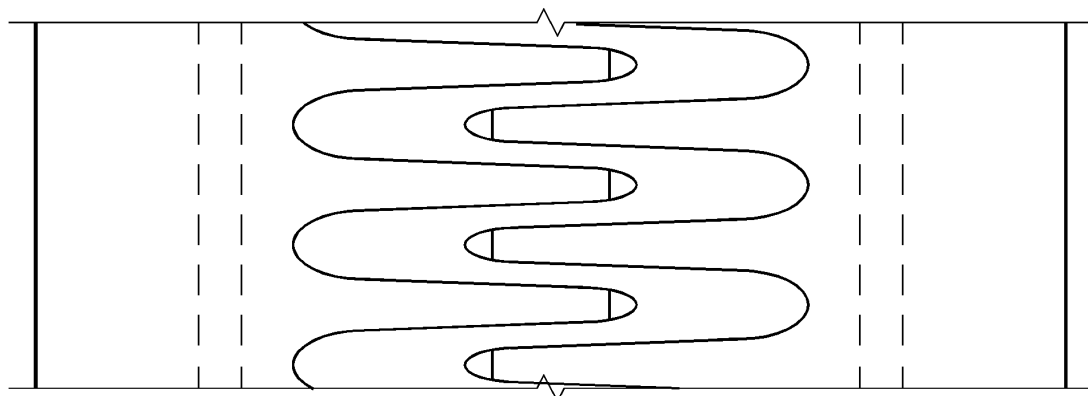
Figure 9.1.4-3

Unfortunately, the anchorages are prone to loosening and breaking out under high-speed traffic. The resulting loose panels and hardware in the roadway present hazards to vehicular traffic, particularly motorcycles. As a consequence of the increased liability, we no longer specify bolt-down panel joints. On bridge overlay and expansion joint rehabilitation projects, bolt-down panels are being replaced with rapid-cure silicone sealant joints or strip seal joints. For rehabilitation of bridges having low speed or low volume traffic, existing bolt-down panel joints may be retained and/or selective damaged panels replaced.

9.1.5 Large Movement Range Joints

A Steel Finger Joints

Finger joints have been successfully used to accommodate medium and large movement ranges. They are generally fabricated from steel plate and are installed in cantilevered configurations. The steel fingers must be designed to support traffic loads with sufficient stiffness to preclude excessive vibration. In addition to longitudinal movement, finger joints must also accommodate any rotations or differential vertical deflection across the joint. Finger joints may be fabricated with a slight downward taper toward the ends of the fingers in order to minimize potential for snowplow blade damage. Unfortunately, finger joints do not provide an effective seal against water infiltration. Elastomeric and metal troughs have been installed beneath steel finger joints to catch and redirect runoff water. However, in the absence of routine maintenance, these troughs clog and become ineffective.



Steel Finger Joint

Figure 9.1.5-1

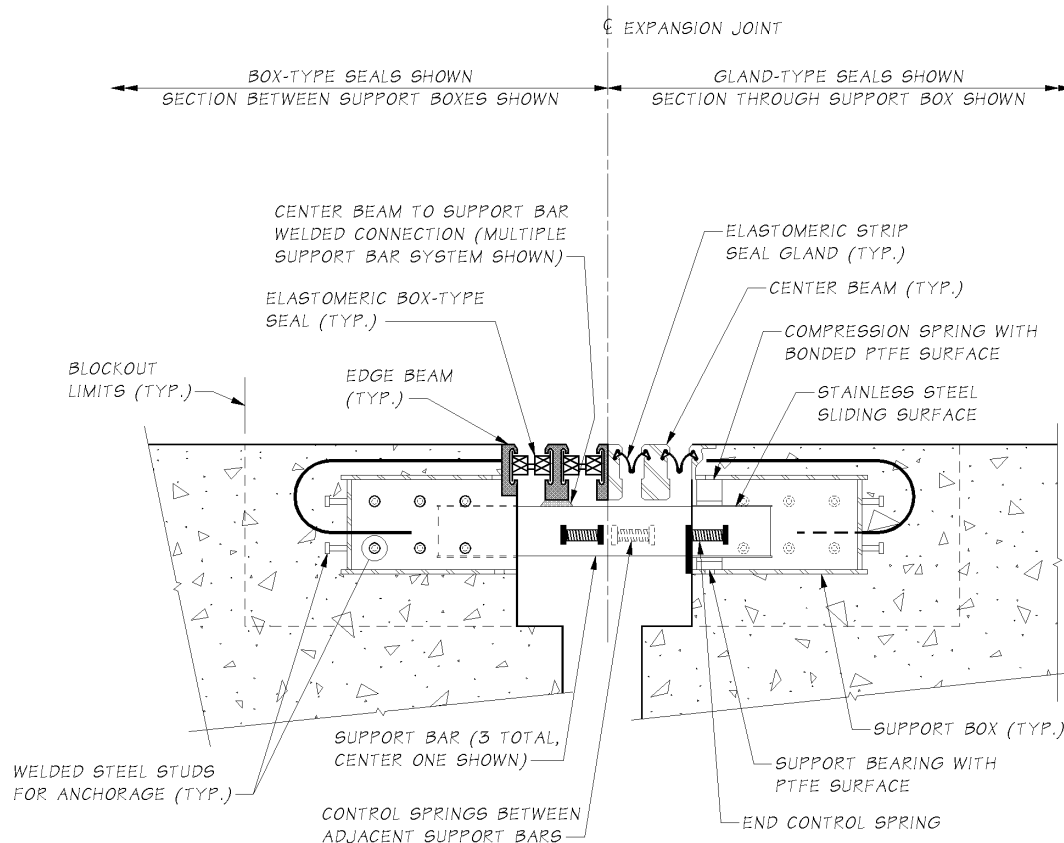
B. Modular Expansion Joints

Modular expansion joints are complex structural assemblies designed to provide watertight wheel load transfer across expansion joint openings. These systems were developed in Europe and introduced into the U.S. in the 1960s. To date, modular expansion joints have been designed and fabricated to accommodate movements of up to 85 in. In Washington state, the largest modular expansion joints are those on the new Tacoma Narrows Bridge. These joints accommodate 48 in. of service movement and 60 in. of seismic movement. Modular expansion joints are generally shipped in a completely assembled configuration. Although center beam field splices are not preferable, smaller motion range modular expansion joints longer than 40 ft. may be shipped in segments to accommodate construction staging and/or shipping constraints.

1. Operational Characteristics

Modular expansion joints comprise a series of steel center beams oriented parallel to the expansion joint axis. Elastomeric strip seals or box-type seals attach to adjacent center beams, preventing infiltration of water and debris. The center beams are supported on support bars, which span in the primary direction of anticipated movement. The support bars are supported on sliding bearings mounted within support boxes. Polytetrafluoroethylene (PTFE) - stainless steel interfaces between elastomeric support bearings and support bars facilitate the unimpeded translation of the support bars as the expansion gap opens and closes. The support boxes generally rest on either cast-in-place concrete or grout pads installed into a preformed block out.

Modular expansion joints can be classified as either single support bar systems or multiple support bar systems. In multiple support bar systems, a separate support bar supports each center beam. In the more complex single support bar system, one support bar supports all center beams at each support location. This design concept requires that each center beam be free to translate along the longitudinal axis of the support bar as the expansion gap varies. This is accomplished by attaching steel yokes to the underside of the center beams. The yoke engages the support bar to facilitate load transfer. Precompressed elastomeric springs and PTFE – stainless steel interfaces between the underside of each center beam and the top of the support bar and between the bottom of the support bar and bottom of the yoke support each center beam and allow it to translate along the longitudinal axis of the support bar. Practical center beam span lengths limit the use of multiple support bar systems for larger movement range modular expansion joints. Multiple support bar systems typically become impractical for more than nine seals or for movement ranges exceeding 27". Hence, the single support bar concept typifies these larger movement range modular expansion joints.



Modular Expansion Joint

Figure 9.1.5-2

The highly repetitive nature of axle loads predisposes modular expansion joint components and connections to fatigue susceptibility, particularly at center beam to support bar connections and center beam field splices. Bolted connections of center beams to support bar have demonstrated poor fatigue endurance. Welded connections are preferred, but must be carefully designed, fatigue tested, fabricated, and inspected to assure satisfactory fatigue resistance. WSDOT'S current special provision for modular expansion joints requires stringent fatigue based design criteria for modular expansion joints. This special provision also specifies criteria for manufacturing, shipping, storing, and installing modular expansion joints.

Modular expansion joints may need to be shipped and/or installed in two or more pieces and subsequently spliced together in order to accommodate project staging and/or practical shipping constraints. Splicing generally occurs after concrete is cast into the block outs. The center beams are the elements that must be connected. These field connections are either welded, bolted, or a hybrid combination of both.

Center beam field splices have historically been the weak link of modular expansion joints because of their high fatigue susceptibility and their tendency to initiate progressive zipper-type failure. The reduced level of quality control achievable with a field operation in regard to a shop operation contributes to this susceptibility. Specific recommendations regarding center beam field splices will be subsequently discussed as they relate to shop drawing review and construction.

2. Movement Design

Calculated total movement range establishes modular expansion joint size. WSDOT policy has been to provide a 15 percent factor of safety on these calculated service movements. Current systems permit approximately 3 in. of movement per elastomeric seal element; hence total movement rating provided will be a multiple of 3 in. To minimize impact and wear on bearing elements, the maximum gap between adjacent center beams should be limited to about 3½ in.

To facilitate the installation of the modular joints at temperatures other than the 64° F normal temperature, the contract drawings shall specify expansion gap distance face-to-face of edge beams as a function of the superstructure temperature at the time of installation.

Modular expansion joint movement design relationships can be expressed as:

$$\begin{aligned} n &= MR / mr \\ G_{\min} &= (n-1) \cdot w + n \cdot g \\ G_{\max} &= G_{\min} + M7R \end{aligned}$$

where MR = total movement range of the modular joint

$$\begin{aligned} mr &= \text{movement range per elastomeric seal} \\ n &= \text{number of seals} \\ n - 1 &= \text{number of center beams} \\ w &= \text{width of each center beam} \\ g &= \text{minimum gap per strip seal element at full closure} \\ G_{\min} &= \text{minimum distance face-to-face of edge beams} \\ G_{\max} &= \text{maximum distance face-to-face of edge beams} \end{aligned}$$

Design Example:

Given: Two cast-in-place post-tensioned concrete box girder bridge frames meet at an intermediate pier where they are free to translate longitudinally. Skew angle is 0° and the bridge superstructure average temperature ranges from 0° F to 120° F. A modular bridge expansion joint will be installed 60 days after post-tensioning operations have been completed. Specified creep is 150 percent of elastic shortening. Assume that 50 percent of total shrinkage has already occurred at installation time. The following longitudinal movements were calculated for each of the two frames:

	Frame A	Frame B
Shrinkage	1.18"	0.59"
Elastic shortening	1.42"	0.79"
Creep (1.5 × Elastic shortening)	2.13"	1.18"
Temperature fall (64° F to 0° F)	3.00"	1.50"
Temperature rise (64° F to 120° F)	2.60"	1.30"

Find: Modular expansion joint size required to accommodate the total calculated movements and the installation gaps measured face-to-face of edge beams at superstructure average temperatures of 40° F, 64° F, and 80° F.

Solution:**Step 1:** Determine modular joint size.

$$\begin{aligned} \text{Total opening movement (Frame A)} &= (0.5) \cdot (1.18'') + 2.13'' + 3.00'' \\ &= 5.72'' \end{aligned}$$

$$\begin{aligned} \text{Total opening movement (Frame B)} &= (0.5) \cdot (0.59'') + 1.18'' + 1.50'' \\ &= 2.98'' \end{aligned}$$

$$\text{Total opening movement (both frames)} = 5.72'' + 2.98'' = 8.70''$$

$$\text{Total closing movement (both frames)} = 2.60'' + 1.30'' = 3.90''$$

Determine size of the modular joint, including a 15 percent allowance:

$$1.15 \cdot (8.70'' + 3.90'') = 14.49'' \rightarrow \text{Use a 15 in. movement rating joint}$$

Step 2: Evaluate installation gaps measured face-to-face of edge beams at superstructure average temperatures of 40° F, 64° F, and 80° F.

$$\text{MR} = 15'' \quad (\text{movement range})$$

$$\text{mr} = 3'' \quad (\text{maximum movement rating per strip seal element})$$

$$n = 15''/3'' = 5 \text{ strip seal elements}$$

$$n - 1 = 4 \text{ center beams}$$

$$w = 2.50'' \quad (\text{center beam top flange width})$$

$$g = 0''$$

$$G_{\min} = 4 \cdot (2.50'') + 4 \cdot (0'') = 10''$$

$$G_{\max} = 10'' + 15'' = 25''$$

$$\begin{aligned} G_{64F} &= G_{\min} + \text{Total closing movement from temperature rise} \\ &= 10'' + 1.15 \cdot (3.90'') = 14.48'' \rightarrow \text{Use } 14\frac{1}{2}'' \end{aligned}$$

$$G_{40F} = 14.5'' + [(64^\circ \text{ F} - 40^\circ \text{ F}) / (64^\circ \text{ F} - 0^\circ \text{ F})] \cdot (3.00'' + 1.50'') = 16.19''$$

$$G_{80F} = 14.5'' - [(80^\circ \text{ F} - 64^\circ \text{ F}) / (120^\circ \text{ F} - 64^\circ \text{ F})] \cdot (2.60'' + 1.30'') = 13.39''$$

Check spacing between center beams at minimum temperature:

$$G_{0F} = 14.50'' + 8.70'' = 23.20''$$

$$\text{Spacing} = [23.20'' - 4(2.50'')] / 5 = 2.64'' < 3\frac{1}{2}'' \rightarrow \text{OK}$$

Check spacing between center beams at 64° F for seal replacement:

$$\text{Spacing} = [14.50'' - 4(2.50'')] / 5 = 0.90'' < 1.50'' \text{ Therefore, the center beams must be mechanically separated in order to replace strip seal elements.}$$

Conclusion: Use a 15 in. modular expansion joint. The gaps measured face-to-face of edge beams at installation temperatures of 40° F, 64° F, and 80° F are 16-3/16 in., 14½ in., and 13¾ in., respectively.

3. Review of Shop Drawings and Structural Design Calculations

The manufacturer's engineer generally performs structural design of modular expansion joints. The project special provisions requires that the manufacturer submit structural calculations, detailed fabrication drawings, and applicable fatigue tests for approval by the Engineer. All structural elements must be designed and detailed for both strength and fatigue. Additionally, modular expansion joints should be detailed to provide access for inspection and periodic maintenance activities, including replacement of seals, control springs, and bearing components.

WSDOT's special provision for modular expansion joints delineates explicit requirements for their design, fabrication, and installation. This comprehensive special provision builds upon WSDOT's past experience specifying modular expansion joints and incorporates the NCHRP Report 402 *Fatigue Design of Modular Bridge Expansion Joints*. The special provisions include requirements for the shop drawings, calculations, material certifications, general fabrication methods, corrosion protection, shipping and handling, storage, installation, fatigue testing, applicable welding codes and certifications, quality control, and quality assurance. It is strongly advised to carefully review this special provision before reviewing modular expansion joint shop drawings and calculations.

Any structural details, including connections, that do not clearly correspond to specific fatigue categories depicted in the LRFD shall be fatigue tested in accordance with the requirements stipulated in the special provision. Documentation of these tests shall accompany the shop drawing submittal.

As stated in the special provisions, the Contractor shall submit documentation of a quality assurance program distinctly separate from in-house quality control. Quality assurance shall be performed by an independent agency and shall be provided by the manufacturer.

Weld procedures shall be submitted for all shop and field welds. These procedures stipulate welding process employed, end preparation of the component welded, weld metal type, preheat temperature, and welder certifications. It is critical that all welds be made in strict accordance with specifications and under very careful inspection.

Field splices of center beams require particularly careful review. WSDOT's special provision recommends several mitigating measures to minimize fatigue susceptibility of center beam field splices. These measures include reducing support box spacing and optimizing fatigue stress range at field splice locations. Keep in mind that the confined nature of the space in which a welder must work can make these welds very difficult to complete. The American Welding Society (AWS) Welding Code prequalifies certain end geometries because experience has shown that high quality welds can be achieved.

Non-prequalified center beam end geometries require the Contractor to submit a Procedure Qualification Record documenting that satisfactory weld quality has been achieved using samples before welding of the actual field piece. The Contractor will generally want to avoid the additional expense associated with these tests and will thus specify a prequalified end geometry.

WSDOT's special provisions require that adequate concrete consolidation be achieved underneath all support boxes. The reviewer should ascertain that the shop drawings detail a vertical minimum of 2 in. between the bottom of each support box and the top of the concrete block out. Alternatively, when vertical clearance is minimal, grout pads can be cast underneath support boxes before casting the concrete within the blockout.

4. Construction Considerations

Temperature adjustment devices are temporarily welded to the modular expansion joints to permit the Contractor to adjust the modular joint width so that it is consistent with the superstructure temperature at the time concrete is placed in the block out. The temperature devices effectively immobilize the modular joint. Once the concrete begins to set up, it is critical to remove these devices as soon as possible. If the modular expansion joint is prevented from opening and closing, it will be subject to very large, potentially damaging, forces.

Prior to placement of concrete into the block out, temporary supports generally bridge across the expansion gap, suspending the modular expansion joint from the bridge deck surface. Following concrete placement, the modular joint is supported by bearing of the support boxes on concrete that has consolidated underneath the blockout. The inspector should assure that adequate concrete consolidation is achieved underneath and around the support boxes.

Following delivery of the modular expansion joint to the jobsite and prior to its installation, the inspector should ascertain that center beam end geometries at field weld splice locations match those shown on the approved weld procedure.

9.2 Bearings

9.2.1 General Considerations

Bridge bearings facilitate the transfer of vehicular and other environmentally imposed loads from the superstructure down to the substructure, and ultimately, to the ground. In fulfilling this function, bearings must accommodate anticipated movements (thermal expansion/contraction) while also restraining undesired movements (seismic displacements). Because the movements allowed by an adjacent expansion joint must be compatible with the movement restriction imposed by a bearing, bearings and expansion joints must be designed interdependently and in conjunction with the anticipated behavior of the overall structure.

Numerous types of bearings are used for bridges. These include steel reinforced elastomeric bearings, fabric pad sliding bearings, steel pin bearings, rocker bearings, roller bearings, steel pin bearings, pot bearings, spherical bearings, disk bearings, and seismic isolation bearings. Each of these bearings possess different characteristics in regard to vertical and horizontal load carrying capacity, vertical stiffness, horizontal stiffness, and rotational stiffness. A thorough understanding of these characteristics is essential for economical bearing selection and design. Spherical bearings, disk bearings, and pot bearings are sometimes collectively referred to as high load multi-rotational (HLMR) bearings.

9.2.2 Force Considerations

Bridge bearings must be explicitly designed to transfer all anticipated loads from the superstructure to the substructure. These forces may be directed vertically, longitudinally, or transversely with respect to the global orientation of the bridge. In accordance with LRFD provisions, most bearing design calculations are based upon service limit state stresses. Impact need not be applied to live load forces in the design of bearings.

Experience has empirically led to the following practical load capacity approximations for various bearing types:

Bearing Type	Approx. Load Capacity
Steel reinforced elastomeric (Method B)	Less than 800 kips
Fabric pad	Less than 600 kips
Steel pin	More than 600 kips
Spherical and disk	More than 800 kips
Seismic isolation	Less than 800 kips

9.2.3 Movement Considerations

Bridge bearings can be detailed to provide translational fixity, to permit free translation in any horizontal direction, or to permit guided translation. The movement restrictions thus imposed by a bearing must be compatible with the movements allowed by an adjacent expansion joint. Additionally, both bearings and expansion joints must be designed consistent with the anticipated load and deformation behavior of the overall structure. Design rotations shall be calculated as follows:

A. Elastomeric and Fabric Pad Bearings

The maximum service limit state rotation for bearings that do not have the potential to achieve hard contact between metal components shall be taken as the sum of unfactored dead and live load rotations plus an allowance for fabrication and construction uncertainties of 0.005 radians.

B. HLMR Bearings

The maximum strength limit state load rotation for bearings that are subject to potential hard contact between metal components shall be taken as the sum of all applicable factored load rotations plus an allowance of 0.01 radians for fabrication and installation tolerances and an allowance of 0.01 radians for other uncertainties. Such bearings include spherical, pot, steel pin, and some types of seismic isolation bearings.

9.2.4 Detailing Considerations

HLMR bearings shall be designed, detailed, fabricated, and installed to facilitate inspection, maintenance, and eventual replacement. Jacking points shall be identified in the contract drawings so that bearings can be reset, repaired, or replaced. In some instances, bearings may need to be reset in order to mitigate unintended displacements induced by construction sequences.

Prestressed concrete girder bridges having end Type A (semi - integral) need not be detailed to accommodate elastomeric bearing replacement at abutments. Prestressed concrete girder bridges having end Type B (L-type abutments) shall be designed and detailed to accommodate elastomeric bearing replacement at abutments. Specifically, girder stops and end diaphragms shall be detailed to accommodate the placement of hydraulic jacks. The standard end diaphragms for long-span girders may not have sufficient flexural and shear capacity to support jacking induced stresses. The designer shall check these and provide sufficient steel reinforcement to accommodate shear forces and bending moments induced by jacking. (Girder end Types A and B are depicted on Figures 5.6.2-4 and 5.6.2-5.) Incidentally, intermediate piers of prestressed concrete girder bridges having steel reinforced elastomeric bearings shall also be designed and detailed to facilitate bearing replacement.

9.2.5 Bearing Types

A. Elastomeric Bearings

Elastomeric bearings are perhaps the simplest and most economical of all bridge bearings. They are broadly classified into four types: plain elastomeric pads, fiberglass reinforced elastomeric pads, steel reinforced elastomeric pads, and cotton duck reinforced elastomeric pads. Of these four types, the latter two are used extensively for bridge construction. Incidentally, cotton duck reinforced elastomeric pads are generally referred to as fabric pad bearings. This subsection will address steel reinforced elastomeric bearings. A subsequent section will address fabric pad bearings.

A steel reinforced elastomeric bearing consists of discrete steel shims vulcanized between adjacent discrete layers of elastomer. The vulcanization process occurs in an autoclave under conditions of high temperature and pressure. The constituent elastomer is either natural rubber or synthetic rubber (neoprene). Steel reinforced elastomeric bearings are commonly used with prestressed concrete girder bridges and may be used with other bridge types. Because of their relative simplicity and fabrication ease, steel reinforced elastomeric bearings offer significant economy relative to HLMR bearings.

Steel reinforced elastomeric bearings rely upon the inherent shear flexibility of the elastomer layers to accommodate bridge movements in any horizontal direction. This shear flexibility also enhances their rotational flexibility. The steel shims limit the tendency for the elastomer layers to bulge laterally under compressive load.

Steel reinforced elastomeric bearings can be designed by either the Method A or Method B procedure delineated in the LRFD provisions. Current WSDOT policy is to design all elastomeric bearings using the Method B provisions, which provides more relief in meeting rotational demands than Method A. The Method A design procedure is a carryover based

upon more conservative interpretation of past theoretical analyses and empirical observations prior to research leading up to the publication of *NCHRP Report 596 Rotation Limits for Elastomeric Bearings*.

Both Method A and Method B design procedures require determination of the optimal geometric parameters to achieve an appropriate balance of compressive, shear, and rotational stiffnesses and capacities. Fatigue susceptibility is controlled by limiting live load compressive stress. Delamination (of steel shim-elastomer interface) susceptibility is controlled by limiting total compressive stress. Assuring adequate shim thickness precludes yield and rupture of the steel shims. Excessive shear deformation is controlled and rotational flexibility is assured by providing adequate total elastomer height. Generally, total elastomer thickness shall be no less than twice the maximum anticipated lateral deformation. Overall bearing stability is controlled by limiting total bearing height relative to its plan dimensions. The most important design parameter for reinforced elastomeric bearings is the shape factor. The shape factor is defined as the plan area of the bearing divided by the area of the perimeter free to bulge (perimeter multiplied by thickness of one layer of elastomer).

Axial, rotational, and shear loading generate shear strain in the constituent elastomeric layers of a typical bearing. Computationally, Method B imposes a limit on the sum of these shear strains. It distinguishes between static and cyclic components of shear strain by applying an amplification factor of 1.75 to cyclic components to reflect cumulative degradation caused by repetitive loading.

In essence, elastomeric bearing design reduces to checking several mathematical equations while varying bearing plan dimensions, number of elastomeric layers and their corresponding thicknesses, and steel shim thicknesses. Because these calculations can become rather tedious, MS Excel spreadsheets have been developed and are available for designs using both Method A and Method B procedures. See the Bearing and Expansion Joint Specialist for these design tools.

LRFD design may result in thicker steel reinforced elastomeric bearings than previous designs, particularly for shorter span bridges. This is a consequence of the increased rotational flexibility required to accommodate the 0.005 radian allowance for uncertainties and partially to inherent conservatism built into the rotational capacity equations.

Although constituent elastomer has historically been specified by durometer hardness, shear modulus is the most important physical property of the elastomer for purposes of bearing design. Research has concluded that shear modulus may vary significantly among compounds of the same hardness. Accordingly, shear modulus shall be specified on the plans as 165 psi at 73° F without reference to durometer hardness.

Elastomeric bearings shall conform to the requirements of AASHTO Specification M 251 *Plain and Laminated Elastomeric Bridge Bearings*. Shims shall be fabricated from ASTM A 1011 Grade 36 steel unless noted otherwise on the plans. Bearings shall be laminated in ½ inch thick elastomeric layers with a minimum total thickness of 1 inch. For overall bearing heights less than 5 inches, a minimum of ¼ inch of side clearance shall be provided over the steel shims. For overall heights greater than 5 inches, a minimum of ½ inch of side clearance shall be provided. Live load compressive deflection shall be limited to 1/16 inch. AASHTO Specification M 251 requires elastomeric bearings to be subjected to a series of tests, including a compression test at 150 percent of the total service load. For this reason, compressive dead load and live load shall be specified on the plans.

With respect to width, elastomeric bearings shall be designed and detailed as follows:

1. For prestressed concrete wide flange girders (WF42G, WF50G, WF58G, WF74G, and W95G), the edge of the bearing pad shall be set between 1 in. minimum and 9 in. maximum inside of the edge of the girder bottom flange.
2. For prestressed concrete I-girders, bulb-tee girders, and deck bulb-tee girders, the edge of the bearing pad shall be set 1 in. in side of the edge of the girder bottom flange.
3. For all prestressed concrete tub girders, the edge of the bearing shall be set 1in. inside of the edge of the bottom slab. Bearing pads for prestressed concrete tub girders shall be centered close to the centerline of each web.
4. For all prestressed concrete slabs, the edge of the bearing shall be set 1 in. inside of the edge of the slab. Two bearing pads and corresponding grout pads are required for each end of the prestressed concrete slabs. The need for steel shims shall be assessed during the bearing design.

As mentioned earlier, LRFD Article 14.4.2.1 requires that a 0.005 radian allowance for uncertainties be included in the design of steel reinforced elastomeric bearings. This allowance applies to both rotations θ_x and θ_y . The Article 14.4.2 Commentary somewhat ambiguously states "An owner may reduce the fabrication and setting tolerance allowances if justified by a suitable quality control plan; therefore, these tolerance limits are stated as recommendations rather than absolute limits." Consult with the Bearings and Expansion Joint Specialist in instances in which the 0.005 radian tolerance precludes convergence to a reasonable design solution.

In order to facilitate compressive load testing, future bearing replacement, and vertical geometry coordination, the following table shall be included in the Plans:

Bearing Design Table	
Service I Limit State	
Dead load reaction	----- kips
Live load reaction (w/o impact)	----- kips
Unloaded height	----- inches
Loaded height (DL)	----- inches
Shear modulus at 73° F	----- psi

In the construction of precast prestressed concrete girder and steel girder bridges, elastomeric bearings are generally not offset to account for temperature during erection of the girders as are most other bearing systems. Girders may be set atop elastomeric bearings at temperatures other than the mean of the temperature range. This is statistically reconciled by assuming a maximum thermal movement in either direction of:

$$\Delta_{temp} = 0.75 \cdot \alpha \cdot L \cdot (T_{MaxDesign} - T_{MinDesign})$$

where $T_{MaxDesign}$ is the maximum anticipated bridge deck average temperature and $T_{MinDesign}$ is the minimum anticipated bridge deck average temperature during the life of the bridge.

For precast prestressed concrete girder bridges, the maximum thermal movement, Δ_{temp} , shall be added to shrinkage and long-term creep movements to determine total bearing height required. The shrinkage movement for this bridge type shall be half that calculated for a cast-in-place concrete bridge.

For cast-in-place concrete bridges, it is assumed that the temperature of concrete at placement is equal to the normal temperature, as defined by the *Standard Specifications*. Total shrinkage movement is added to the maximum thermal movement, Δ_{temp} , to determine required total height of the elastomeric bearing, as noted in Section 9.1.2-A.

B. Fabric Pad Sliding Bearings

Fabric pad sliding bearings incorporate fabric pads with a polytetrafluoroethylene (PTFE) - stainless steel sliding interface to permit large translational movements. Unlike a steel reinforced elastomeric bearing having substantial shear flexibility, the fabric pad alone cannot accommodate translational movements. Fabric pads can accommodate very small amounts of rotational movement; less than can be accommodated by more flexible steel reinforced elastomeric bearings. Practical size considerations limit the use of fabric pad bearings to total service load reactions under about 600 kips.

PTFE, also referred to as Teflon, is available in several forms: unfilled sheet, dimpled lubricated, filled, and woven. Filled PTFE contains glass, carbon, or other chemically inert fibers that enhance its resistance to creep (cold flow) and wear. Interweaving high strength fibers through PTFE material creates woven PTFE. Dimpled PTFE contains dimples, which act as reservoirs for silicone grease lubricant.

Friction coefficients for PTFE – stainless steel surfaces vary significantly as a function of PTFE type, contact pressure, and ambient temperature. The AASHTO LRFD provides friction coefficients as a function of these variables. Dimpled lubricated PTFE at high temperatures and high contact pressures typically yield the lowest friction coefficients. Filled PTFE at low temperatures and low contact pressures yield the highest friction coefficients.

In order to minimize frictional resistance, a Number 8 (Mirror) finish should be specified for all flat stainless steel surfaces in contact with PTFE. The low-friction characteristics of a PTFE – stainless steel interface are actually facilitated by fragmentary PTFE sliding against PTFE after the fragmentary PTFE particles are absorbed into the asperities of the stainless steel surface.

In fabric pad sliding bearings, the PTFE is generally recessed half its depth into a steel backing plate, which is generally bonded to the top of a fabric pad. The recess provides confinement that minimizes creep (cold flow). The stainless steel sheet is typically seal welded to a steel sole plate attached to the superstructure.

Silicone grease is not recommended for non-dimpled PTFE. Any grease will squeeze out under high pressure and attract potentially detrimental dust and other debris.

1. Fabric Pad Design

WSDOT's design criteria for fabric pad bearings are based upon manufacturers' recommendations, supported by years of satisfactory performance. These criteria differ from AASHTO LRFD provisions in that they recognize significantly more rotational flexibility in the fabric pad. Our maximum allowable service load average bearing pressure for fabric pad bearing design is 1,200 psi. WSDOT's maximum allowable service load edge bearing pressure for fabric pad bearing design is 2,000 psi. A 1,200 psi compressive stress corresponds to 10 percent strain in the fabric pad while a 2,000 psi compressive stress corresponds to 14 percent compressive strain. Based upon this information, the following design relationship can be established:

$$\theta = \frac{2 \times (.14 - .10) \times T}{L}$$

$$\theta = \frac{.08 \times T}{L}$$

$$T = 12.5 \times \theta \times L$$

where Θ = rotation due to loading plus construction tolerances

L = pad length (parallel to longitudinal axis of beam)

T = fabric pad thickness required

As an example:

Given: DL + LL = 240 kips

Rotation = 0.015 radians

Allowable bearing pad pressure = 1200 psi

$f'_c = 3000$ psi

Find: fabric pad plan area and thickness required

Solution:

Pad area required = $240,000/1200 = 200$ in²

Try a 20" wide \times 10" long fabric pad

$T = 12.5(.015)(10") = 1.88"$

Solution: Use a 20" \times 10" \times 1 $\frac{7}{8}"$ fabric pad.

2. PTFE – Stainless Steel Sliding Surface Design

PTFE shall be $\frac{1}{8}$ in. thick and recessed $\frac{1}{16}$ in. into a $\frac{1}{2}$ in. thick steel plate that is bonded to the top of the fabric pad. With the PTFE confined in this recess, the LRFD code permits an average contact stress of 4,500 psi for all loads calculated at the service limit state and an average contact stress of 3,000 psi for permanent loads calculated at the service limit state. The LRFD code permits slightly higher edge contact stresses.

For example, suppose:

DL = 150 kips

LL = 90 kips

$A_{PTFE} > (150 \text{ kips} + 90 \text{ kips})/4.5 \text{ ksi} = \underline{53.3}$ in²

$A_{PTFE} > 150 \text{ kips}/\underline{3} \text{ ksi} = \underline{50.0}$ in²

Selected area of PTFE must exceed 53.3 in²

Stainless steel sheet shall be finished to a No. 8 (Mirror) finish and seal welded to the sole plate.

C. Pin Bearings

Steel pin bearings are generally used to support heavy reactions with moderate to high levels of rotation about a single predetermined axis. This situation generally occurs with long straight steel plate girder superstructures.

D. Rocker and Roller Type Bearings

Steel rocker bearings have been used extensively in the past to allow both rotation and longitudinal movement while supporting large loads. Because of their seismic vulnerability and the more extensive use of steel reinforced elastomeric bearings, rocker bearings are no longer specified for new bridges.

Steel roller bearings have also been used extensively in the past. Roller bearings permit both rotation and longitudinal movement. Pintles are generally used to connect the roller bearing to the superstructure above and to the bearing plate below. Nested roller bearings have also been used in the past. Having been supplanted by more economical steel reinforced elastomeric bearings, roller bearings are infrequently used for new bridges today.

E. Spherical Bearings

A spherical bearing relies upon the low-friction characteristics of a curved PTFE - stainless steel interface to provide a high level of rotational flexibility in multiple directions. An additional flat PTFE - stainless steel surface can be incorporated into the bearing to additionally provide either guided or non-guided translational movement capability.

Woven PTFE is generally used on the curved surfaces of spherical bearings. Woven PTFE exhibits enhanced creep (cold flow) resistance and durability characteristics relative to unwoven PTFE. When spherical bearings are detailed to accommodate translational movement, woven PTFE is generally specified on the flat sliding surface also. The LRFD code permits an average contact stress of 4,500 psi for all loads calculated at the service limit state and an average contact stress of 3,000 psi for permanent loads calculated at the service limit state. The LRFD code permits slightly higher edge contact stresses.

Both stainless steel sheet and solid stainless steel have been used for the convex sliding surface of spherical bearings. According to one manufacturer, curved sheet is generally acceptable for contact surface radii greater than 14 in. to 18 in. For smaller radii, a solid stainless steel convex plate or a stainless steel inlay is used. The inlay is welded to the solid conventional steel. If the total height of the convex plate exceeds about 5 in., a stainless steel inlay will likely be more economical.

Most spherical bearings are fabricated with the concave surface oriented downward to minimize dirt infiltration between PTFE and the stainless steel surface. Structural analysis of the overall structure must recognize the center of rotation of the bearing not being coincident with the neutral axis of the girder above.

The contract drawings must show the diameter and height of the spherical bearing in addition to all dead, live, and seismic loadings. Total height depends upon the radius of the curved surface, diameter of the bearing, and total rotational capacity required. Consult the Bearing and Expansion Joint Specialist for design calculation examples. Additionally, sole plate connections, base plate, anchor bolts, and any appurtenances for horizontal force transfer must be detailed on the plans. The spherical bearing manufacturer is required to submit shop drawings and detailed structural design calculations of spherical bearing components for review by the Engineer.

F. Disk Bearings

A disk bearing is composed of an annular shaped urethane disk designed to provide moderate levels of rotational flexibility. A steel shear-resisting pin in the center provides resistance against lateral force. A flat PTFE - stainless steel surface can be incorporated into the bearing to also provide translational movement capability, either guided or non-guided.

G. Seismic Isolation Bearings

Seismic isolation bearings mitigate the potential for seismic damage by utilizing two related phenomena: dynamic isolation and energy dissipation. Dynamic isolation allows the superstructure to essentially float, to some degree, while substructure elements below move with the ground during an earthquake. The ability of some bearing materials and elements to deform in certain predictable ways allows them to dissipate earthquake energy that might otherwise damage critical structural elements.

Numerous seismic isolation bearings exist, each relying upon varying combinations of dynamic isolation and energy dissipation. These devices include lead core elastomeric bearings, high damping rubber, friction pendulum, hydraulic dampers, and various hybrid variations.

Effective seismic isolation bearing design requires a thorough understanding of the dynamic characteristics of the overall structure as well as the candidate isolation devices. Isolation devices are differentiated by maximum compressive load capacity, lateral stiffness, lateral displacement range, maximum lateral load capacity, energy dissipation per cycle, functionality in extreme environments, resistance to aging, fatigue and wear properties, and effects of size.

The Highway Innovative Technology Evaluation Center (HITEC) has developed guidelines for testing seismic isolation and energy dissipating devices. With the goal of disseminating objective information to design professionals, HITEC has tested and published technical reports on numerous proprietary devices. These tests include performance benchmarks, compressive load dependent characterization, frequency dependent characterization, fatigue and wear, environmental aging, dynamic performance at extreme temperatures, durability, and ultimate performance.

9.2.6 Miscellaneous Details

A. Temporary Support before Grouting Masonry Plate

The masonry plate of a HLMR bearing is generally supported on a grout pad that is installed after the bearing and superstructure girders above have been erected. This procedure allows the Contractor to level and slightly adjust the horizontal location of the bearing before immobilizing it by placing the grout pad. Several methods have been developed to temporarily support the masonry plate until the grout is placed. The two most commonly used methods will be discussed here.

1. Shim Packs

Multiple stacks of steel shim plates can be placed atop the concrete surface to temporarily support the weight of the girders on their bearings before grouting. engineering judgment must be used in selecting the number and plan size of the shims taking grout flowability and shim height adjustability into consideration.

2. Two-step Grouting with Cast Sleeves

A two-step grouting procedure with cast-in-place voided cores can be used for smaller HLMRs not generally subjected to uplift. Steel studs are welded to the underside of the masonry plate to coincide with the voided cores. With temporary shims installed between the top of the concrete surface and the underside of the masonry plate, the voided cores are fully grouted. Once the first stage grout has attained strength, the shims are removed, the masonry plate is dammed, and grout is placed between the top of the concrete surface and the underside of the masonry plate.

B. Anchor Bolts

Anchor bolts shall be designed to resist all horizontal shear forces and direct tension force due to uplift.

Anchor bolts shall be ASTM A 449 where strengths equal to ASTM A 325 are required and ASTM A 354, Grade BD, where strengths equal to ASTM A 490 are required. ASTM F 1554 bolts with supplemental Charpy test requirements shall be specified in applications in which the bolts are subject to seismic loading.

9.2.7 Contract Drawing Representation

High load multi-rotational bearings are generally depicted schematically in the contract drawings. Each bearing manufacturer has unique fabricating methods and procedures that allow it to fabricate a bearing most economically. Depicting the bearings schematically with loads and geometric requirements provides each manufacturer the flexibility to innovatively achieve optimal economy.

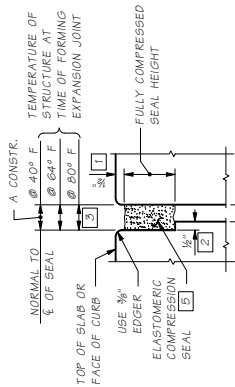
9.2.8 Shop Drawing Review

The manufacturer designs and develops shop drawings for high load multi-rotational bearings. The Engineer is responsible for checking and approving the calculations and shop drawings. The calculations shall verify the structural adequacy of all components of the bearing. Each bearing shall be detailed to permit the inspection and replacement of components.

9.2.9 Bearing Replacement Considerations

In some situations, existing bearings, or elements thereof, must be replaced consequent to excessive wear or seismic rehabilitation. Bearing replacement operations generally require lifting of superstructure elements using hydraulic jacks. The designer is responsible for calculating anticipated lifting loads and stipulating these loads on the contract drawings. Limitations on lift height shall also be specified. Consideration shall be given to lift height as it relates to adjacent expansion joints elements and adjoining sections of railing. Stresses induced as a consequence of differential lift height between multiple hydraulic jacks are generally addressed by stipulating restrictions in the plans or special provisions.

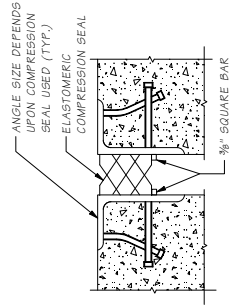
Past experience shows that actual lifting loads nearly always exceed calculated lifting loads. Many factors may contribute to this phenomenon, including friction in the hydraulic jack system and underestimation of superstructure dead loads. Unless the Bearing and Expansion Joint Specialist or the Bridge Design Engineer approves a variance, contract documents shall require that all hydraulic jacks be sized for 200 percent of the calculated lifting load. In all cases, the designer shall verify from manufacturer's literature that appropriate hydraulic jacks are available to operate within the space limitations imposed by a particular design situation.



COMPRESSION SEAL

CONCRETE OPENING

- 1 USE 1/4" FOR ALL SEALS.
- 2 USE 1/4" FOR ALL SEALS.
- 3 COMPUTE "A CONSTR." PER EQUATION (12) @ 40°F, 64°F, AND 80°F
- 4 TO BE CHECKED BY THE DESIGNER. SHALL BE LARGE ENOUGH TO PREVENT CLOSURE UNDER THERMAL MOVEMENTS.
- 5 SEE 60M SECTION 91.3A AND DESIGN EXAMPLE FOR COMPRESSION SEAL DESIGN AND SEE "COMPRESSION SEAL TABLE" ON THIS SHEET.



COMPRESSION SEAL

ARMORED OPENING.
USE IN BRIDGE WIDENINGS WITH EXISTING ARMORED JOINTS

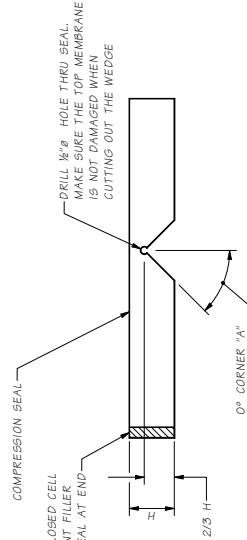
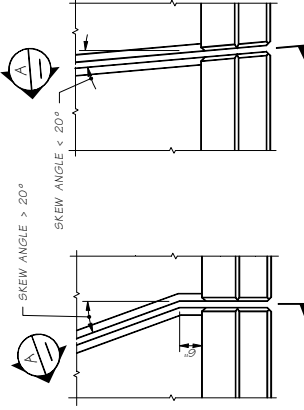
NOTE:
DESIGNER TO USE APPROPRIATE DETAILS FROM THIS SHEET AND CONSULT WITH EXPANSION JOINT SPECIALIST FOR LATEST PLAN SHEET LAYOUT, NOTES, AND UP-TO-DATE DETAILS.

COMPRESSION SEAL TABLE

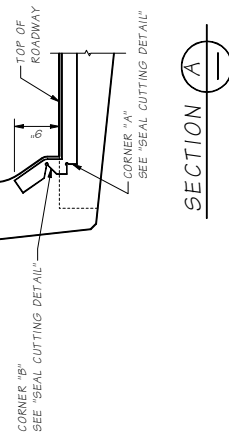
D.S. SEAL	WATSON BOWMAN		ACME	
	WIDTH	SEAL	WIDTH	SEAL
CV-20	2"	WA-200	2"	2"
CV-2502	2 1/8"	WA-250	2 1/8"	2 1/8"
CV-30	3"	WA-300	3"	3"
CV-35	3 1/8"	WA-350	3 1/8"	3 1/8"
CV-40	4"	WA-400	4"	4"

TESTING SHALL BE PER AASHTO M-220 PRIOR TO USE.

NOTE:
COMPRESSION SEALS GREATER THAN FOUR INCHES WIDE SHOULD NOT BE USED



SEAL CUTTING DETAIL

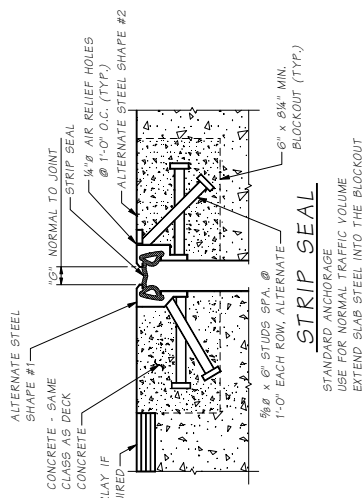


Bridge Design Engr.		MUST ANDAROSI/Expansion Joints/COMPRESSION SEAL DET.mxd		SHEET NO.		TOTAL SHEETS	
Supervisor	Checked By	State	FED. AID PROJ. NO.	WASH	JOB NUMBER	DATE	
Designed By	Drawn By	10				BY: APPD	
Checked By	Bridge Projects Engr.					REVISION	
Printed Plan By	Architect/Specifier						
Wsd Feb 06 05:04:58 #6097							

Washington State Department of Transportation

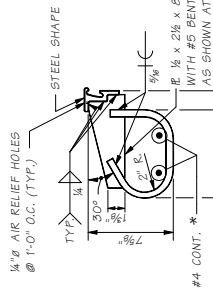
BRIDGE AND STRUCTURES OFFICE

EXPANSION JOINTS
EXPANSION JOINT DETAILS
COMPRESSION SEAL



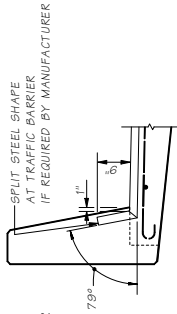
STRIP SEAL

STANDARD ANCHORAGE
USE FOR NORMAL TRAFFIC VOLUME
EXTEND SLAB STEEL INTO THE BLOCKOUT

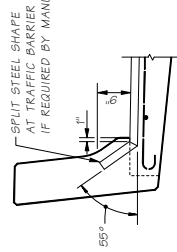


STRIP SEAL

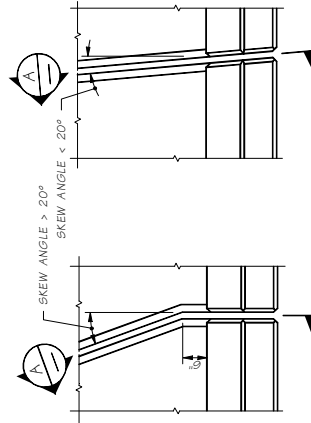
SPECIAL ANCHORAGE
USE FOR HIGH TRAFFIC VOLUME
REQUIRES 9" x 1'-0" MIN. BLOCKOUT
EXTEND SLAB STEEL INTO THE BLOCKOUT
EXTEND BLOCKOUT TO EDGE OF DECK
* PLACED AFTER EXPANSION JOINT
IS IN POSITION. THREAD INTO
PLACE FROM THE ENDS.



SECTION A
FOR STRIP SEAL
SINGLE SLOPE BARRIER



SECTION A
FOR STRIP SEAL
"F" SHAPE BARRIER



PLAN ~ EXPANSION JOINT

STEEL SHAPE TYPES

MANUFACTURER	ITEM NAME	S				W				T				Y					
		T	W	Y	T	W	Y	T	W	Y	T	W	Y	T	W	Y			
D. S. BROWN	DSB STRIP SEAL A2R-400	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"
WATSON BOWMAN ACME	WABO STRIP SEAL A2R-400	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"
R.J. WATSON, INC.	R.J. STRIP SEAL 400	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"
HEXCEL FTYE CO.	STRIP J200-C ES500	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"	1/2"	1/2"	3/4"

* TRIM OUTSTANDING LEGS OF 50CM2 SHAPE FOR USE IN TRAFFIC BARRIER

NOTE:
DESIGNER TO USE APPROPRIATE DETAILS FROM THIS SHEET AND CONSULT WITH EXPERT PLANNING ENGINEER NOTES, AND UP-TO-DATE DETAILS.

STRIP SEAL NOTES:

- DESIGNER SHALL INCLUDE APPROPRIATE DETAILS AND TABLES IN THE PLANS.
- SEE BDM SECTION 9.14B AND DESIGN EXAMPLE FOR STRIP SEAL DESIGN AND FOR DETERMINING OPENING "G" NORMAL TO THE JOINT. FILL IN AMOUNTS CALCULATED AND STEEL SHAPES SELECTED.
- FOR SKEW ANGLE GREATER THAN 30° SEE JOINT SPECIALIST.
- SEE JOINT SPECIALIST PRIOR TO SPECIFYING A 5" MOTION RANGE STRIP SEAL.
- A GROUP 1 PERMITS A 9/8" GAP BETWEEN STEEL SUPPORTING ELEMENTS AT FULL CLOSURE AND A GROUP 2 STRIP SEAL PERMITS FULL CLOSURE.
- DO NOT USE STEEL SHAPES WITH HORIZONTAL LEGS IN CURB OR BARRIER REGION.

2" MOTION RANGE

GROUP	MANUFACTURER	ITEM NAME	OPENING "G" NORMAL TO JT.			MIN. INSTALLATION WIDTH NORMAL TO JOINT	OPENING "G" NORMAL TO JOINT
			MIN.	MAX.	MIN.		
1	D. S. BROWN	DSB STRIP SEAL A2R-400	3/8"	4 3/8"	1/8"	3/4"	1/2"
2	WATSON BOWMAN ACME	WABO STRIP SEAL SE-300	0"	3"	1/8"	1/2"	1/2"
2	R.J. WATSON, INC.	R.J. STRIP SEAL 200	0"	2"	1/8"	1/2"	1/2"
1	HEXCEL FTYE CO.	STRIP J200-C ES500	3/8"	5 3/8"	1/8"	1/2"	1/2"

3" MOTION RANGE

GROUP	MANUFACTURER	ITEM NAME	OPENING "G" NORMAL TO JT.			MIN. INSTALLATION WIDTH NORMAL TO JOINT	OPENING "G" NORMAL TO JOINT
			MIN.	MAX.	MIN.		
1	D. S. BROWN	DSB STRIP SEAL A2R-400	1/2"	4 1/2"	1/8"	1/2"	1/2"
2	WATSON BOWMAN ACME	WABO STRIP SEAL SE-300	0"	3"	1/8"	1/2"	1/2"
2	R.J. WATSON, INC.	R.J. STRIP SEAL 300	0"	3"	1/8"	1/2"	1/2"
1	HEXCEL FTYE CO.	STRIP J300-C ES500	1/2"	5 1/2"	1/8"	1/2"	1/2"

4" MOTION RANGE

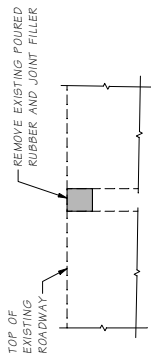
GROUP	MANUFACTURER	ITEM NAME	OPENING "G" NORMAL TO JT.			MIN. INSTALLATION WIDTH NORMAL TO JOINT	OPENING "G" NORMAL TO JOINT
			MIN.	MAX.	MIN.		
1	D. S. BROWN	DSB STRIP SEAL A2R-400	3/8"	4 3/8"	1/8"	3/4"	1/2"
2	WATSON BOWMAN ACME	WABO STRIP SEAL SE-400	0"	4"	1/8"	1/2"	1/2"
2	R.J. WATSON, INC.	R.J. STRIP SEAL 400	0"	4"	1/8"	1/2"	1/2"
1	HEXCEL FTYE CO.	STRIP J400-C ES500	3/8"	5 3/8"	1/8"	1/2"	1/2"

5" MOTION RANGE

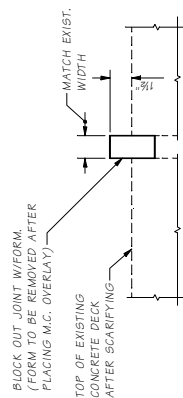
GROUP	MANUFACTURER	ITEM NAME	OPENING "G" NORMAL TO JT.			MIN. INSTALLATION WIDTH NORMAL TO JOINT	OPENING "G" NORMAL TO JOINT
			MIN.	MAX.	MIN.		
1	D. S. BROWN	DSB STRIP SEAL L2-500	1/2"	5 1/2"	1/8"	1/2"	1/2"
2	WATSON BOWMAN ACME	WABO STRIP SEAL SE-500	0"	5"	1/8"	1/2"	1/2"
2	R.J. WATSON, INC.	R.J. STRIP SEAL 500	1/2"	5"	1/8"	1/2"	1/2"

** GROUP COLUMN NOT TO BE SHOWN IN CONTRACT PLANS. FOR DESIGN PURPOSES ONLY.

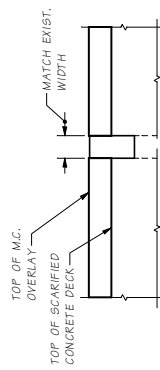
Bridge Design Engr. Supervisor Designed By Checked By Decaled By Bridge Projects Engr. Plans, then by Architect/Specifier		STANDARD 10 WASH. JOB NUMBER		EXPANSION JOINTS EXPANSION JOINT DETAILS STRIP SEAL	
Washington State Department of Transportation		BRIDGE AND STRUCTURES OFFICE		EXPANSION JOINTS EXPANSION JOINT DETAILS STRIP SEAL	



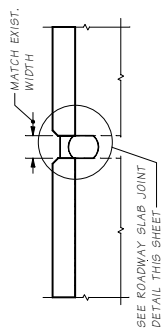
SECTION A
CONSTRUCTION STEP 1
EXISTING EXPANSION JOINT



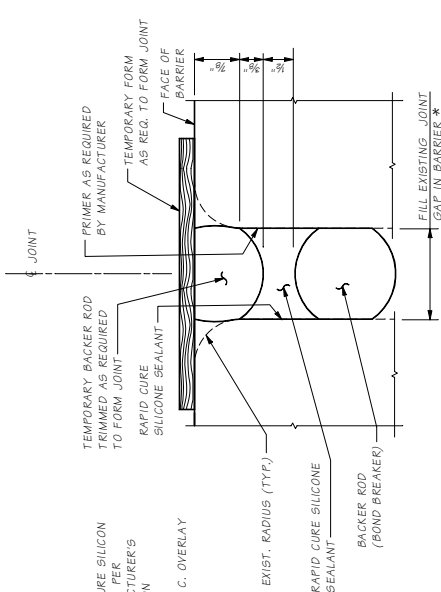
SECTION A
CONSTRUCTION STEP 4



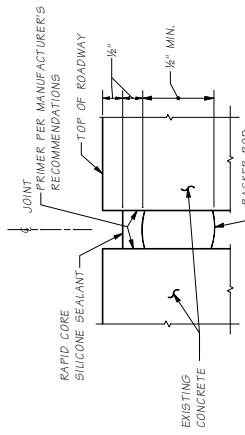
SECTION A
CONSTRUCTION STEP 5



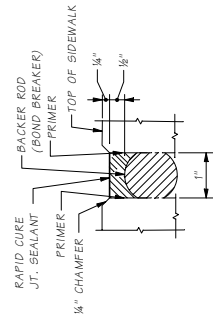
SECTION A
STEPS 6-9



SECTION B
RETROFIT AT
CURB & SIDEWALK

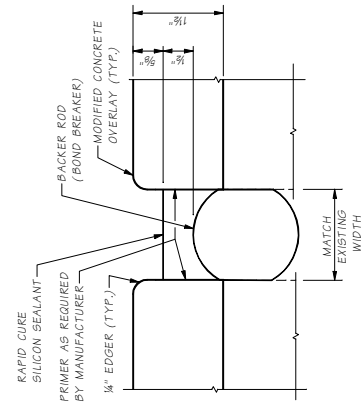


SECTION C
AT ROADWAY



SECTION C
AT SIDEWALK

SECTION C
EXPANSION JOINT
MODIFICATION AT
EXISTING BARRIER



EXPANSION JOINT DETAIL
EXPANSION JOINT MODIFICATION
AT ROADWAY SLAB

CONSTRUCTION STEPS:

1. REMOVE EXISTING POURED RUBBER & JOINT FILLER MATERIAL FROM EXPANSION JOINT.
2. CLEAN SIDES AND BOTTOM OF JOINT OPENING TO CLEAN AND SOUND CONCRETE.
3. BLOW JOINT OPENING WITH OIL-FREE COMPRESSED AIR TO REMOVE LAITANCE AND DEBRIS FROM REMOVAL OPERATIONS.
4. PLACE FORM IN EXISTING JOINT OPENING TO A HEIGHT LEVEL WITH THE FINAL ROADWAY ELEVATION.
5. PLACE MODIFIED CONCRETE OVERLAY TO FINAL RDWY ELEVATION.
6. REMOVE FORM FROM JOINT OPENING AND LIGHTLY SANDBLAST TO REMOVE ALL RESIDUE.
7. PRIME VERTICAL FACES OF JOINT IN ACCORDANCE WITH SEALANT MANUFACTURER'S RECOMMENDATION.
8. PLACE AN APPROPRIATELY SIZED BAKER ROD TO THE CORRECT DEPTH IN JOINT OPENING IN ACCORDANCE WITH SEALANT MANUFACTURER'S DIRECTIONS.
9. PLACE RAPID CURE SILICONE SEALANT IN ACCORDANCE WITH MANUFACTURER'S DIRECTIONS.

Bridge Design Eng. Supervisor Designed By Checked By Detailed By Bridge Projects Eng. Drawn By In-charge/Operator		MAINTENANCE/STANDARD/SEALANT/SILICONE SEAL DETAILS.mxd COUNTY STATE ID WASH JOB NUMBER		FEDERAL PROJ. NO. SHEET NO. TOTAL SHEETS	
DATE REVISION BY APPD		BRIDGE AND STRUCTURES OFFICE		EXPANSION JOINTS SILICONE SEAL EXPANSION JOINT DETAILS	
Washington State Department of Transportation		SHEET OF SHEETS			

Chapter 10 Signs, Barriers, Approach Slabs & Utilities

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10.1 Sign and Luminaire Supports

10.1.1 Loads

A. General

The reference used in developing the following office criteria is the AASHTO “*Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*,” Fourth Edition Dated 2001 including interims, and shall be the basis for analysis and design.

B. Dead Loads

Sign (incl. panel and windbeams, does not include vert. bracing.)	3.25 lbs./ft. ²
Luminaire (effective projected area of head = 3.3 sq. ft.)	60 lbs./each
Fluorescent Lighting	3.0 lbs./ln. ft
Standard Signal Head	60 lbs./each
Mercury Vapor Lighting	6.0 lbs./ln. ft
Sign Brackets	Calc.
Structural Members	Calc.
5 foot wide maintenance walkway (incl. sign mounting brackets & handrail)	160 lbs./ln. ft.
Signal Head w/3 lenses (effective projected area with backing plate = 9.2 sq ft.)	60 lbs. each

C. Wind Loads

A major change in the AASHTO 2001 Specification wind pressure equation is the use of a 3 second gust wind speed in place of a fastest-mile wind speed used in the previous specification. The 3 second wind gust map in AASHTO is based on the wind map in ANSI/ASCE 7-95.

Basic wind speed of 90 mph shall be used in computing design wind pressure using Equation 3-1 of AASHTO Section 3.8.1.

Do not use the Alternate Method of Wind Pressures given in Appendix C of the AASHTO 2001 Specifications.

D. Design Life and Recurrence Interval (Table 3-3, AASHTO 2001)

50 years for luminaire supports, overhead sign structures, and traffic signal structures.

10 years for roadside sign structures.

E. Ice Loads

3 psf applied around all the surfaces of structural supports, horizontal members, and luminaires, but applied to only one face of sign panels (AASHTO Section 3.7).

F. Fatigue Design:

Fatigue design shall conform to AASHTO Section 11. Fatigue Categories are listed in Table 11-1. Cantilever structures, poles, and bridge mounted sign brackets shall conform to the following fatigue categories.

Fatigue Category I for overhead cantilever sign structures (maximum span of 30 ft. and no VMS installation) and bridge mounted sign brackets.

Fatigue Category II for high-level (high-mast) lighting poles in excess of 98 ft. in height

Fatigue Category III for overhead cantilever traffic signal structures at traffic intersections. (Maximum span shall be 65 ft.) If vehicle speeds are posted at greater than 45 mph, then overhead cantilever traffic signals need to be designed for Fatigue Category I.

The “XYZ” limitation shown in Table 10.1.4-2 shall be met for Monotube Cantilevers. The “XYZ” limitation consists of the product of the sign area (XY) and the arm from the centerline of the posts to the centerline of the sign (Z). See Appendix 10.1-A2-1 for details.

G. Live Load:

A live load consisting of a single load of 500 lb distributed over 2.0 ft. transversely to the member shall be used for designing members for walkways and platforms. The load shall be applied at the most critical location where a worker or equipment could be placed, see AASHTO 2001, Section 3.6.

F. Group Load Combinations:

Sign, luminaire, and signal support structures are designed using the maximum of the following four load groups (AASHTO Section 3.4 and Table 3-1):

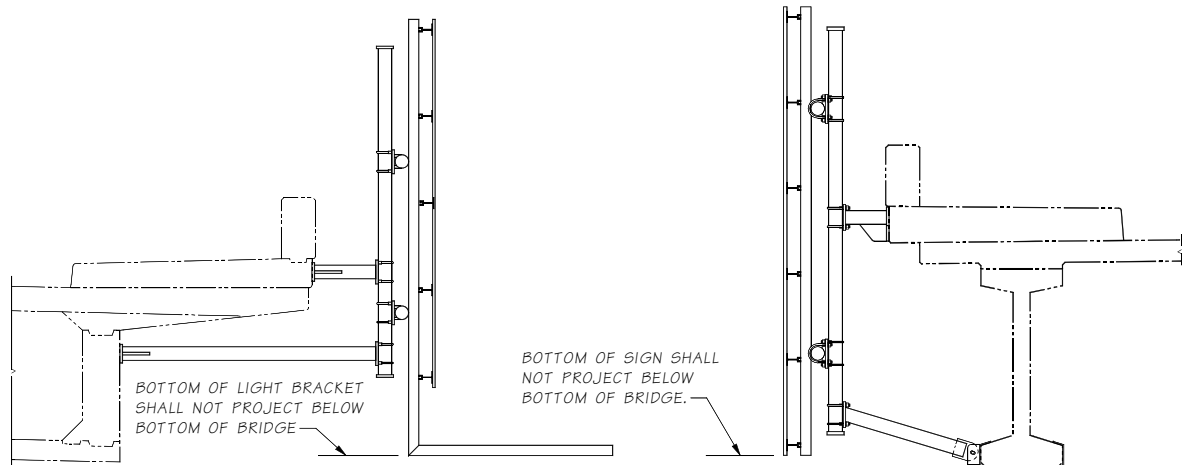
Group Load	Load Combination	Percent of *Allowable Stress
I	DL	100
II	DL+W**	133
III	DL+Ice+½(W**)	133
IV	Fatigue	See AASHTO Section 11 for Fatigue loads and stress range
* No load reduction factors shall be applied in conjunction with these increased allowable stresses.		
** W—Wind Load		

10.1.2 Bridge Mounted Signs

A. Vertical Clearance

All new signs mounted on bridge structures shall be positioned such that the bottom of the sign or lighting bracket does not extend below the bottom of the bridge as shown in Figure 10.1.2-1. The position of the sign does not need to allow for the future placement of lights below the sign. If lights are to be added in the future they will be mounted above the sign. To ensure that the bottom of the sign or lighting bracket is above the bottom of the bridge, the designer should maintain at least a nominal 2 inch dimension between the bottom of the sign or lighting and the bottom of the bridge. Maximum sign height shall be decided by the Region. If the structure is too high above the roadway, then the sign should not be placed on the structure.

Bridge mounted sign brackets shall be designed to account for the weight of added lights, and for the wind affects on the lights to ensure bracket adequacy if lighting is attached in the future.

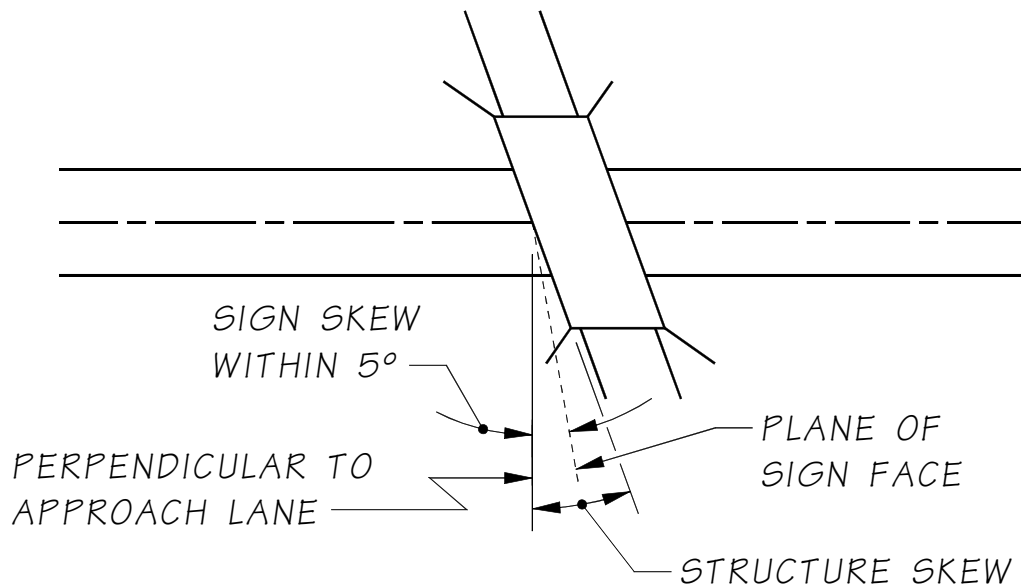


Sign Vertical Clearance

Figure 10.1.2-1

B. Geometrics

1. Signs should be installed at approximate right angles to approaching motorists. For structures above a tangent section of roadway, signs shall be designed to provide a sign skew within 5° from perpendicular to the lower roadway (see Figure 10.1.2-2).

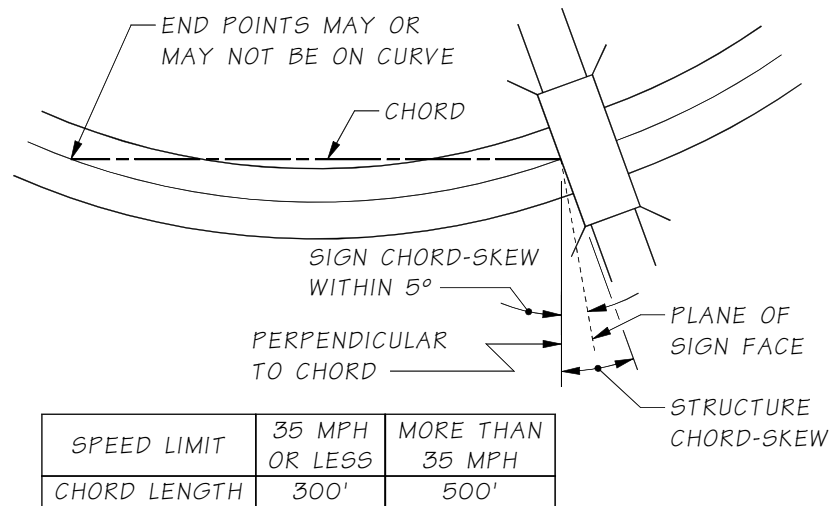


Sign Skew on Tangent Roadway

Figure 10.1.2-2

2. For structures located on or just beyond a horizontal curve of the lower roadway, signs shall be designed to provide a sign chord skew within 5° from perpendicular to the chord-point determined by the approach speed (see Figure 10.1.2-3).

- The top of the sign shall be level.



Sign Skew on Curved Roadway
Figure 10.1.2-3

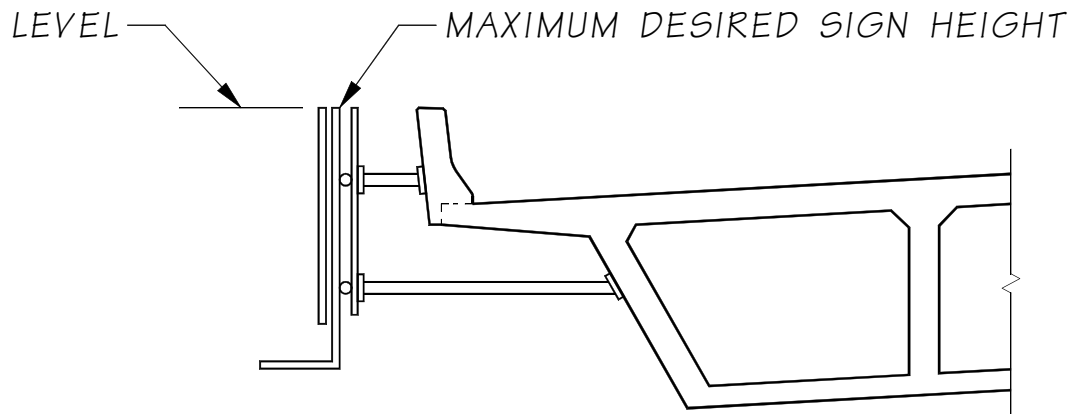


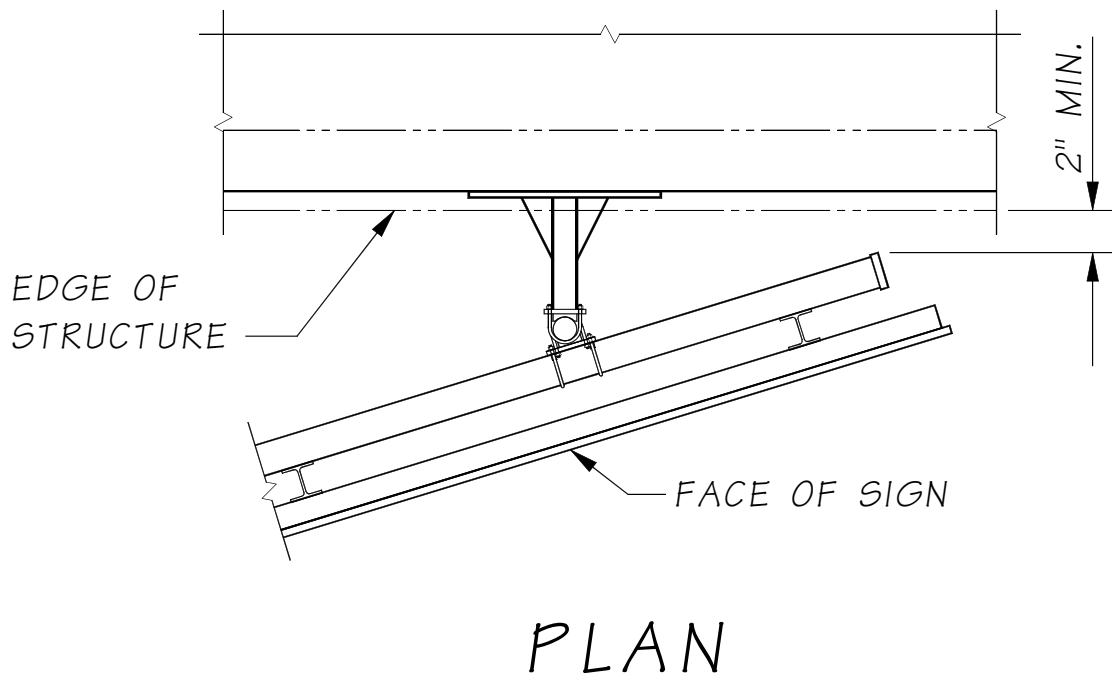
Figure 10.1.2-4

C. Aesthetics

- When possible, the support structure should be hidden from view of traffic.
- The sign support shall be detailed in such a manner that will permit the sign and lighting bracket to be installed level.
- When the sign support will be exposed to view, special consideration is required in determining member sizes and connections to provide as pleasing an appearance as possible.

D. Sign Placement

1. When possible, the designer should avoid locating signs under bridge overhangs. This causes partial shading or partial exposure to the elements and problems in lifting the material into position and making the required connections. Signs shall never be placed directly under the drip-line of the structure. These conditions may result in uneven fading, discoloring, and difficulty in reading. When necessary to place a sign under a bridge due to structural or height requirements, the installation should be reviewed by the Region Traffic Design Office.
2. A minimum of 2 inches of clearance shall be provided between back side of the sign support and edge of the structure. See Figure 10.1.2-5.

**Sign Horizontal Location***Figure 10.1.2-5*

E. Installation

1. Resin bonded anchors or cast-in-place ASTM A 307 anchor rods should be used to install the sign brackets on the structure. Size and minimum installation depth shall be given in the plans. The resin bonded anchors should be installed normal to the concrete surface. Resin bonded anchors shall not be placed through the webs or flanges of prestressed or post tensioned girders unless approved by the WSDOT Bridge Design Engineer.
2. Bridge mounted sign structures shall not be placed on bridges with steel superstructures unless approved by the WSDOT Bridge Design Engineer.

10.1.3 Monotube Sign Structures Mounted on Bridges

A. Design Loads

Design loads for the supports of the Sign Bridges shall be calculated based on assuming a 12-foot deep sign over the entire roadway width, under the sign bridge. This will account for any signs that may be added in the future. For Cantilever design loads, guidelines specified in Section 10.1.1 shall be followed. The design loads shall follow the same criteria as described in Section 10.1.1. Loads from the sign bridge shall be included in the design of the supporting bridge. In the cases where a sign structure is mounted on a bridge the design limit of the Sign Structure where the AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals,” Fourth Edition Dated 2001 including Interims is applicable is from the anchor rods and above. The design limit where the BDM and AASHTO LRFD Bridge Design Specifications, Fourth Edition Dated 2007 including Interims is applicable is the concrete around the anchor bolt group and the connecting elements to the bridge structure. Loads from the AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals,” Fourth Edition Dated 2001 including Interims shall be taken as unfactored loads for use in LRFD design.

B. Vertical Clearance

Vertical clearance for Monotube Sign Structures shall be 20'-0" minimum from the bottom of the lowest sign to the highest point in the traveled lanes. See Appendix 10.1-A1-1, 10.1-A2-1, and 10.1-A3-1 for sample locations of Minimum Vertical Clearances.

C. Geometrics

Sign structures shall be placed at approximate right angles to approaching motorists. Dimensions and details of sign structures are shown in the Standard Plans G-60.10, G-60.20, G-60.30, G-70.10, G-70.20, G-70.30 and Appendix 10.1-A1-1, 2, & 3 and 10.1-A2-1, 2, & 3. When maintenance walkways are included, refer to Standard Plans G-95.10, G-95.20, G-95.30.

10.1.4 Monotube Sign Structures

A. Sign Bridge Standard Design

Table 10.1.4-1 provides the standard structural design information to be used for a Sign Bridge Layout, Appendix 10.1-A1-1; along with the Structural Detail sheets, which are Appendix 10.1-A1-2 and Appendix 10.1-A1-3.

B. Cantilever Standard Design

Table 10.1.4-2 provides the standard structural design information to be used for a Cantilever Layout, Appendix 10.1-A2-1; along with the Structural Detail sheets, which are Appendix 10.1-A2-2 and Appendix 10.1-A2-3.

STANDARD MONOTUBE SIGN BRIDGES																	
SPAN LENGTH	POSTS (V)				BEAM A (V)				BEAM B (V)				BEAM C (V)				CAMBER
	"S"	"H"	"A"	"B"	"T1"	"L1"	"B"	"C"	"T2"	"L2"	"B"	"C"	"T2"	"L3"	"B"	"C"	
LESS THAN 60'-0"	30'-0" OR LESS	1'-6"	2'-0"	1/2"	6'-0"	2'-0"	2'-0"	3/8"	0'-0"	2'-0"	2'-0"	3/8"	13'-0" TO 48'-0"	2'-0"	2'-0"	3/8"	2 3/4"
60'-0" TO 75'-0"	30'-0" OR LESS	1'-6"	2'-3"	1/2"	6'-0"	2'-3"	2'-0"	3/8"	9'-0" TO 14'-0"	2'-3"	2'-0"	3/8"	30'-0" TO 35'-0"	2'-3"	2'-0"	3/8"	3 3/4"
+75'-0" TO 90'-0"	30'-0" OR LESS	1'-6"	2'-3"	3/8"	6'-0"	2'-3"	2'-0"	3/8"	14'-0" TO 19'-0"	2'-3"	2'-0"	3/8"	35'-0" TO 40'-0"	2'-3"	2'-0"	3/8"	5"
+90'-0" TO 105'-0"	30'-0" OR LESS	1'-9"	2'-6"	3/8"	6'-0"	2'-6"	2'-3"	1/2"	19'-0" TO 26'-6"	2'-6"	2'-3"	1/2"	40'-0"	2'-6"	2'-3"	1/2"	6"
+105'-0" TO 120'-0"	30'-0" OR LESS	1'-9"	2'-6"	3/8"	6'-0"	2'-6"	2'-3"	1/2"	16'-6" TO 34'-0"	2'-6"	2'-3"	1/2"	40'-0"	2'-6"	2'-3"	1/2"	7 1/2"
+120'-0" TO 135'-0"	30'-0" OR LESS	2'-0"	2'-6"	3/8"	6'-0"	2'-6"	2'-6"	1/2"	34'-0" TO 41'-6"	2'-6"	2'-6"	1/2"	40'-0"	2'-6"	2'-6"	1/2"	8 1/2"
+135'-0" TO 150'-0"	30'-0" OR LESS	2'-0"	2'-6"	3/8"	6'-0"	2'-6"	2'-6"	1/2"	41'-6" TO 49'-0"	2'-6"	2'-6"	1/2"	40'-0"	2'-6"	2'-6"	1/2"	10 1/2"

SPAN LENGTH	POST BASE (V)					BOLTED SPLICE #1 L1 TO L2 AND L1 TO L3						BOLTED SPLICE #2 L2 TO L3					MAXIMUM SIGN AREA	
	"D1"	"S5"	"S6"	"T3"	"T6"	"S1"	"S2"	"S3"	"S4"	"T4"	"T5"	"S1"	"S2"	"S3"	"S4"	"T4"		"T5"
LESS THAN 60'-0"	1 1/2"	4	4	2 1/4"	3/4"	5	-	5	-	2"	5/8"	-	-	-	-	-	-	500 SQ. FT.
60'-0" TO 75'-0"	1 3/4"	4	4	2 1/4"	3/4"	6	-	5	-	2"	5/8"	6	-	5	-	2 1/4"	3/4"	600 SQ. FT.
+75'-0" TO 90'-0"	1 3/4"	4	4	2 1/2"	3/4"	6	-	5	-	2"	5/8"	6	-	5	-	2 1/4"	3/4"	750 SQ. FT.
+90'-0" TO 105'-0"	1 3/4"	4	5	2 1/2"	1"	7	-	6	-	2"	5/8"	7	5	6	4	2 1/2"	1"	750 SQ. FT.
+105'-0" TO 120'-0"	1 3/4"	4	5	2 1/2"	1"	7	-	6	-	2"	5/8"	7	5	6	4	2 1/2"	1"	850 SQ. FT.
+120'-0" TO 135'-0"	2"	4	5	2 1/2"	1"	7	-	7	-	2"	5/8"	7	5	7	5	2 1/2"	1"	800 SQ. FT.
+135'-0" TO 150'-0"	2"	4	5	2 1/2"	1"	7	-	7	-	2"	5/8"	7	5	7	5	2 1/2"	1"	800 SQ. FT.

(V) NOTE: DENOTES MAIN LOAD CARRYING TENSILE MEMBERS OR TENSION COMPONENTS OF FLEXURAL MEMBERS.

Table 10.1.4-1

STANDARD MONOTUBE CANTILEVERS

SPAN LENGTH	POSTS (V)				BEAM A (V)				BEAM B (V)				CAMBER
	"S"	"H"	"A"	"B"	"T1"	"L1"	"B"	"C"	"T2"	"L2"	"B"	"C"	
LESS THAN 20'-0"	30'-0" OR LESS	1'-6"	2'-0"	3/8"	6'-0"	2'-0"	2'-0"	3/8"	14'-0"	2'-0"	2'-0"	3/8"	2"
20'-0" TO 30'-0"	30'-0" OR LESS	1'-6"	2'-0"	1/2"	6'-0"	2'-0"	2'-0"	3/8"	14'-0" TO 24'-0"	2'-0"	2'-0"	3/8"	3 1/2"

SPAN LENGTH	POST BASE (V)					BOLTED SPLICE						MAXIMUMS		
	"D1"	"S5"	"S6"	"T3"	"T6"	"S1"	"S2"	"S3"	"S4"	"T4"	"T5"	SIGN AREA	"XYZ"	"Z"
LESS THAN 20'-0"	1 1/2"	4	4	2"	3/4"	5	-	5	-	2"	5/8"	168 SQ. FT.	2604 C.F.	15'-6"
20'-0" TO 30'-0"	2"	4	4	2"	3/4"	5	3	5	3	2 1/2"	5/8"	252 SQ. FT.	4410 C.F.	17'-6"

(V) NOTE: DENOTES MAIN LOAD CARRYING TENSILE MEMBERS OR TENSION COMPONENTS OF FLEXURAL MEMBERS.

Table 10.1.4-2

C. Balanced Cantilever Standard Design

Appendix 10.1-A3-1; along with the Structural Detail sheets, Appendix 10.1-A3-2 and Appendix 10.1-A3-3, provides the standard structural design information to be used for a Balanced Cantilever Layout, Balanced Cantilevers are typically for VMS sign applications and shall have the sign dead load balanced with a maximum difference one third to two thirds distribution.

D. Monotube BDM Sheet Guidelines

The following guidelines apply when using the Monotube Sign Structure Appendix 10.1-A1-1, 2, & 3, 10.1-A2-1, 2, & 3, 10.1-A3-1, 2, & 3, 10.1-A4-1, 2, & 3, and 10.1-A5-1.

1. Each sign structure shall be detailed and must specify:
 - a. Sign structure base Elevation, Station and Number.
 - b. Type of Foundation 1, 2, or 3 shall be used for the Monotube Sign Structures, unless a special design is required. The average Lateral Bearing Pressure for each foundation shall be noted on the Foundation sheet(s).
 - c. If applicable, label the Elevation View "Looking Back on Stationing".
2. Designers shall verify the cross-referenced page numbers and details are correct.

B. Monotube Quantities

Quantities for structural steel are given in Table 10.1.4-3.

Sign Structure Material Quantities										
ASTM A572 GR. 50 or ASTM 588	Cantilever			Sign Bridge						
	20' ≤	20' to 30'	Balanced	60' ≤	60' to 75'	75' to 90'	90' to 105'	105' to 120'	120' to 135'	135' to 150'
Post (plf)	99	132	132	132	144	176	204	204	215	215
Base PL (ea)	431	490	490	490	578	585	654	654	688	688
Beam, near Post (plf)	116	116	116	116	124	124	139	139	171	195
Span Beam (plf)	116	116	116	116	124	124	162	185	195	195
Corner Stiff. (ea set)	209	204	115	204	238	236	312	312	371	369
Splice Pl #1 (1pr)	482	482	482	482	692	692	892	883	780	780
Splice Pl #2 (1pr)	--	--	--	482	615	615	718	802	715	780
Brackets (ea)	60	60	60	60	65	65	69	69	70	70
6" Hand Hole (ea)	18	18	18	18	18	18	18	18	18	18
6" x 11" Hand Hole (ea)	30	30	30	30	30	30	18	30	30	30
Anchor Bolt PL (ea)	175	175	175	175	185	185	311	311	326	326
Seal Plates (1 bridge)	217	216	216	316	614	612	770	674	860	860

Sign Structure Steel Quantities

Table 10.1.4-3

10.1.5 Foundations

A. Monotube Sign Bridge and Cantilever Sign Structure Foundation Types

The Geotechnical Branch shall be consulted as to which foundation type is to be used. Standard foundation designs are provided in WSDOT Standard Plans G-60.20 & G-60.30 and G-70.20 & G-70.30; and in BDM Section 10.1.5. The following paragraphs describe the four types of foundations detailed in this section.

1. The Foundation Type 1, a drilled shaft, is the preferred foundation type. The standard drilled shafts are designed for a lateral bearing pressure of 2,500 psf. See Appendix 10.1-A4-1 & 2 for Foundation Type 1 standard design information. The Geotech report for this foundation should include the soil friction angle and if temporary casing is required for shaft construction, in addition to the allowable lateral bearing pressures. When the Geotechnical engineer specifies temporary casing, it shall be clearly shown on shaft plans, for each required shaft.
2. The Foundation Type 2 is an alternate to Type 1 when drilled shafts are not suitable to the site. Foundation Type 2 is designed for a lateral bearing pressure of 2,500 psf. See Appendix 10.1-A4-3 for Foundation Type 2 standard design information.
3. The Foundation Type 3 replaces the foundation Type 2 for poor soil conditions where the lateral bearing pressure is between 2,500 psf and 1,500 psf. See Appendix 10.1-A4-3 for Type 3 Foundation standard design information.
4. Barrier Foundations are foundations that include a barrier in the top portion of Foundation Types 1, 2, & 3. Foundations details shall be modified to include Barrier Foundation details. Appendix 10.1-A5-1 details a single slope barrier.

B. Luminaire, Signal Standard and Camera Pole Foundation Types

Luminaire foundation options are shown on Standard Plan J-28.30. Signal Standard and Camera Pole foundation options are provided in the Plan Sheet Library, on the WSDOT Design Standards Home Page.

C. Foundation Design

Shaft type foundations constructed in soil for sign bridges, cantilever sign structures, luminaires, signal standards and strain poles are designed per the current edition of the AASHTO Standard Specifications For Highway Signs, Luminaires, and Traffic Signals; Section 13.10; Embedment of Lightly Loaded Small Poles And Posts. This design method assumes the presence of uniform soil properties with depth, including a single value for Allowable Lateral Bearing Pressure. For foundation locations with multiple soil layers within the anticipated foundation depth (and multiple values of allowable lateral bearing pressure), consideration should be given to using a single "weighted average" value of allowable lateral bearing pressure for design. For foundation locations where a soft soil (with low allowable lateral bearing pressures) is overlaid by a stronger soil (with higher allowable lateral bearing pressures), the foundation can be conservatively designed for the lower allowable lateral bearing pressure value. This design method accounts for the lateral loads applied to the foundation due to the soil pressure (increasing with depth) and the lateral loads applied from the structure above. An additional increase in lateral resistance should not be added for increasing soil lateral pressures with depth.

No provisions for foundation torsional capacity are provided in Section 10.13 of the AASHTO Standard Specifications For Highway Signs, Luminaires, and Traffic Signals. The following approach can be used to calculate torsional capacity of sign structure, luminaire, and signal standard foundations:

Torsional Capacity, T_u ,

$$T_u = F \cdot \tan \phi \cdot D$$

Where,

F = Total force normal to shaft surface (kip)

D = Diameter of shaft (ft)

ϕ = Soil friction angle (degree), use smallest for variable soils

1. Monotube Sign Bridge and Cantilever Sign Structures Foundation Type 1 Design:

The standard embedment depth "Z", shown in the table on Appendix 10.1-A4-1, shall be used as a minimum embedment depth and shall be increased if the shaft is placed on a sloped surface, or if the allowable lateral bearing pressures are reduced from the standard 2500 psf. The standard depth assumed that the top 4 feet of the C.I.P. cap is not included in the lateral resistance (i.e., shaft depth "D" in the code mentioned above), but is included in the overturning length of the sign structure. Bridge Special Provisions 210201A1.GB8, 210501.GB8, and 210309F2.FB8 shall be included with all Foundation Type 1 shafts.

2. Monotube Sign Bridge and Cantilever Structures Foundation Type 2 & 3:

These foundation designs are standards and shall not be adjusted or redesigned. They are used in conditions where a Foundation Type 1 (shaft) would be impractical due to difficult drilling or construction and when the Geotechnical Engineer specifies their use. The concept is that the foundation excavation would maintain a vertical face in the shape of the Foundation Type 2 or 3. Contractors often request to over-excavate and backfill the hole, after formwork has been used to construct this foundation type. This is only allowed with the Geotechnical engineer's approval, if the forming material is completely removed, and if the backfill material is either CDF or concrete class 3000 or better.

3. Monotube Sign Bridge and Cantilever Structures Special Design Foundations:

The Geotechnical Engineer will identify conditions where the foundation types (1, 2, or 3) will not work. In this case, the design forces are calculated, using the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and traffic Signals, and applied at the bottom of the structure base plate. These forces are then considered service loads and the special design foundation is designed with the appropriate Service, Strength, and Extreme Load Combination Limit States and current design practices of the AASHTO LRFD Bridge Design Specifications and the WSDOT *Bridge Design Manual*. Some examples of these foundations are spread footings, columns and shafts that above ground adjacent to retaining walls, or connections to traffic barriers on bridges. The anchor rod array shall be used from the BDM Tables 10.1.4-1 and 10.1.4-2 and shall be long enough to develop the rods into the confined concrete core of the foundation. The rod length and the reinforcement for concrete confinement, shown in the top four feet of the Foundation Type 1, shall be used as a minimum.

4. Signal Foundation Design:

Bridge Special Provisions 20021.GB8, 20051.GB8, and 20034041.FB8 shall be included with these foundation designs when specified by the Geotechnical engineer.

D. Foundation Quantities

- Barrier quantities are approximate and can be used for all Foundation Types:

Class 4000 Concrete 7.15 CY (over shaft foundation)
 Grade 60 rebar 372 lbs.

- Miscellaneous steel quantities (anchor rods, anchor plate, and template) for all Monotube Sign Structure foundation types are listed below (per foundation). Quantities vary with span lengths as shown.

60 feet & under = 1,002 pounds
 61 feet to 90 feet = 1,401 pounds
 91 feet to 120 feet = 1,503 pounds
 121 feet to 150 feet: Barrier mounted sign bridge not recommended for these spans.

- Monotube Sign Bridge and Cantilever Sign Structure Type 1-3 Foundation quantities for concrete, rebar and excavation are given in Table 10.1.5-1. For Sign Bridges, the quantities shown below are for one foundation and there are two foundations per Sign Bridge. If the depth “Z” shown in the table on Appendix 10.1-A4-1 is increased, these values should be recalculated.

Sign Structure Foundation Material Quantities						
	Cantilever Signs		Sign Bridges			
Concrete Cl. 4000 (cu. yard)	20' & Under	20' –30'	60' & Under	60' – 90'	90' – 120'	120' – 150'
Type 1	6.3	7.5	7.7	9.4	10.6	11.4
Type 2	8.0	10.5	10.0	12.2	14.1	15.0
Type 3	11.1	14.1	13.0	16.1	18.6	20.0
Rebar Gr. 60 Pounds						
Type 1	685	1,027	1,168	2,251	3,256	4,255
Type 2	772	1,233	1,190	1,724	2,385	2,838
Type 3	917	1,509	1,421	2,136	2,946	3,572
Excavation (cu. yard)						
Type 1	9.8	10.9	10.9	12.8	14.1	14.9
Type 2	20.7	25.7	24.6	29.0	32.9	34.6
Type 3	29.0	34.6	32.9	39.0	44.0	47.8

Table 10.1.5-1

10.1.6 Truss Sign Bridges: Foundation Sheet Design Guidelines

If a Truss sign structure is used, refer WSDOT *Standard Plans* for foundation details. There are four items that should be addressed when using the WSDOT *Standard Plans*, which are outlined below. For details for F-shape barrier details not shown in *Standard Plans* contact Bridge Office to access archived Bridge Office details.

1. Determine conduit needs. If none exist, delete all references to conduit. If conduit is required, verify with the Region as to size and quantity.
2. Show sign bridge base elevation, number, dimension and station.
3. Transition section shall be per Std. Plan.
4. The quantities shall be based on the Std. Plan details as needed.

10.2 Bridge Traffic Barriers

10.2.1 General Guidelines

The design criteria for bridge traffic barriers on structures shall be in accordance with Chapter 13 of the LRFD Bridge Design Specifications adopted by AASHTO. WSDOT's bridge traffic barrier standard test level is TL-4.

The WSDOT Bridge and Structures standard for new bridge traffic barriers is a 32-inch high F-Shape concrete barrier. This shape is the preferred shape by the FHWA. It should be used on all interstates, major highway routes, and over National Highway System (NHS) routes unless special conditions apply.

Use of a Single Slope concrete bridge traffic barrier shall be limited to locations where there is Single Slope concrete barrier on the approach grade to a bridge or for continuity within a corridor. The Single Slope bridge traffic barrier is 34 inches high which is consistent with the heights being used on grade applications. (See WSDOT *Design Manual* for additional background and criteria.)

Use the taller 42-inch high bridge traffic barriers on interstate or freeway routes only in the following circumstances:

- Accident history suggests a need.
- Large trucks make up a significant portion of the ADT
- Adverse roadway geometrics increase the possibility of hitting the traffic barrier at a high angle (such as on ramps for freeway to freeway connections with sharp curvature in the alignment).
- For the protection of schools, businesses or other important facilities below the bridge.
- For continuity within a corridor.

In addition, NCHRP Report 350 was adopted by AASHTO to give specific requirements for crash testing of bridge barriers prior to their use on all new or retrofitted bridge structures. The LRFD Bridge Design Specifications differentiate crash test criteria for various test levels depending upon traffic volume, design speed, vehicle mix, and other factors which produce a vast variation in traffic railing performance needs from one site to another.

A list of crash tested traffic barriers can be found thru the FHWA at:
http://safety.fhwa.dot.gov/roadway_dept/road_hardware/bridgerailings.htm

Bridge traffic barriers shall be rigidly connected to the bridge deck. Median bridge traffic barriers shall be either rigidly connected to bridge deck or allow a minimum of two feet of slide distance between the toe of the traffic barrier and the pavement lane marking.

10.2.2 Bridge Railing Test Levels

It must be recognized that bridge traffic barrier performance needs differ greatly from site to site. Barrier designs and costs should match facility needs. This concept is embodied in the AASHTO LRFD Bridge Design Specifications. Six different bridge railing test levels, TL-1 thru TL-6, and associated crash test/performance requirements are given in Chapter 13 of these design specifications along with guidance for determining the appropriate test level for a given bridge.

10.2.3 Available WSDOT Designs

A. Test Level 2

1. Service Level 1 (SL-1) Weak Post Guardrail

This bridge traffic barrier is a crash tested weak post rail system. It was developed by Southwest Research Institute and reported in NCHRP Report 239 for low-volume rural roadways with little accident history. We have utilized this design on some of our short concrete spans and on our timber bridges. A failure mechanism is built into this rail system such that upon a 2 kip applied impact load the post will break away from the mounting bracket. The three beam guardrail will contain the vehicle by virtue of its ribbon strength. This failure mechanism assures minimal or no damage to the bridge deck and stringers. The appropriate guardrail approach transition shall be a Case 14 placement as shown on WSDOT Standard Plan C-2h. For complete details see Appendix 10.4-A1.

2. Texas T-411 Aesthetic Concrete Baluster

Texas developed this standard for a section of highway that was considered to be a historic landmark. The existing deficient concrete baluster rail was replaced with a much stronger concrete baluster that satisfactorily passed the crash test performance criteria set forth by the NCHRP Report 230. For details visit TXDOT's Bridge and Structures web site at: www.txdot.gov/contact_us/bridge.htm

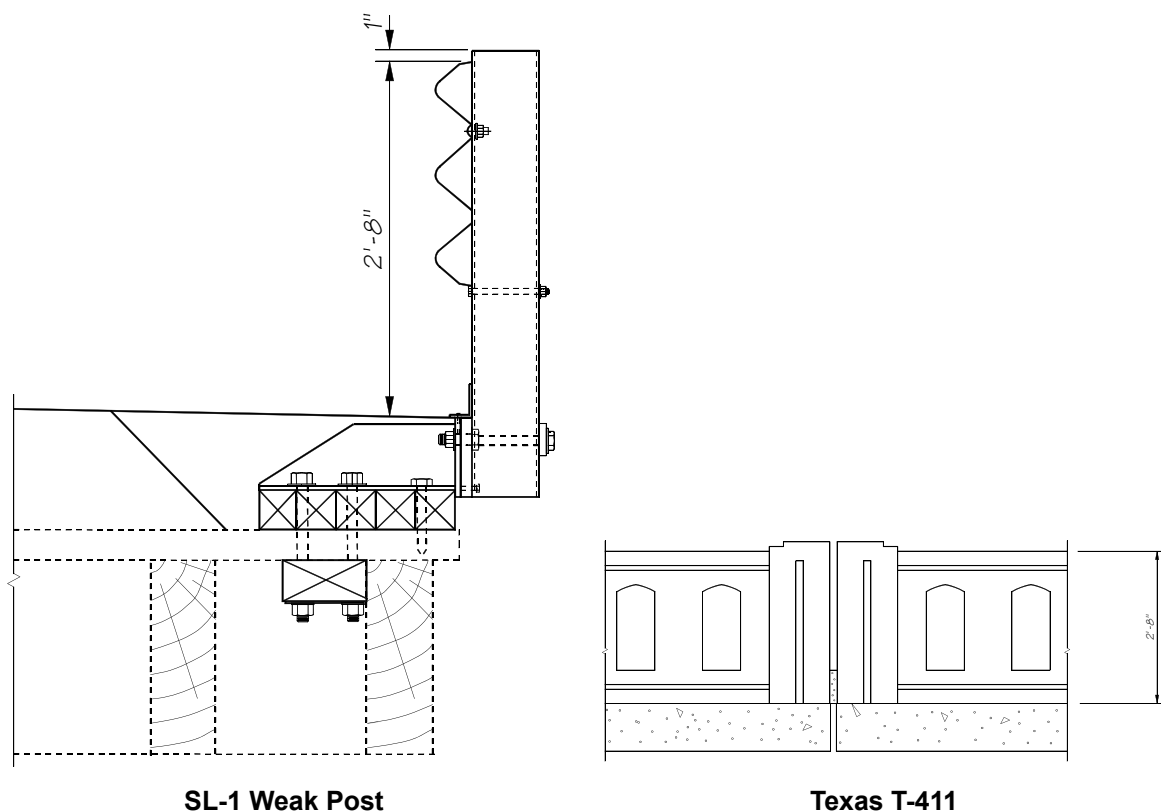


Figure 10.2.3-1

B. Test Level 4 Traffic Barriers

1. Traffic Barrier – Shape F

This configuration was crash tested in the late 1960's, along with the New Jersey Shape, under NCHRP 230 and again at this test level under NCHRP 350. The steeper vertical shape tested better than the New Jersey face and had less of an inclination to roll vehicles over upon impact. The 3" toe of the traffic barrier is the maximum depth that an ACP or HMA overlay can be placed. For complete details see Appendix 10.2-A1 & A2.

2. Traffic Barrier – Single Slope

This concrete traffic barrier system was designed by the state of California in the 1990's to speed up construction by using the "slip forming" method of construction. It was tested under NCHRP 350. WSDOT has increased the height from 32" to 34" to match the approach traffic barrier height and to allow the placement of one HMA overlay. Due to inherent problems with the "slip forming" method of traffic barrier construction WSDOT has increased the concrete cover on the traffic side from 1½" to 2½". For complete details see Appendix 10.2-A3.

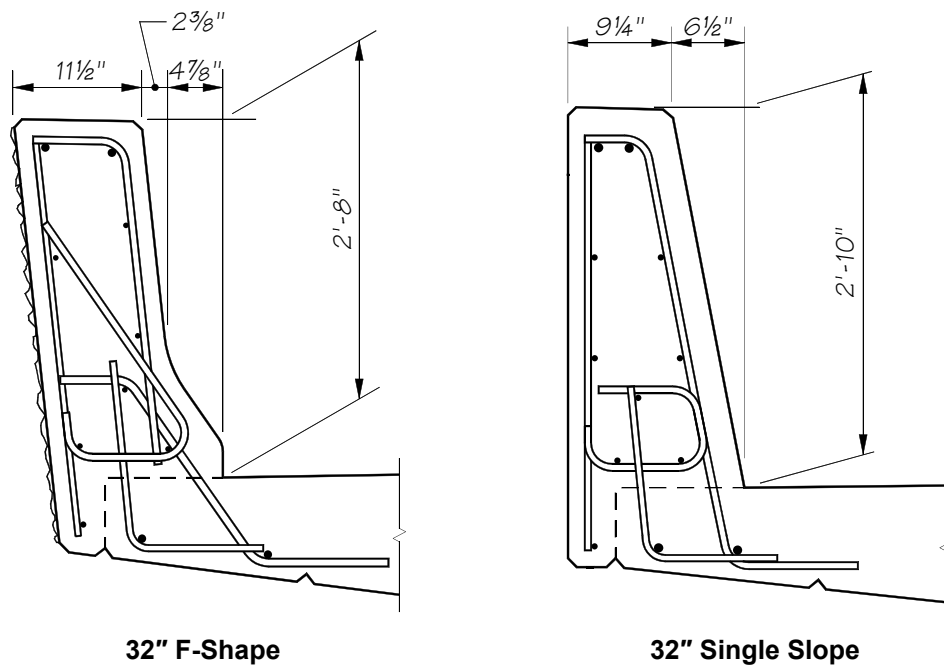


Figure 10.2.3-2

3. Pedestrian Barrier

This crash tested rail system offers a simple to build concrete alternative to the New Jersey and F-Shape configurations. This system was crash tested under both NCHRP 230 and 350. Since the traffic face geometry is better for pedestrians and bicyclists, WSDOT uses this system primarily in conjunction with a sidewalk. For complete details see Appendix 10.2-A4.

4. Oregon 2-Tube Curb Mounted Traffic Barrier

This is another crash tested traffic barrier that offers a lightweight, see-through option. This system was crash tested under both NCHRP 230 and 350. A rigid thrie beam guardrail transition is required at the bridge ends. For details see the Oregon Bridge and Structure web site at: http://egov.oregon.gov/ODOT/HWY/ENGSERVICES/bridge_drawings.shtml#Bridge_200__Bridge_Rails

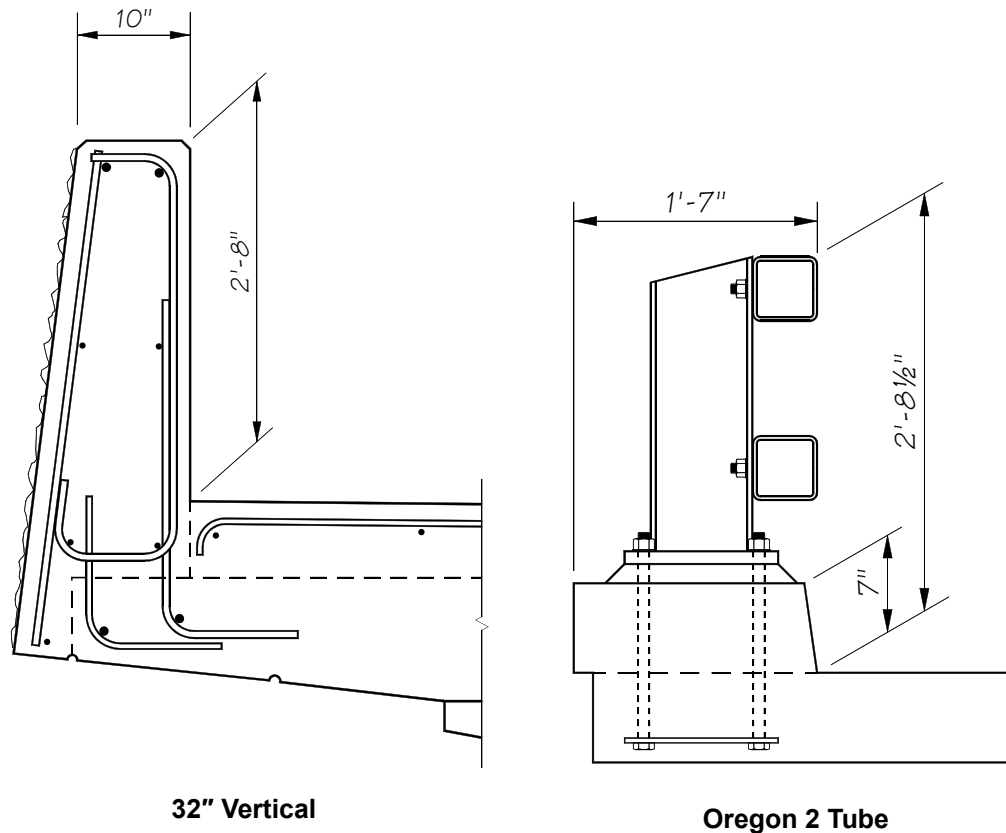


Figure 10.2.3-3

C. Test Level 5 Traffic Barriers

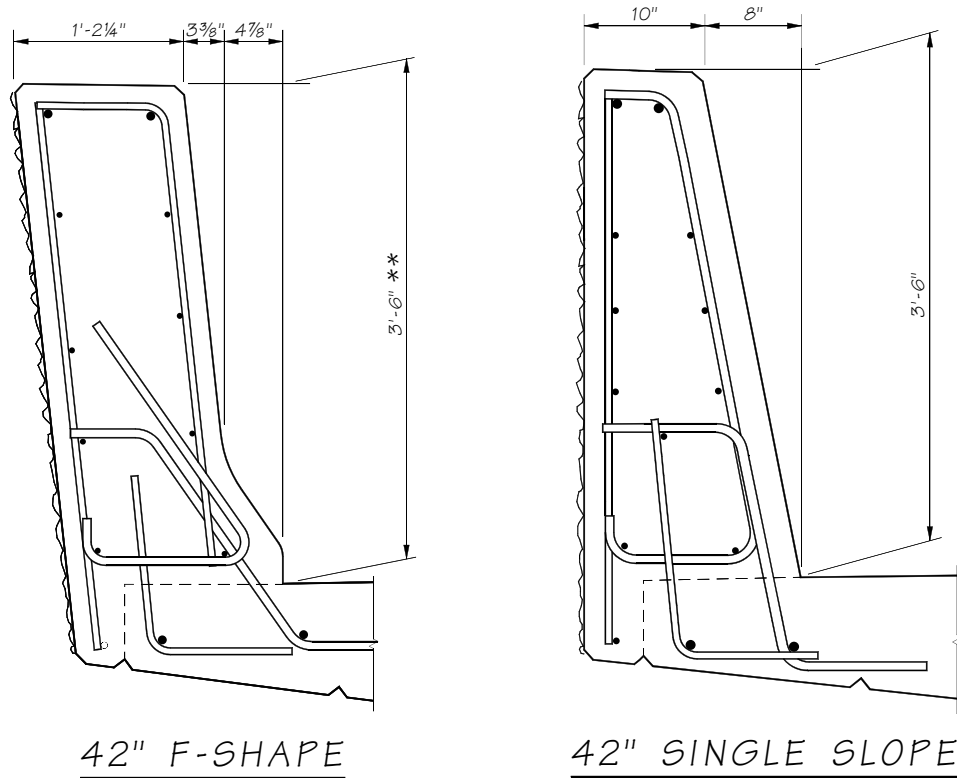
1. Traffic Barrier – Shape F 42"

This barrier is very similar to the 32 inch F-shape concrete barrier in that the slope of the front surface is the same except for height. This barrier has been designed for a TL-5 impact. For complete details see Appendices 10.2-A5-1B, 10.2-A5-2B, 10.2-A5-3.

This type of barrier was used on a portion of the Seattle Access project in Seattle due to the large proportion of trucks and buses and to protect buildings below the bridge structure. This barrier is also used on bridges with sharp curvature such as Bridge 101/515E-S.

2. Traffic Barrier – Single Slope 42"

This crash tested option offers a simple to build alternative to the Shape F configuration. For complete details see Appendices 10.2-A6-1B, 10.2-A6-2B, 10.2-A6-3.



42" F-Shape

42" Single Slope

Figure 10.2.3-4

10.2.4 Design Criteria

A. Design Values

AASHTO LRFD Appendix A13 shall be used to design bridge traffic barriers and their supporting elements (i.e. the deck).

Concrete traffic barriers shall be designed using yield line analysis as described in AASHTO LRFD A13.3.1. WSDOT Standard F Shape and Single Slope barriers meet these requirements.

Deck overhangs supporting traffic barriers shall be designed per AASHTO LRFD A13.4. For concrete traffic barriers in Design Case 1, AASHTO requires M_s , the deck overhang flexural resistance, to be greater than M_c of the concrete traffic barrier base. This requirement is consistent with yield line analysis (see AASHTO LRFD CA13.3.1), but results in overconservative deck overhang designs.

In order to prevent this unnecessary overdesign of the deck overhang, the nominal traffic barrier resistance to transverse load R_w (AASHTO LRFD Bridge Design Specifications A13.3.1)

transferred from the traffic barrier to deck overhang shall not exceed 120% of the design force F_t (AASHTO LRFD Table A13.2-1) required for a traffic barrier.

The deck overhang shall be designed in accordance with the requirements of AASHTO LRFD A13.4.2 to provide a flexural resistance M_s , acting coincident with the tensile force T . At the inside face of the barrier M_s may be taken as:

$$\text{for an interior barrier segment - } M_s = \frac{R_w \cdot H}{L_C + 2 \cdot H}$$

$$\text{and for an end barrier segment - } M_s = \frac{R_w \cdot H}{L_C + H}$$

However, M_s need not be taken greater than M_c at the base. T shall be taken as:

$$\text{for an interior barrier segment - } T = \frac{R_w}{L_C + 2 \cdot H}$$

$$\text{and for an end barrier segment - } T = \frac{R_w}{L_C + H}$$

When an HMA overlay is required for initial construction, increase the weight for Shape F traffic barrier. See Section 10.2.4.C for details.

B. Geometry

Standard WSDOT traffic barriers have been crash tested and shall not be significantly modified unless they are retested to NCHRP 350 or approved by the FHWA as described in Chapter 13 of the AASHTO Specifications. The traffic face geometry is part of the crash test and shall not be modified. Contact the WSDOT Bridge and Structure's Traffic Barrier Specialist for further guidance.

Thickening of the traffic barrier is permissible for architectural reasons. Concrete clear cover must meet minimum concrete cover requirements but can be increased to accommodate rustication grooves or patterns.

C. Standard Detail Sheet Modifications

When designing and detailing a bridge traffic barrier on a superelevated bridge deck the following guidelines shall be used:

- For bridge decks with a superelevation of 8% or less, the traffic barriers (and the median barrier, if any) shall be oriented perpendicular to the bridge deck.
- For bridge decks with a superelevation of more than 8%, the traffic barrier on the low side of the bridge (and median barrier, if any) shall be oriented perpendicular to an 8% superelevated bridge deck. For this situation, the traffic barrier on the high side of the bridge shall be oriented perpendicular to the bridge deck.

The standard detail sheets are generic and may need to be modified for each project. The permissible modifications are:

- Removal of the electrical conduit, junction box, and deflection fitting details.
- Removal of design notes.
- If the traffic barrier does not continue on to a wall, remove W1 and W2 rebar references.
- Removal of the non-applicable guardrail end connection details and verbiage.
- If guardrail is attached to the traffic barrier use either the thrie beam design "F" detail or the W-beam design "F" detail.

Barrier Impact Design Forces on Traffic Barrier & Deck Overhang									
Parameters	Type F 32 in.		Single Slope 34 in.		Type F 42 in.		Single Slope 42 in.		End*
	Interior	End*	Interior	End*	Interior	End*	Interior	End*	
Traffic Barrier Design	Average M_c (ft-kips/ft)	20.62	19.39	19.39	29.18	29.18	25.22	25.22	25.22
	M_c at Base (ft-kips/ft)	27.24	26.11	26.11	37.00	37.00	34.52	34.52	34.52
	M_w (ft-kips)	42.48	44.72	44.72	97.83	96.91	83.87	79.14	79.14
	L_c (ft)	8.61	4.75	9.19	14.48	9.26	14.45	9.19	9.19
	R_w (kips)	133.09	73.48	125.79	241.47	154.33	208.16	132.49	132.49
Deck Overhang Design	F_t (kips)	54.00	54.00	54.00	124.00	124.00	124.00	124.00	124.00
	$1.2F_t$ (kips)	64.80	64.80	64.80	148.80	148.80	148.80	148.80	148.80
	Design R_w (kips)	64.80	64.80	64.80	148.80	148.80	148.80	148.80	132.49
	$R_w * H / (L_c + aH)$ (ft-kips/ft)**	12.40	23.29	12.36	24.24	40.83	24.28	36.53	36.53
	Design M_s (ft-kips/ft)	12.40	23.29	12.36	24.24	37.00	24.28	34.52	34.52
Deck to Barrier Reinforcement	Design T (kips/ft)	4.65	8.74	4.36	6.93	11.67	6.94	10.44	10.44
	A_s required (in ² /ft)	0.36	0.69	0.30	0.54	0.83	0.51	0.73	0.73
	A_s provided (in ² /ft)	0.41	0.62	0.41	0.59	0.88	0.59	0.88	0.88
	S_1 Bars	#5 @ 9 in	#5 @ 6 in	#5 @ 9 in	#6 @ 9 in	#6 @ 6 in	#6 @ 9 in	#6 @ 6 in	#6 @ 6 in

*Traffic barrier cross sectional dimensions and reinforcement used for calculation of end segment parameters are the same as interior segments. Parameters for modified end segments shall be calculated per AASHTO-LRFD article A13.3, A13.4, and the WSDOT BDM.

**a = 1 for an end segment and 2 for an interior segment.

Loads are based on vehicle impact only. For deck overhang design, the designer must also check other limit states per LRFD A13.4.1.

$f_v = 60$ ksi

$f'_c = 4$ ksi

Table 10.2.4-1

If the traffic barrier continues off the bridge, approach slab, or wall, remove the following:

- Guardrail details from all sheets
- Conduit end flare detail
- Modified end section detail and R1A or R2A rebar details from all sheets
- End section bevel
- Increase the 3" toe dimension of the Shape F traffic barriers up to 6" to accommodate HMA overlays.

D. Miscellaneous Design Information

- Show the back of Pavement Seat in the "Plan – Traffic Barrier" detail.
- At roadway expansion joints, show traffic barrier joints normal to centerline except as shown on sheets in Chapter 9 Appendix 9.1-A1-1 and A2-1.
- When an overlay is required the 2'-8" minimum dimension shown in the "Typical Section – Traffic Barrier" shall be referenced to the top of the overlay.
- When bridge lighting is part of the contract include the lighting bracket anchorage detail sheet.
- Approximate quantities for the Traffic barrier sheets are:

Barrier Type	Concrete Weight (lb/ft)	Steel Weight (lb/ft)
32' F-shape (3" toe)	470	18.6
32' F-shape (6" toe)	525	19.1
34' Single Slope	505	16.1
42' F-shape (3" toe)	730	25.8
42' F-shape (6" toe)	790	28.4
42' Single Slope	690	22.9
32" Pedestrian	658*	14.7

Using concrete class 4000 with a unit weight of 160 lb/ft³
 * with 6" sidewalk, will vary with sidewalk thickness

- Steel Reinforcement Bars:
 S_1 & S_2 or S_3 & S_4 and W_1 & W_2 bars (if used) shall be included in the Bar List.

10.3 At Grade Traffic Barriers

10.3.1 Median Barriers

The top of the median traffic barrier shall have a minimum width of 6". If a luminaire or sign is to be mounted on top of the median traffic barrier, then the width shall be increased to accommodate the mounting plate and 6" of clear distance on each side of the luminaire or sign pole. The transition flare rate shall follow the WSDOT *Design Manual*.

A. Differential Grade Median Barriers

Barriers at grade are sometimes required in median areas with different roadway elevations on each side. The standard Single Slope barrier s can be used for a grade difference up to 10" for a 2'-10" safety shape and up to 6" for a 3'-6" safety shape. See WSDOT Standard Plans C-13 and C-14a for details.

If the difference in grade elevations is 4'-0" or less, then the barrier shall be designed using AASHTO LFD barrier loading with the following requirements:

1. The differential grade traffic barrier shall be designed to 10 kips, as a minimum loading.
2. For soil loads without traffic impact, the barrier shall be designed as a combination of a standard retaining wall (barrier weight resists overturning and sliding) and a cantilever retaining wall (passive soil resistance resists overturning and sliding) using the factors of safety for retaining walls found in the BDM. Earthquake Group VII loads need not be considered.
3. Traffic impact loads shall be added to the side of the barrier retaining soil.
4. For soil loads with traffic impact, the barrier shall be designed as a combination of a standard retaining wall (barrier weight resists overturning and sliding) and a cantilever retaining wall (passive soil resistance resists overturning and sliding). The design shall be based on stability requirements for overturning with a factor of safety $M_R/M_O \geq 1.3$ and sliding $F_R/F_S \geq 1.3$.
5. To meet the stability requirements of item 4, several feet of barrier length are required. The length of the barrier required for stability shall be no more than 10 times the overall height. The barrier shall be designed for lateral bending over this length assuming it acts as a beam on an elastic foundation for this length with a 10K point load. The barrier shall also be designed for torsion from the moment induced by the 10K load about the barrier c.g.
6. A special impact analysis shall be performed at the barrier ends if the barrier terminates without being connected to a rigid object or dowelled to another barrier. Differential barrier deflection from traffic impact may cause a vehicle to "snag" on the undeflected barrier. The barrier depth may need to be increased at the end to prevent this deflection.
7. The differential grade traffic barrier shall have dummy joints at 8 to 12 foot centers based on project requirements.
8. Full depth expansion joints with shear dowels at the top will be required at intervals based on analysis but not to exceed a 120'-0" maximum spacing.

Median traffic barriers with a grade difference greater than 4'-0" shall be designed as standard plan retaining walls with a traffic barrier at the top and a barrier shape at the cut face.

10.3.2 Shoulder Barriers

At grade CIP shoulder barriers are sometimes used adjacent to bridge sidewalk barriers in lieu of standard precast Type 2 barriers. This barrier cross section has an equivalent mass and resisting moment for stability as the embedded double-face New Jersey Traffic Barrier which has been satisfactorily crash tested. A wire rope and pin connection shall be made at the bridge barrier end section per Standard Plan C-8. If a connection is made to an existing traffic barrier or parapet on the bridge, 15-inch long holes shall be drilled for the wire rope connection and shall be filled with an epoxy bonding agent.

10.3.3 Traffic Barrier Moment Slab

A. General Guidelines

Traffic barrier moment slabs that are placed on Structural Earth (SE) walls are part of the propriety wall design and shall be design by the SE wall manufacturers. The SE wall manufacturers will be allowed to design the traffic barrier moment slabs using either the LRFD or the LFD code.

B. Design Guidelines

The traffic barrier moment slab system for non-propriety walls, Geosynthetic, and for at-grade applications shall be designed in accordance with AASHTO LRFD Section 11.10.10.2 and Section 13. The design requirements are as follows:

1. Parapets and traffic barriers shall satisfy crash testing requirements as specified in Section 13. The traffic barrier portion of the moment slab shall be designed by the yield line method of analysis with the assumption that the barrier is mounted on a rigid surface or use a crash tested barrier. Traffic barrier to slab connection shall be designed with the requirement of Strength Limit State with a minimum transverse force of $1.2F_T$ as specified in AASHTO LRFD Table A13.2-1.
2. The moment slab shall be strong enough to resist the ultimate strength of the standard traffic barrier parapet.
3. The traffic barrier moment slab system shall be designed to the Extreme Event-II limit state and use Test Level 4 as a minimum loading. The yield line analysis of LRFD A13.3.1 is NOT applicable to traffic barrier moment slab system. The system shall be analyzed as beam on elastic foundation to determine the length of barrier resisting the collision force and designed to resist overturning moments, sliding, and bearing capacity by their own mass plus the mass of the soil and pavement above the anchoring slab. The traffic barrier moment slab system shall not directly transmit loads to the top of the wall facing panels.
 - a. The traffic barrier shall have dummy joints at 8 to 12 foot centers base on project requirements of wall panel widths. Full depth expansion joints with shear pins or dowels will be required at the minimum intervals based on the stability analysis with a 120'-0" maximum spacing.
4. The generic Extreme Event-II limit state soil parameters for structural fill under ultimate failure conditions are as follows:
 - Extreme Event soil total horizontal shear resistance: $Q_R = 1$ KSF
 - Extreme Event soil bearing resistance: $q_{ult} = 2$ KSF

These values may be used to extract soil spring coefficients in longitudinal, transverse, and vertical directions for moment slab barriers on structural earth wall systems or at grade applications. The Geotechnical Engineer may provide alternate values in the Geotechnical Report.

10.3.4 Precast Traffic Barrier

A. Concrete Barrier Type 2

“Concrete Barrier Type 2” (see WSDOT Standard Plan C-8) may be used on bridges for median applications or for temporary traffic control based on the following guidelines:

1. For temporary applications, no anchorage is required if there is 2 feet or greater slide distance between the back of the traffic barrier and an object and 3 feet or greater to the edge of the bridge deck or a severe drop off (see WSDOT *Design Manual*).
2. For permanent applications in the median, no anchorage will be required if there is 2 feet or greater slide distance between the traffic barrier and the traffic lane.
3. For temporary applications, the traffic barrier shall not be placed closer than 9 inches or 6 inches to the edge of a bridge deck or substantial drop-off and shall be anchored (see WSDOT Standard Plans K-80.35 and K-80.37).
4. The traffic barrier shall not be used to retain soil that is sloped or greater than the barrier height or soil that supports a traffic surcharge.

B. Concrete Barrier Type 4 and Alternative Temporary Concrete Barrier

“Concrete Barrier Type 4 (see the WSDOT Standard Plan C-8a), is not a free standing traffic barrier. This barrier shall be placed against a rigid vertical surface that is at least as tall as the traffic barrier. In addition, Alternative Temporary Concrete Barrier Type 4 – Narrow Base (WSDOT Standard Plan K-80.30) shall be anchored to the bridge deck as shown in WSDOT Standard Plan K-80.37. The “Concrete Barrier Type 4 and Alternative Temporary Concrete Barrier” are not designed for soil retention.

10.4 Bridge Traffic Barrier Rehabilitation

10.4.1 Policy

The bridge traffic barrier retrofit policy is: “to systematically improve or replace existing deficient rails within the limits of roadway resurfacing projects”. This is accomplished by:

- Utilizing an approved crash tested rail system that is appropriate for the site or
- Designing a traffic barrier system to the strength requirements set forth by Section 2 of AASHTO Standard Specifications for Highway Bridges, 17th edition.”

10.4.2 Guidelines

A strength and geometric review is required for all bridge rail rehabilitation projects. If the strength of the existing bridge rail is unable to resist an impact of 10 kips or has not been crash tested, then modifications or replacement will be required to improve its redirection characteristics and strength. Bridges that have deficient bridge traffic barriers were designed to older codes. The AASHTO LFD load of 10 kips shall be used in the retrofit of existing traffic barrier systems constructed prior to the year 2000. The use of the AASHTO LRFD criteria to design traffic barrier rehabs will result in a bridge deck that has insufficient reinforcement to resist moment from a traffic barrier impact load and will increase the retrofit cost due to expensive deck modifications.

10.4.3 Design Criteria

Standard thrie beam guardrail post spacing is 6'- 3" except for the SL-1 Weak Post, which is at 8'-4". Post spacing can be increased up to 10'- 0" if the thrie beam guardrail is nested (doubled up).

Gaps in the guardrail are not allowed because they produce snagging hazards. The exceptions to this are:

- Movable bridges at the expansion joints of the movable sections.
- At traffic gates and drop down net barriers.
- At stairways.

Design F guardrail end sections will be used at the approach and trailing end of these gaps.

For Bridge Traffic Barrier Rehabilitation the following information will be needed from the Region Design office:

- Bridge Site Data Rehabilitation Sheet – Form # 235-002A.
- Photos, preferably digital Jpegs.
- Layout with existing dimensions.
- Standard Plan thrie beam guardrail transitions (selected by Region Design office) to be used at each corner of the bridge (contact bridges and structures office for thrie beam height).
- Location of any existing utilities.
- Measurements of existing ACP to top of curb at the four corners, midpoints and the locations of minimum and maximum difference (5 locations each side as a minimum).
- Diagram of the location of Type 3 anchors, if present, including a plan view with vertical and horizontal dimensions of the location of the Type 3 anchor connection relative to the intersecting point of the back of pavement seat with the curb line.
- The proposed overlay type, quantities of removal and placement.
- For timber bridges, the field measurement of the distance from the edge of bridge deck to the first and second stringer is required for mounting plate design.

Placement of the retrofit system will be determined from the WSDOT *Design Manual*. Exceptions to this are bridges with sidewalk strength problems, pedestrian access issues, or vehicle snagging problems.

10.4.4 WSDOT Bridge Inventory of Bridge Rails

The WSDOT Bridge Preservation office maintains an inventory of all bridges in the state on the State of Washington Inventory of Bridges.

Concrete balusters are deficient for current lateral load capacity requirements. They have approximately 3 kips of capacity whereas 10 kips is required.

The combination high-base concrete parapet and metal rail may or may not be considered adequate depending upon the rail type. The metal rail Type R, S, and SB attached to the top of the high-base parapet are considered capable of resisting the required 5 kips of lateral load. Types 3, 1B, and 3A are considered inadequate. See the WSDOT *Design Manual* for replacement criteria.

10.4.5 Available Retrofit Designs

A. Washington Thrie Beam Retrofit of Concrete Balusters

This system consists of thrie beam guardrail stiffening of existing concrete baluster rails with timber blockouts. The Southwest Research Institute conducted full-scale crash tests of this retrofit in 1987. Results of the tests were satisfactory and complied with criteria for a Test Level 2 (TL2) category in the Guide Specifications. For complete details see Appendix 10.4-A1-1.

B. New York Thrie Beam Guardrail

This crash tested rail system can be utilized at the top of a raised concrete sidewalk to separate pedestrian traffic from the vehicular traffic or can be mounted directly to the top of the concrete deck. For complete details see Thrie Beam Retrofit Concrete Curb in Appendix 10.4-A1-3.

C. Concrete Parapet Retrofit

This is similar to the New York system. For complete details see Appendix 10.4-A1-2.

D. SL-1 Weak Post

This design has been utilized on some short concrete spans and timber bridges. A failure mechanism is built into this rail system so that upon impact with a 2 kip load the post will break away from the mounting bracket without damaging the bridge deck. The thrie beam guardrail will contain the vehicle by virtue of its ribbon strength. This failure mechanism assures minimal damage to the bridge deck and stringers. For complete details see Appendix 10.4-A1-4.

10.4.6 Available Replacement Designs

A. Traffic Barrier – Shape F Retrofit

This is WSDOT's preferred replacement of deficient traffic barriers and parapets on high volume highways with a large truck percentage. All interstate highway bridges shall use this type of barrier unless special conditions apply. For complete details see Appendix 10.4-A2.

10.5 Bridge Railing

10.5.1 Design

WSDOT pedestrian and bike/pedestrian railings are designed in accordance with Chapter 13 in the AASHTO LRFD Bridge Design Specifications.

10.5.2 Railing Types

1. Bridge Railing Type Pedestrian

This pedestrian railing is designed to sit on top of the 32" and 34" traffic barriers and to meet pedestrian height requirements of 42". For complete details see Appendix 10.5-A1.

2. Bridge Railing Type BP and S-BP

These railings are designed to meet the minimum bicycle height requirements of 54", and sit on top of the 32" and 34" traffic barriers. The AASHTO LRFD Bridge Design Specifications calls for a minimum of 42" but WSDOT requires a minimum height of 54".

There are two versions – the BP and S-BP. The BP is the standard railing and is made out of aluminum. The S-BP is the steel version designed for use in rural areas because of aluminum theft. For complete details see Appendix 10.5-A2 and A3.

3. Pedestrian Railing

This railing is designed to sit on top of a six-inch curb on the exterior of a bridge sidewalk. It meets the bicycle height requirements of 54". For complete details see Appendix 10.5-A4.

4. Bridge Railing Type Chain Link Snow Fence

This is designed to minimize plowed snow from falling off the bridge on to traffic below. For complete details see Appendix 10.5-A5.

10.6 Bridge Approach Slabs

Bridge approaches typically experience two types of settlement, global and local. Global settlement is consolidation of the deeper natural foundation soils. Local settlement is mainly compression of fill materials directly beneath the approach pavement due to construction. The combination of global and local settlements adjacent to the bridge end piers form the characteristic “bump” in the pavement at the bridge. The approach slab significantly reduces local settlement and will provide a transition to the long term roadway differential settlements. Generally, abutments with a deep foundation will have greater differential roadway settlements than spread footing foundations.

When are Approach Slabs Required?

Bridge approach slabs are required for all new and widened bridges, except when concurrence is reached between the Geotechnical Branch, the Region Design Project Engineer Office, and the Bridge and Structures Office, that approach slabs are not appropriate for a particular site. In accordance with WSDOT *Design Manual*, the State Geotechnical Engineer will include a recommendation in the Geotechnical Report for a bridge on whether or not bridge approach slabs should be used at the bridge site. Factors considered while evaluating the need for bridge approach slabs include the amount of expected settlement and the type of bridge structure.

Standard Plan A-40.50

The Standard Plan A-40.50 is available for the Local Agencies (or others) to use or reference in a contract. Bridge and Structures Office designs will provide detailed information in a customized approach slab Plan View and show the approach slab length on the Bridge Layout Sheet.

Bridge Runoff

Bridge runoff at the abutments shall be carried off and collected at least 10 feet beyond the bridge approach slab. Drainage structures such as grate inlets and catch basins shall be located in accordance with Standard Plan B-95.40 and the recommendations of the Hydraulics Office.

Approach Pay Item

All costs in connection with constructing bridge approach slabs are included in the unit contract price per square yard for “Bridge Approach Slab”. The pay item includes steel reinforcing bars, approach slab anchors, concrete, and compression seals.

10.6.1 Notes to Region for Preliminary Plan

All bridge preliminary plans shall show approach slabs at the ends of the bridges. In the Notes to Region in the first submittal of the Preliminary Plan to the Region, the designer shall ask the following questions:

1. Bridge approach slabs are shown for this bridge, and will be included in the Bridge PS&E. Do you concur?
2. The approach ends of the bridge approach slabs are shown normal to the survey line (a) with or (b) without steps (the designer shall propose one alternative). Do you concur?
3. Please indicate the pavement type for the approach roadway.

Depending on the type and number of other roadway features present at the bridge site (such as approach curbs and barriers, drainage structures, sidewalks, utilities and conduit pipes) or special construction requirements such as staged construction, other questions in the Notes to Region pertaining to the bridge approach slabs may be appropriate.

Special staging conditions exist when the abutment skew is greater than 30 degrees and for wide roadway widths. This includes bridge widenings with (or without) existing bridge approach slabs. The preliminary plan should include details showing how these conditions are being addressed for the bridge approach slabs, and the designer shall include appropriate questions in the Notes to Region asking for concurrence with the proposed design.

10.6.2 Approach Slab Design Criteria

The standard bridge approach slab design is based on the following criteria:

1. The bridge approach slab is designed as a slab in accordance with AASHTO LRFD. (Strength Limit State, IM = 1.33, no skew).
2. The support at the roadway end is assumed to be a uniform soil reaction with a bearing length that is approximately $\frac{1}{3}$ the length of the approach slab, or $25\text{ft}/3 = 8$ feet.
3. The Effective Span Length (S_{eff}), regardless of approach length, is assumed to be:
25 foot approach - 8 feet = 17 feet with a 25% allowable reduction in loads
4. Longitudinal reinforcing bars do not require modification for skewed approaches or slab lengths greater than 25 feet.
5. The approach slab is designed with a 2 inch concrete cover to the bottom reinforcing.

10.6.3 Bridge Approach Slab Detailing

The bridge approach slab and length along center line of project shall be shown in the Plan View of the Bridge Layout sheet. The Bridge Plans will also include approach slab information as shown on BDM Sheets 10-A1-1, 10-A1-2, and 10-A1-3. The Approach Slab Plan sheets should be modified as appropriate to match the bridge site conditions. Approach slab Plan Views shall be customized for the specific project and one anchor type shown on the third sheet will be used on the bridge. The anchor not used should be deleted.

Plan View dimensions need to define the plan area of the approach slab. The minimum dimension from the bridge is 25 feet. If there are skewed ends, then dimensions need to be provided for each side of the slab, or a skew angle and one side, in addition to the width. For slabs on a curve, the length along the project line and the width need to be shown.

Similar to Bridge Traffic Barrier detailing, approach slab steel detailing need only show size, spacing, and edge clearance. The number and total spaces can be determined by the contractor. If applicable, the traffic barrier AS1 and AS2 along with the extra top transverse bar in the slab need to be shown in the Plan View. Also remember that the spacing of the AS1 bars decreases near joints. When the skew is greater than 20 degrees, then AP8 bars need to be rotated at the acute corners of the bridge approach slab.

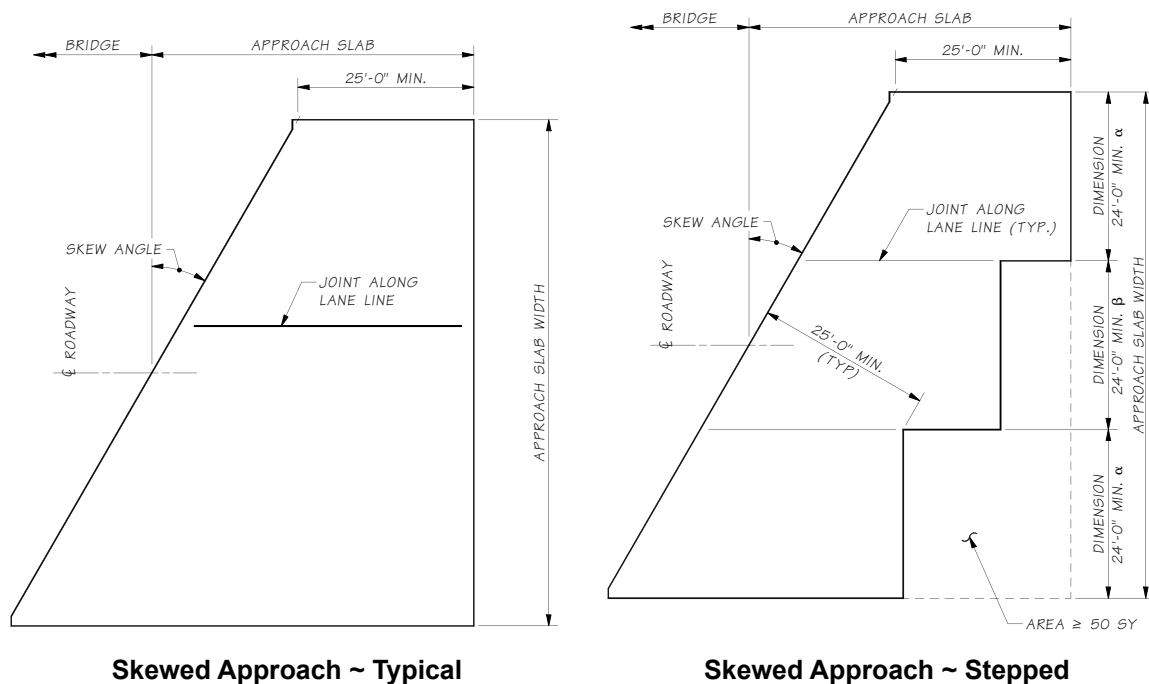
Bending diagrams shall be shown for all custom reinforcement. All Approach Slab sheets will have the AP2 and AP7 bars. If there is a traffic barrier, then AP8, AS1, and AS2 bars shall be shown.

Additional layout and details may be required to address special roadway features and construction requirements such as: roadway curbs and barriers, sidewalks, utilities and conduits and staging. This means, if sidewalks and interior barriers (such as traffic-pedestrian barriers) are present, special details will be required in the Bridge Plans to show how the sidewalks and interior barriers are connected to and constructed upon the bridge approach slab. If the bridge construction is staged, then the approach slabs will also require staged construction.

10.6.4 Skewed Approach Slabs

For all skewed abutments, the roadway end of the bridge approach slab shall be normal to the roadway centerline. The Bridge Design Engineer should be consulted when approach slab skew is greater than 45 degrees.

The roadway end of the approach may be stepped to reduce the size or to accommodate staging construction widths. A general rule of thumb is that if the approach slab area can be reduced by 50 SY or more, then the slab should be stepped. At no point should the roadway end of the approach slab be closer than 25 feet to the bridge. These criteria apply to both new and existing bridge approach slabs. If stepped, the design should provide the absolute minimum number of steps and the longitudinal construction joint shall be located on a lane line. See Figure 10.6.4-1 for clarification.



Skewed Approach ~ Typical

Skewed Approach ~ Stepped

α - DIMENSION MAY BE ONE LANE WIDTH PLUS THE SHOULDER WIDTH IF THE SHOULDER $\geq 8'-0"$.

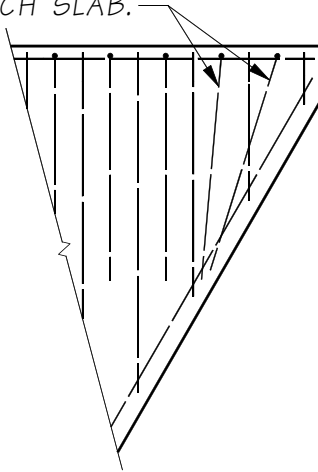
β - DIMENSION MAY BE TWO LANE WIDTHS.

Skewed Approach

Figure 10.6.4-1

In addition, for bridges with traffic barriers and skews greater than 20 degrees, the AP8 bars shall be rotated in the acute corners of the bridge approach slabs. Typical placement is shown in the FLARED CORNER STEEL detail, Figure 10.6.4-2.

ROTATE AP8 BARS
IN ACUTE CORNERS
OF APPROACH SLAB.



Flared Corner Steel

Figure 10.6.4-2

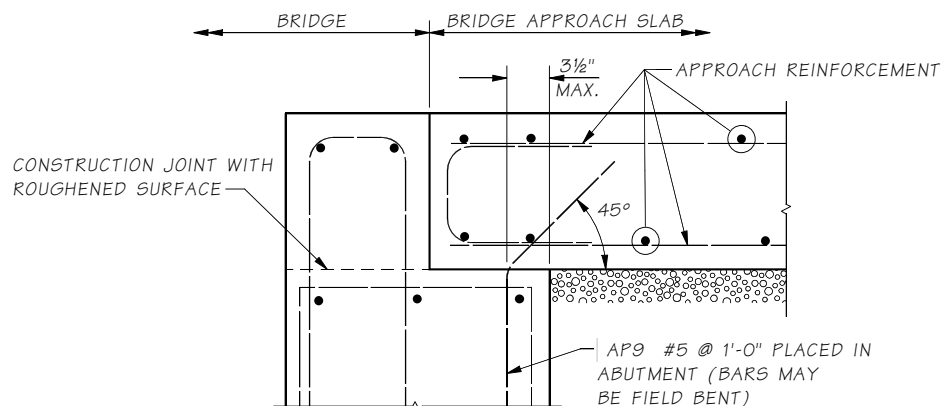
10.6.5 Approach Anchors and Expansion Joints

For semi-integral abutments or stub abutments, the Bridge Designer must check the joint design to make sure the movement of the standard joint is not exceeded. In general, the approach slab is assumed to be stationary and the joint gap is designed to vary with the bridge movement. The BDM Approach Slab Sheets 10-A1-3 and Standard Plan A-40.50 detail a typical 2½ inch compression seal. For approach slabs with barrier, the compression seal should extend into the barrier.

Approach slab anchors installed at bridge abutments should be as shown in the Bridge Plans. For bridges with semi-integral type abutments, this can be accomplished by showing the approach slab anchors in the End Diaphragm or Pavement Seat details.

L type abutments

L type abutments do not require expansion joints or approach anchors because the abutment and approach slab are both considered stationary. A pinned connection is preferred. The L TYPE ABUTMENT ANCHOR detail, as shown below, must be added to the abutment Plan Sheets. The pinned anchor for bridges with L type abutments shall be a #5 bar at one foot spacing, bent as shown, with 1'-0" embedment into both the pier and the bridge approach slab. This bar shall be included in the bar list for the bridge substructure.



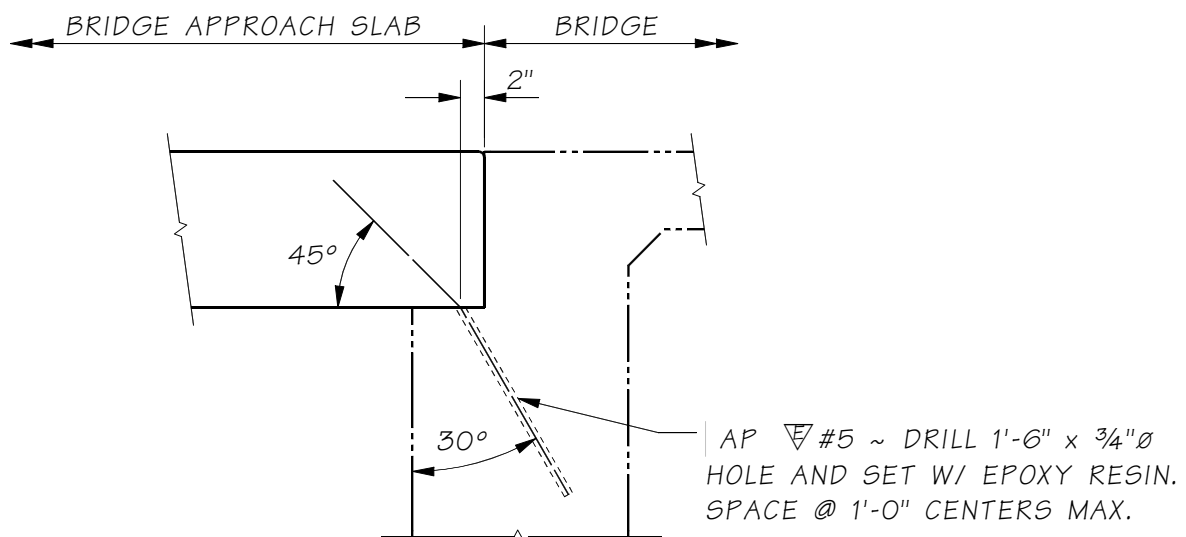
L Type Abutment Anchor Detail

Figure 10.6.5-1

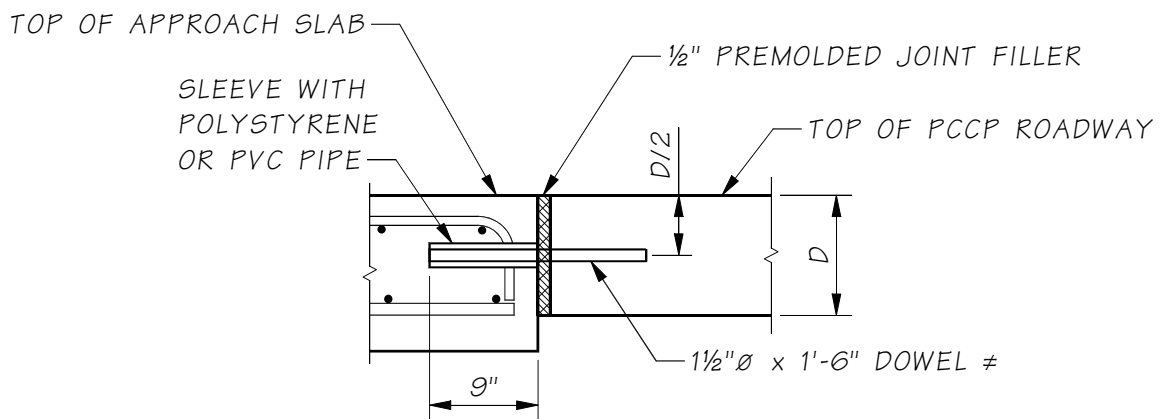
10.6.6 Approach Slab Addition or Retrofit to Existing Bridges

When approach slabs are to be added or replaced on existing bridges, modification may be required to the pavement seats. Either the new approach slab will be pinned to the existing pavement seat, or attached with approach anchors with a widened pavement seat. Pinning is a beneficial option when applicable as it reduces the construction cost and time.

The pinning option is only allowed as an approach slab addition or retrofit to an existing bridge. Figure 10.6.6-1 shows the pinning detail. As this detail eliminates the expansion joint between the approach slab and the bridge, the maximum bridge superstructure length is limited to 150 feet. The Bridge Design Engineer may modify this requirement on a case by case basis. Additionally, if the roadway end of the approach slab is adjacent to PCCP roadway, then the detail shown in Figure 10.6.6-2 applies. PCCP does not allow for as much movement as HMA and a joint is required to reduce the possibility of buckling.



Pinned Approach Slab Detail
Figure 10.6.6-1



INSERT DOWELS PARALLEL TO CENTER LINE
ALONG TRANSVERSE CONSTRUCTION JOINT.

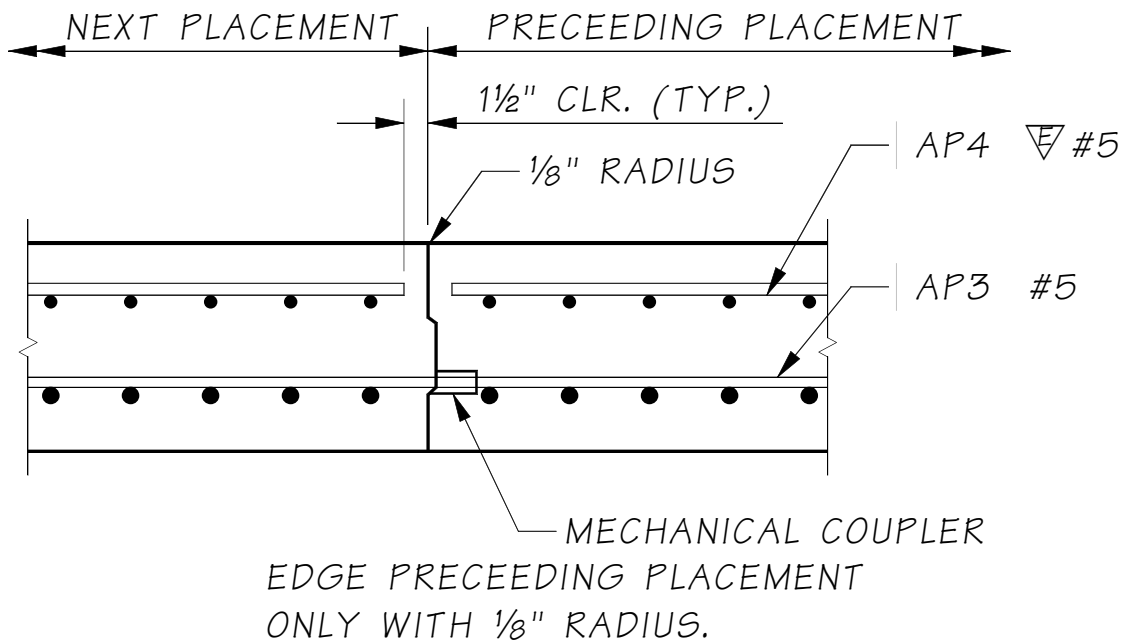
≠ DRILL 1 3/4" Ø HOLE AND SET WITH EPOXY RESIN
IF PLACED INTO EXISTING PCCP ROADWAY.

PCCP Roadway Dowel Bar Detail
Figure 10.6.6-2

When pinning is not applicable, then the approach slab must be attached to the bridge with approach anchors. If the existing pavement seat is less than 10 inches, the seat shall be replaced with an acceptable, wider pavement seat. The Bridge Design Engineer may modify this requirement on a site-specific basis. Generic pavement seat repair details are shown in Appendix 10.6-A2-1 for a concrete repair and Appendix 10.6-A2-2 for a steel T-section repair. These sheets can be customized for the project and added to the Bridge Plans.

10.6.7 Approach Slab Staging

Staging plans will most likely be required when adding or retrofitting approach slabs on existing bridges. The staging plans will be a part of the bridge plans and should be on their own sheet. Coordination with the Region is required to ensure agreement between the bridge staging sheet and the Region traffic control sheet. The longitudinal construction joints required for staging shall be located on lane lines. As there may not be enough room to allow for a lap splice in the bottom transverse bars, a mechanical splice option should be added. If a lap splice is not feasible, then only the mechanical splice option should be given. See Figure 10.6.6-3.



EDGE PRECEEDING PLACEMENT ONLY WITH 1/8" RADIUS.

Alternate Longitudinal Joint Detail

Figure 10.6.6-3

10.7 Traffic Barrier on Approach Slabs

Placing the traffic barrier on the approach slab is beneficial for the following reasons.

- The approach slab resists traffic impact loads and may reduce wing wall thickness
- Simplified construction and conduit placement
- Bridge runoff is diverted away from the abutment

Most bridges will have some long-term differential settlement between the approach roadway and the abutment. Therefore, a gap between the approach slab and wing (or wall) should be shown in the details. The minimum gap is twice the long-term settlement, or 2 inches as shown in Figure 10.7-1. A 3 inch gap is also acceptable.

When the traffic barrier is placed on the approach slab, the following barrier guidelines apply.

- Barrier should extend to the end of the approach slab
- Conduit deflection or expansion fittings must be called out at the joints
- Junction box locations should start and end in the approach
- The transverse top reinforcing in the slab must be sufficient to resist a traffic barrier impact load. A 6'-0" (hooked) #6 epoxy coated bar shall be added to the approach slab as shown in Figure 10.7-1.

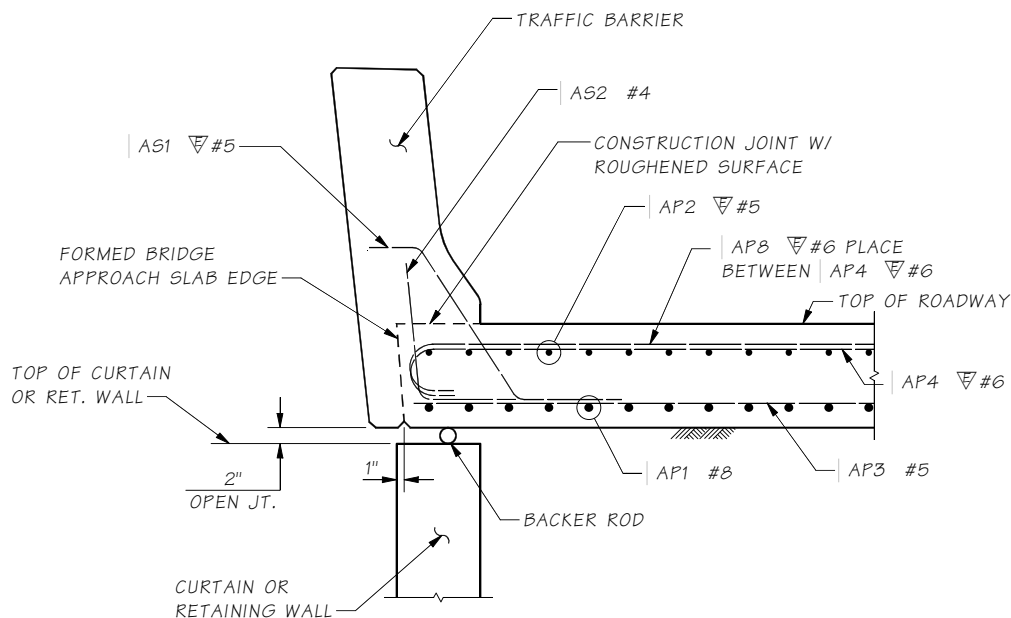


Figure 10.7-1

10.7.1 Approach Slab over Wing Walls, Cantilever Walls or Geosynthetic Walls

All walls that are cast-in-place below the approach slab should continue the barrier soffit line to grade. This includes geosynthetic walls that have a cast-in-place fascia. Figure 10.7.1-1 shows a generic layout at an abutment. Note the sectional Gap Detail, Figure 10.7-1 applies.

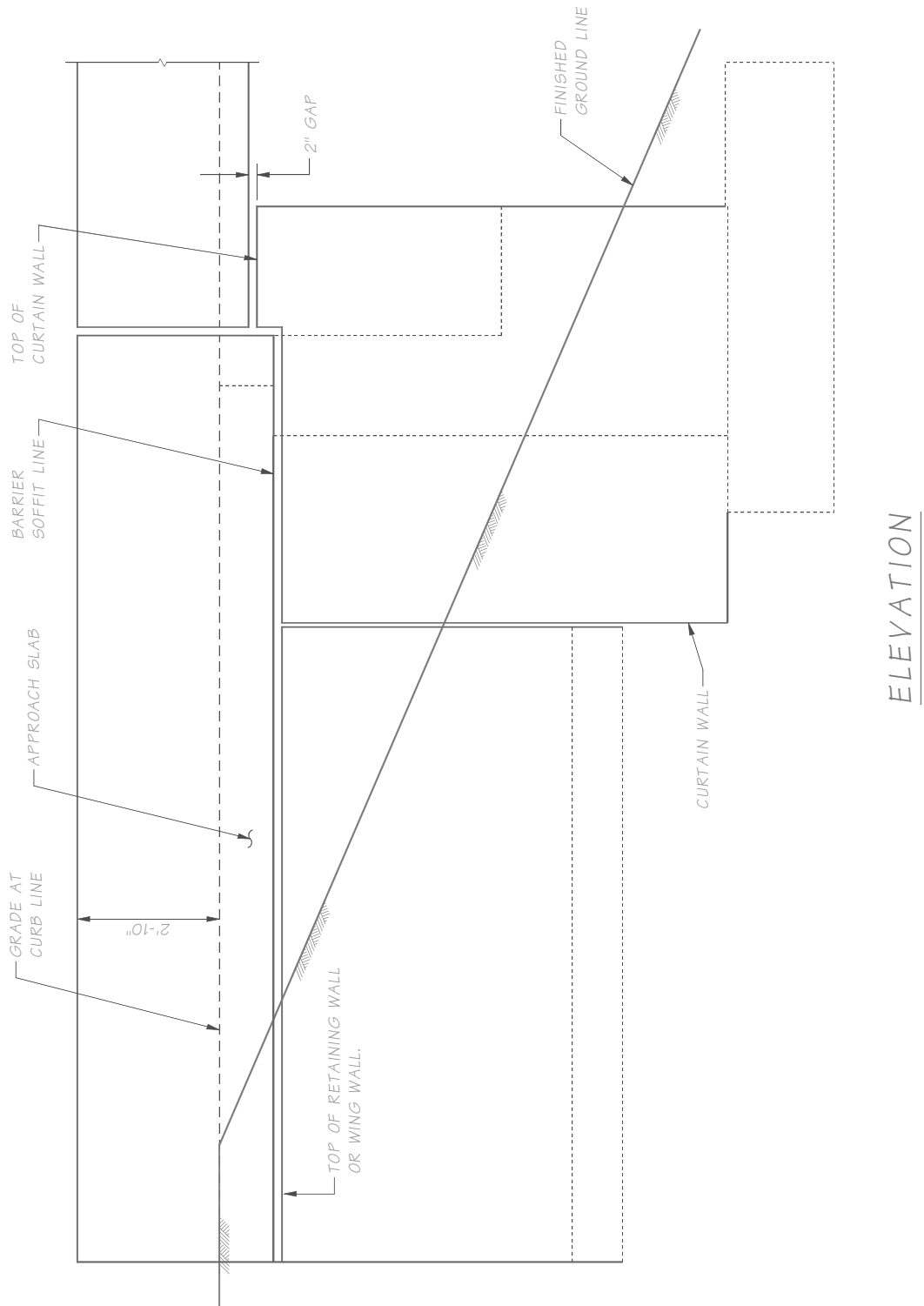


Figure 10.7.1-1

10.7.2 Approach Slab over SE Walls

The tops of Structure Earth (SE) walls are uneven and must be covered with a fascia to provide a smooth soffit line. Usually SE walls extend well beyond the end of the approach slab and require a moment slab. Since SEW barrier is typically 5'-0" deep from the top of the barrier, the soffit of the SEW barrier and bridge barrier do not match. The transition point for the soffit line should be at the bridge expansion joint as shown in Figure 10.7.2-2. This requires an extended back side of the barrier at the approach slab to cover the uneven top of the SE wall.

Battered wall systems, such as block walls, use a thickened section of the curtain wall to hide some of the batter. The State Bridge and Structures Architect will provide dimensions for this transition when required.

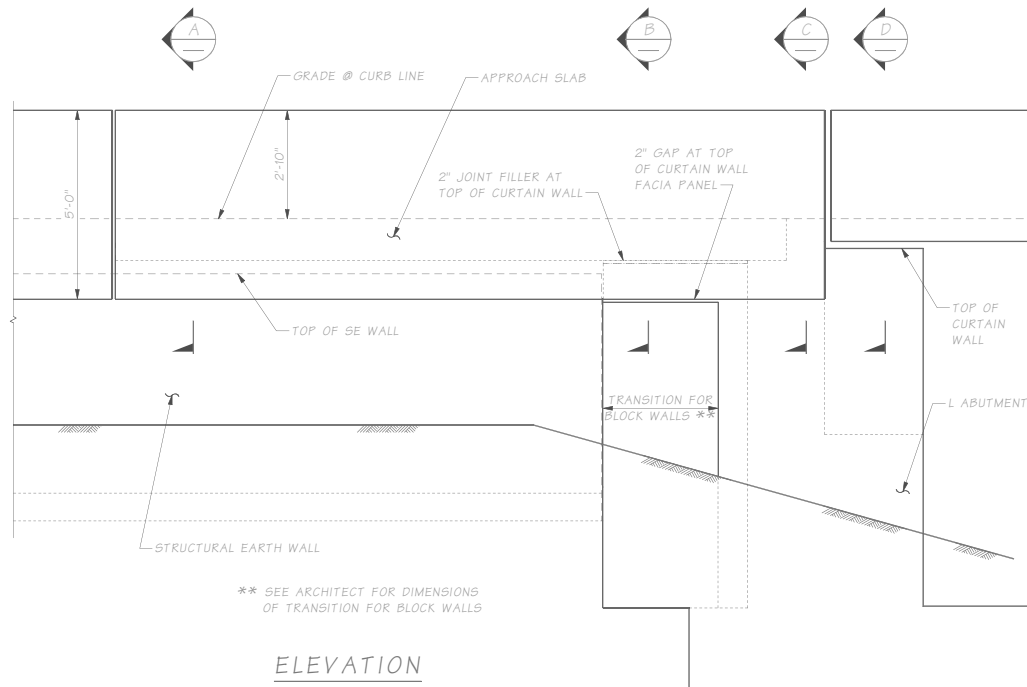


Figure 10.7.2-1

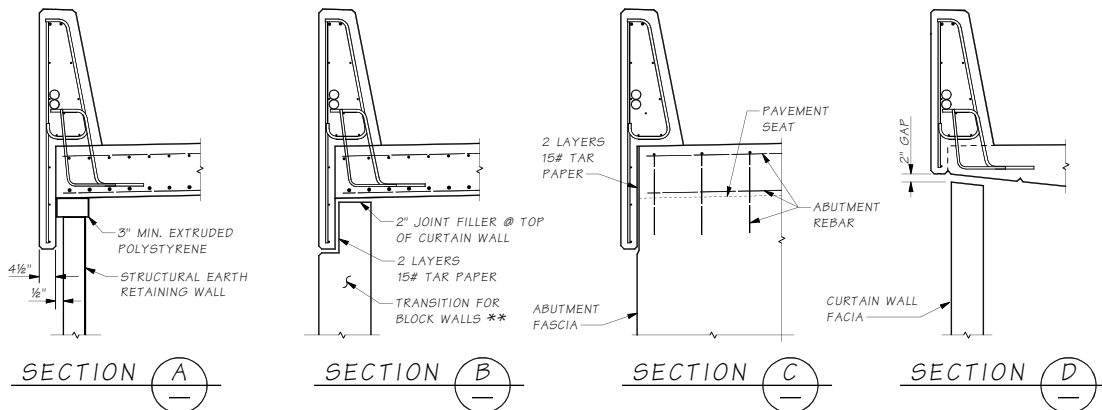


Figure 10.7.2-2

10.8 Utilities Installed with New Construction

10.8.1 General Concepts

The utilities to be considered under this section are electrical (power and communications) volatile fluids (gas), water, and sewer/storm water pipes. The Bridge designer shall determine if the utility may be attached to the structure and the location. Bridge plans shall include all hardware specifications and details for the utility attachment as provided in any written correspondence with the utility.

The Specifications Engineer will contact the Region Utility Engineer for additional design or construction requirements that may be stipulated in the utility agreement.

Responsibilities of the Utility Company

The Region or utility company will initiate utility installations and provide design information. The utility company shall be responsible for calculating design stresses in the utility and design of the support system. Utility support design calculations with a State of Washington Profession Engineer stamp, shall be submitted to the Bridge and Structures Office for review. The following information shall be provided by the Utility Company and shown in the final Bridge Plans.

- Location of the utility outside the limits of the bridge structure
- Number of utilities, type, size, and weight (or Class) of utility lines
- Utility minimum bending radius for the conduit or pipeline specified

Utility General Notes and Design Criteria are stated in DOT Form 224-047 “General Notes and Design Criteria for Utility Installations”. This form outlines most of the general information required by the Utility Company to design their attachments. The Bridge Office will generally provide the design for lightweight hanger systems, such as electrical conduits, attached to new structures.

Confined Spaces

A confined space is any place having a limited means of exit that is subject to the accumulation of toxic or flammable contaminants or an oxygen deficient environment. Confined spaces include but are not limited to pontoons, box girder bridges, storage tanks, ventilation or exhaust ducts, utility vaults, tunnels, pipelines, and open-topped spaces more than 4 feet in depth such as pits, tubes, vaults, and vessels. The designer should provide for the following:

- A sign with “Confined Space Authorized Personnel Only.”
- In the “Special Provisions Check List,” alert and/or indicate that a special provision might be needed to cover confined spaces.

Coating and Corrosion Protection

When the bridge is to receive pigmented sealer, consideration shall be given to painting any exposed utility lines and hangers to match the bridge. When a pigmented sealer is not required, steel utility conduits and hangers shall be painted or galvanized for corrosion protection. The special provisions shall specify cleaning and painting procedures.

10.8.2 Utility Design Criteria

All utilities shall be designed to resist Strength and Extreme Event Limits States. This includes and not limited to dead load, expansion, surge, and earthquake forces. Designers should review DOT Form 224-047 “General Notes and Design Criteria” and the items in this section when designing a utility system or providing a review for an existing bridge attachment.

The Bridge Engineer shall review the utility design to ensure the utility support system will carry all transverse and vertical loading. Loading will include (and is not limited to): Dead Load, Temperature expansion, dynamic action (water hammer), and Seismic inertial load.

Utility Location

Utilities should be located, if possible, such that a support failure will not result in damage to the bridge, the surrounding area, or be a hazard to traffic. In most cases, the utility is installed between girders. Utilities and supports must not extend below the bottom of the superstructure. Utilities shall be installed no lower than 1 foot 0 inches above the bottom of the girders. In some cases when appurtenances are required (such as air release valves), care should be taken to provide adequate space. The utility installation shall be located so as to minimize the effect on the appearance of the structure. Utilities shall not be attached above the bridge deck nor attached to the railings or posts.

Termination at the Bridge Ends

Utility conduit and encasements shall extend 10 feet minimum beyond the ends of the structure in order to reduce effects of embankment settlement on the utility and provide protection in case of future work involving excavation near the structure. This requirement shall be shown on the plans. Utilities off the bridge must be installed prior to paving of approaches. This should be stated in the Special Provisions.

Utility Expansion

The utilities shall be designed with a suitable expansion system as required to prevent longitudinal forces from being transferred to bridge members.

Water mains generally remain a constant temperature and are anchored in the ground at the abutments. However, the bridge will move with temperature changes and seismic forces. Pipe support systems must be designed to allow for the bridge movements. For short bridges, this generally means the bridge will move and the utility will not since it is anchored at the abutments. For long bridges that require pipe expansion joints, design must carefully locate pipe expansion joints and the corresponding longitudinal load-carrying support.

Electrical conduits that use PVC should have an expansion device for every 100 foot of pipe due to the higher coefficient of expansion. If more than two joints are specified, a cable or expansion limiting device is required to keep the ends from separating.

Gas Lines or Volatile Fluids

Pipelines carrying volatile fluids through a bridge superstructure shall be designed by the utility company in accordance with WAC 480-93, Gas Companies—Safety, and Minimum Federal Safety Standard, Title 49 Code of Federal Regulations (CFR) Section part 192. WAC 468-34-210, Pipelines—Encasement, describes when casing is required for carrying volatile fluids across structures. Generally, casing is not required for pipelines conveying natural gas per the requirements of WAC 468-34-210. If casing is required, then WAC 468-34-210 and WAC 480-93-115 shall be followed.

Water Lines

Water lines shall be galvanized steel pipe or ductile iron pipe. Transverse support or bracing shall be provided for all water lines to carry Strength and Extreme Event Lateral Loading. Fire control piping is a special case where unusual care must be taken to handle the inertial loads and associated deflections. Normally, the Hydraulic Section will also be involved in this case.

In box girders (closed cell), a rupture of a water line will generally flood a cell before emergency response can shut down the water main. This will be designed for as an Extreme Event II load case, where the weight of water is a dead load (DC). Additional weep holes or open grating should be considered to offset this Extreme Event (see Figure 10.8.3-1).

Sewer Lines

Normally, an appropriate encasement pipe is required for sewer lines on bridges. Sewer lines must meet the same design criteria as waterlines. See the utility agreement or the Hydraulic Section for types of sewer pipe material typically used.

Telephone and Power Conduit

Generally, telephone, television cable, and power conduit shall be galvanized steel pipe or a PVC pipe of a UL approved type and shall be Schedule 40 or heavier. Where such conduit is buried in concrete curbs or barriers or has continuous support, such support is considered to be adequate. Where hangers or brackets support conduit at intervals, the distance between supports shall be small enough to avoid excessive sag between supports. Generally, the conduit shall be designed to support the cable in bending without exceeding working stresses for the conduit material.

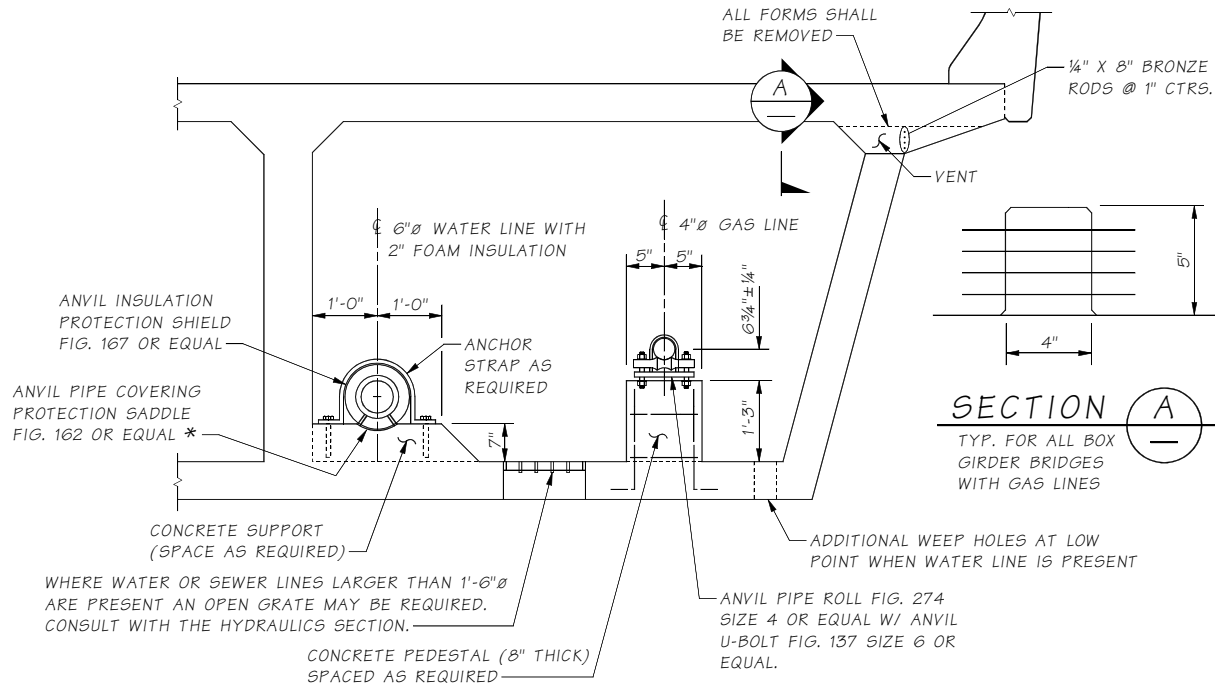
10.8.3 Box Girder Bridges

Internal illumination is required for steel box girder bridges, and appropriate conduit piper and fixtures shall be detailed as part of the bridge design. Girder cells with utilities must have access. Current practice for access is to locate hatches in the bottom flange. More than one hatch is usually required to access all sections of the cell in a bridge.

Access and ventilation shall always be provided in box girder cells containing gas lines.

Continuous Support and Concrete Pedestals

Special utilities (such as water or gas mains) in box girder bridges should use concrete pedestals. This allows the utility to be placed, inspected, and tested before the deck is cast. Concrete pedestals consist of concrete supports formed at suitable intervals and provided with some type of clamping device. A continuous support may be achieved by providing a ledge of concrete to support the conduit. Continuous supports should be avoided due to the very high cost and additional dead load to the structure.



CONCRETE UTILITY SUPPORTS

* SEE ANVIL PIPE HANGERS CATALOG.

Figure 10.8.3-1

10.8.4 Traffic Barrier Conduit

All new bridge construction will install two (2) 2-inch galvanized steel conduits in the traffic barriers. These conduits generally carry wiring for Traffic Signals (TS) and Lighting (LT). Other wiring may be installed or the conduit may be used for future applications.

Conduits shall be stubbed-out at a concrete junction box provided in the Region Plans. The Bridge Plans must show the placement of the conduits to clear the structure or any foreseeable obstructions.

The galvanized steel conduit shall be wrapped with corrosion resistant tape at least one foot inside and outside of the concrete structure, and this requirement shall be so stated on the plans. The corrosion resistant tape shall be 3M Scotch 50, Bishop 5, Nashua AVI 10, or approved equal. The usual location of the conduit throughout the remainder of the bridge should be in the traffic barrier.

Pull boxes shall be provided at a maximum spacing of 180 feet. For fiber optics only, spacing shall not exceed 360 feet. The pull box size shall conform to the specifications of the National Electric Code or be a minimum of 6 inches by 6 inches by 18 inches to facilitate pulling of wires. Galvanized steel pull boxes (or junctions boxes) shall meet the specifications of the "NEMA Type 4X" standard and shall be stated on the plans. Stainless steel pull boxes shall be allowed as an option to the galvanized steel.

In the case of existing bridges, an area 2 feet in width shall be reserved for conduit beginning at a point either 4 feet or 6 feet outside the face of usable shoulder. The fastening for and location of attaching the conduit to the existing bridge should be worked out on a job-by-job basis.

10.8.5 Conduit Types

All electrical conduits shall be Rigid Galvanized Steel (RGS) or PVC pipe, Schedule 40 or greater.

Steel Pipe

All steel pipe utility conduits shall be Schedule 40 or greater. All pipe and fittings shall be galvanized except for special uses.

PVC Pipe

PVC pipe may be used with suitable considerations for deflection, placement of expansion fittings, and of freezing water within the conduits. PVC pipe should not be placed in concrete traffic barriers when the slip form method is used due to damage and pipe separation that often occurs during concrete placement.

High Density Polyethylene (HDPE)

This material may be specified by some utilities. Unless other data is available, support as for PVC. Same restrictions to traffic barriers apply.

10.8.6 Utility Supports

The following types of supports are generally used for various utilities. Selection of a particular support type should be based on the needs of the installation and the best economy. All utility installations shall address temperature expansion in the design of the system or expansion devices.

Utility supports shall be designed so that a failure will not result in damage to the bridge, the surrounding area, or be a hazard to traffic. Utility supports shall be designed so that any loads imposed by the utility installation do not overstress the conduit, supports, bridge structure, or bridge members.

Designs shall provide longitudinal and transverse support for loads from gravity, earthquakes, temperature, inertia, etc. It is especially important to provide transverse and longitudinal support for inserts that cannot resist moment.

The Bridge Engineer should request calculations from the utility company for any attachment detail that may be questionable. Utility attachments, which exert moments or large forces at the supports, shall be accompanied by at least one set of calculations from the utility company. Bridge attachments designed to resist surge forces should always be accompanied by calculations.

Concrete Embedment

This is the best structural support condition and offers maximum protection to the utility. Its cost may be high for larger conduit and the conduit cannot be replaced.

Pipe Hangers

Utility lines shall be suspended by means of cast-in-place anchors, whenever possible. This is the most common type of support for utilities to be hung under the bridge deck. This allows the use of standard cast-in-place inserts and is very flexible in terms of expansion requirements. For heavy pipes over traffic (10" water main or larger), a Safety Factor of 1.5 should be used to resist vertical loads for Strength design. This is to avoid complete failure of the utility hanger system by failure of one hanger. Vertical inserts will not provide resistance to longitudinal forces. Longitudinal and transverse supports shall be provided for ITS conduits.

Transverse supports may be provided by a second hanger extending from a girder or by a brace against the girder. The Appendix 10.8-A1-1 and 10.8-A1-2 depict typical utility support installations and placement at abutments and diaphragms.

Where PVC conduit is to be supported by hangers or pedestals at intervals, the distance between supports shall be small enough to avoid excessive sag of the conduit. For recommended support spacing and tabulated properties of PVC pipe, see Table 10.8.6-1.

PROPERTIES OF PVC PIPE

The following are recommended support spacings for PVC pipe.
(Ref: Western Plastics Corporation)

	Nominal Size		O.D.		I.D.		Wall Thickness		Pounds Per 100 Feet	Newtons Per Meter	Recom. Support Spacing*	
	Inches	MM	Inches	MM	Inches	MM	Inches	MM			(Feet)	(M)
PVC Schedule 40	¾	19	1.050	26.7	.824	20.9	.113	2.87	22.0	1.80	4	1.2
	1	25	1.315	33.4	1.049	26.6	.133	3.38	32.0	2.67	4½	1.4
	1¼	32	1.660	42.2	1.380	35.1	.140	3.50	43.5	3.61	5	1.5
	1½	38	1.900	48.3	1.610	40.9	.145	3.68	52.0	4.31	5	1.5
	2	51	2.375	60.3	2.067	52.5	.154	3.91	69.5	5.78	5	1.5
	2½	64	2.875	73.0	2.469	62.7	.203	5.16	109.5	9.18	6	1.8
	3	75	3.500	88.9	3.068	77.9	.216	5.49	143.0	12.0	6	1.8
	4	102	4.500	114.3	4.026	102.3	.237	6.02	203.5	17.1	6½	2.0
	5	127 (Use 5" PVC Class 200)	6.625	168.3	6.065	154.1	.280	7.11	359.0	30.1	7	2.1
	6	152 (Use 8" PVC Class 160)									7½	2.3
	8	203 (Use 8" PVC Class 160)									8	2.4
	10	254									8½	2.6
12	310									9½	2.9	

	Nominal Size		O.D.		I.D.		Wall Thickness		Pounds Per 100 Feet	Newtons Per Meter	Recom. Support Spacing*	
	Inches	MM	Inches	MM	Inches	MM	Inches	MM			(Feet)	(M)
PVC Schedule 80	½	13	.840	21.3	.546	13.9	.147	3.73	20.5	1.72	4½	1.4
	¾	19	1.050	26.7	.742	18.8	.154	3.91	28.0	2.34	4½	1.4
	1	25	1.315	33.4	.957	24.3	.179	4.55	41.0	3.45	5	1.5
	1¼	32	1.660	42.2	1.278	32.5	.191	4.85	56.5	4.76	5½	1.7
	1½	38	1.900	48.3	1.500	38.1	.200	5.08	68.5	5.78	5½	1.7
	2	51	2.375	60.3	1.939	49.3	.218	5.54	94.5	7.99	6	1.8
	2½	64	2.875	73.0	2.323	59.0	.276	7.01	144.5	12.2	6½	2.0
	3	75	3.500	88.9	2.900	73.7	.300	7.62	193.0	16.3	7	2.1
	4	102	4.500	114.3	3.826	97.2	.337	8.56	282.0	23.8	7½	2.3
	5	127	5.563	141.3	4.813	122.3	.375	9.53	392.0	33.0	8	2.4
	6	152	6.625	168.3	5.761	146.3	.432	10.97	539.0	45.4	9	2.7
	8	203									9½	2.9

*Spacings shown are set for a 100° maximum temperature.

The physical properties of PVC material are:

E = 410,000 psi

Tensile Strength = 7,300 psi at 78°F

Working Stress in Bending 4.0 k/in.²

Temperature Coefficient - .035 inches per 100 degrees F per foot

Table 10.8.6-1

10.9 Utility Review Procedure for Installation on Existing Bridges

It is the responsibility of the Region Utilities Engineer to forward any proposed existing bridge attachments to the Bridge Preservation Office. The Bridge Preservation Office is responsible for reviewing only those details pertaining to the bridge crossing such as attachment details or trenching details adjacent to bridge piers or abutments.

The Bridge Preservation Office reviews proposed utility attachments and either approves the attachment or Returns For Correction (RFC). A current file for most utility attachments is maintained in the Bridge Preservation Office. The turnaround time for reviewing the proposals should not exceed two weeks; however, most attachments that have simple connections with epoxy anchors can be reviewed, stamped, and responded to within one day. This is provided that corrections and additional notes are minimal.

Occasionally, a utility company will request a conceptual approval of their proposed attachment before they invest their time in detailed drawings and calculations. Often they will request this approval by sending a sketch of their proposal directly to the Bridge Office. A letter of response will be sent directly to the utility that concurs with their proposal or suggests an alternate. This letter includes instructions for them to resubmit their final proposal through the Region Utilities Engineer with a courtesy copy of this letter sent to the Region Utilities Engineer.

The Region determines the number of copies to be returned. Most Regions send five copies of the proposed utility attachment. If the proposal is approved, Bridge Preservation will file one copy in the Utility file and return four marked copies. If it has been returned for correction or not approved, one copy is placed in the utility file and two marked copies are returned, thru the Region, to the Utility. See Section 10.9.1, "Utility Review Checklist".

Utility attachments, which exert moments or large forces at the supports, should be accompanied by at least one set of calculations from the utility company. Bridge attachments designed to resist surge forces should always be accompanied by calculations. The engineer may request calculations from the utility company for any attachment detail that may be questionable.

The engineer shall check the utility company's design with his own calculations. The connection detail shall be designed to successfully transfer all forces to the bridge without causing overstress in the connections or to the bridge members to which they are attached. For large utilities, the bridge itself shall have adequate capacity to carry the utility without affecting the live load capacity.

Guidelines for Utility Companies

Detailing guidelines for utility companies to follow when designing utility attachments are listed in DOT Form 224-047, "General Notes and Design Criteria for Utility Installations to Existing Bridges". Commonly used systems are detailed in the Appendix 10.9-A1-1, "Utility Installation Guideline Details for Existing Bridges".

10.9.1 Utility Review Checklist

This checklist applies to all proposed utility attachments to existing bridges.

1. Complete cursory check to become familiar with the proposal.
2. Determine location of existing utilities.
 - a. Check Bridge Inspection Report for any existing utilities.
 - b. Check Bridge Preservation's utility file for any existing utility permits or franchises and possible as-built plans.

- c. Any existing utilities on the same side of the structure as the proposed utility should be shown on the proposal.
 - d. Obtain as-built plans from bridge vault if not in an existing utility file.
3. Review the following with all comments in red:
 - a. Layout that includes dimension, directions, SR number and bridge number.
 - b. Adequate spacing of supports.
 - c. Adequate strength of supports as attached to the bridge (calculations may be necessary).
 - d. Maximum design pressure and regular operating pressure for pressure pipe systems.
 - e. Adequate lateral bracing and thrust protection for pressure pipe systems.
 - f. Does the utility obstruct maintenance or accessibility to key bridge components?
 - g. Check Location (elevation and plan view) of the utility with respect to pier footings or abutments. If trench limits encroach within the 45° envelope from the footing edge, consult the Materials Lab.
 - h. Force mains or water flow systems may require encasement if they are in excavations below the bottom of a footing.
4. Write a letter of reply or email to the Region so that a copy will be returned to you indicating that the package has been accepted and sent out.
5. Stamp and date the plans using the same date as shown on the letter of reply or email.
6. Create a file folder with the following information:
 - a. Bridge no., name, utility company or utility type, and franchise or permit number.
 - b. One set of approved plans and possibly one or two pages of the original design plans if necessary for quick future reference. Previous transmittals and plans not approved or returned to correction should be discarded to avoid unnecessary clutter of the files.
 - c. Include the letter of submittal and a copy of the letter of reply or email after it has been accepted.
7. Give the complete package to the section supervisor for review and place the folder in the utility file after the review.

10.10 Drainage Design

Even though it is rare that poor drainage is directly responsible for a structural failure, it still must be a primary consideration in the design. Poor drainage can cause problems such as ponding on the roadway, erosion of abutments, and deterioration of structural members. Collecting the runoff and transporting it away from the bridge can prevent most of the problems. Proper geometrics during the preliminary stage is essential in order to accomplish this. The Hydraulics Section recommends placing the bridge deck drainage off of the structure. Therefore, the Bridge Design Section has adopted the policy that all expansion joints will be watertight.

Geometrics

Bridges should have adequate transverse and longitudinal slopes to allow the water to run quickly to the drains. A transverse slope of .02'/ft. and longitudinal slope of 0.5 percent for minimum values are adequate. Avoid placing sag vertical curves and superelevation crossovers on the structure that could result in hydroplaning conditions or, in cold climates, sheets of ice from melting snow. The use of unsymmetrical vertical curves may assist the designer in shifting the low point off the structure.

Hydrology

Hydrological calculations are made using the rational equation. A 10-year storm event with a 5-minute duration is the intensity used for all inlets except for sag vertical curves where a 50-year storm intensity is required.

On Bridge Systems

Where bridge length and geometry require a bridge drain system within the bridge, the first preference is to place 5-inch diameter pipe drains that have no bars and drop straight to the ground. At other times, such as for steel structures, the straight drop drain is unacceptable and a piping system with bridge drains is required. The minimum pipe diameter should be 6 inches with no sharp bends within the system. The Hydraulics Section should be contacted to determine the type of drain required (preferably Neenah).

Construction

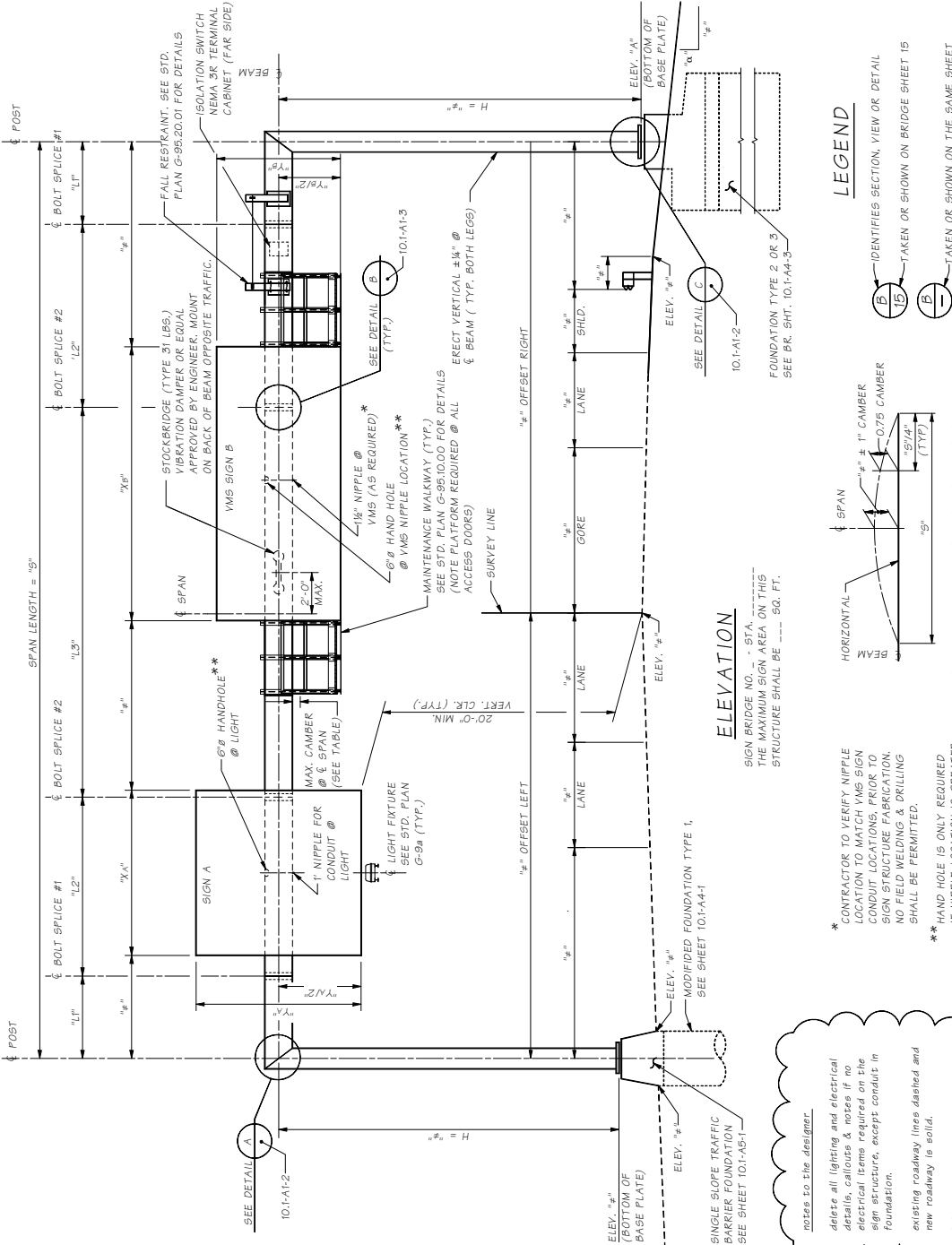
Bridge decks have a striated finish in accordance with the *Standard Specifications* listed below, however, the gutters have an untextured finish (steel trowel) for a distance of 2 feet from the curb. This untextured area provides for smooth gutter flow and a Manning n value of .015 in the design.

Standard Specification Section 6-02.3(10) — Bridge Decks

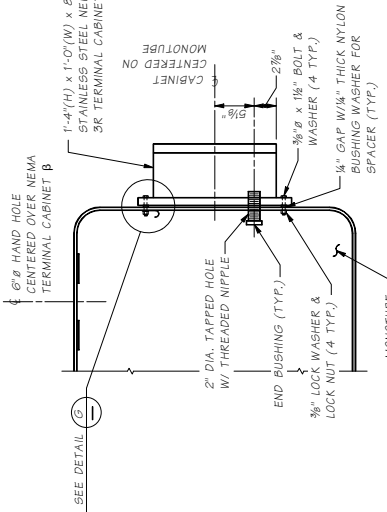
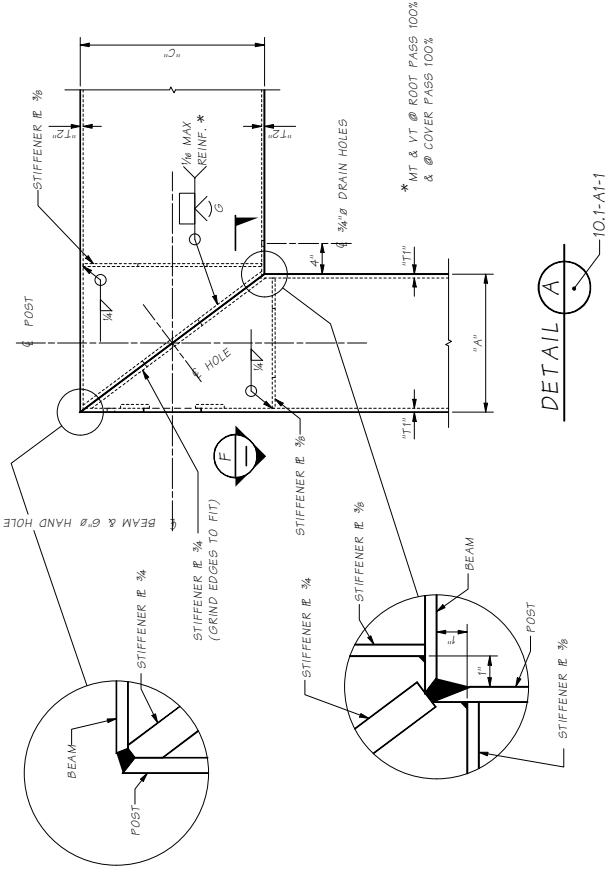
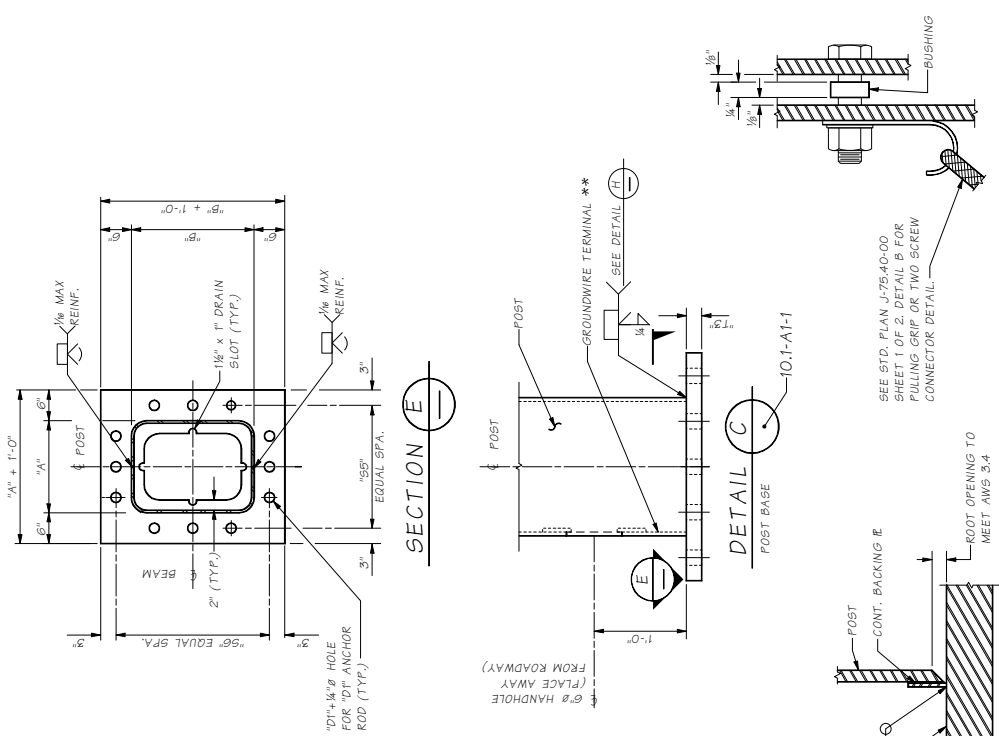
Standard Specification Section 6-02.3(10) — Approach Slabs

GENERAL NOTES

- ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION DATED 2002 AND AMENDMENTS.
- THE SIGN STRUCTURES DESIGN AND ANALYSIS HAS BEEN DONE IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS - FOURTH EDITION - DATED 2002 AND INTERIMS, USING BASIC WIND SPEED OF 90 MPH AND 50 YEARS OF DESIGN LIFE. FATIGUE DESIGN OF THE STRUCTURE CONFORMS TO FATIGUE CATEGORY 1 OF THE SPECIFIED AASHTO STANDARD SPECIFICATIONS.
- ALL BUTT JOINT WELDS SHALL BE FULL PENETRATION GROOVE WELDS WITH BACK-UP PLATES OF 1/4" MIN. THICKNESS.
- THE BACK-UP PLATES FOR ALL FULL PENETRATION WELDS SHALL BE WELDED CONTINUOUSLY TO THE JOINED PIECES. THIS CAN BE DONE BY EITHER A CONTINUOUS FILLET WELD ON THE BACK SIDE OF THE PIECE, OR BY A CONTINUOUS WELD IN THE ROOT OF THE FULL PENETRATION WELD, UNLESS OTHERWISE NOTED.
- ALL BOLTS, RODS, AND RELATED HARDWARE SHALL BE GALVANIZED AFTER FABRICATION PER AASHTO M 232.
- STEEL SURFACES SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AASHTO M 111. ALL EXTERIOR STEEL SURFACES SHALL BE PAINTED IN ACCORDANCE WITH THE SPECIAL PROVISIONS.
- SIGN PANELS AS SHOWN IN THE CONTRACT PLANS SHALL BE INSTALLED WITH THE SIGN STRUCTURE OR IMMEDIATELY AFTER THE SIGN STRUCTURE IS ERECTED.
- FABRICATE BEAM TO PROVIDE SMOOTH PARABOLIC CAMBER CURVE. SEE CAMBER DIAGRAM. DO NOT SHIM AT BOLTED SPLICES.
- FABRICATE POST STRAIGHT.
- MATERIALS SPECIFICATIONS:
ALL STRUCTURAL STEEL EXCEPT AS OTHERWISE NOTED
ANCHOR RODS ASTM F 1554 GR. 105
HANDHOLE COVER SCREWS ASTM F 593 GR. 1
SPlice BOLTS AASHTO M 164
SIGN BRACKET RODS ASTM A 307
MOUNTING BEAM BOLTS AASHTO M 164
COVER PLATES ASTM A 36
- BOTTOM OF BASE PLATE ELEVATIONS AND POST HEIGHTS SHOWN ARE APPROXIMATE. THE CONTRACTOR SHALL FIELD MEASURE ANCHOR ROD LOCATIONS, ELEVATIONS, CLEARANCES AND ALL STEEL STRUCTURE DIMENSIONS, AND SUBMIT TO ENGINEER FOR APPROVAL PRIOR TO FABRICATION.
- POSTS, BASE PLATES, BEAMS AND SPlice PLATES ARE MAIN LOAD CARRYING MEMBER. FIELD MEMBER CONNECTIONS OF LEVEL MEMBERS AND SHALLOW CHAIRS SHALL BE FULL PENETRATION GROOVE WELDS AS DESCRIBED IN SECTION G-9.3 FOR AASHTO M 270 MATERIAL. NON-DESTRUCTIVE TEST ACCEPTANCE CRITERIA TO CONFORM TO TENSILE MEMBERS WITH CYCLIC LOAD.
- SEE OTHER PLANS FOR CONDUIT PENETRATIONS AND HAND HOLES. REFER TO ELECTRICAL PLANS FOR INTERNAL ROUTING OF CONDUCTORS. CONDUIT CONDUCTORS SHALL NOT BE ATTACHED TO THE OUTSIDE OF THE SIGN STRUCTURE. ISOLATION SWITCH SHALL BE LOCATED NEAR THE SHOULDER OF ROADWAY ON THE OPPOSITE SIDE OF THE BEAM AS THE SIGNS. SEE NEMA 3R TERMINAL CABINET DETAIL ON SHEET 10.1-A2-1.
- THE MAXIMUM SIGN AREA ON THE STRUCTURE SHALL BE AS NOTED.



		STANDARD SIGN BRIDGES	
BRIDGE AND STRUCTURES OFFICE		MONOTUBE SIGN BRIDGE LAYOUT	
BRIDGE DESIGN NO. _____ STATE _____ COUNTY _____ FEDERAL PROJ. NO. _____ SHEET NO. _____ OF _____ SHEETS		DESIGNED BY _____ CHECKED BY _____ DRAWN BY _____ DATE _____	



DETAIL C

SECTION E

DETAIL H

DETAIL F

NEMA 3R TERMINAL CABINET DETAIL

B IF NO OTHER HAND HOLE IS WITHIN 1'-6\"/>

SECTION F

DIAGONAL STIFFENER
NOT SHOWN.

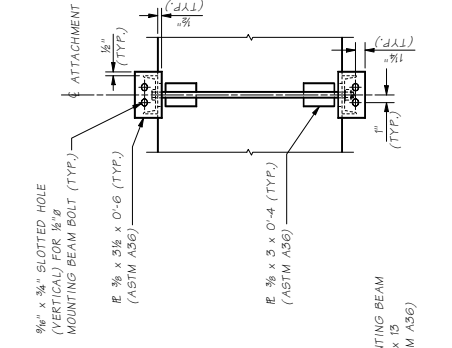
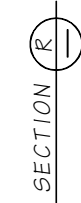
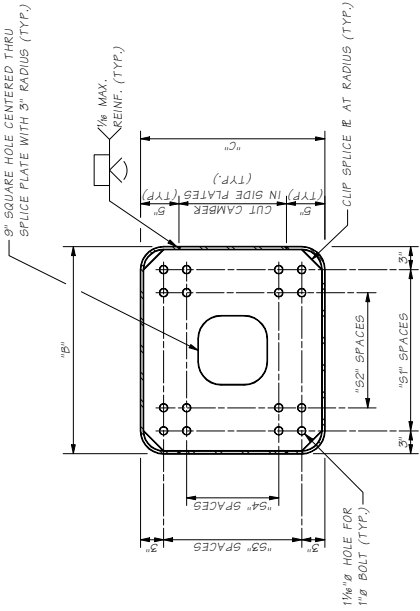
STANDARD SIGN BRIDGES
MONOTUBE SIGN BRIDGE
STRUCTURAL DETAILS 1



BRIDGE AND
STRUCTURES
OFFICE

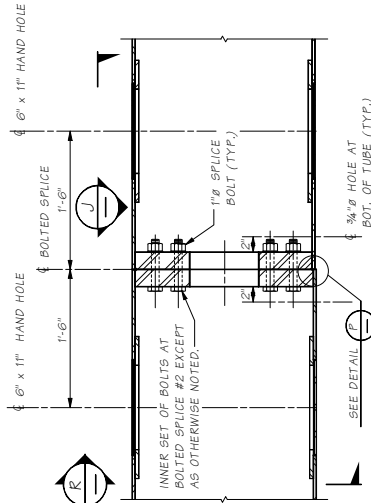
Bridge Design Dept	WA	10	WASH	PROJECT NO.	NO.	SHEET NO.	TOTAL SHEETS
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Design Projects Eng.							
Architect/Specifier							
DATE							
REVISION							
BY							

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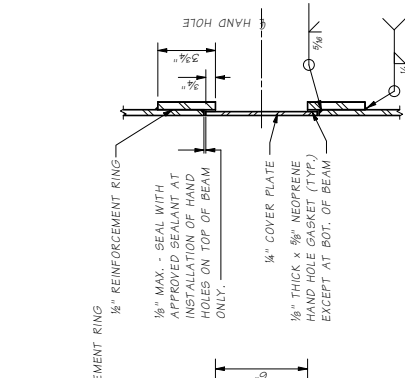


ATTACHMENT BRACKET DETAIL

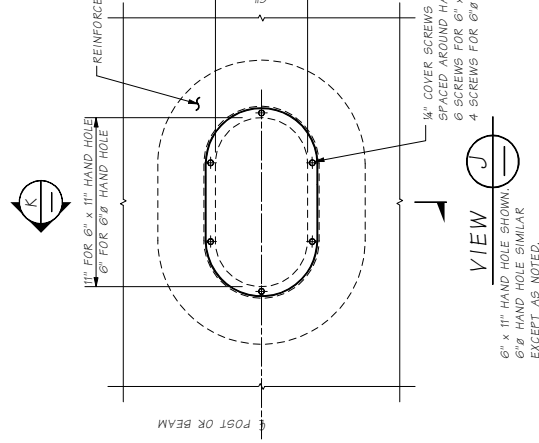
PAINTE ENTIRE ATTACHMENT BRACKET TO MATCH EXISTING
STRUCTURE EXCEPT FOR MOUNTING BEAM, SIGN, LIGHT,
BEAM LENGTHS, SIZE AND SPACING SHALL BE DETERMINED
FROM THE CONTRACT PLANS OR THE STANDARD PLANS.
VARIABLE MESSAGE SIGNS SHALL HAVE MOUNTING BEAMS
@ 3'-0" MAXIMUM.



DETAIL P



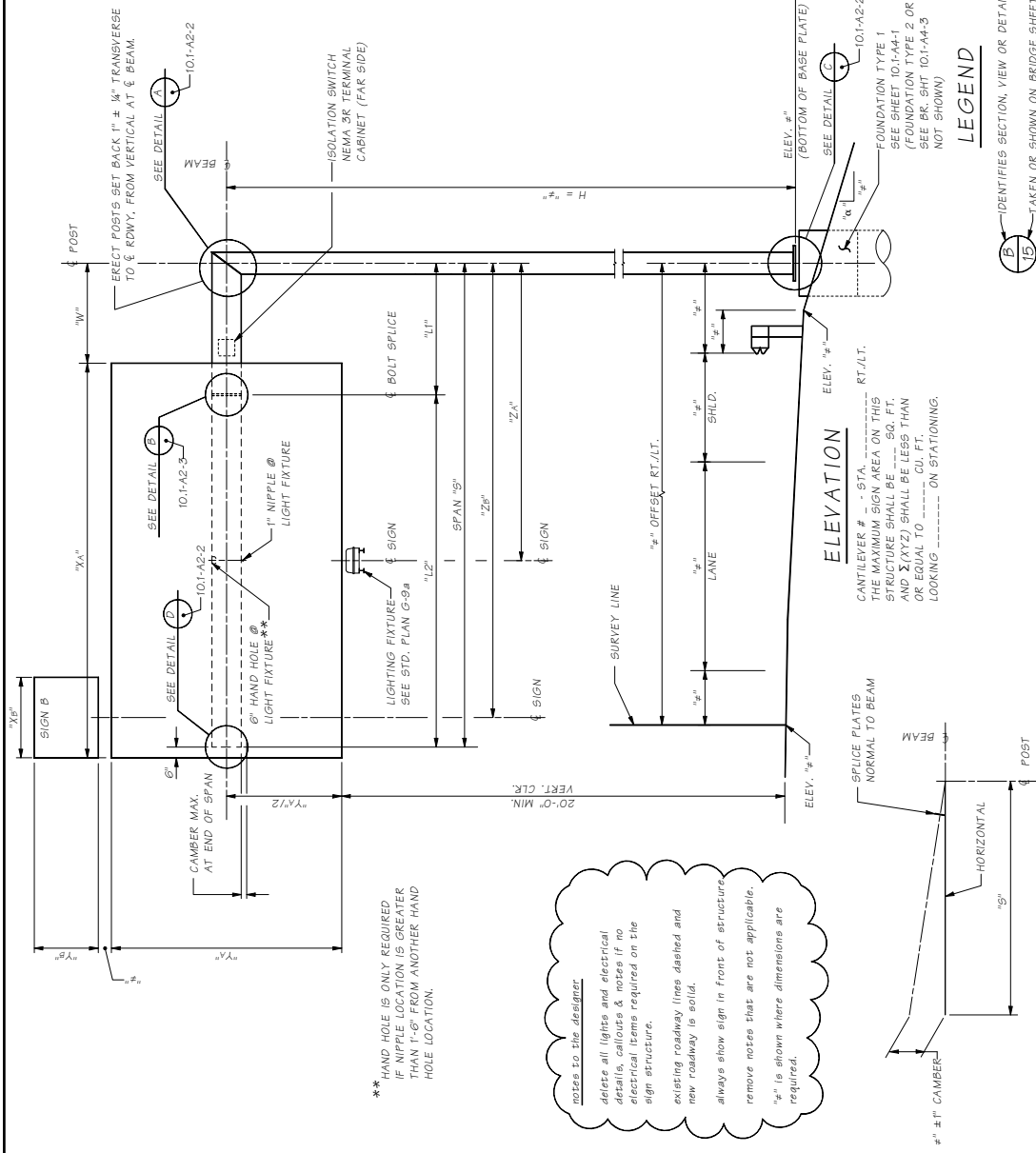
DETAIL K



VIEW J

BRIDGE DESIGN ENGINEER	DATE	REVISION	BY	APP'D.

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION				STANDARD SIGN BRIDGES	
BRIDGE AND STRUCTURES OFFICE				MONOTUBE SIGN BRIDGE STRUCTURAL DETAILS 2	
JOB NO.	SHEET	OF	SHEETS	SCALE	SHEETS



** HAND HOLE IS ONLY REQUIRED IF NIPPLE LOCATION IS GREATER THAN 1'-6" FROM ANOTHER HAND HOLE LOCATION.

note to the designer
delete all lights and electrical details, callouts & notes if no electrical items required on the sign structure.
existing roadway lines dashed and new roadway is solid.
always show sign in front of structure.
remove notes that are not applicable.
"x" is shown where dimensions are required.

GENERAL NOTES

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION DATED 200... AND AMENDMENTS.
2. THE SIGN STRUCTURES DESIGN AND ANALYSIS HAS BEEN DONE IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS - FOURTH EDITION - DATED 200... AND INTERIMS, USING BASIC WIND SPEED OF 90 MPH AND 50 YEARS OF DESIGN LIFE. FATIGUE DESIGN OF THE STRUCTURE CONFORMS TO FATIGUE CATEGORY 1 OF THE SPECIFIED AASHTO STANDARD SPECIFICATIONS.
3. ALL BUTT JOINT WELDS SHALL BE FULL PENETRATION GROOVE WELDS WITH BACK-UP PLATES OF 1/4" MIN. THICKNESS.
4. THE BACK-UP PLATES FOR ALL FULL PENETRATION WELDS SHALL BE WELDED CONTINUOUSLY TO THE JOINED PIECES. THIS CAN BE DONE BY EITHER A CONTINUOUS FILLET WELD ON THE BACK SIDE OF THE PIECE, OR BY A CONTINUOUS WELD IN THE ROOT OF THE FULL PENETRATION WELD, UNLESS OTHERWISE NOTED.
5. ALL BOLTS, RODS, AND RELATED HARDWARE SHALL BE GALVANIZED AFTER FABRICATION PER AASHTO M 232.
6. STEEL SURFACES SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AASHTO M 111. ALL EXTERIOR STEEL SURFACES SHALL BE PAINTED IN ACCORDANCE WITH THE SPECIAL PROVISIONS.
7. SIGN PANELS AS SHOWN IN THE CONTRACT PLANS SHALL BE INSTALLED WITH THE SIGN STRUCTURE OR IMMEDIATELY AFTER THE SIGN STRUCTURE IS ERECTED.
8. FABRICATE BEAM TO PROVIDE STRAIGHT CAMBER. SEE CAMBER DIAGRAM. DO NOT SHIM AT BOLTED SPICES.
9. FABRICATE POST STRAIGHT.
10. MATERIALS SPECIFICATIONS:
ALL STRUCTURAL STEEL EXCEPT AS OTHERWISE NOTED A57M A 572 GR. 50 OR A57M A 588
ANCHOR RODS ASTM F 1554 GR. 105
HANDHOLE COVER SCREWS ASTM F 593 GR. 1
SPICE BOLTS AASHTO M 164
SIGN BRACKET RODS ASTM A 307
MOUNTING BEAM BOLTS AASHTO M 164
COVER PLATES ASTM A 36
11. BOTTOM OF BASE PLATE ELEVATIONS AND POST HEIGHTS SHOWN ARE APPROXIMATE. THE CONTRACTOR SHALL FIELD MEASURE ANCHOR ROD LOCATIONS, ELEVATIONS, CLEARANCES AND ALL STEEL STRUCTURE DIMENSIONS, AND SUBMIT TO ENGINEER FOR APPROVAL PRIOR TO FABRICATION.
12. POSTS, BASE PLATES, BEAMS AND SPICE PLATES ARE MAIN LOAD CARRYING MEMBERS OF THE SIGN STRUCTURE. THE MEMBERS OF THE SIGN STRUCTURE SHALL MEET THE LONGITUDINAL CHARGY Y-NOTCH TEST AS DESCRIBED IN SECTION 6-03.2 FOR AASHTO M 270 MATERIAL. NON-DESTRUCTIVE TEST ACCEPTANCE CRITERIA TO CONFORM TO TENSILE MEMBERS WITH CYCLIC LOAD.
13. SEE OTHER PLANS FOR CONDUIT PENETRATIONS AND HAND HOLES. REFER TO ELECTRICAL PLANS FOR INTERNAL ROUTING OF CONDUCTORS. CONDUIT SWITCH SHALL NOT BE ATTACHED TO THE OUTSIDE OF THE SIGN STRUCTURE. ISOLATION SWITCH SHALL BE LOCATED NEAR THE SHOULDER OF ROADWAY ON THE OPPOSITE SIDE OF THE BEAM AS THE SIGNS. SEE NEMA 3R TERMINAL CABINET DETAIL ON SHEET 10.1-A2-2.
14. NO YMS ALLOWED ON CANTILEVER MONOTUBE SIGN STRUCTURES.
15. THE MAXIMUM SIGN AREA ON THE STRUCTURE SHALL BE AS NOTED.

BEAM CAMBER DIAGRAM

10.1-A2-1 SHEET

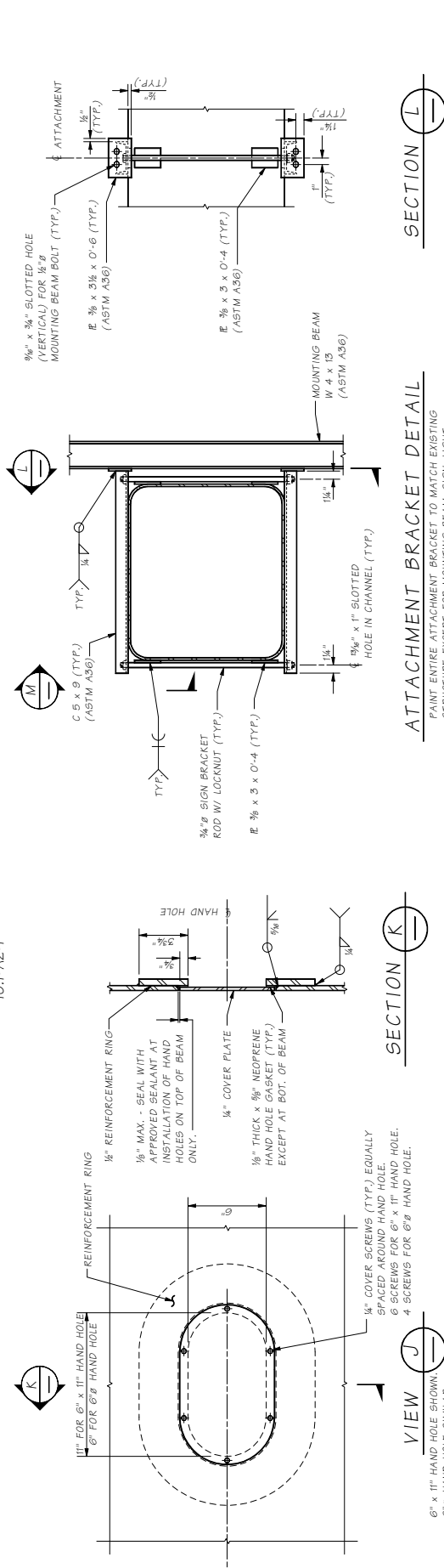
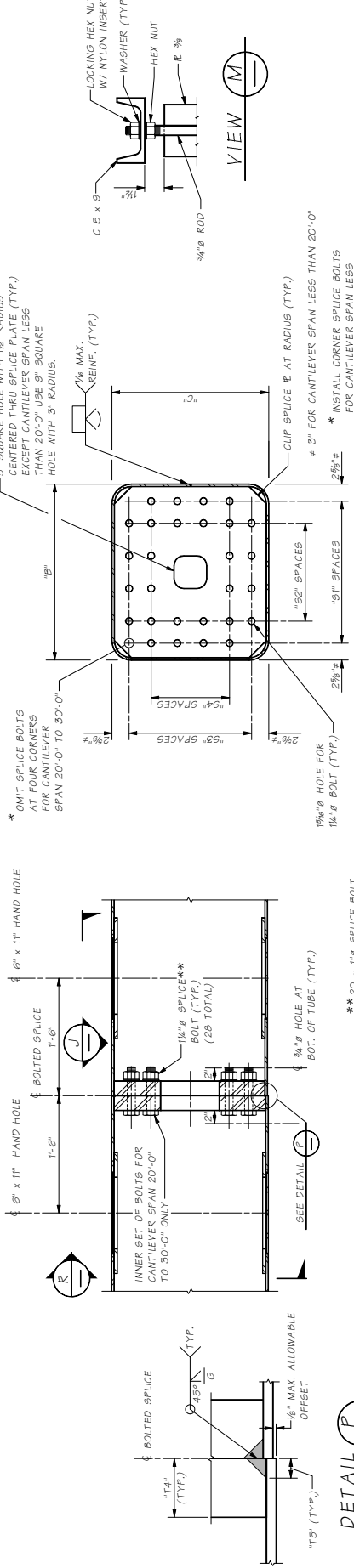
Washington State Department of Transportation

BRIDGE AND STRUCTURES OFFICE

STANDARD SIGN BRIDGES
MONOTUBE CANTILEVER LAYOUT

Bridge Design Dept:	WASH STATE DEPT OF TRANSPORTATION	PROJECT NO.:		TOTAL SHEETS:	
Supervisor:		STATE:	WA	SHEET NO.:	10.1-A2-1
Designed By:		COUNTY:	10	DATE:	
Checked By:		JOB NUMBER:		BY:	
Bridge Projects Eng.:		DATE:		REVISION:	
Project Plan By:					
Checked/Specified:					

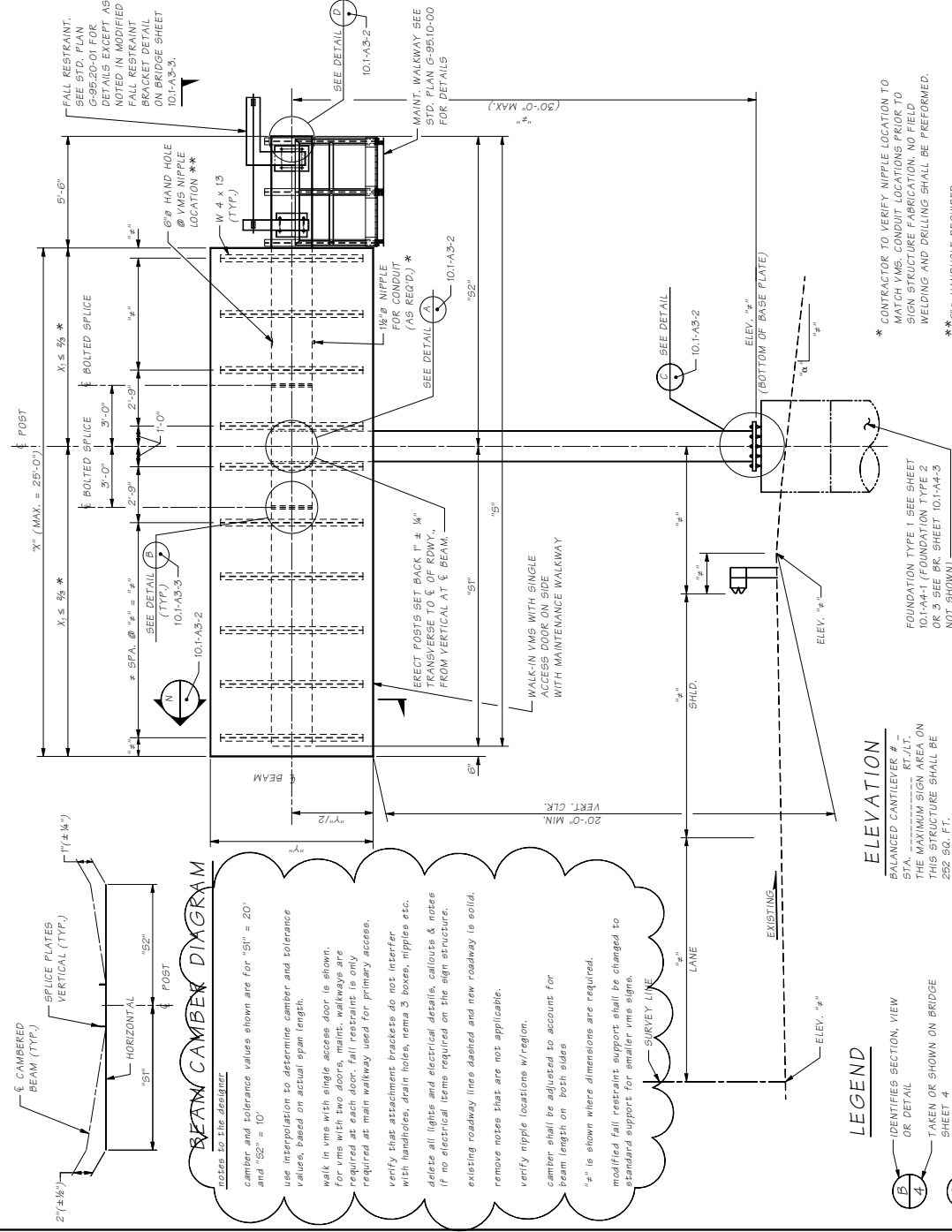
Mon Feb 09 07:45:01 2010



ATTACHMENT BRACKET DETAIL
 PAINT ENTIRE ATTACHMENT BRACKET TO MATCH EXISTING STRUCTURE EXCEPT FOR MOUNTING BEAM. SIGN LIGHT BEAM LENGTHS, SIZE AND SPACING SHALL BE DETERMINED FROM THE CONTRACT PLANS OR THE STANDARD PLANS.

Bridge Design Engineer: Supervisor: Designed By: Checked By: Bridge Projects Eng: Brian Thorn By: Checked/Sealcheck: DATE: _____ REVISION: _____ BY: _____ APPD: _____	MAINT. AND R.D. (5) Sign. Bridges / M.T. Cant. / STRUCT. DETAILS 2: MAN.	SHEET NO.: _____ TOTAL SHEETS: _____	FEDERAL PROJ. NO.: _____ STATE: _____ COUNTY: _____ DISTRICT: _____	WASH. STATE DEPARTMENT OF TRANSPORTATION BRIDGE AND STRUCTURES OFFICE	STANDARD SIGN BRIDGES MONOTUBE CANTILEVER STRUCTURAL DETAILS 2
--	--	---	--	--	--

Monotube Sign Structures
Balanced Cantilever Layout



BEAM CAMBER DIAGRAM

Notes to the designer:
 camber and tolerance values shown are for "S1" = 20' and "S2" = 10'.
 use interpolation to determine camber and tolerance values, based on actual span length.
 walk in vms with single access door is shown. for vms with two doors, main, nips, walkways are required at each door. fall restraints are only required at main walkway used for primary access.
 verify that attachment brackets do not interfere with handholes, main nips, noma 3 boxes, nipples etc.
 delete all lights and electrical details, callouts & notes if no electrical items required on the sign structure.
 existing roadway lines dashed and new roadway is solid.
 remove notes that are not applicable.
 verify nipple locations w/region.
 camber shall be adjusted to account for beam length on both sides
 "*" is shown where dimensions are required.
 modified fall restraint support shall be changed to standard support for smaller vms signs.

ELEVATION

BALANCED CANTILEVER # _____
 STA. _____ RT./LT. _____
 THE MAXIMUM SIGN AREA ON THIS STRUCTURE SHALL BE 282 SQ. FT.

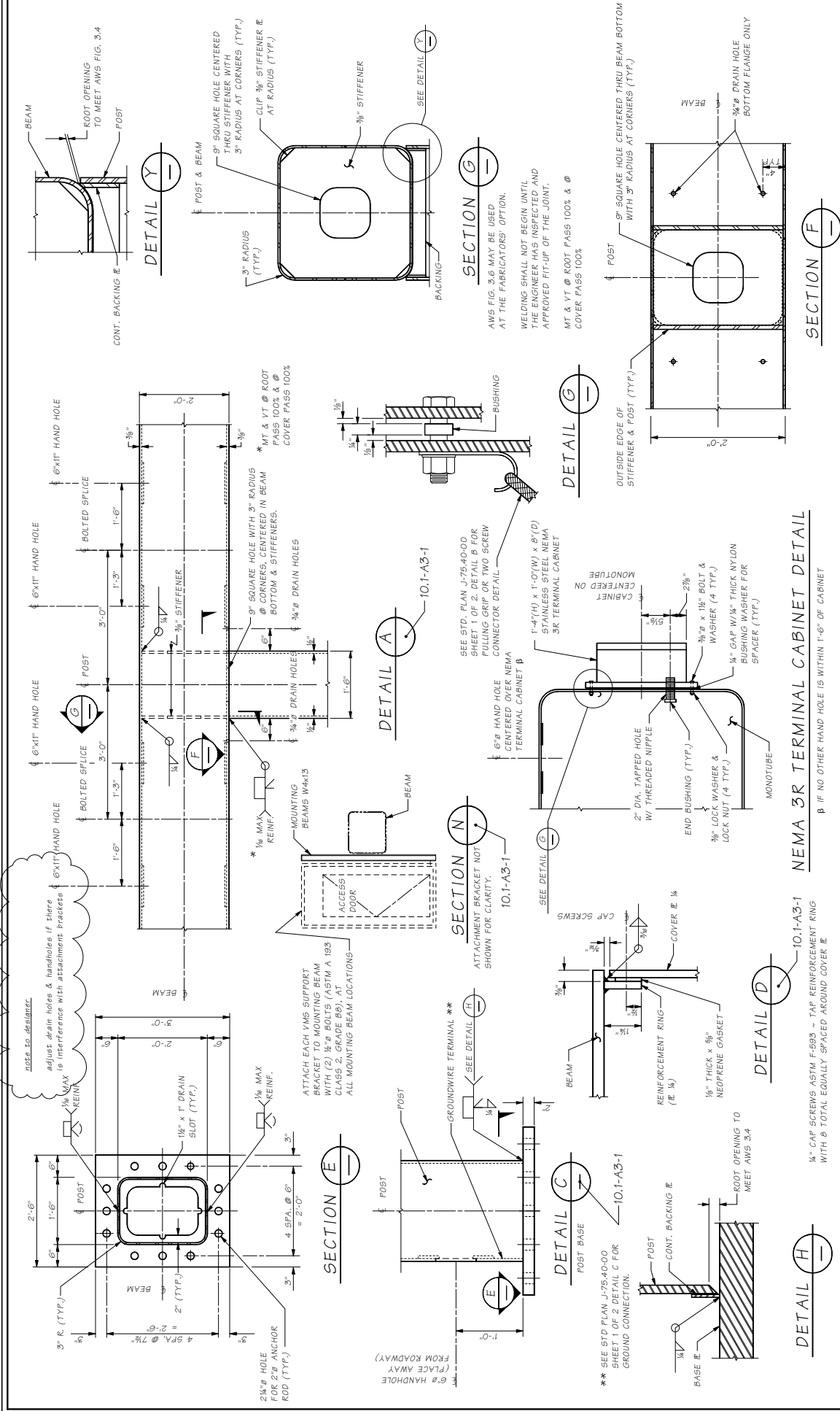
LEGEND

- IDENTIFIES SECTION, VIEW OR DETAIL
- TAKEN OR SHOWN ON BRIDGE SHEET 4
- TAKEN OR SHOWN ON THE SAME SHEET

GENERAL NOTES

- ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION DATED 2002, AND AMENDMENTS.
- THE SIGN STRUCTURES DESIGN AND ANALYSIS HAS BEEN DONE IN ACCORDANCE WITH ASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS - FOURTH EDITION - DATED 2002, AND INTERIMS, USING BASIC WIND SPEED OF 90 MPH AND 50 YEARS OF DESIGN LIFE. FATIGUE DESIGN OF THE STRUCTURE CONFORMS TO FATIGUE CATEGORY 1 OF THE SPECIFIED ASHTO STANDARD SPECIFICATIONS.
- ALL BUTT JOINT WELDS SHALL BE FULL PENETRATION GROOVE WELDS WITH BACK-UP PLATES OF 1/4" MIN. THICKNESS.
- THE BACK-UP PLATES FOR ALL FULL PENETRATION WELDS SHALL BE WELDED CONTIGUOUSLY TO THE JOINED PIECES. THIS CAN BE DONE BY EITHER CONTIGUOUS WELD IN THE ROOT OF THE FULL PENETRATION WELD, UNLESS OTHERWISE NOTED.
- ALL BOLTS, RODS, AND RELATED HARDWARE SHALL BE GALVANIZED AFTER FABRICATION PER ASHTO M 232.
- STEEL SURFACES SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASHTO M 111. ALL EXTERIOR STEEL SURFACES SHALL BE PAINTED IN ACCORDANCE WITH THE SPECIAL PROVISIONS.
- SIGN PANELS AS SHOWN IN THE CONTRACT PLANS SHALL BE INSTALLED WITH THE SIGN STRUCTURE OR IMMEDIATELY AFTER THE SIGN STRUCTURE IS ERECTED.
- FABRICATE BEAM TO PROVIDE STRAIGHT CAMBER. SEE CAMBER DIAGRAM. DO NOT SHIM AT BOLTED SPLICES.
- FABRICATE POST STRAIGHT.
- MATERIALS SPECIFICATIONS:
 ALL STRUCTURAL STEEL EXCEPT AS OTHERWISE NOTED
 ANCHOR RODS ASTM F 1554 GR. 105
 HANDHOLE COVER SCREWS ASTM F 593 GR. 1
 SPLICE BOLTS ASHTO M 164
 SIGN BRACKET RODS ASHTO M 307
 WALK-IN VMS BEAM BOLTS ASHTO M 164
 COVER PLATES ASHTO A 36
- SEE OTHER PLANS FOR CONDUIT PENETRATIONS AND HAND HOLES. REFER TO ELECTRICAL PLANS FOR INTERNAL ROUTINGS OF CONDUITS. CONDUIT CONDUCTORS SHALL NOT BE ATTACHED TO THE OUTSIDE OF THE SIGN STRUCTURE. ISOLATION SWITCH SHALL BE LOCATED NEAR THE SHOULDER OF ROADWAY ON THE OPPOSITE SIDE OF THE BEAM AS THE SIGNS. SEE NEWA 3K TERMINAL CABINET DETAIL ON SHEET 10.1-A2-1.
- THE MAXIMUM SIGN AREA ON THE STRUCTURE SHALL BE AS NOTED.
- THE TOTAL BEAM LENGTH "S" FOR VMS & WALKWAYS SHALL NOT EXCEED 30'-0".

BRIDGE AND STRUCTURES OFFICE		Washington State Department of Transportation		STANDARD SIGN BRIDGES MONOTUBE BALANCED CANTILEVER LAYOUT	
Bridge Design Dept.	WORK NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	OF SHEETS
Supervisor	10	WASH			
Designed By					
Checked By					
Drawn By					
Project No. By					
Checked/Rechecked					
DATE					



SR FILE NO. 10.1-A3-2

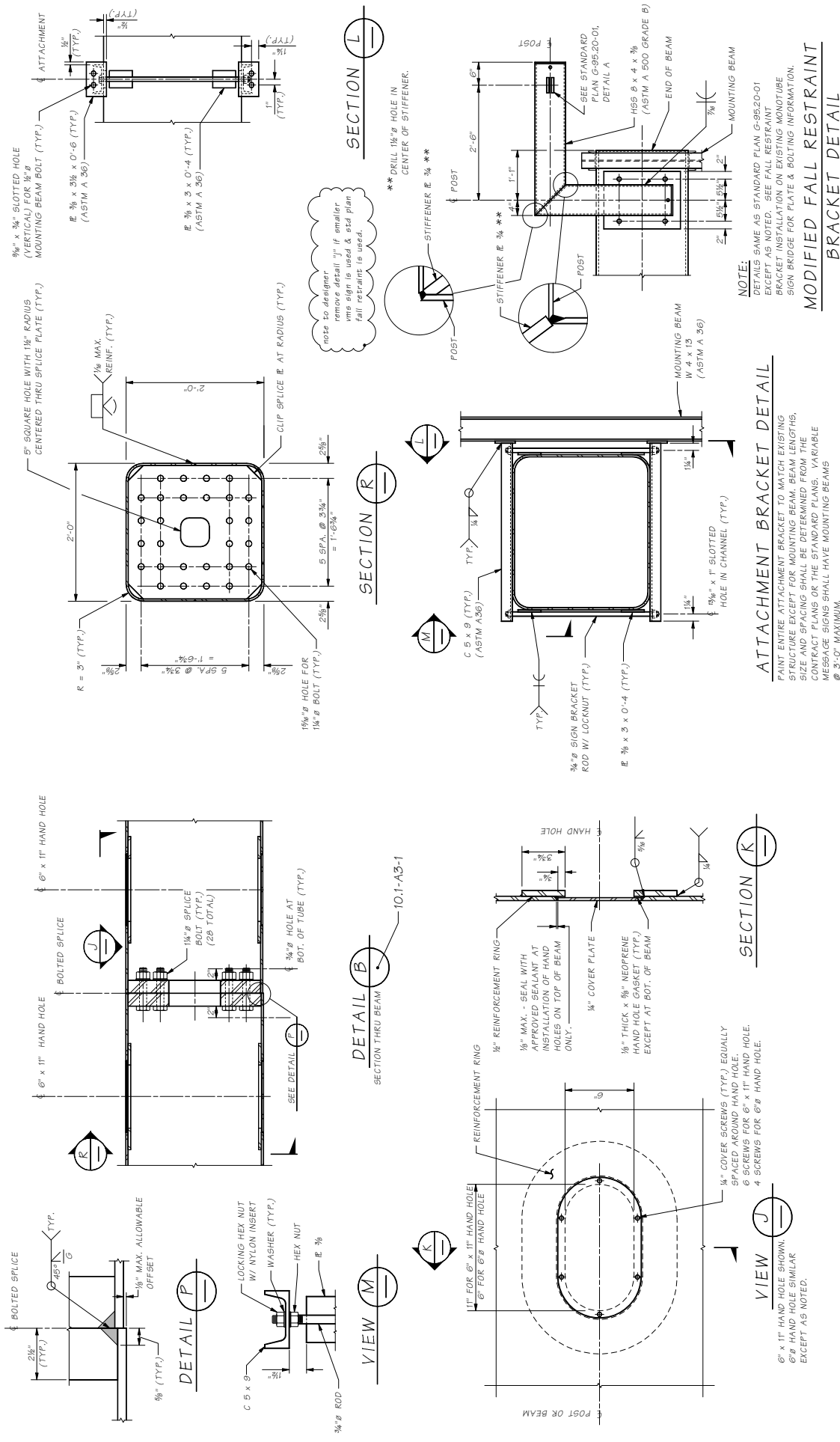
SHEET NO. _____

Bridge Design Dept.	WASH STATE	MAN	TOTAL SHEETS
Supervisor	STATE	FED. AID PROJ. NO.	SHEET NO.
Checked By	10	WASH	
Designed By		JOB NUMBER	
Bridge Projects Eng.		DATE	
Printed From By		REVISION	
Architect/Specifier		BY	APD

BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

STANDARD SIGN BRIDGES
MONOTUBE BALANCED CANTILEVER
STRUCTURAL DETAILS 1



Bridge Design Dept:	WSP-10000005	Sheet No.:	10	of	10
Supervisor:		FILE NO.:	10.1-A3-3		
Designed By:		DATE:			
Checked By:		REVISION:			
Bridge Projects Eng.:					
Project Plan By:					
Checked/Specified:					
BRIDGE AND STRUCTURES OFFICE Washington State Department of Transportation		STANDARD SIGN BRIDGES MONOTUBE BALANCED CANTILEVER STRUCTURAL DETAILS 2			

ANCHOR ROD - "D" 8" x 4'-4" LONG *
THREADED ROD WITH 2 WASHERS
AND 4 HEAVY HEX NUTS (TYP.).
THREAD EACH END 8". GALVANIZE
EXPOSED ANCHOR ROD END FOR 1'-0" MIN.

CONCRETE CLASS 4000

TEMPERARY CASING
DESIGNER TO REMOVE IF NOT REQUIRED

WELDED LAP SPLICE ONLY
(SEE SHEET 10.1-A4-2 FOR DETAILS)

#5 #4 SPIRAL @ 1'-0" PITCH

4" CLR.

#4 SPIRAL

SHAFT DIAMETER
SEE TABLE

**CONSTRUCTION JOINT W/
ROUGHENED SURFACE**
SEE SPIRAL TERMINATION
DETAIL ON SHEET 10.1-A4-2.

**CLAMP CONDUCTOR TO REINFORCING
WITH LISTED CONNECTOR SUITABLE
FOR USE EMBEDDED IN CONCRETE.**

FINISHED GROUND LINE

2 [5] #5
CAP OF ONE FOUNDATION
MAY BE FLAGGED WHILE SIGN
BRIDGE IS TEMPORARILY
SUPPORTED IN PLACE

**SEE ANCHOR B DETAIL
ON THIS SHEET**

2 [1] #4 (TYP.)

**GROUNDING CONDUCTOR NON-INSULATED
#4 AWG STRANDED COPPER, PROVIDE 3'-0"
MIN. SLACK. ROUTE CONDUCTOR TO GROUND
WIRE TERMINAL SHOWN IN DETAIL C 10.1-A1-2,
SIGN STRUCTURE 10.1-A2-2, OR 10.1-A3-2.**

**NOTE: USE A TEMPLATE TO LOCATE AND SECURE
RODS IN PLACE DURING FOUNDATION
INSTALLATION. FOR DETAILS, SEE ANCHOR
ROD ARRAY THIS SHEET.**

**USE CENTRALIZER TO PLACE
SHAFT REINFORCEMENT.
SEE SHEET 10.1-A4-2 FOR
DETAILS AND NOTES.**

ANCHOR ROD ARRAY
SHIP THE ANCHOR ROD ARRAY
ASSEMBLY AS A COMPLETE UNIT.
ALTERNATE 135° HOOKS
EVERY OTHER BAR

SHAFT DIAMETER

SHAFT DIAMETER

**3/8" CHAMFER
(TYP.)**

Ø [2] #5

Ø [3] #4

Ø [5] #5

Ø [4] #4

Ø [1] #4 SPIRAL

STEEL CONDUIT

PLAN
ANCHOR RODS NOT SHOWN.

ANCHOR ROD DETAIL
SEE SIGN STRUCTURE BASE PLATE
FOR ANCHOR ROD PATTERN

**"D" 8" ASTM A36
(GALVANIZING
NOT REQUIRED)**

**1/8" HOLE
(TYP.)**

**1/8" HOLE
(TYP.)**

POST

BEAM

4" (TYP.)

2" (TYP.)

ANCHOR B DETAIL
PROVIDE SCREEN
AROUND BASE. SEE
"SCREEN DETAIL" ON
SHEET 10.1-A4-2.

3'-0" MAX.

FINISHED GROUND LINE

**1/8" Ø STEEL
CONDUIT TO
BE INSTALLED
WHERE DIRECTED
BY THE ENGINEER.**

3'-0" MIN.

POST

VIEW

BENDING DIAGRAM

MARK	LOCATION	SIZE	NO. REQ'D.	LENGTH
1	CAP VERTICAL	4	4	5'-6 1/2"
2	CAP HOOPS	5	6	"A"
3	SHAFT VERTICAL	"X"	"Y"	"Z"-6"
4	SHAFT SPIRAL	4	1	"A"
5	CAP TOP	5	4	"A"

**NOTE: CONCRETE COVER SHALL BE
1 1/2" UNLESS SHOWN OTHERWISE.**

***"A" - DETERMINE FROM PLANS**

**SHAFT DIA.
MINUS 5"**

**SHAFT DIA.
MINUS 3" (TYP.)**

**SHAFT DIA.
MINUS 8"**

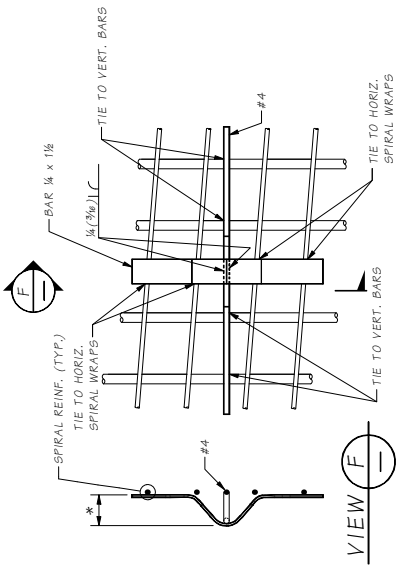
**SHAFT DIA.
MINUS 5"**

BRIDGE AND STRUCTURES OFFICE
Washington State Department of Transportation

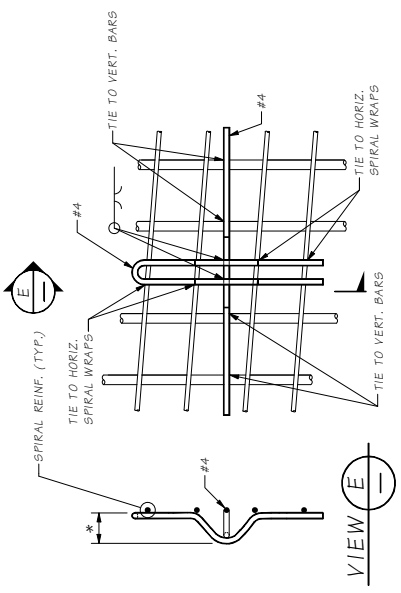
STANDARD SIGN BRIDGES
MONOTUBE SIGN STRUCTURES
FOUNDATION TYPE 1 - SHEET 1 OF 2

DESIGNED BY	DATE	REVISION	BY	APPROV.
CHECKED BY				
PROJECT NO.				
DATE				
JOB NO.				
SHEET				

10.1-A4-1

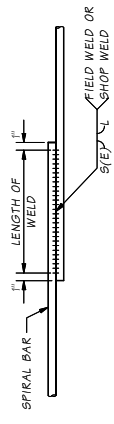


CENTRALIZER DETAIL
EPOXY COAT CENTRALIZER OR
PAINT WITH INORGANIC ZINC
AFTER FABRICATION (OPTION 2)



CENTRALIZER DETAIL
EPOXY COAT CENTRALIZER OR
PAINT WITH INORGANIC ZINC
AFTER FABRICATION (OPTION 1)

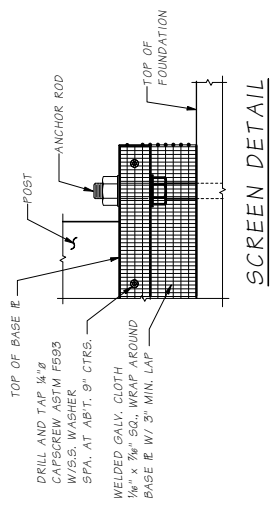
GENERALIZER DETAIL NOTES:
EACH LEG SHOULD BE TIED TO TWO
VERTICAL BARS OR TWO SPIRALS.
SEE SPECIAL PROVISIONS FOR SPACING
REQUIREMENTS.
* CONCRETE COVER - MINUS 1/8"



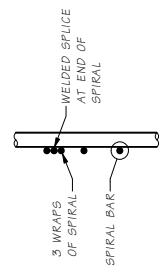
WELDED LAP SPLICE DETAIL

WELDING SHALL MEET THE REQUIREMENTS
OF STD. SPEC. 6-02.3(24)E
FOR WELD DIMENSIONS. SEE TABLE BELOW.

WELD DIMENSIONS (IN.)	LENGTH (L)
#4	12
#5	18
#6	24



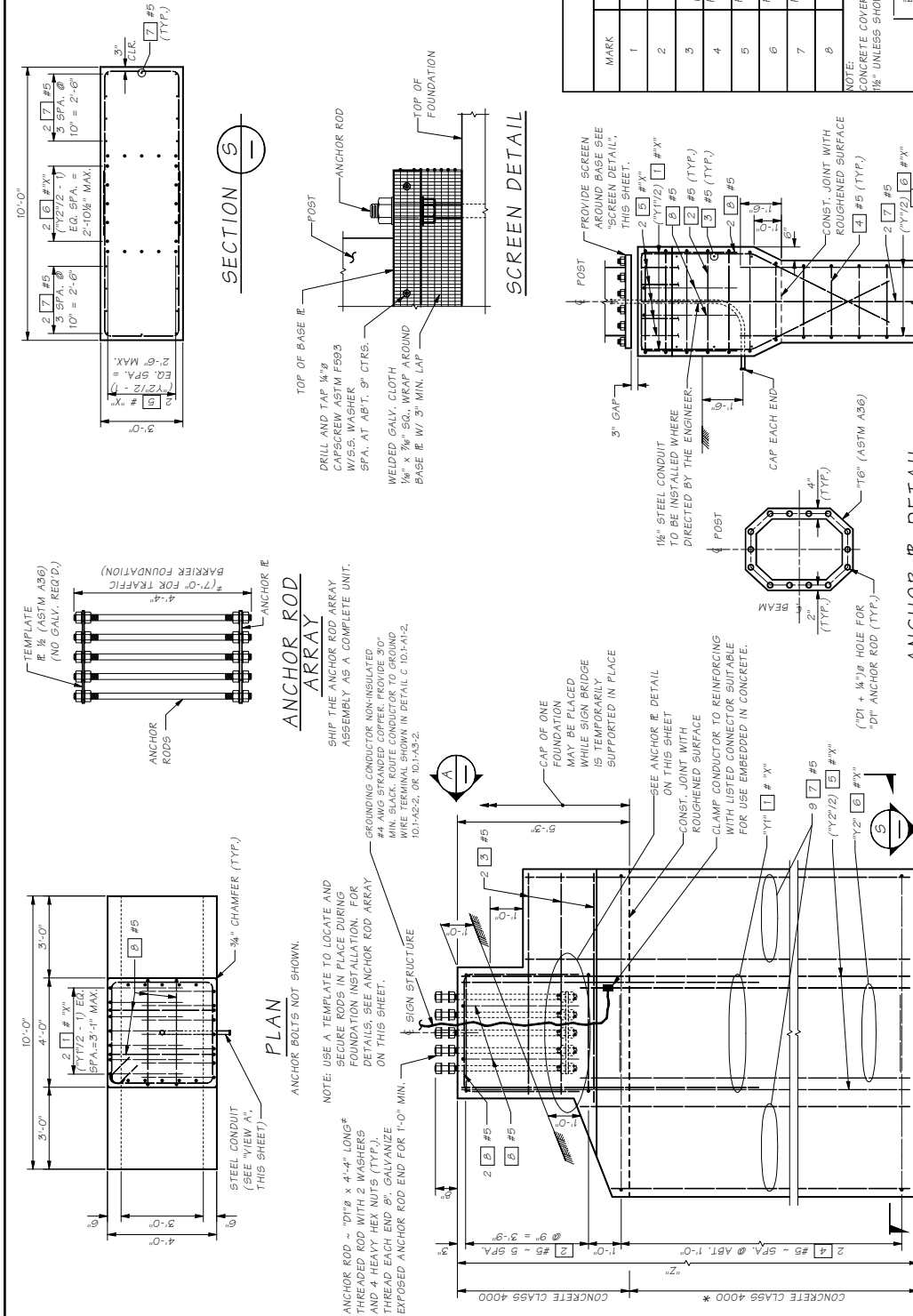
SCREEN DETAIL



SPIRAL TERMINATION DETAIL

Bridge Design Eng.	MUSTAFA ARSALAN	Bridge Engineer	BRIDGE FND. TYPE 1, 2 MAN.	NO. 10	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor				10	WASH			
Checked By					JOB NUMBER			
Bridge Projects Eng.								
Printed By								
Checked/Specified								
DATE		REVISION	BY	APPD				





TYPE 2 FOUNDATION TABLE**

STRUCTURE TYPE	SPAN LENGTH (9') LESS THAN	DEPTH (2') LESS THAN	REINFORCEMENT	
			SIZE	SPACING
CANTILEVER SIGN	20'-0" TO 30'-0"	7'-3"	9	8
	30'-0" TO 60'-0"	9'-6"	9	12
SIGN BRIDGE	60'-0" TO 90'-0"	9'-0"	9	12
	90'-0" TO 120'-0"	11'-0"	9	16
	120'-0" TO 150'-0"	12'-9"	11	14
* SHAFT DEPTH "2" IS BASED ON ALLOWABLE LATERAL BEARING PRESSURE OF 2500 PSF OR MORE.				

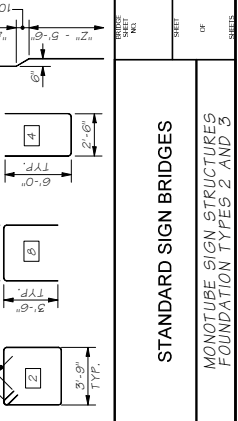
TYPE 3 FOUNDATION TABLE***

STRUCTURE TYPE	SPAN LENGTH (9') LESS THAN	DEPTH (2') LESS THAN	REINFORCEMENT	
			SIZE	SPACING
CANTILEVER SIGN	20'-0" TO 30'-0"	11'-0"	9	8
	30'-0" TO 60'-0"	13'-9"	9	12
SIGN BRIDGE	60'-0" TO 90'-0"	12'-9"	9	12
	90'-0" TO 120'-0"	15'-6"	9	16
	120'-0" TO 150'-0"	17'-9"	11	14
** SHAFT DEPTH "2" IS BASED ON ALLOWABLE LATERAL BEARING PRESSURE BETWEEN 1500 PSF AND 2499 PSF.				

BENDING DIAGRAM

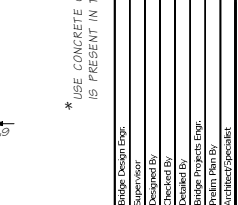
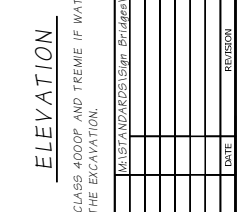
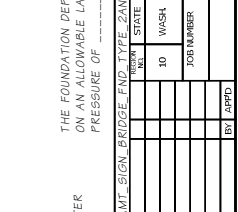
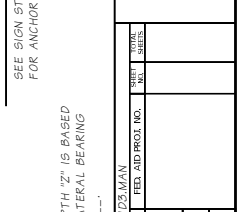
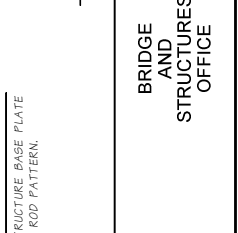
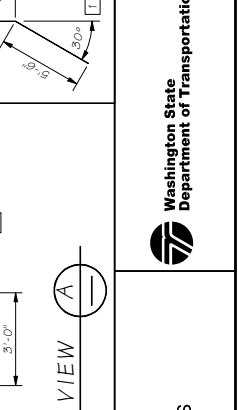
MARK	LOCATION	SIZE	NO. REQ'D.	LENGTH
1	CAP VERTICAL	"x"	"y"	9'-8"
2	CAP HOOPS	5	6	16'-0"
3	CAP HORIZONTAL	5	6	"A"
4	FOUNDATION HOOPS	5	16	15'-6"
5	FOUNDATION VERTICAL	"x"	"y"	2" - 6"
6	FOUNDATION VERTICAL	"x"	"y"	2" = 4'-0"
7	FOUNDATION VERTICAL	5	18	"A"
8	CAP TOP	5	4	10'-4"

NOTE: CONCRETE COVER SHALL BE UNLESS SHOWN OTHERWISE.
** "A" - DETERMINE FROM PLANS



Washington State Department of Transportation

STANDARD SIGN BRIDGES
MONOTUBE SIGN STRUCTURES
FOUNDATION TYPES 2 AND 3



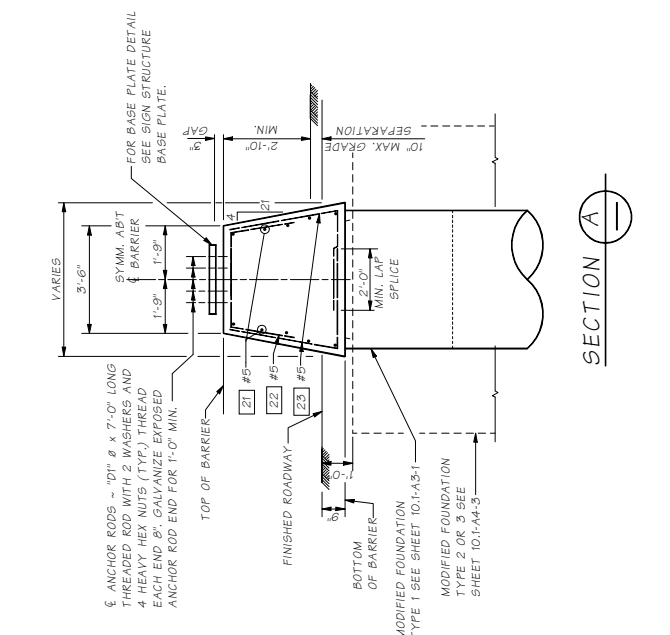
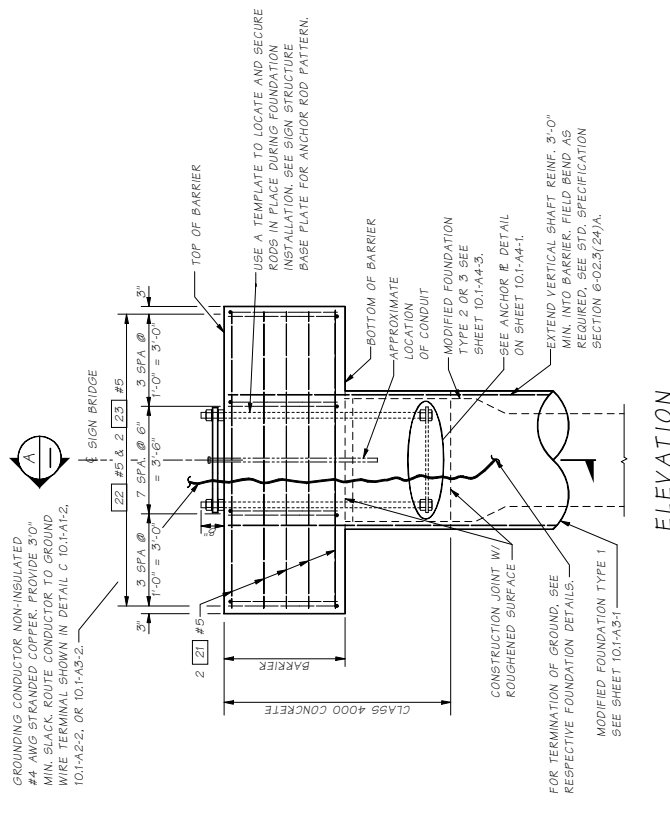
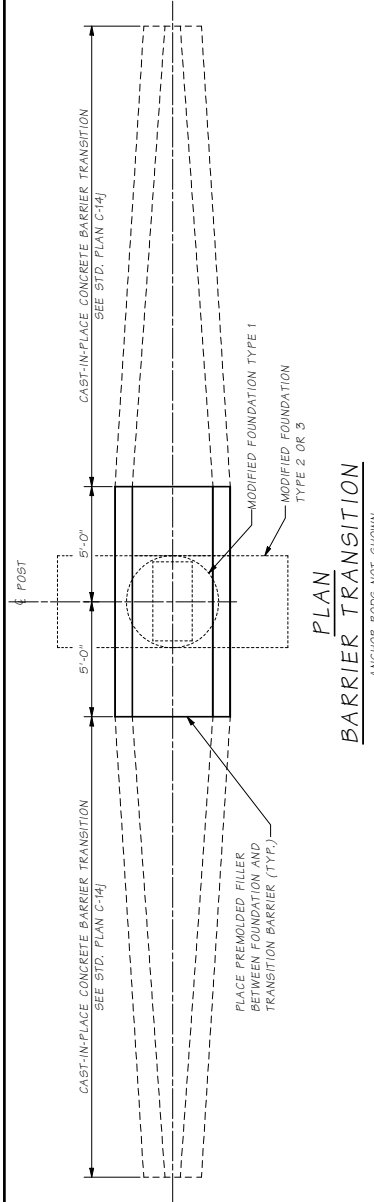
BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

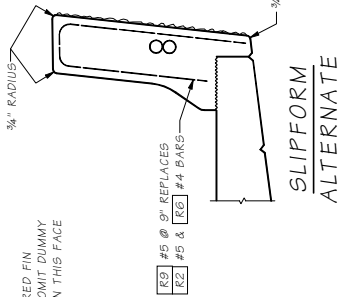
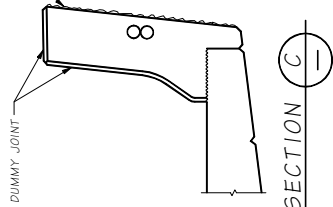
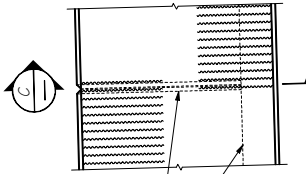
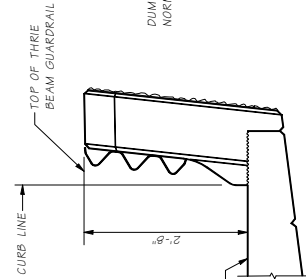
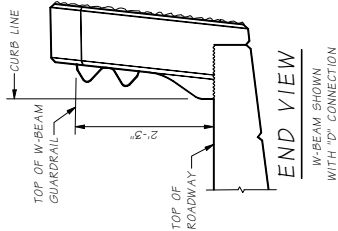
Bridge Design Dept. _____ STATE _____
 Supervisor _____ PER. AND PROJ. NO. _____ SHEET NO. _____
 Designed By _____ WASH _____
 Checked By _____ 10 _____
 Bridge Projects Eng. _____ JOB NUMBER _____
 Permit Plan By _____ DATE _____
 Checked/Sealed _____ REVISION _____
 Mon Feb 08 07:44:54 2010

BENDING DIAGRAM				
MARK	LOCATION	SIZE	NO. REQ'D	LENGTH
21	MEDIAN BARRIER HORIZONTAL	5	10	9'-9"
22	MEDIAN BARRIER VERTICAL	5	14	7'-8"
23	MEDIAN BARRIER VERTICAL	5	28	6'-4"

NOTE: CONCRETE COVER SHALL BE 1/2" UNLESS SHOWN OTHERWISE.



Bridge Design Eng:	MA/STANDARD/RS/US/Gr	BR/Idgs/W/T	DB/L	FACE/	SINGLE	SCOPE	END/MAN	TOTAL SHEETS
Supervisor:								
Designed By:								
Checked By:								
Scale Projects Eng:								
Project Man By:								
Checked/Spec/est:								
DATE:								
REVISION:								
BY:								
DATE:								
STATE:	WA	FED. AID PROJ. NO.:		SHEET NO.:		TOTAL SHEETS:		
COUNTY:	10	WASH						
JOB NUMBER:								
BRIDGE AND STRUCTURES OFFICE								
Washington State Department of Transportation								
STANDARD SIGN BRIDGES								
MONOTUBE SIGN STRUCTURE								
SINGLE SLOPE TRAFFIC BARRIER FOUNDATION								



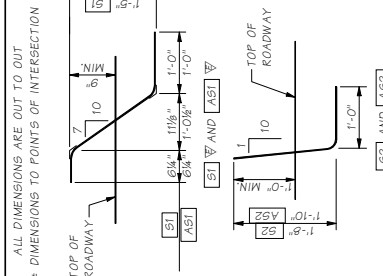
JUNCTION BOX LOCATIONS	
STATION	TS* OR "L"†

TS = TRAFFIC SYSTEM
LT = LIGHTING SYSTEM

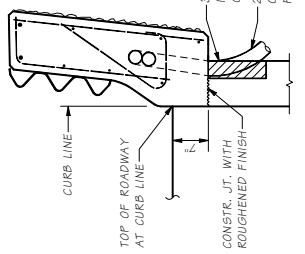
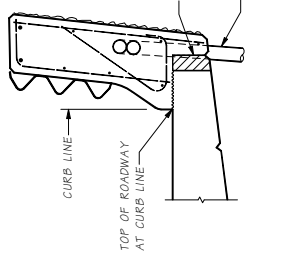
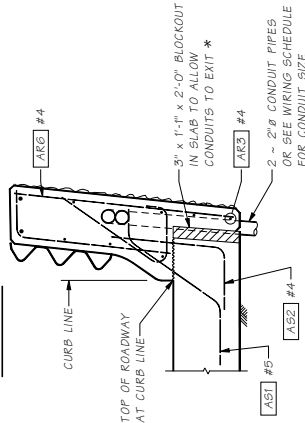
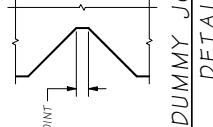
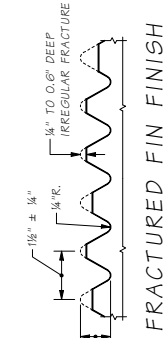
JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS.

INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.

BENDING DIAGRAM



NOTE TO DESIGNER: SET AND [R2] LENGTH BASED ON STANDARD DECK THICKNESS.



FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"

FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"

DETAIL FOR RETAINING WALL OR WINGWALL FOR REINFORCING NOT SHOWN SEE STD. PLAN D-15 OR WINGWALL PLAN.

FOR [W1] & [W2] BARS SEE WINGWALL OR RETAINING WALL PLANS.

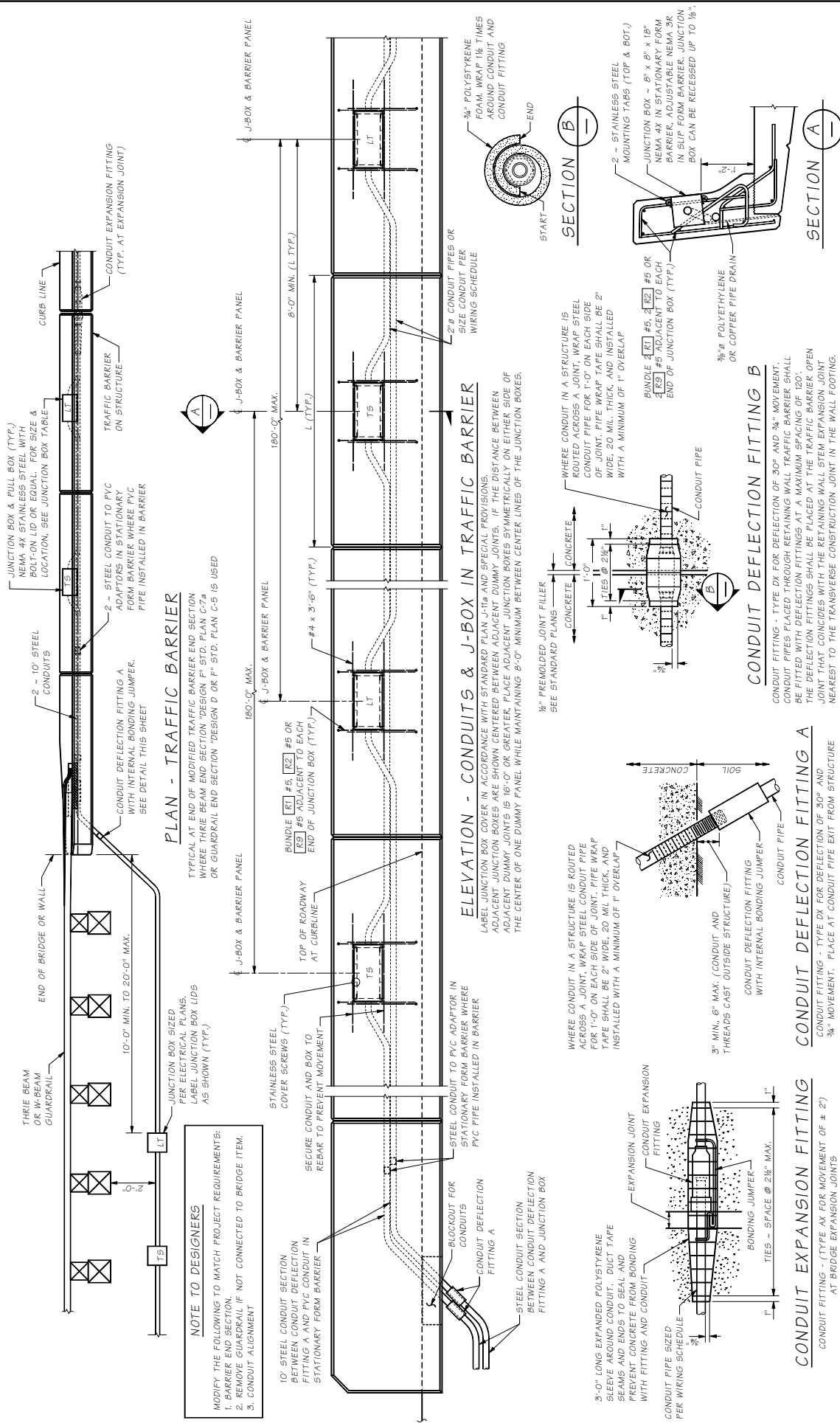
Bridge Design Dept.									
Supervisor									
Checked By									
Design Date									
Revision									

FED. AID PROJ. NO.					
STATE					
COUNTY					
JOB NUMBER					
DATE					

BRIDGE AND STRUCTURES OFFICE

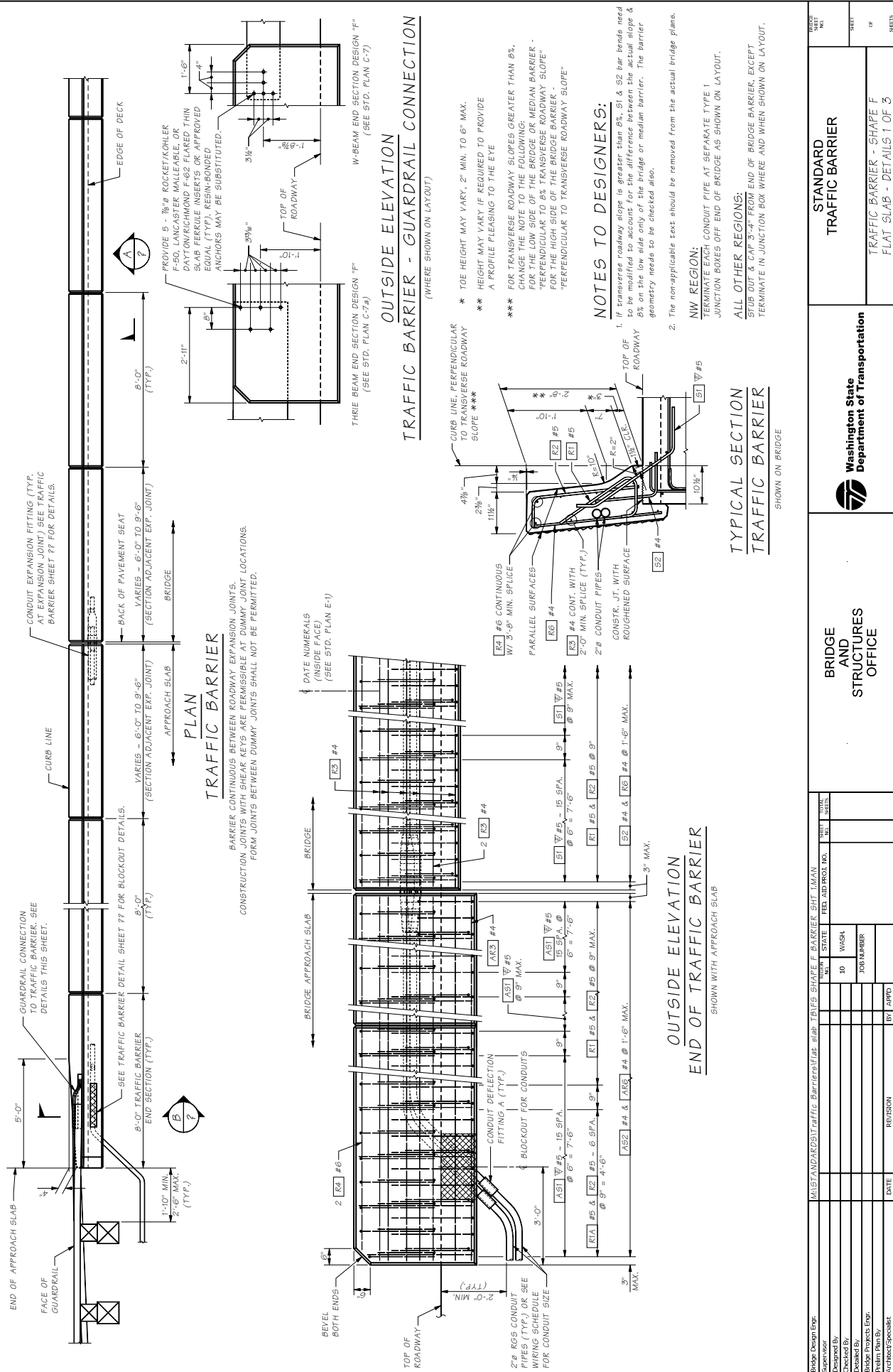


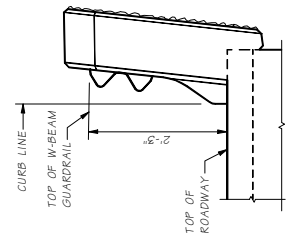
STANDARD TRAFFIC BARRIERS	
TRAFFIC BARRIER - SHAPE F	
DETAILS 2 OF 3	



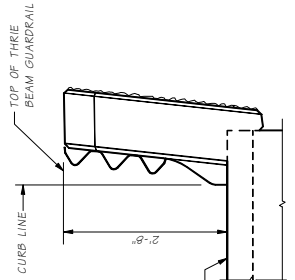
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Supervisor:	STATE:	FED. AID PROJ. NO.:	DATE:	REVISION:
Designed By:	10	WASH	DATE:	REVISION:
Checked By:	10	WASH	DATE:	REVISION:
Bridge Projects Eng.:	10	WASH	DATE:	REVISION:
Drawn (Rev. By):	10	WASH	DATE:	REVISION:
Checked/Sealed:	10	WASH	DATE:	REVISION:

Bridge Design Dept: WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
Standard Plans: BRIDGE AND STRUCTURES OFFICE
Traffic Barrier - Shape F
Detail 3 of 3

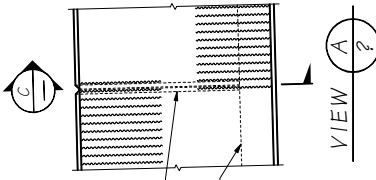




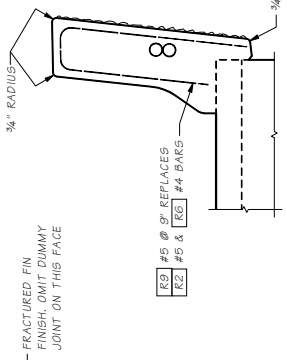
END VIEW
W-BEAM SHOWN
WITH "D" CONNECTION



END VIEW
THREE BEAM SHOWN
WITH "D" CONNECTION



VIEW A



SLIPFORM
ALTERNATE

SEE "TYPICAL SECTION - TRAFFIC BARRIER" FOR ADDITIONAL DETAILS

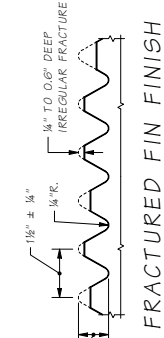
THE CONTRACTOR IS ADVISED THAT THE SLIPFORM CONSTRUCTION METHOD IS A PATENTED PROPRIETARY PROCESS FOR BARRIERS WITH A FRACTURED FIN FINISH.

JUNCTION BOX LOCATIONS	
STATION	OFFSET "TS" OR "LT"

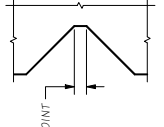
TS = TRAFFIC SYSTEM
LT = LIGHTING SYSTEM

JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS.

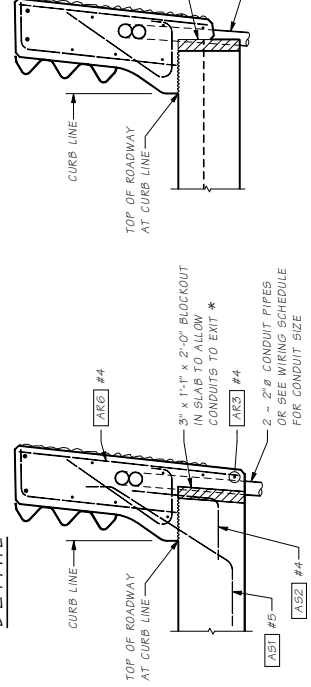
INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.



FRACTURED FIN FINISH



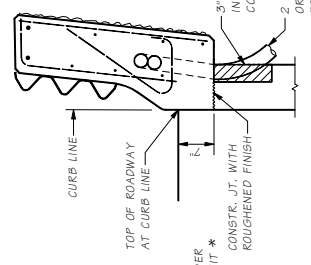
DUMMY JOINT
DETAIL



SECTION B BRIDGE

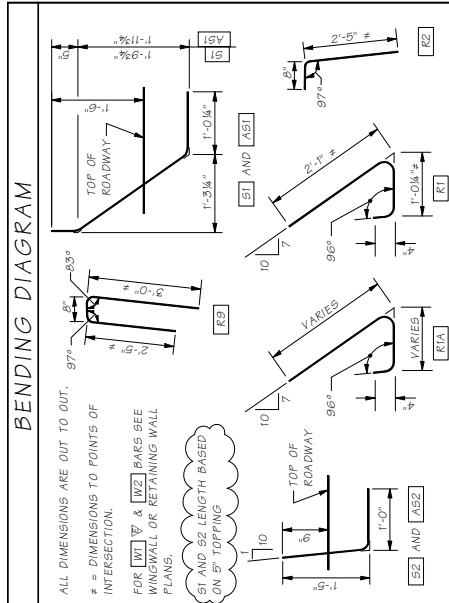
FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"

* BLOCKOUT WIDTH MAY BE INCREASED TO 6" TO ALLOW CONDUITS OF A LARGER DIAMETER THAN 2" TO EXIT BARRIER OR WALL WITHOUT REBAR STEEL CONFLICT



SECTION B WALL

DETAIL FOR RETAINING WALL OR WINGWALL. FOR REINFORCING NOT SHOWN SEE STD. PLAN D-15 OR WINGWALL PLANS.



BENDING DIAGRAM

ALL DIMENSIONS ARE OUT TO OUT.

* = DIMENSIONS TO POINTS OF INTERSECTION.

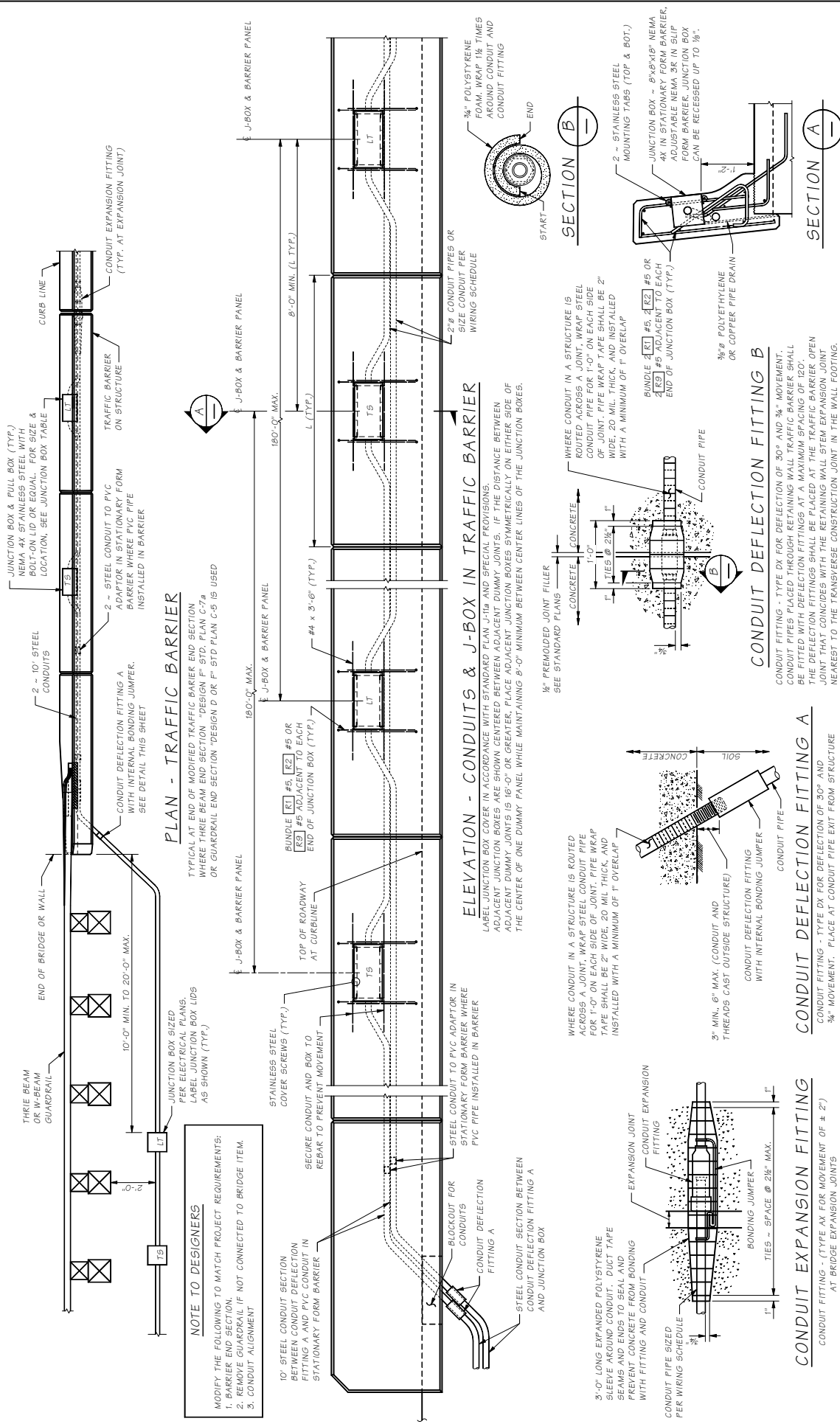
FOR [W1] & [W2] BARS SEE WINGWALL OR RETAINING WALL PLANS.

[S1] AND [S2] LENGTH BASED ON 5\"/>

Bridge Design Dept. Supervisor: _____ Checked By: _____ Drawn By: _____ Date: _____		FILE NO. _____ SHEET NO. _____	
MUST AND AS2/STAFFIC BARRIER/SLAB TYPE B SHAPE F BARRIERS SHIT 2 MIN		TOTAL SHEETS: _____ SHEET NO.: _____	
WASH STATE FEDERAL PROJ. NO. _____	WASH JOB NUMBER _____	BRIDGE AND STRUCTURES OFFICE Washington State Department of Transportation	
DATE: _____ REVISION: _____ BY: _____ APD: _____	STANDARD TRAFFIC BARRIERS TRAFFIC BARRIER - SHAPE F FLAT SLAB - DETAILS 2 OF 3		

10.2-A2-2

13:56:42 2009

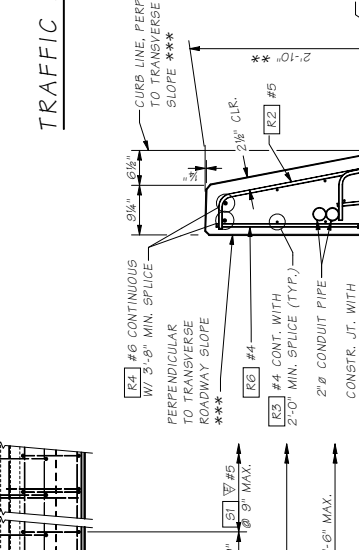
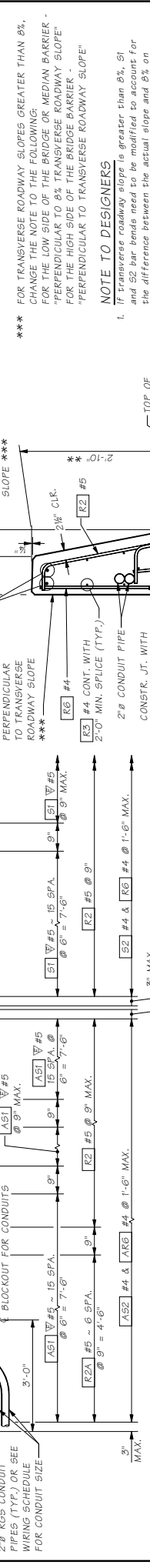
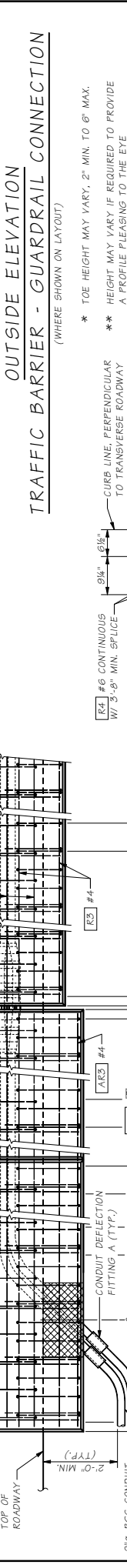
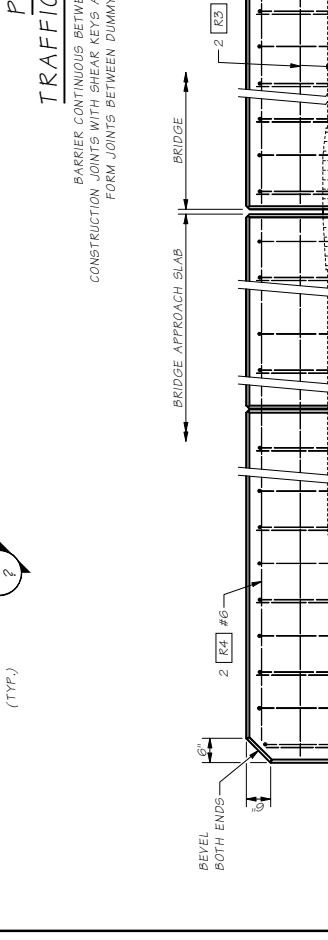
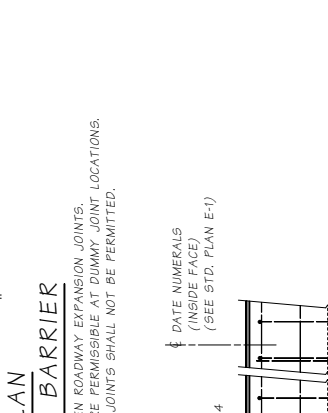
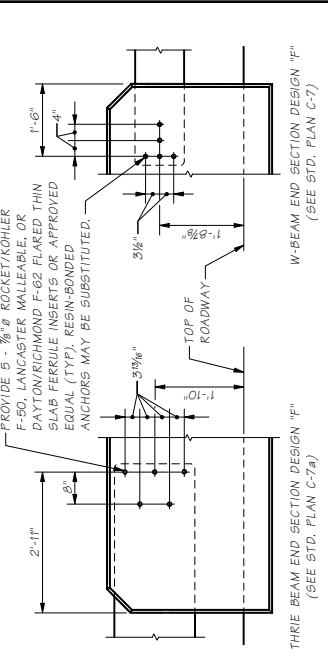
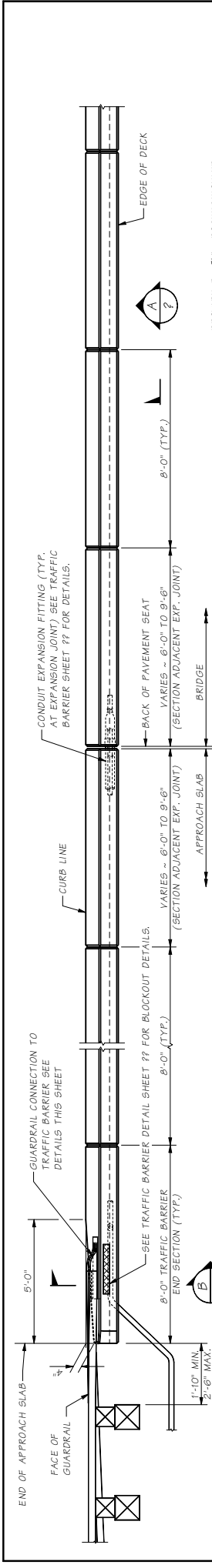


NOTE TO DESIGNERS

MODIFY THE FOLLOWING TO MATCH PROJECT REQUIREMENTS:

1. BARRIER END SECTION.
2. REMOVE GUARDRAIL IF NOT CONNECTED TO BRIDGE ITEM.
3. CONDUIT ALIGNMENT

Bridge Design Dept:	MUSTANDAKP251Traffic BarrierDetail3	DATE:	10/13/09
Supervisor:		DESIGNED BY:	
Checked By:		Checked By:	
Drawn By:		Drawn By:	
Scale:		Scale:	
Project No.:		Project No.:	
Revision:		Revision:	
DATE:		DATE:	
BY:		BY:	
APP'D:		APP'D:	
FILE NO.		FILE NO.	
SHEET NO.		SHEET NO.	
TOTAL SHEETS		TOTAL SHEETS	
STATE	10	STATE	10
FED. AID PROJ. NO.		FED. AID PROJ. NO.	
WASH		WASH	
JOB NUMBER		JOB NUMBER	
BRIDGE AND STRUCTURES OFFICE		BRIDGE AND STRUCTURES OFFICE	
Washington State Department of Transportation		Washington State Department of Transportation	
STANDARD TRAFFIC BARRIERS		STANDARD TRAFFIC BARRIERS	
TRAFFIC BARRIER - FLAT SLAB		TRAFFIC BARRIER - FLAT SLAB	
FLAT SLAB - DETAILS 3 OF 3		FLAT SLAB - DETAILS 3 OF 3	



TRAFFIC BARRIER - GUARDRAIL CONNECTION
(WHERE SHOWN ON LAYOUT)

TYPICAL SECTION
TRAFFIC BARRIER
SHOWN ON BRIDGE

OUTSIDE ELEVATION
END OF TRAFFIC BARRIER
SHOWN WITH BRIDGE APPROACH SLAB

NOTE TO DESIGNERS

- If transverse roadway slope is greater than 8%, S1 and S2 bar bends need to be modified to account for the difference between the actual slope and 8% on the low side only of the bridge or median barrier. The barrier geometry needs to be checked also.
- The non-applicable text should be removed from the actual bridge plans.

NW REGION:
TERMINATE EACH CONDUIT PIPE AT SEPARATE TYPE A JUNCTION BOXES OFF END OF BRIDGE AS SHOWN ON LAYOUT.

ALL OTHER REGIONS:
STUB OUT & CAP 3'-4" FROM END OF BRIDGE BARRIER, EXCEPT TERMINATE IN JUNCTION BOX WHERE AND WHEN SHOWN ON LAYOUT.

******* FOR TRANSVERSE ROADWAY SLOPES GREATER THAN 8%, CHANGE THE NOTE TO THE FOLLOWING:
FOR THE LOW SIDE OF THE BRIDGE OR MEDIAN BARRIER - "PERPENDICULAR TO 8% TRANSVERSE ROADWAY SLOPE"
FOR THE HIGH SIDE OF THE BRIDGE BARRIER - "PERPENDICULAR TO TRANSVERSE ROADWAY SLOPE"

******* TOE HEIGHT MAY VARY, 2" MIN. TO 6" MAX.
****** HEIGHT MAY VARY IF REQUIRED TO PROVIDE A PROFILE PLEASING TO THE EYE

PROVIDE 5 - #5 @ 12" ROCKET/KOHLER F-50, LANCASTER MALLEABLE, OR DAYTON/RICHMOND F-62 FLARED THIN SLAB FERRULE INSERTS OR APPROVED EQUAL (TYP), RESIN-BONDED ANCHORS MAY BE SUBSTITUTED.

CONSTRUCTION JOINTS WITH SHEAR KEYS ARE PERMISSIBLE AT DUMMY JOINT LOCATIONS. FORM JOINTS BETWEEN DUMMY JOINTS SHALL NOT BE PERMITTED.

CONSTRUCTION JOINTS WITH SHEAR KEYS ARE PERMISSIBLE AT DUMMY JOINT LOCATIONS. FORM JOINTS BETWEEN DUMMY JOINTS SHALL NOT BE PERMITTED.

BARRIER CONTINUOUS BETWEEN ROADWAY EXPANSION JOINTS. CONSTRUCTION JOINTS WITH SHEAR KEYS ARE PERMISSIBLE AT DUMMY JOINT LOCATIONS. FORM JOINTS BETWEEN DUMMY JOINTS SHALL NOT BE PERMITTED.

DATE NUMERALS (INSIDE FACE)
(SEE STD. PLAN E-1)

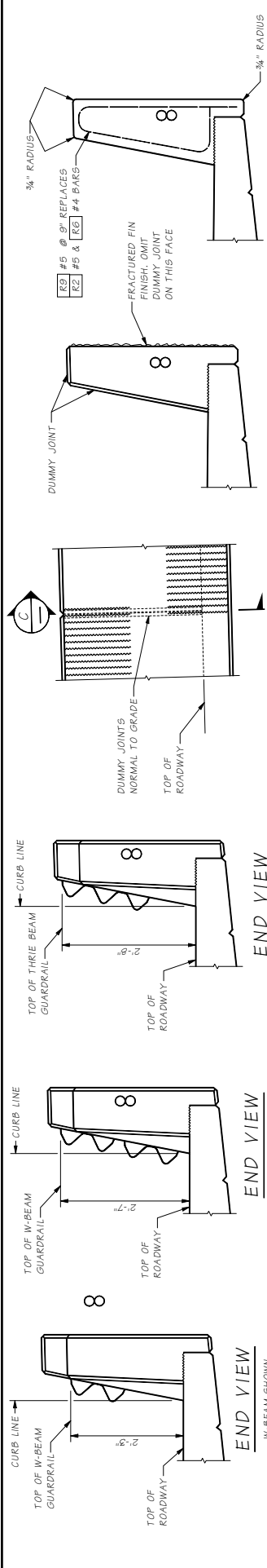
REINFORCEMENT CALLOUTS:
R2A #5 @ 4'-6"
R2 #5 @ 9"
R2 #4 & R6C #4 @ 1'-6" MAX.
R3 #4
R2 #5 @ 9"
S1 #5 @ 9" MAX.
S2 #4 @ 7'-6"
S2 #5 @ 9"
S1 #5 @ 9" MAX.
S2 #4 & R6 #4 @ 1'-6" MAX.

TRAFFIC BARRIER
STANDARD
TRAFFIC BARRIERS
TRAFFIC BARRIER - SINGLE SLOPE
DETAILS 1 OF 3

Bridge Design Engr. Supervisor Designed By Checked By Bridge Projects Engr. Permit Stamp By Architect/Specifier	DATE REVISION BY APPD	FEDERAL PROJECT NO. STATE COUNTY FEDERAL AID DISTRICT NO. STATE COUNTY	SHEET NO. TOTAL SHEETS
---	--------------------------------	---	---------------------------

MAINT AND RD DIST Traffic Barrier Single Slope SHEET 11 MAN
 WASHINGTON STATE
 WASH
 FEDERAL PROJECT NO.
 STATE
 COUNTY
 FEDERAL AID DISTRICT NO.
 STATE
 COUNTY

Washington State Department of Transportation
 BRIDGE AND STRUCTURES OFFICE



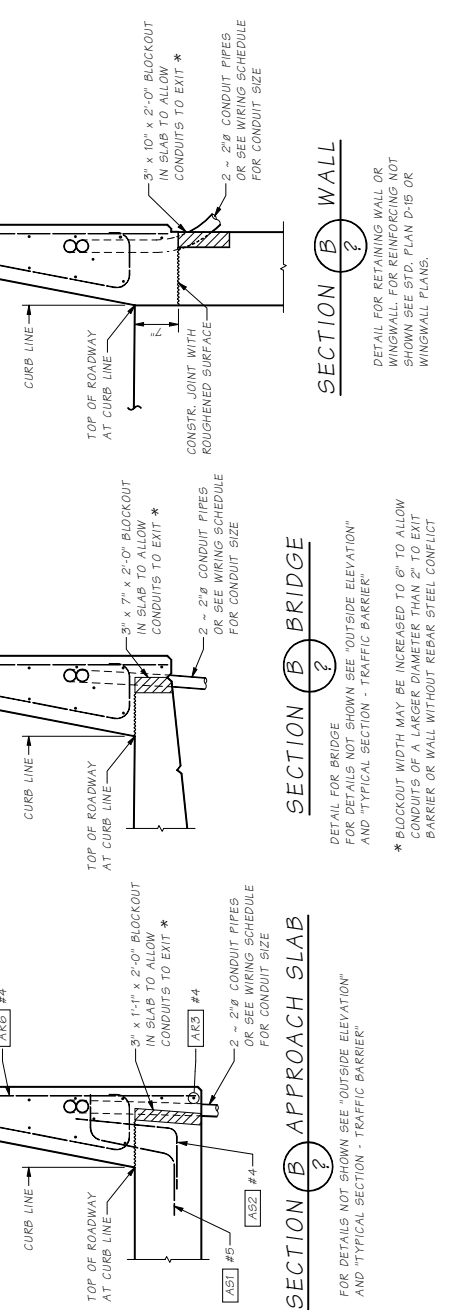
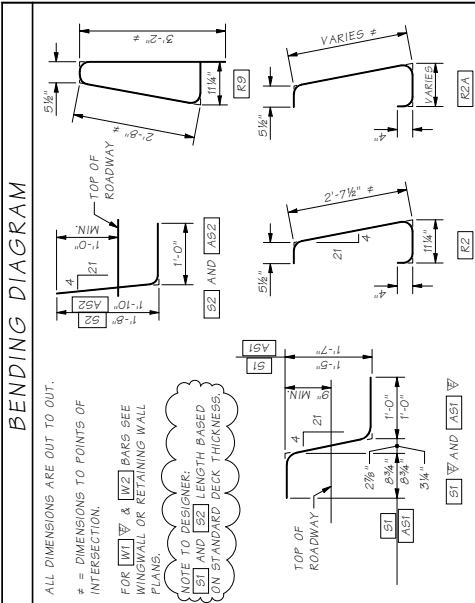
JUNCTION BOX LOCATIONS

STATION	OFFSET	"15" OR "11"

T9 = TRAFFIC SYSTEM
LT = LIGHTING SYSTEM

JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS.

INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.



Bridge Design Eng. _____
 Supervisor _____
 Checked By _____
 Checked By _____
 Bridge Projects Eng. _____
 Print Run By _____
 Architect/Specifier _____

DATE _____

REVISION _____

DATE _____

BY APD

JOB NO. _____

SHEET NO. _____

MAINTENANCE/AS2/TRAFFIC Barrier/Single Slope/Sliffform SHEET 2 of 3

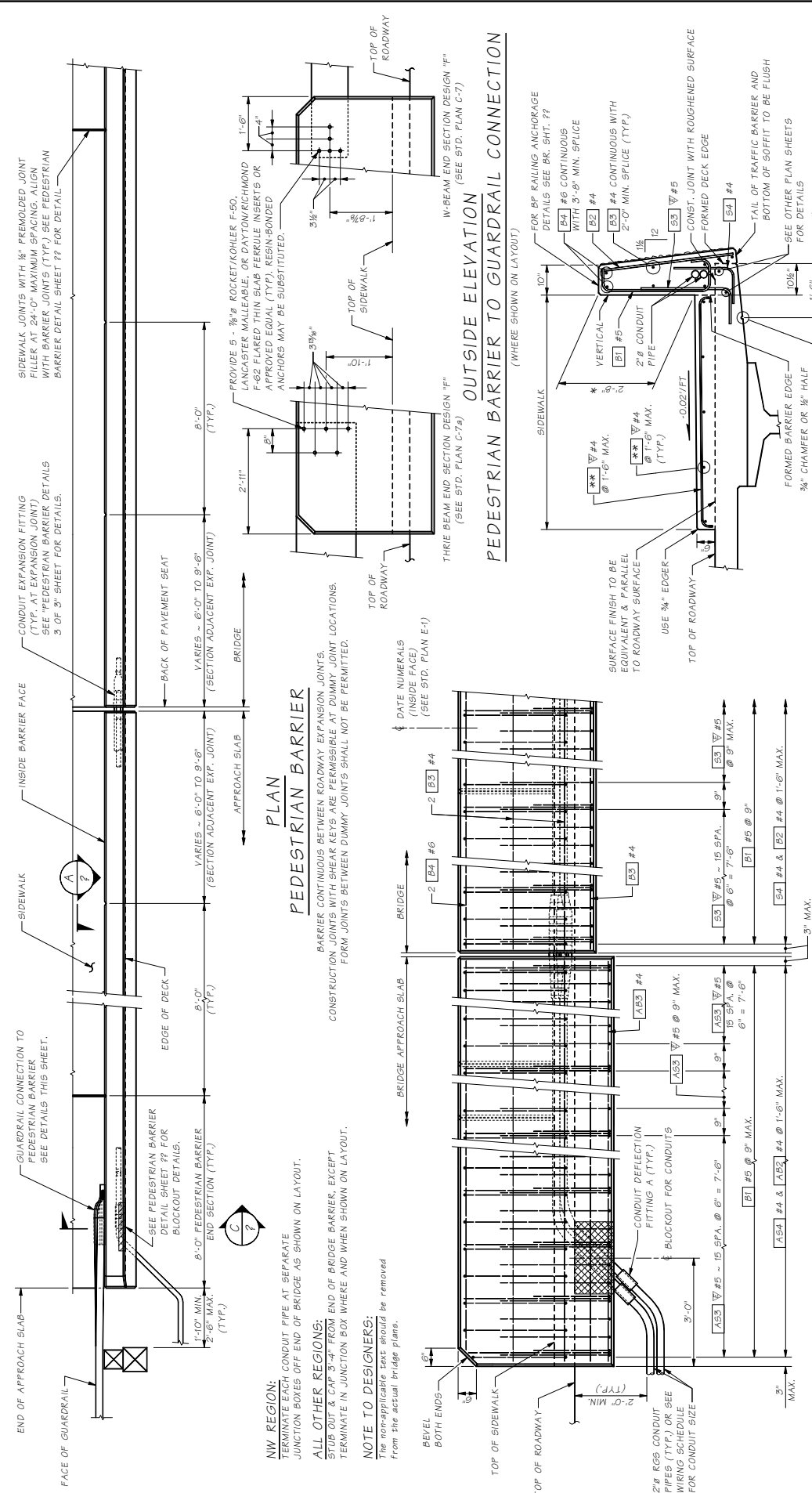
NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH			

Washington State Department of Transportation

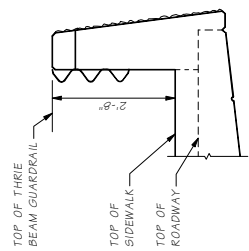
BRIDGE AND STRUCTURES OFFICE

STANDARD TRAFFIC BARRIERS

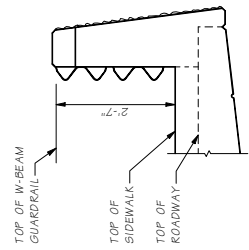
TRAFFIC BARRIER - SINGLE SLOPE
DETAILS 2 OF 3



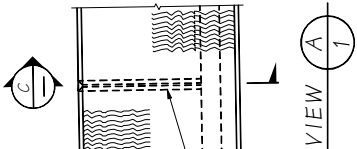
JOB NO.		SHEET	
10.2-A4-1		58	
Bridge Design Dept.	WASH	FED. AID PROJ. NO.	TOTAL SHEETS
Supervisor	STATE	PER. PROJ. NO.	SHEET NO.
Designed By	10	WASH	
Checked By		FOR NUMBER	
Bridge Projects Eng.			
Drawn From By		DATE	REVISION
Architect/Engineer			
Washington State Department of Transportation		BRIDGE AND STRUCTURES OFFICE	
STANDARD TRAFFIC BARRIERS		PEDESTRIAN BARRIER DETAILS 1 OF 3	



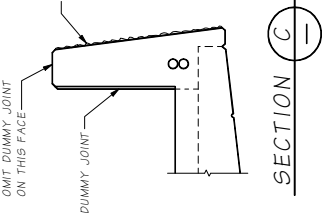
END VIEW
THREE BEAM SHOWN WITH "D" CONNECTION



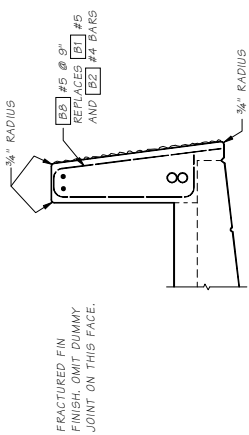
END VIEW
DUAL W-BEAM SHOWN WITH "D" CONNECTION



VIEW A



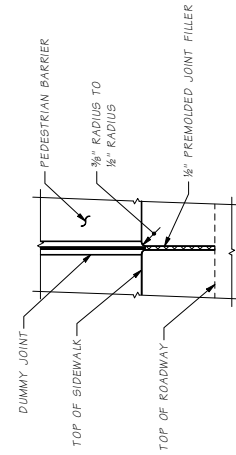
SECTION C



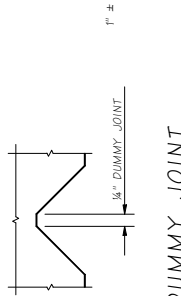
SLIPFORM ALTERNATE

JUNCTION BOX LOCATIONS	
STATION	OFFSET "TS" OR "LT"

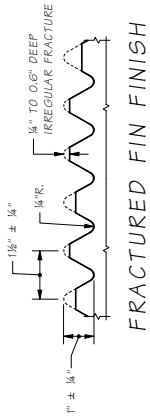
TS = TRAFFIC SYSTEM
LT = LIGHTING SYSTEM
JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS. INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.



SIDEWALK JOINT DETAIL
SIDEWALK REINFORCING STEEL NOT SHOWN FOR CLARITY.

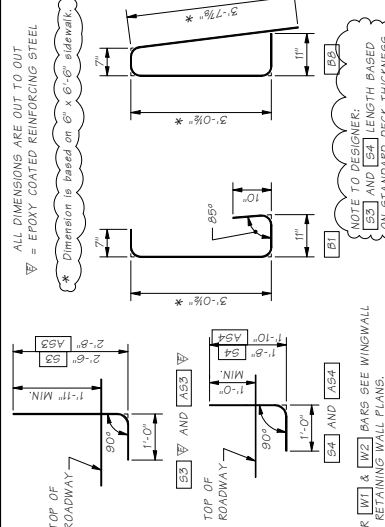


DUMMY JOINT DETAIL



FRACTURED FIN FINISH

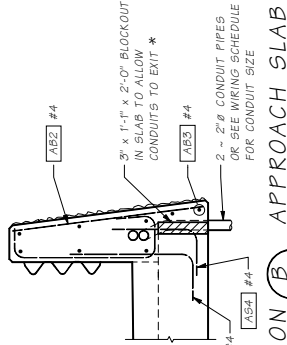
BENDING DIAGRAM



FOR [W1] & [W2] BARS SEE WINGWALL OR RETAINING WALL PLANS.

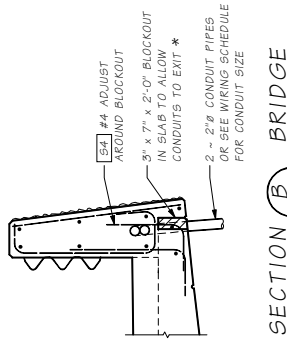
Bridge Design Dept. _____
 Supervisor _____
 Checked By _____
 Date _____
 Drawn By _____
 Date _____

SECTION B APPROACH SLAB



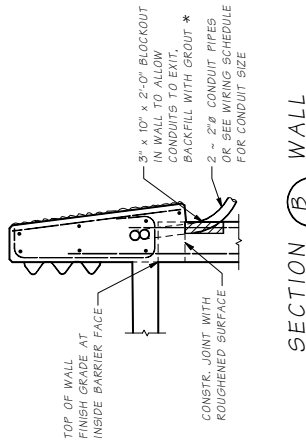
SECTION B APPROACH SLAB
FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - PEDESTRIAN BARRIER"

SECTION B BRIDGE



SECTION B BRIDGE
FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - PEDESTRIAN BARRIER"

SECTION B WALL



SECTION B WALL
DETAIL FOR RETAINING WALL OR WINGWALL. FOR REINFORCING NOT SHOWN SEE STD. PLAN D-15 OR WINGWALL PLANS.

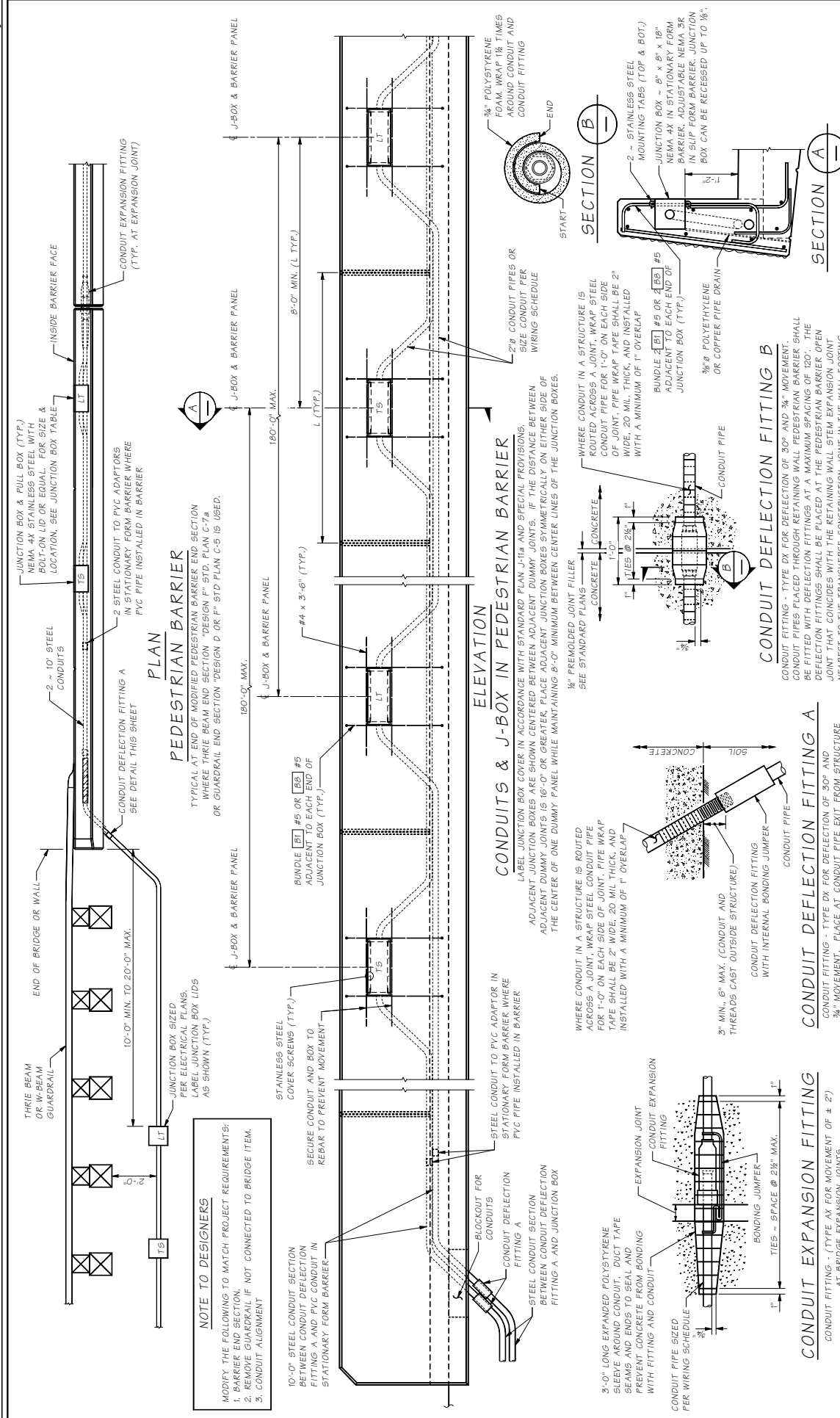
DATE	REVISION	BY	APP'D

MAINTENANCE PERSONNEL		WARRANTY PERSONNEL		CONTRACTOR		SUPERVISOR	
NAME	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS	DATE	BY	APP'D

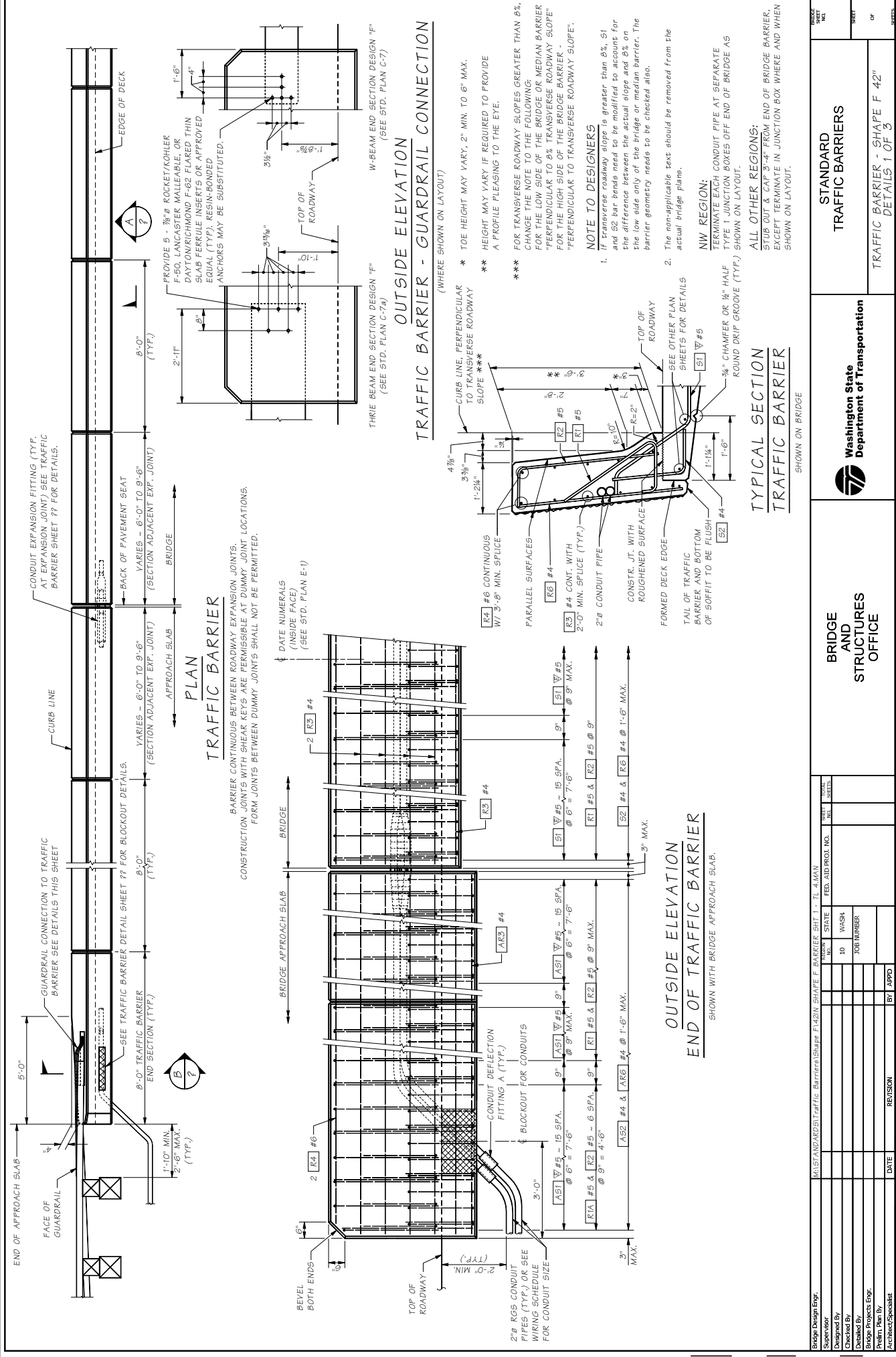
BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

STANDARD TRAFFIC BARRIERS	PEDESTRIAN BARRIER DETAILS 2 OF 3
SHEET NO.	SHEET



Bridge Design Dept.	WASH	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor	10	WASH			
Designed By					
Checked By					
Bridge Projects Eng.					
Project Man. By					
Contract/Speciack					
DATE					
REVISION					
BY					
APPROV.					
WASH STATE DEPARTMENT OF TRANSPORTATION					
BRIDGE AND STRUCTURES OFFICE					
STANDARD TRAFFIC BARRIERS					
PEDESTRIAN BARRIER DETAILS 3 OF 3					



Bridge Design Engr. Supervisor Designed By Checked By Bridge Projects Engr. Permit Seal By Architect/Specifier	MAINT AND/OR Traffic Barrier STATE ID JOB NUMBER	SHEET NO. TOTAL SHEETS	FED. AID PROJ. NO. STATE WASH	DATE REVISION	BY APPD	DATE 15:59:25 2009
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Washington State Department of Transportation

BRIDGE AND STRUCTURES OFFICE

STANDARD TRAFFIC BARRIERS

TRAFFIC BARRIER - SHAPE F 42" DETAILS 1 OF 3

SHOWN ON BRIDGE

TYPICAL SECTION TRAFFIC BARRIER

SHOWN WITH BRIDGE APPROACH SLAB.

END OF TRAFFIC BARRIER

OUTSIDE ELEVATION TRAFFIC BARRIER - GUARDRAIL CONNECTION

TRAFFIC BARRIER - GUARDRAIL CONNECTION (WHERE SHOWN ON LAYOUT)

THREE BEAM END SECTION DESIGN "F" (SEE STD. PLAN C-7a)

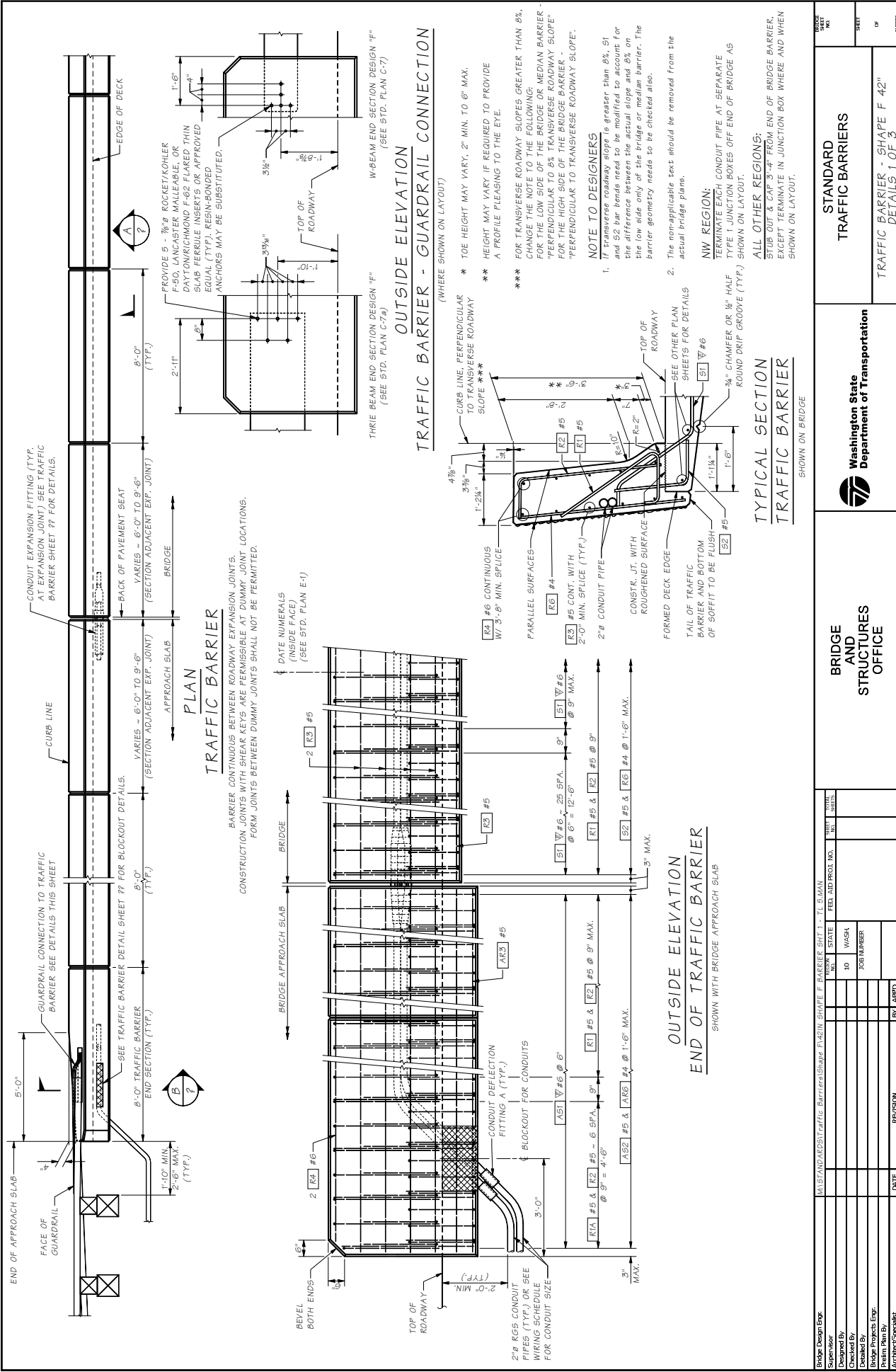
W-BEAM END SECTION DESIGN "F" (SEE STD. PLAN C-7)

NOTE TO DESIGNERS

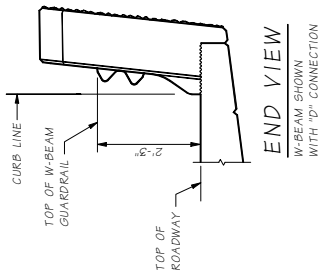
- If transverse roadway slope is greater than 5%, S1 and S2 bar bends need to be modified to account for the difference between the actual slope and 5% on the low side only of the bridge or median barrier. The barrier geometry needs to be checked also.
- The non-applicable text should be removed from the actual bridge plans.

NW REGION: TERMINATE EACH CONDUIT PIPE AT SEPARATE TYPE 1 JUNCTION BOXES OFF END OF BRIDGE AS SHOWN ON LAYOUT.

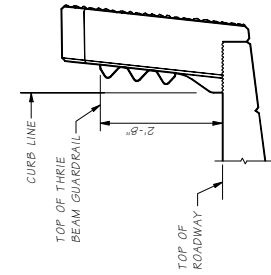
ALL OTHER REGIONS: STUB OUT & CAP 3'-4" FROM END OF BRIDGE BARRIER, EXCEPT TERMINATE IN JUNCTION BOX WHERE AND WHEN SHOWN ON LAYOUT.



Bridge Design Dept. _____ Supervisor _____ Checked By _____ Bridge Projects Eng. _____ Detail/Spec/Asst. _____		MUST AND REQUIRED Traffic Barrier Shape F 42" - T1 & M1 FEDERAL PROJ. NO. _____ STATE _____ COUNTY _____ JOB NUMBER _____ DATE _____		BRIDGE AND STRUCTURES OFFICE Washington State Department of Transportation		STANDARD TRAFFIC BARRIERS TRAFFIC BARRIER - SHAPE F 42" DETAILS 1 OF 3	
Bridge Design Dept. _____ Supervisor _____ Checked By _____ Bridge Projects Eng. _____ Detail/Spec/Asst. _____		MUST AND REQUIRED Traffic Barrier Shape F 42" - T1 & M1 FEDERAL PROJ. NO. _____ STATE _____ COUNTY _____ JOB NUMBER _____ DATE _____		BRIDGE AND STRUCTURES OFFICE Washington State Department of Transportation		STANDARD TRAFFIC BARRIERS TRAFFIC BARRIER - SHAPE F 42" DETAILS 1 OF 3	



END VIEW
W-BEAM SHOWN WITH "D" CONNECTION



END VIEW
THREE BEAM SHOWN WITH "D" CONNECTION

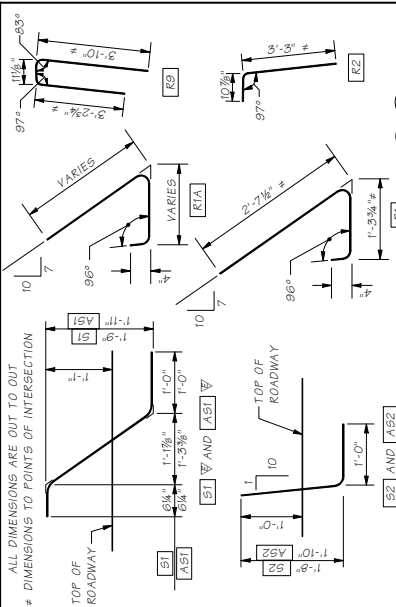
JUNCTION BOX LOCATIONS	
STATION	OFFSET "T5" OR "LT"

T5 = TRAFFIC SYSTEM
LT = LIGHTING SYSTEM

JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS.

INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.

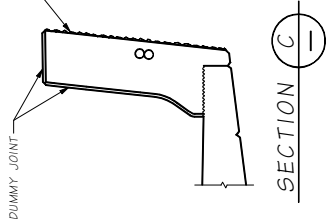
BENDING DIAGRAM



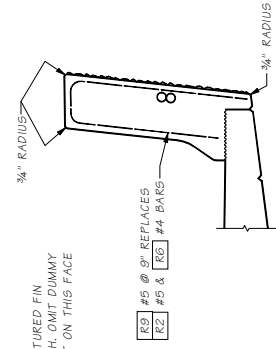
ALL DIMENSIONS ARE OUT TO OUT
DIMENSIONS TO POINTS OF INTERSECTION

NOTE TO DESIGNER:
[S1] AND [S2] LENGTH BASED ON STANDARD DECK THICKNESS.

FOR [W1] AND [W2] BARS SEE WINGWALL OR RETAINING WALL PLANS.



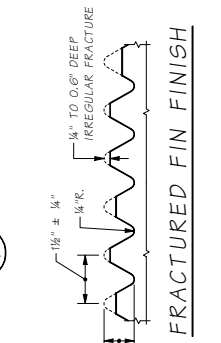
SECTION C



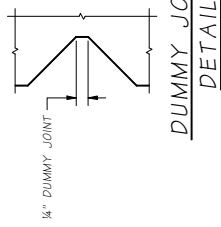
SLIPFORM ALTERNATE

SEE "TYPICAL SECTION - TRAFFIC BARRIER" FOR ADDITIONAL DETAILS

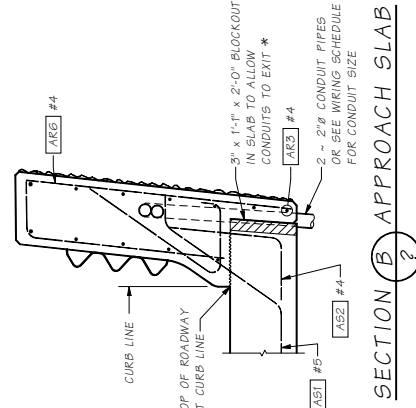
THE CONTRACTOR IS ADVISED THAT THE SLIPFORM CONSTRUCTION METHOD IS A PATENTED PROPRIETARY PROCESS FOR BARRIERS WITH A FRACTURED FIN FINISH.



FRACTURED FIN FINISH

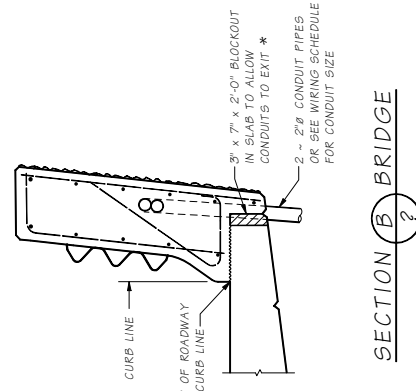


DUMMY JOINT DETAIL



SECTION B APPROACH SLAB

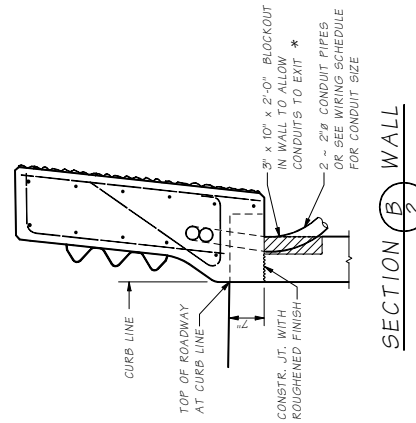
FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"



SECTION B BRIDGE

FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"

* BLOCKOUT WIDTH MAY BE INCREASED TO 6" TO ALLOW CONDUITS OF A LARGER DIAMETER THAN 2" TO EXIT BARRIER OR WALL WITHOUT KEAK-STEEL CONFLICT

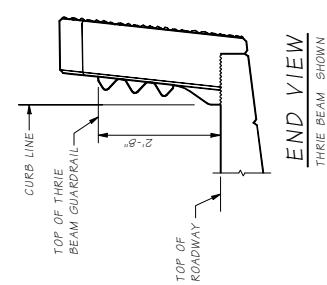


SECTION B WALL

DETAIL FOR WINGWALL FOR REINFORCING NOT SHOWN SEE WINGWALL PLANS.

Design Engineer										
Subcontractor										
Contract No.										
Checked By										
Scale										
Date										
Job No.										
Sheet										
Project										
Revision										

Washington State Department of Transportation	STANDARD TRAFFIC BARRIER
BRIDGE AND STRUCTURES OFFICE	TRAFFIC BARRIER - SHAPE F 42" DETAIL 2 OF 3

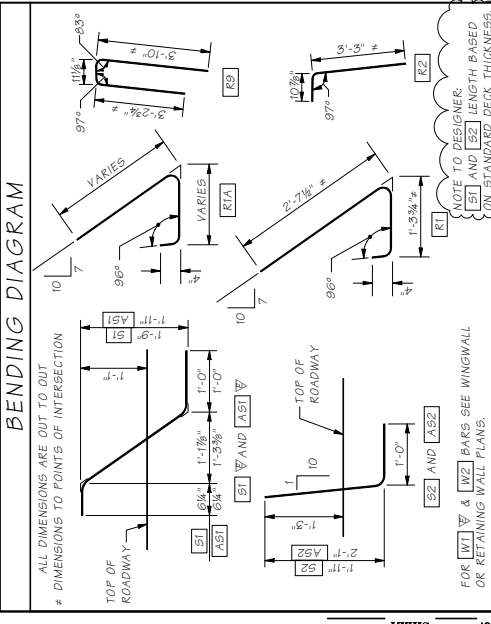
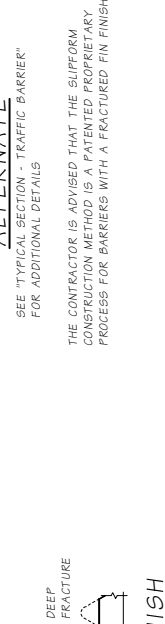
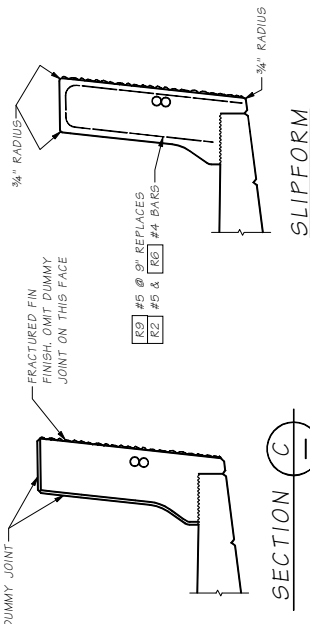
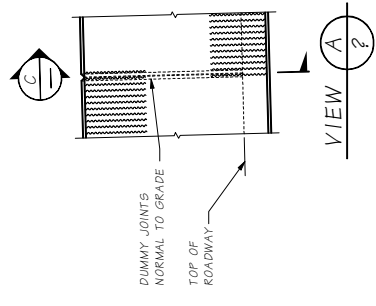


JUNCTION BOX LOCATIONS	
STATION	OFFSET

T5 = TRAFFIC SYSTEM
 LT = LIGHTING SYSTEM

JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS.

INSTALL ALL CONDUIT RINGS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.



10.2-A5-2B

NO.	DATE	BY	APPD.	REVISION

DATE: 10.2.2009

DESIGNED BY	
CHECKED BY	
DRAWN BY	
INCHES/FEET	

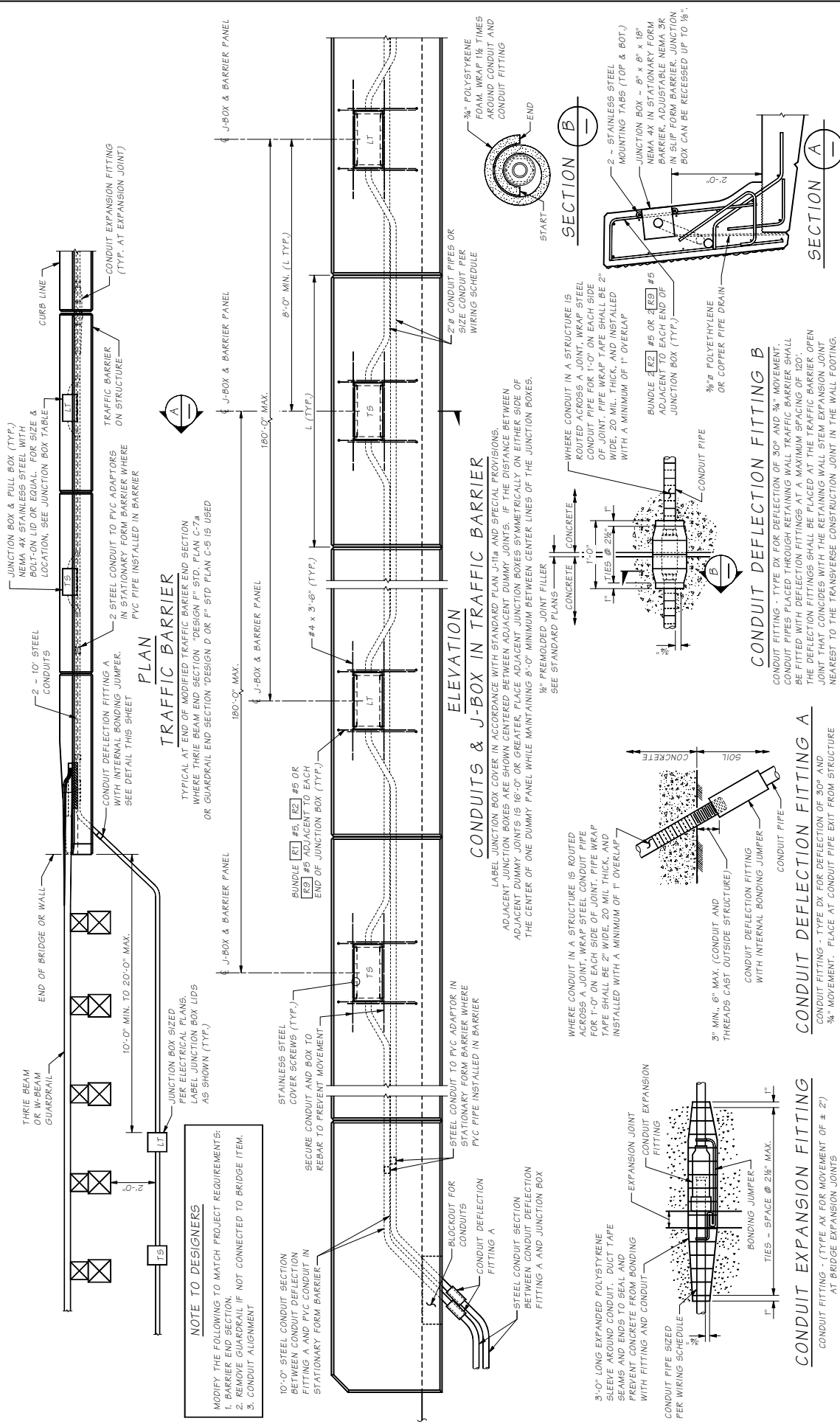
FED. AID PROJ. NO.	
STATE	
SECTION	
JOB NUMBER	

BRIDGE AND STRUCTURES OFFICE



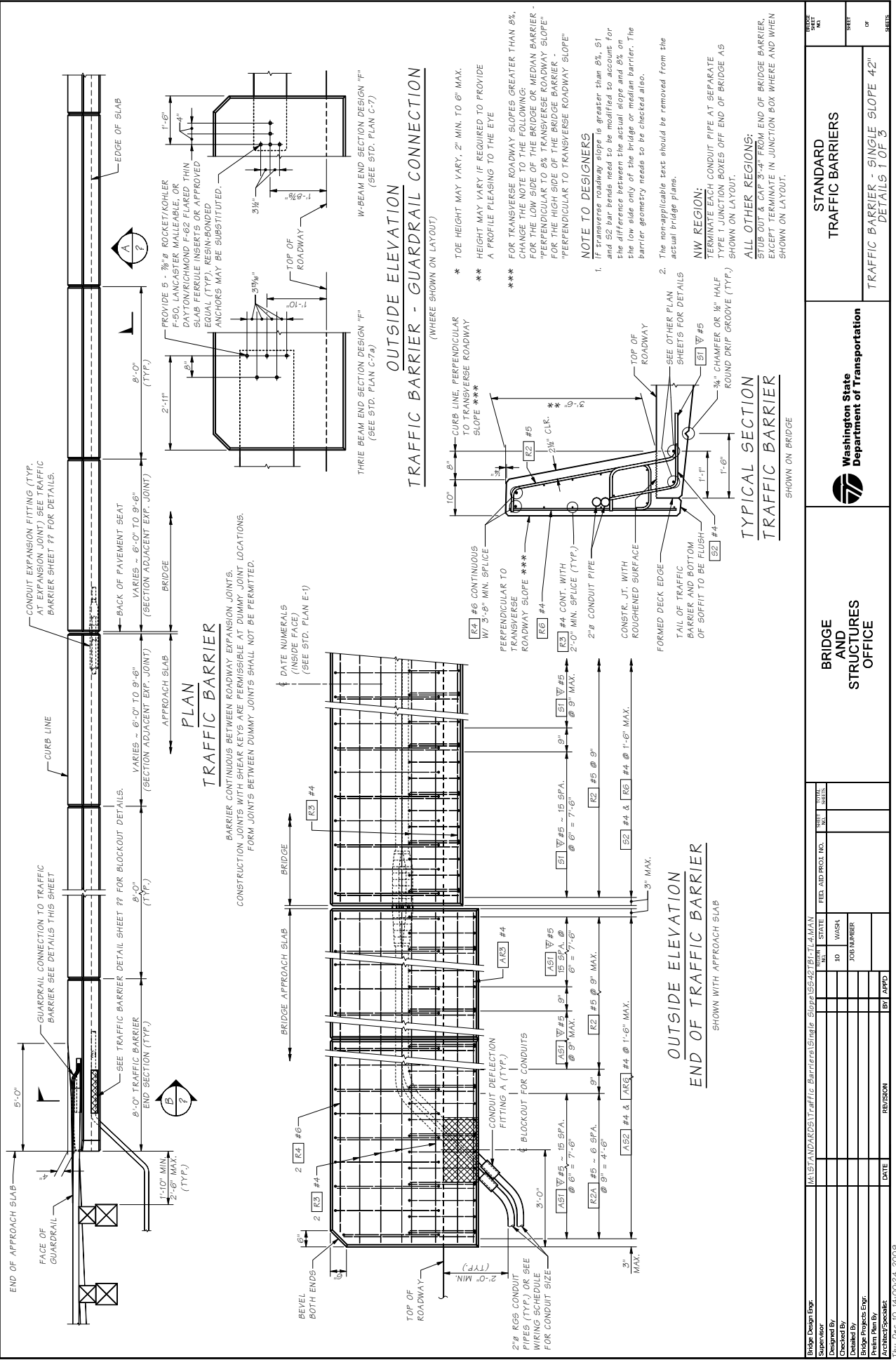
STANDARD TRAFFIC BARRIER

TRAFFIC BARRIER - SHAPE F 42" DETAIL 2 OF 3

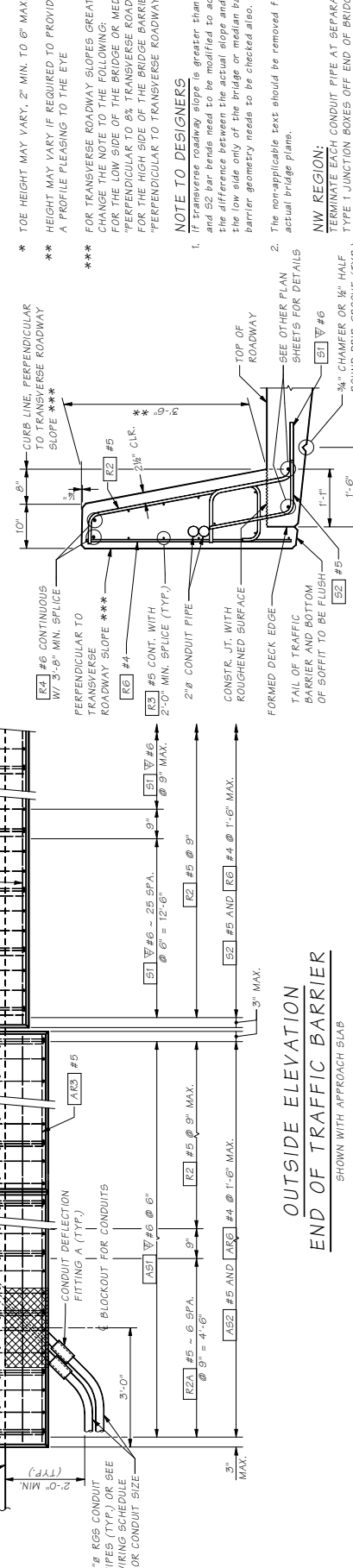
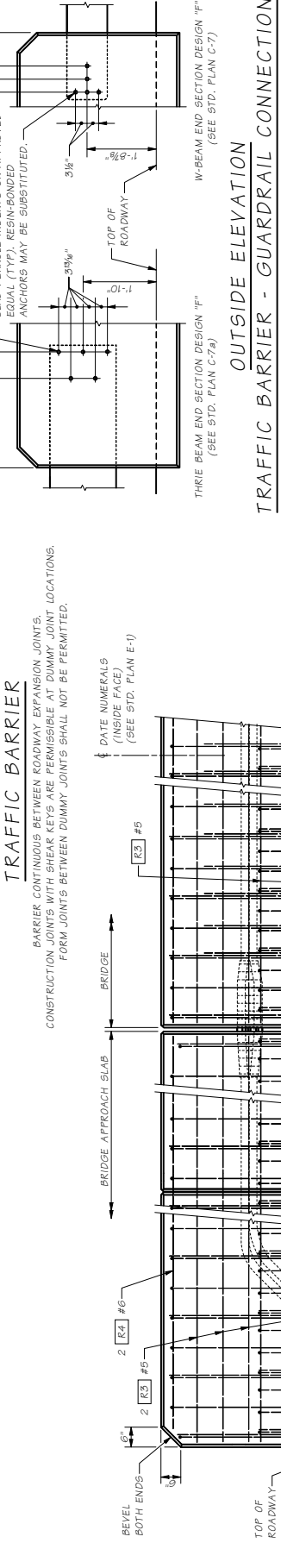
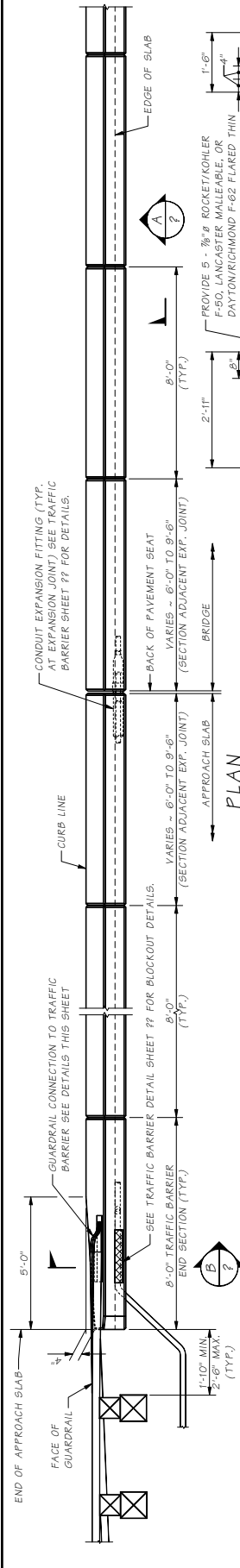


NOTE TO DESIGNERS
 MODIFY THE FOLLOWING TO MATCH PROJECT REQUIREMENTS:
 1. BARRIER END SECTION.
 2. REMOVE GUARDRAIL IF NOT CONNECTED TO BRIDGE ITEM.
 3. CONDUIT ALIGNMENT

BRIDGE DESIGN ENGINEER											
SUPERVISOR											
DESIGNED BY											
CHECKED BY											
DRAWN BY											
DATE											
REVISION											
JOB NO.											
SHEET NO.											
SHEET											
WASHINGTON STATE DEPARTMENT OF TRANSPORTATION											
BRIDGE AND STRUCTURES OFFICE											
STANDARD TRAFFIC BARRIER											
TRAFFIC BARRIER - SHAPE F 42" DETAIL 3 OF 3											



JOB NO.
SHEET



WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

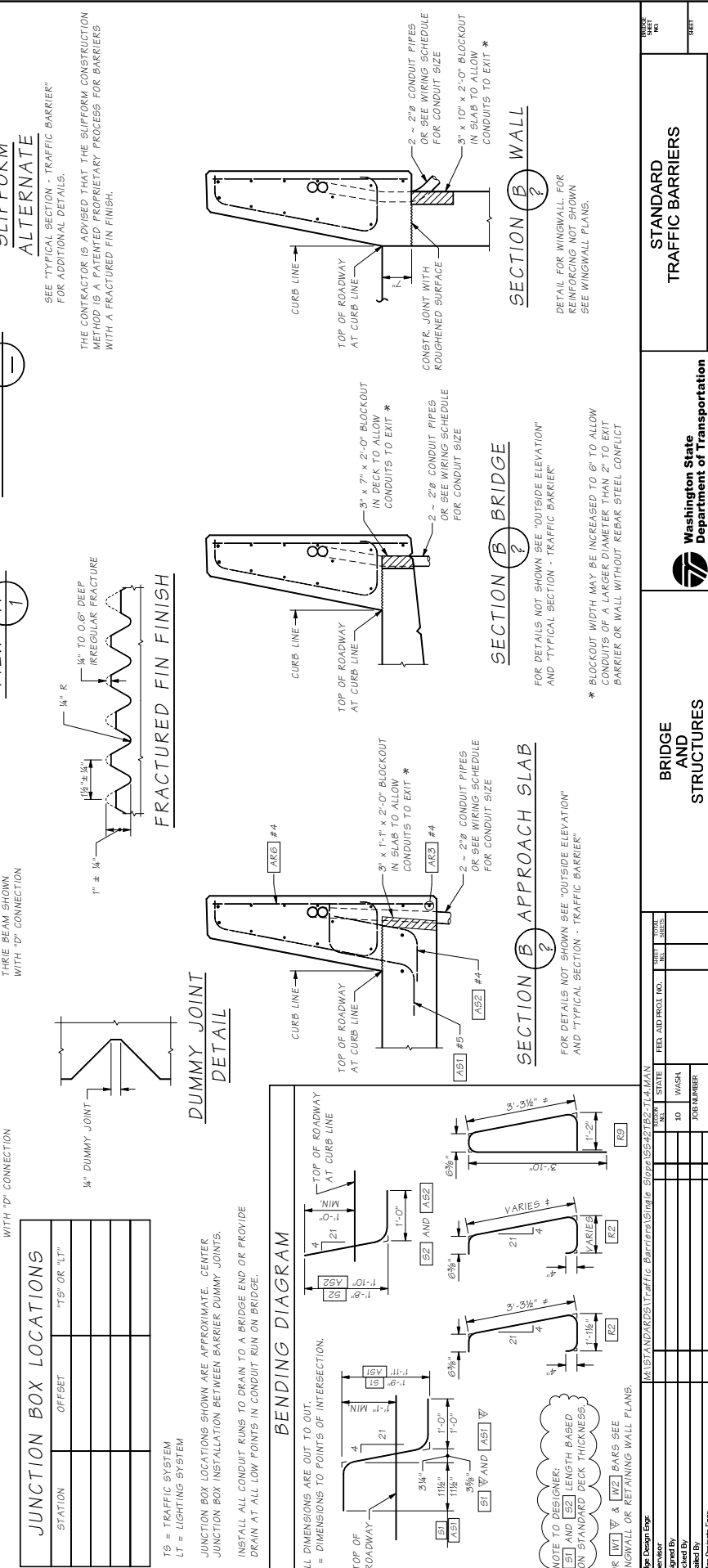
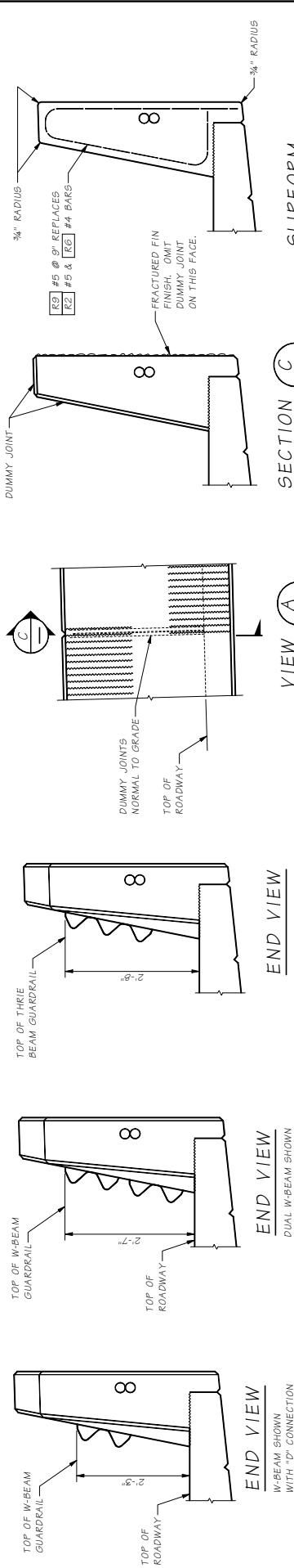
BRIDGE AND STRUCTURES OFFICE

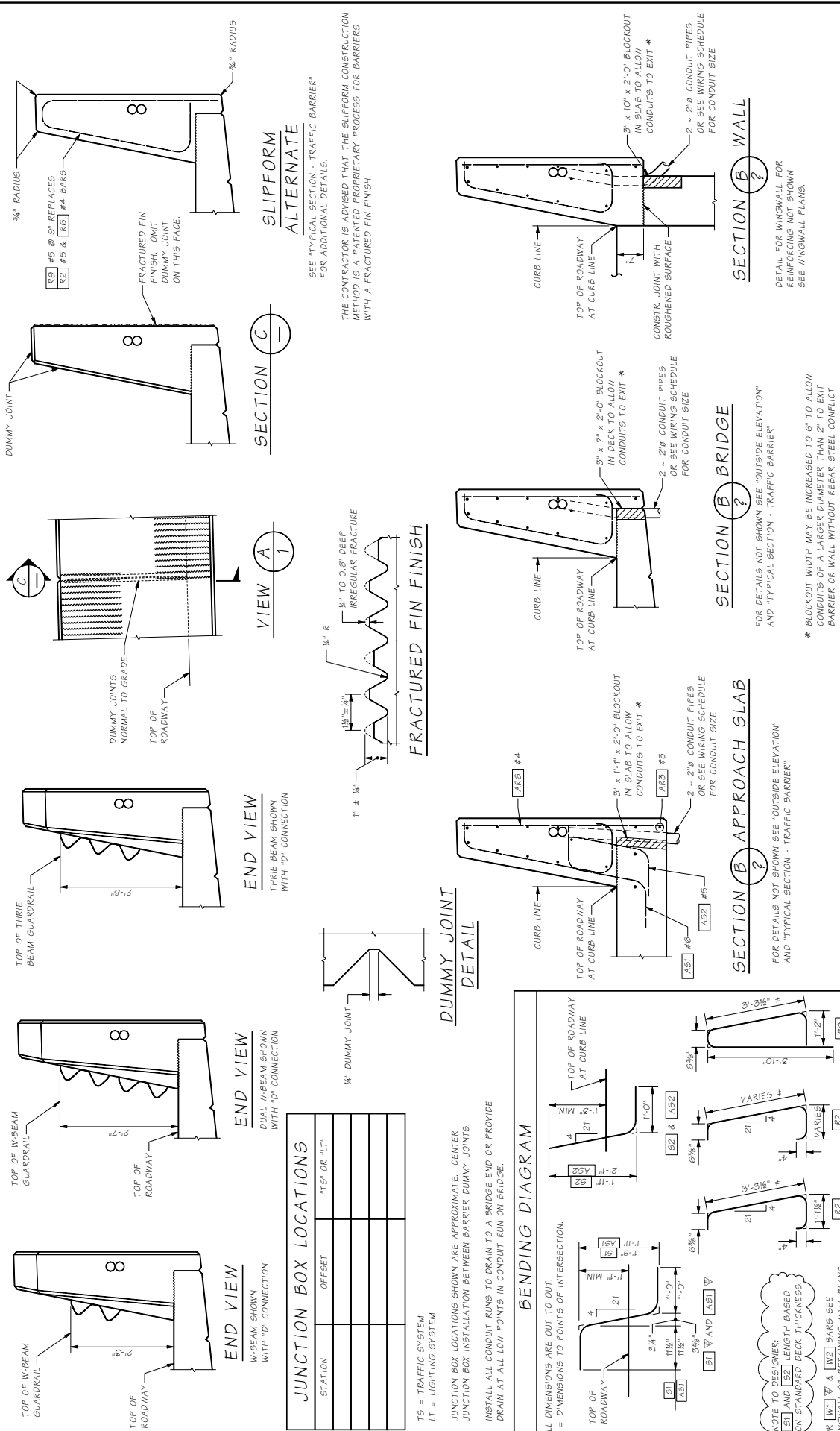
STANDARD TRAFFIC BARRIERS

TRAFFIC BARRIER - SINGLE SLOPE 42"
DETAILS 1 OF 3

MAINTENANCE/TRAFFIC BARRIER/Single Slope/US42181/1/5/MAN		FED. AID PROJ. NO.		SHEET NO.		TOTAL SHEETS	
NO.	STATE						
10	WASH						
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	
Checked By:		Job Number:		By:		APD	

The Dec 10 14:00:21 2009





STANDARD TRAFFIC BARRIERS

Washington State Department of Transportation

BRIDGE AND STRUCTURES OFFICE

TRAFFIC BARRIER - SINGLE SLOPE 42" DETAILS 2 OF 3

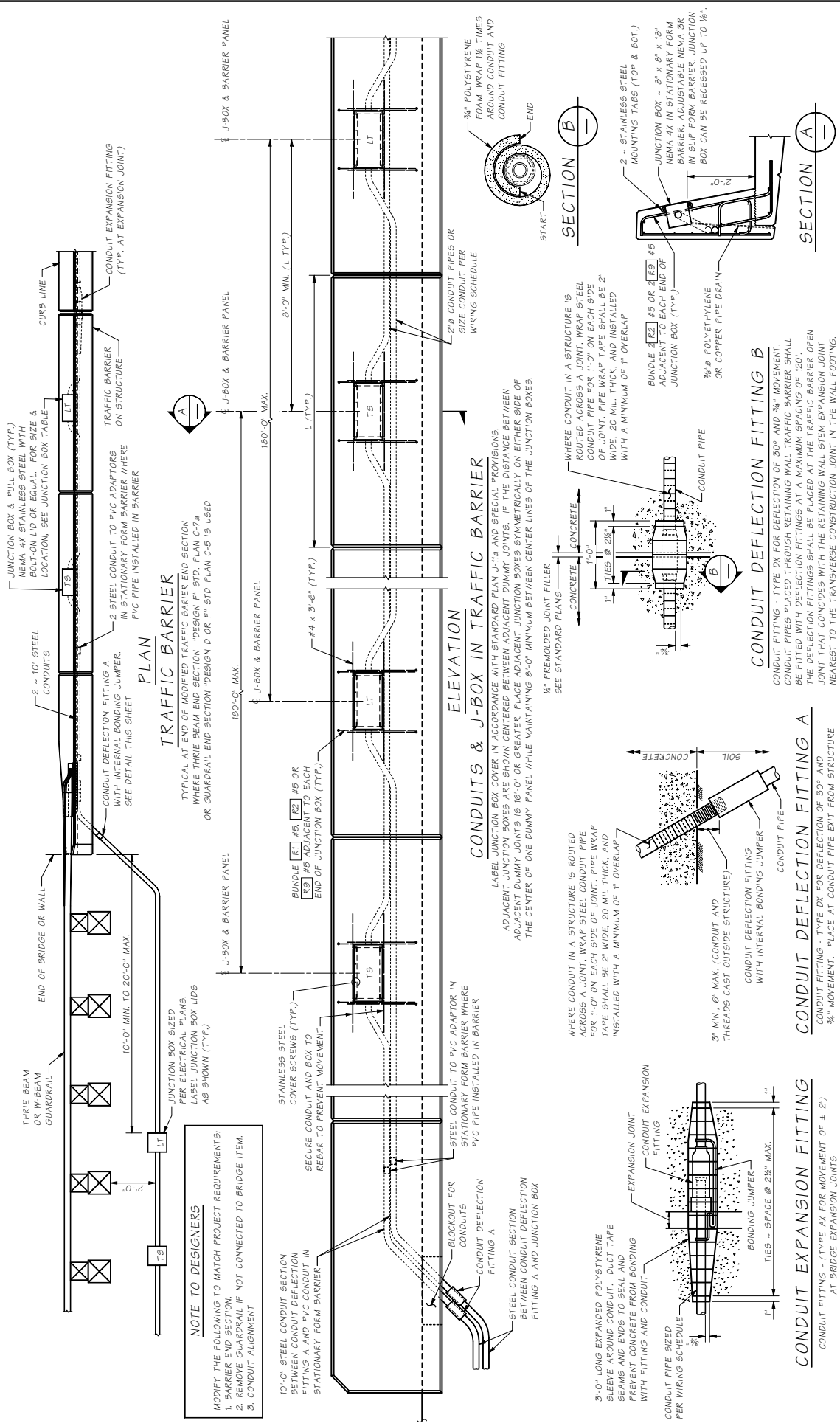
REVISION

DATE	BY	APP'D

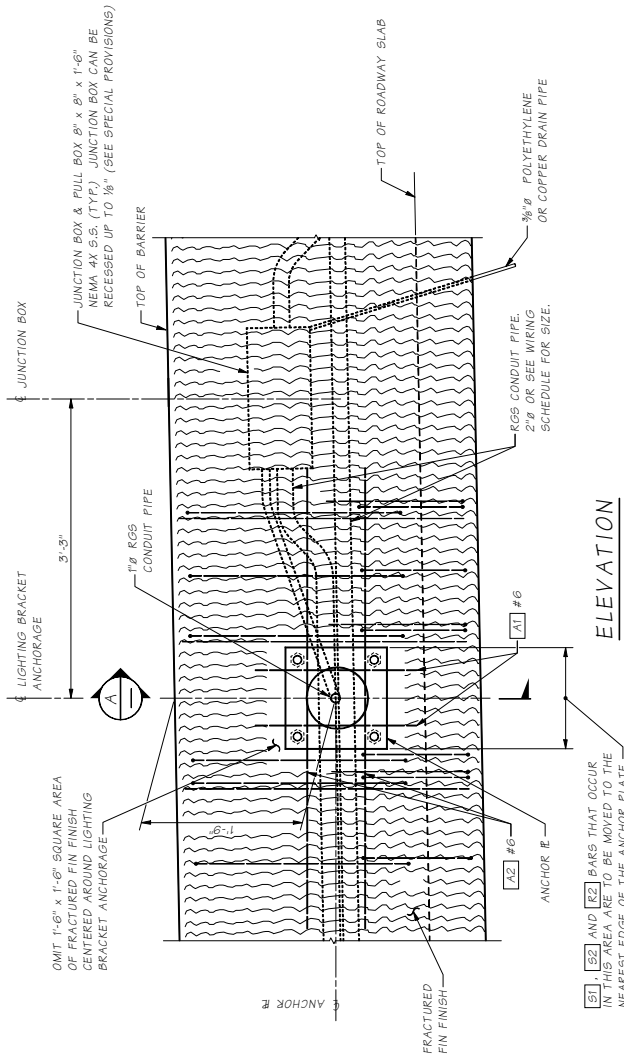
DESIGNED BY: WASH STATE DOT
CHECKED BY: WASH STATE DOT
DRAWN BY: WASH STATE DOT
DATE: 10/14/09

JOB NO. 10.2-A6-2B

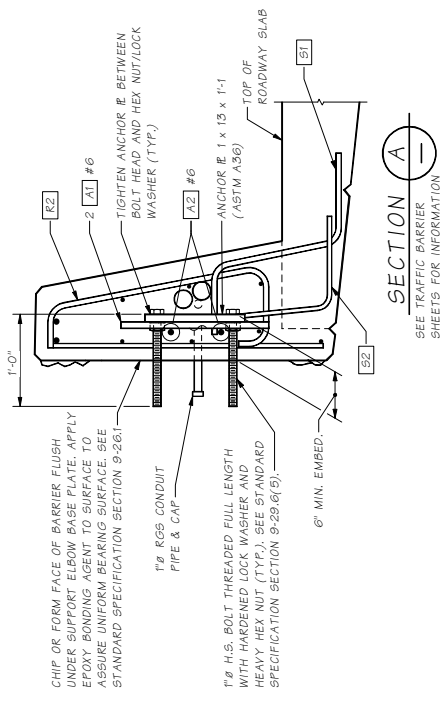
SHEET 58 OF 58



Bridge Design Dept:	WASH STATE TRAFFIC BARRIERS	DATE:	REVISION:
Supervisor:		DATE:	
Designed By:		DATE:	
Checked By:		DATE:	
Bridge Projects Eng:		DATE:	
Drawn From By:		DATE:	
Architect/Specifier:		DATE:	
Job No.:		Job No.:	
SHEET		SHEET	
OF		OF	
SHEETS		SHEETS	

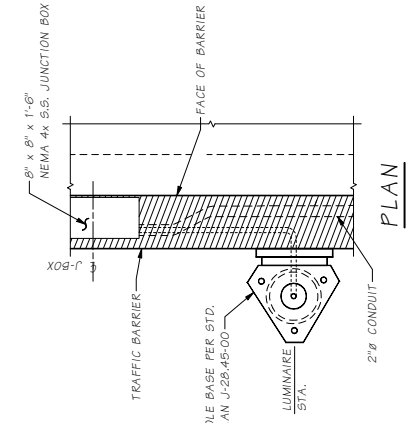


ELEVATION

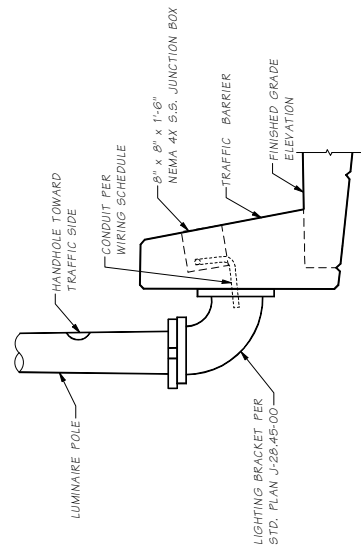


SECTION A

NOTE:
ALL CONDUITS SHALL BE RIGID GALVANIZED STEEL (RGS).
INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END
OR PROVIDE DRAIN AT ALL LOW POINTS WITHIN CONDUIT RUN.
SEE "TRAFFIC BARRIER SHEETS" FOR BARRIER DIMENSIONS.

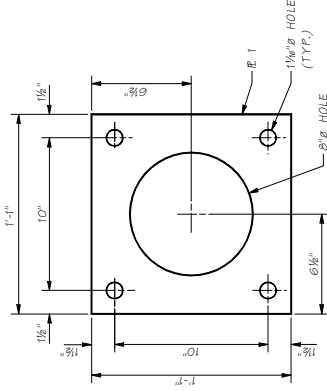


PLAN



**ELEVATION PROFILE
LUMINAIRE SUPPORT**

SHOWN FOR BRIDGE, WALLS ARE SIMILAR



ANCHOR PLATE

GALVANIZE PER AASHTO M 111

LUMINAIRE POLE LOCATIONS ON BRIDGE & WALLS		
STATION	OFFSET	
XXX 0+000.000		0.000 RT.
XXX 0+000.000		0.000 RT.

ANCHORAGE BARLIST			
MARK #	SIZE	LENGTH	BEND TYPE
A1	6	1'-9"	STRAIGHT
A2	6	5'-0"	STRAIGHT

Washington State Department of Transportation

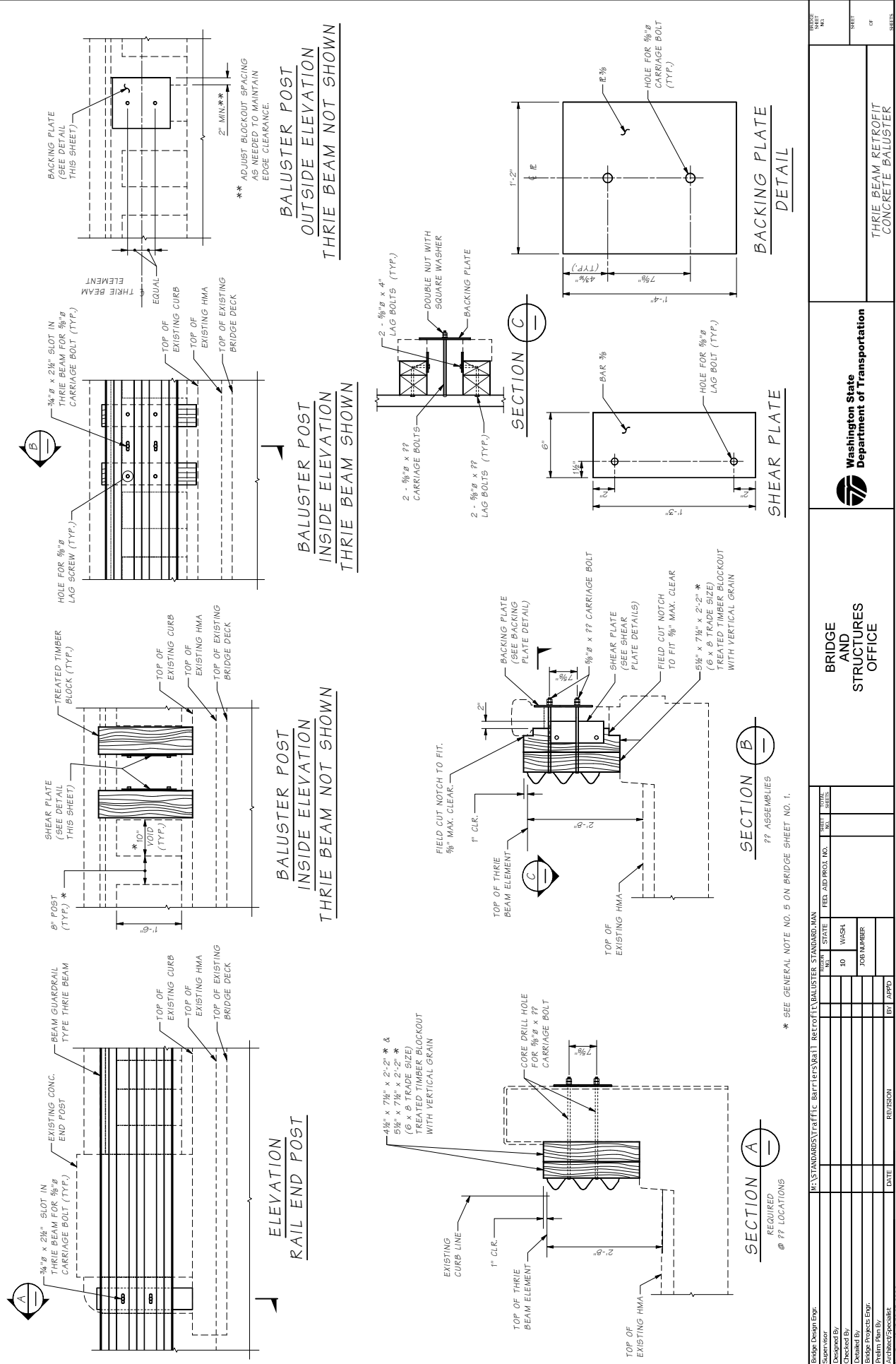
BRIDGE AND STRUCTURES OFFICE

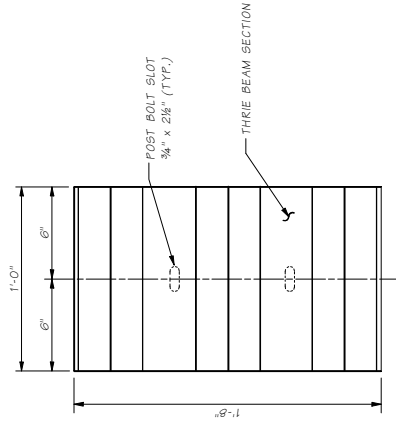
STANDARD TRAFFIC BARRIERS

TRAFFIC BARRIER - SINGLE SLOPE LUMINAIRE ANCHORAGE DETAILS

Bridge Design Eng. _____ MUSTAFA ANDAR (25) Traffic Barrier/Luminaire Anchor Plate - S1/S2/MAN
 Supervisor _____ JOB NO. _____ STATE _____ FED. AID PROJ. NO. _____ SHEET _____ TOTAL SHEETS _____
 Checked By _____ TO WASH _____
 Checked By _____ JOB NUMBER _____
 Bridge Projects Eng. _____
 Permit Plan By _____
 Architect/Specifier _____ DATE _____ REVISION _____ BY _____ APD _____

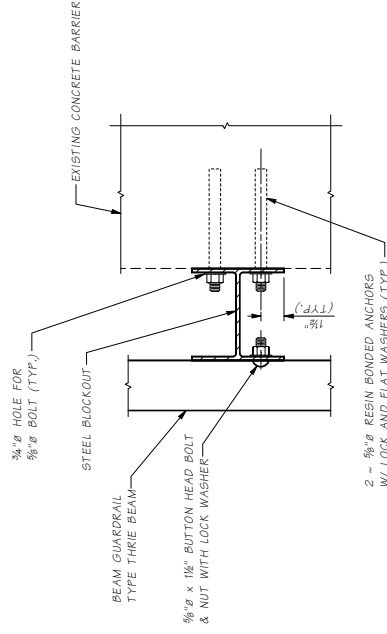
SR JOB NO. _____ SHEET NO. _____
 10.2-A7-2
 Thu Dec 10 13:59:00 2009



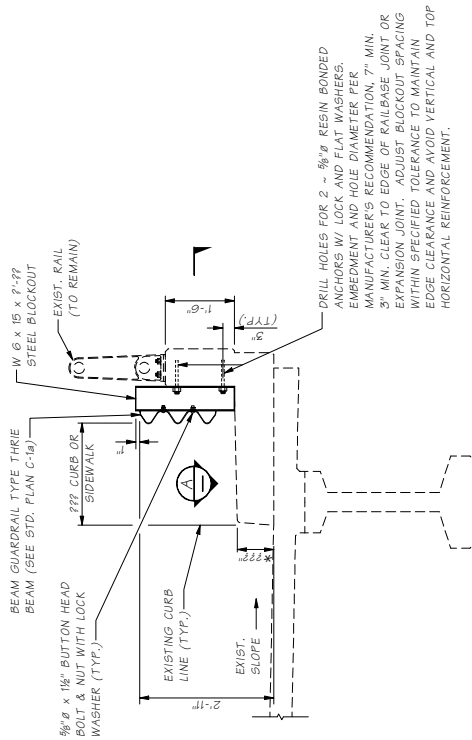


BACKUP PLATE

BACKUP PLATE REQUIRED AT POST WHERE NO THRIE BEAM GUARDRAIL SPLICE OCCURS.



SECTION A

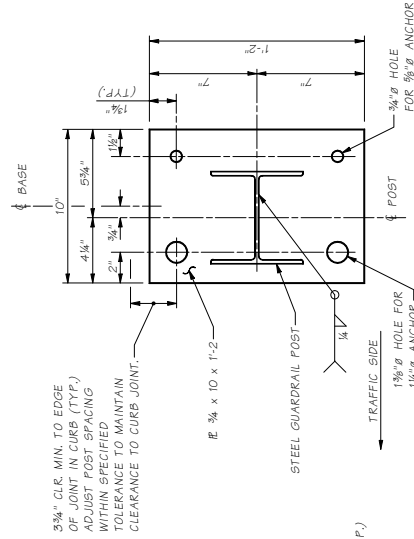


**TYPICAL SECTION
AT STEEL BLOCKOUT**

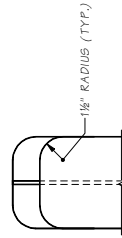
(?? ASSEMBLIES REQUIRED)

* SEE GENERAL NOTE NO. 5 ON BRIDGE SHEET NO. 1.

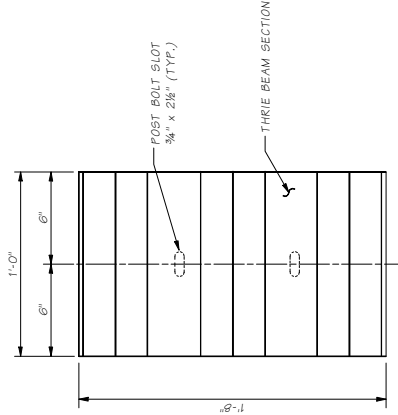
Bridge Design Dept. _____ Supervisor _____ Checked By _____ Checked By _____ Bridge Projects Eng. _____ Prelim Prep By _____ Architect/Specifier _____		STANDARD SPECIFIC BATTERS (B1) RETROFIT PARAPET STANDARD MAN COUNTY STATE FED. AID PROJ. NO. SHEET NO. TOTAL SHEETS 10 WASH _____ JOB NUMBER _____ DATE REVISION BY APPD		WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BRIDGE AND STRUCTURES OFFICE THRIE BEAM RETROFIT CONCRETE RAILBASE		SHEET NO. _____ OF _____ SHEETS
--	--	--	--	---	--	---------------------------------



BASE PLATE DETAIL

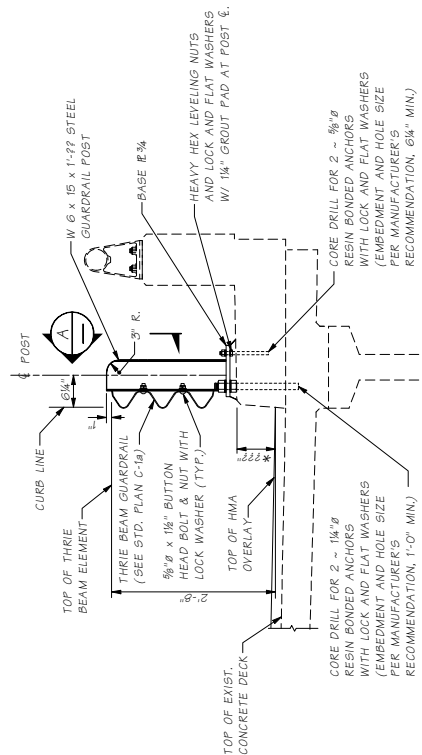


VIEW A



BACKUP PLATE

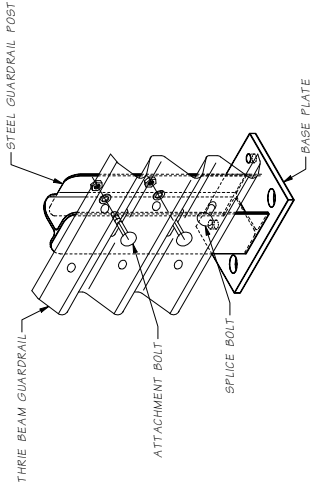
BACKUP PLATE REQUIRED AT POST WHERE NO THRIE BEAM GUARDRAIL SPLICE OCCURS.



TYPICAL STEEL POST ANCHORAGE

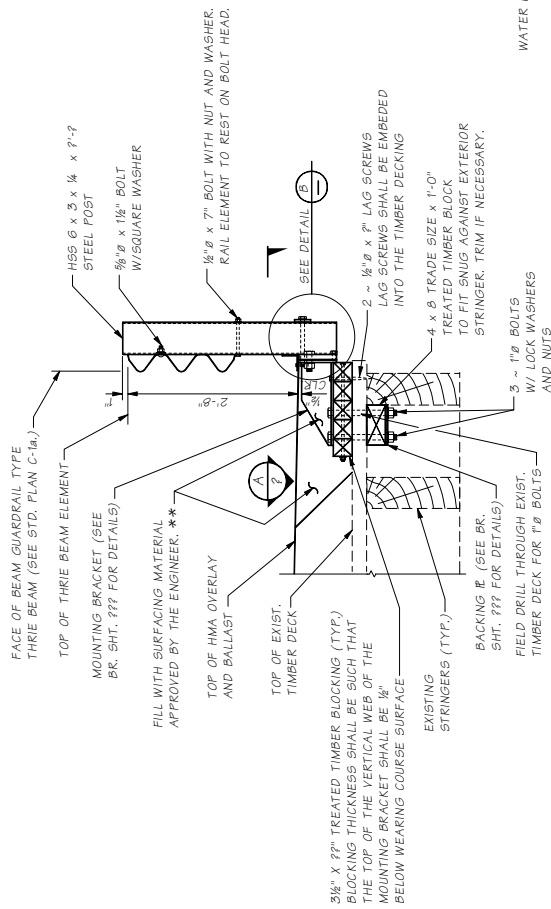
?? POSTS REQUIRED

* SEE GENERAL NOTE NO. 9 ON BRIDGE SHEET NO. 1.



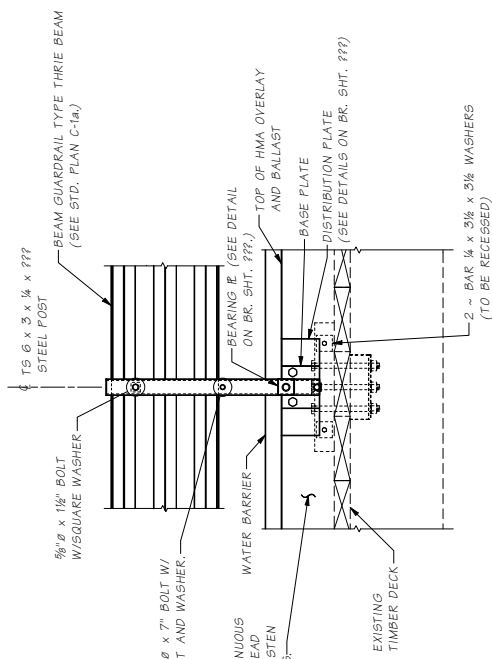
ISOMETRIC VIEW

Bridge Design Eng: Supervisor: Designed By: Checked By: Bridge Projects Eng: Permit Plan By: Fabricator/Supplier:	REVISIONS NO. DATE DESCRIPTION BY APP'D	FEDERAL PROJECT NO.	STATE	COUNTY	SHEET NO.	TOTAL SHEETS
		WASH	10	WASH	JOB NUMBER	SHEET OF SHEETS
BRIDGE AND STRUCTURES OFFICE			Washington State Department of Transportation			
THRIE BEAM RETROFIT CONCRETE CURB						

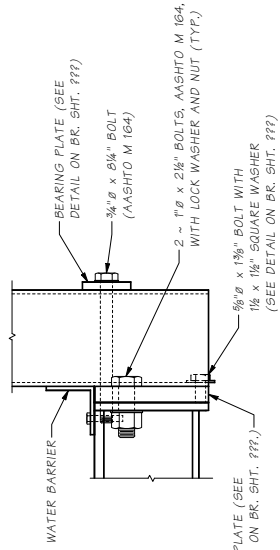


GUARDRAIL POST ASSEMBLY
(TYPICAL ASSEMBLIES)

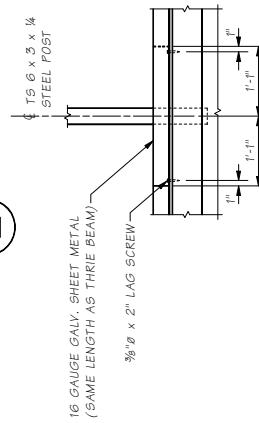
** THICKNESS OF SURFACING MATERIAL SHALL BE SUCH THAT THE TOP OF THE VERTICAL WEB OF THE MOUNTING BRACKET SHALL BE 1/8" BELOW WEARING COURSE SURFACE



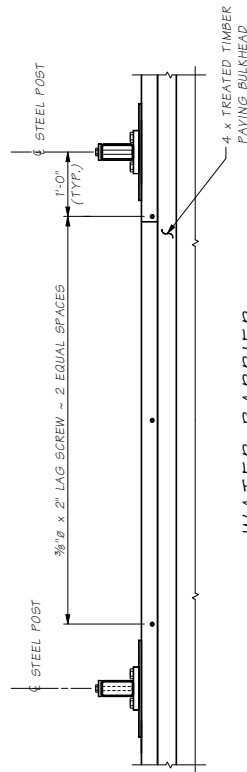
OUTSIDE ELEVATION AT TYPICAL GUARDRAIL POST



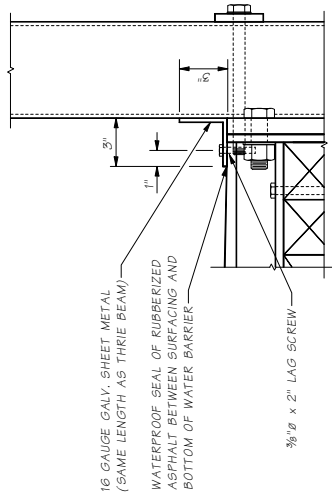
DETAIL B



WATER BARRIER SPLICING DETAIL

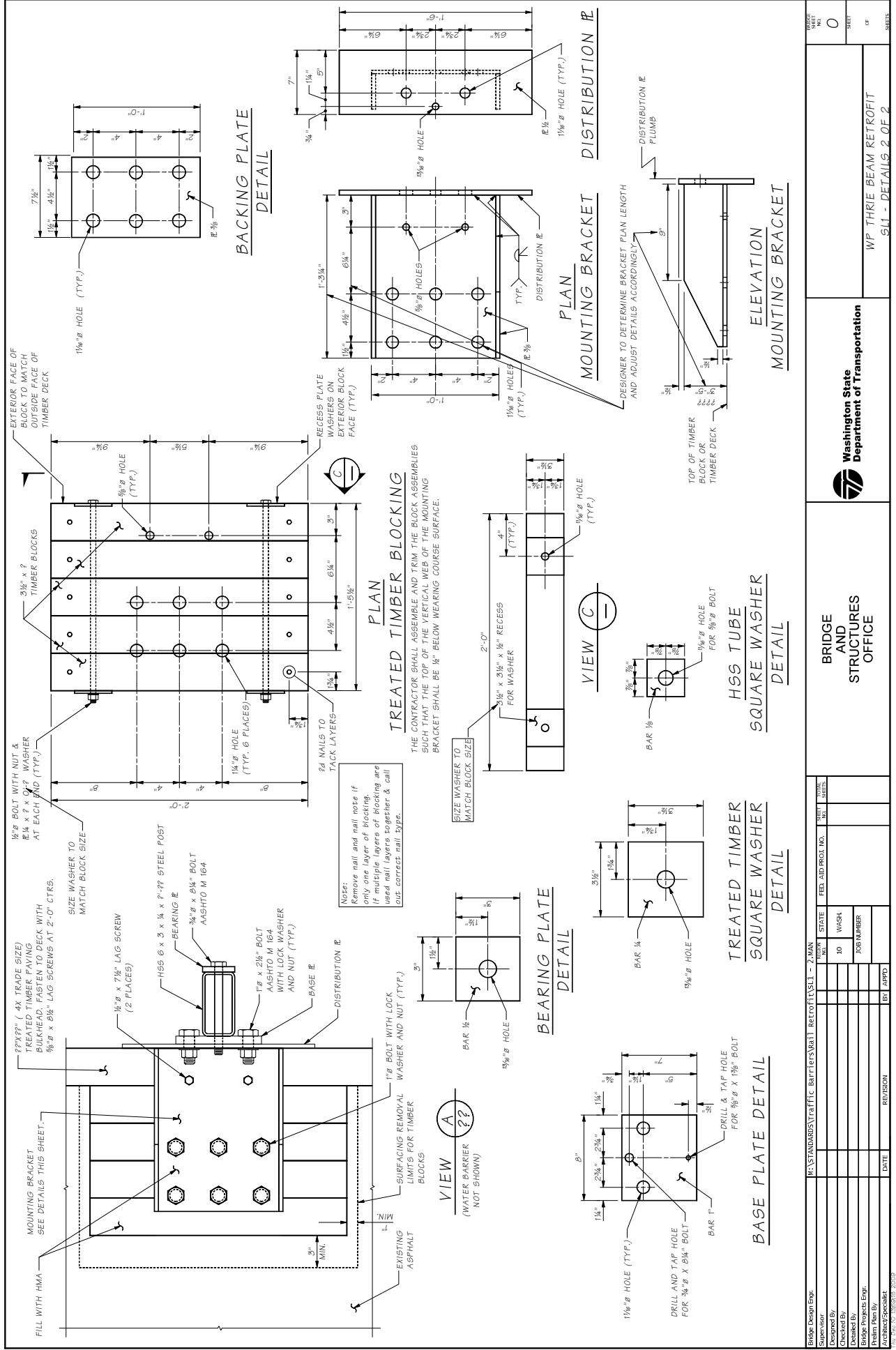


WATER BARRIER PLAN

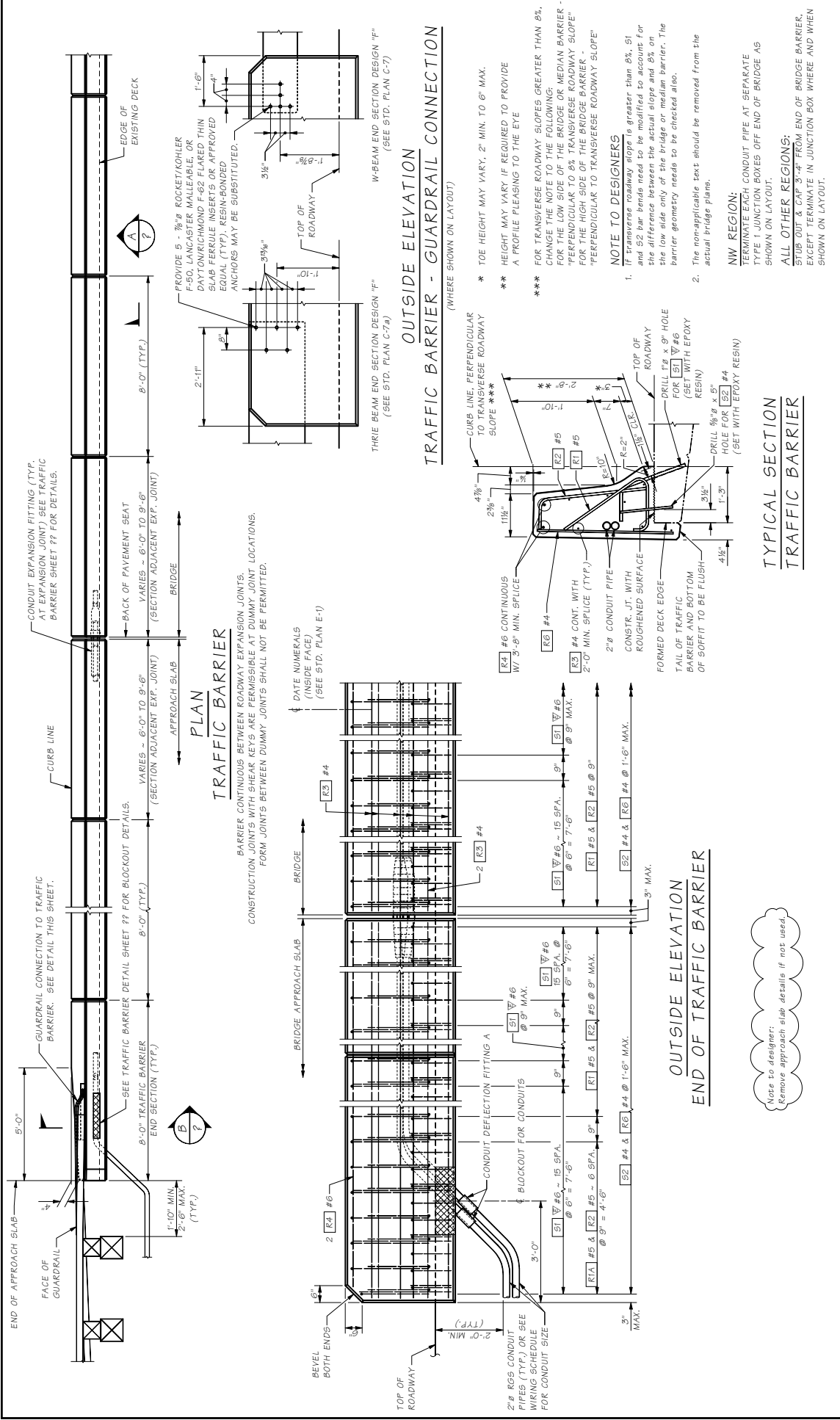


WATER BARRIER DETAIL

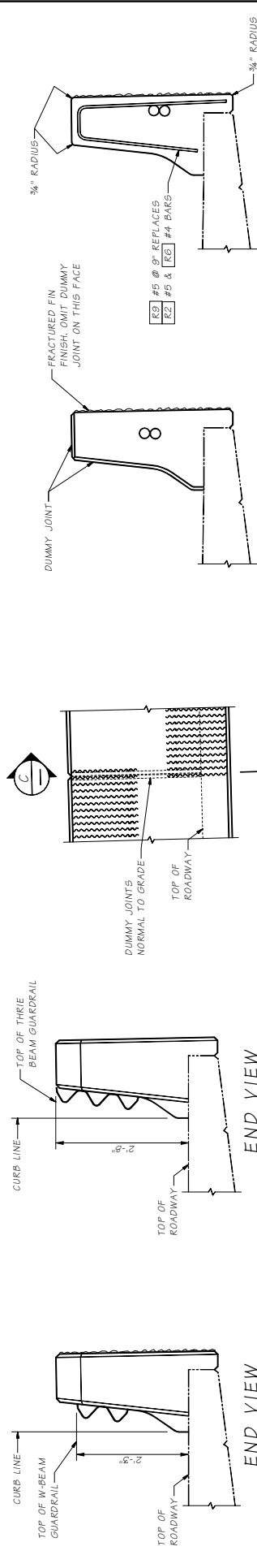
BRIDGE DESIGN ENGR.	DATE	REVISION	BY	APPD
SUPERVISOR				
DESIGNED BY				
CHECKED BY				
BRIDGE PROJECT ENGR.				
PRIN. DESIGNED BY				
PROJECT SHEET NO.				
PROJECT NO.				
STATE	10	WASH		
FED. AID PROJ. NO.				
CONTRACT NO.				
SHEET NO.				
TOTAL SHEETS				
BRIDGE AND STRUCTURES OFFICE				
Washington State Department of Transportation				
WP THRIE BEAM RETROFIT SL1 - DETAILS 1 OF 2				



Bridge Design Dept:	STANDARDS/STAFFC/BARRIERS/WAT	RETROFIT/S11 - 2	MAN	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS	
Supervisor:				WASH		10		
Designed By:								
Checked By:								
Bridge Projects Eng:								
Project Man. By:								
Author/Reviser:								
DATE:								
REVISION:								
BY:								
DATE:								
JOB NO.	SHEET 0							
SR	10.4-A1-5							
	Washington State Department of Transportation							
	BRIDGE AND STRUCTURES OFFICE							
	WP THRIE BEAM RETROFIT							
	S11 - DETAILS 2 OF 2							



Bridge Design Eng:	MASTANDARDOSTI#Traffic Barrier Rehab	DATE	REVISION	BY	APPD
Supervisor		DATE	REVISION	BY	APPD
Designed By	10 WASH	DATE	REVISION	BY	APPD
Checked By	JON MERRER	DATE	REVISION	BY	APPD
Bridge Projects Eng:		DATE	REVISION	BY	APPD
Drawn (Rev. By):		DATE	REVISION	BY	APPD
Architect/Specifier:		DATE	REVISION	BY	APPD
Work No.		STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Washington State Department of Transportation					
BRIDGE AND STRUCTURES OFFICE					
STANDARD TRAFFIC BARRIERS					
TRAFFIC BARRIER - SHAPE F REHABILITATION - DETAILS 1 OF 3					

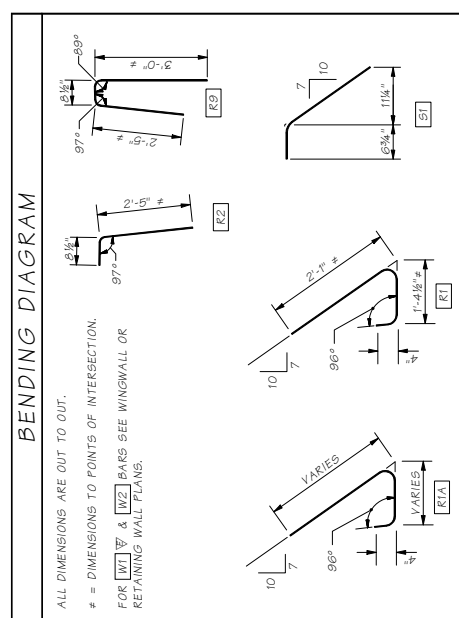


SEE "TYPICAL SECTION - TRAFFIC BARRIER" FOR ADDITIONAL DETAILS

THE CONTRACTOR IS ADVISED THAT THE SLIPFORM CONSTRUCTION METHOD IS A PATENTED PROPRIETARY PROCESS FOR BARRIERS WITH A FRACTURED FIN FINISH.

STATION	OFFSET	"TS" OR "LT"

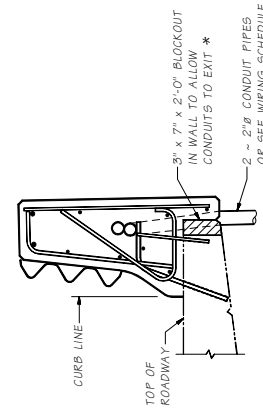
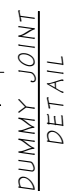
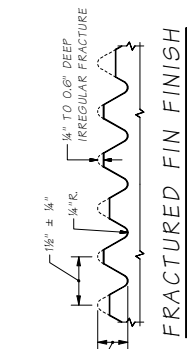
TS = TRAFFIC SYSTEM
LT = LIGHTING SYSTEM
JUNCTION BOX LOCATIONS SHOWN ARE APPROXIMATE. CENTER JUNCTION BOX INSTALLATION BETWEEN BARRIER DUMMY JOINTS.
INSTALL ALL CONDUIT RIMS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.



ALL DIMENSIONS ARE OUT TO OUT.

* = DIMENSIONS TO POINTS OF INTERSECTION.

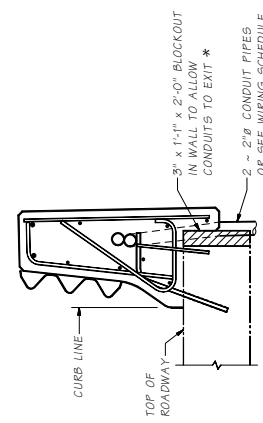
FOR [W1] & [W2] BARS SEE WINGWALL OR RETAINING WALL PLANS.



SECTION B BRIDGE

FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"

* BLOCKOUT WIDTH MAY BE INCREASED TO 6" TO ALLOW CONDUITS OF A LARGER DIAMETER THAN 2" TO EXIT BARRIER OR WALL WITHOUT REBAR STEEL CONFLICT.



SECTION B APPROACH SLAB

FOR DETAILS NOT SHOWN SEE "OUTSIDE ELEVATION" AND "TYPICAL SECTION - TRAFFIC BARRIER"

Bridge Design Dept:	STANDARD/POST/Traffic Barrier/Rehab/TS-Z-MAN	WORK NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor:		10	WASH			
Designed By:						
Checked By:						
Bridge Projects Eng:						
Drawn Plan By:						
Checked/Sealed:						
DATE	REVISION	BY	APPD			

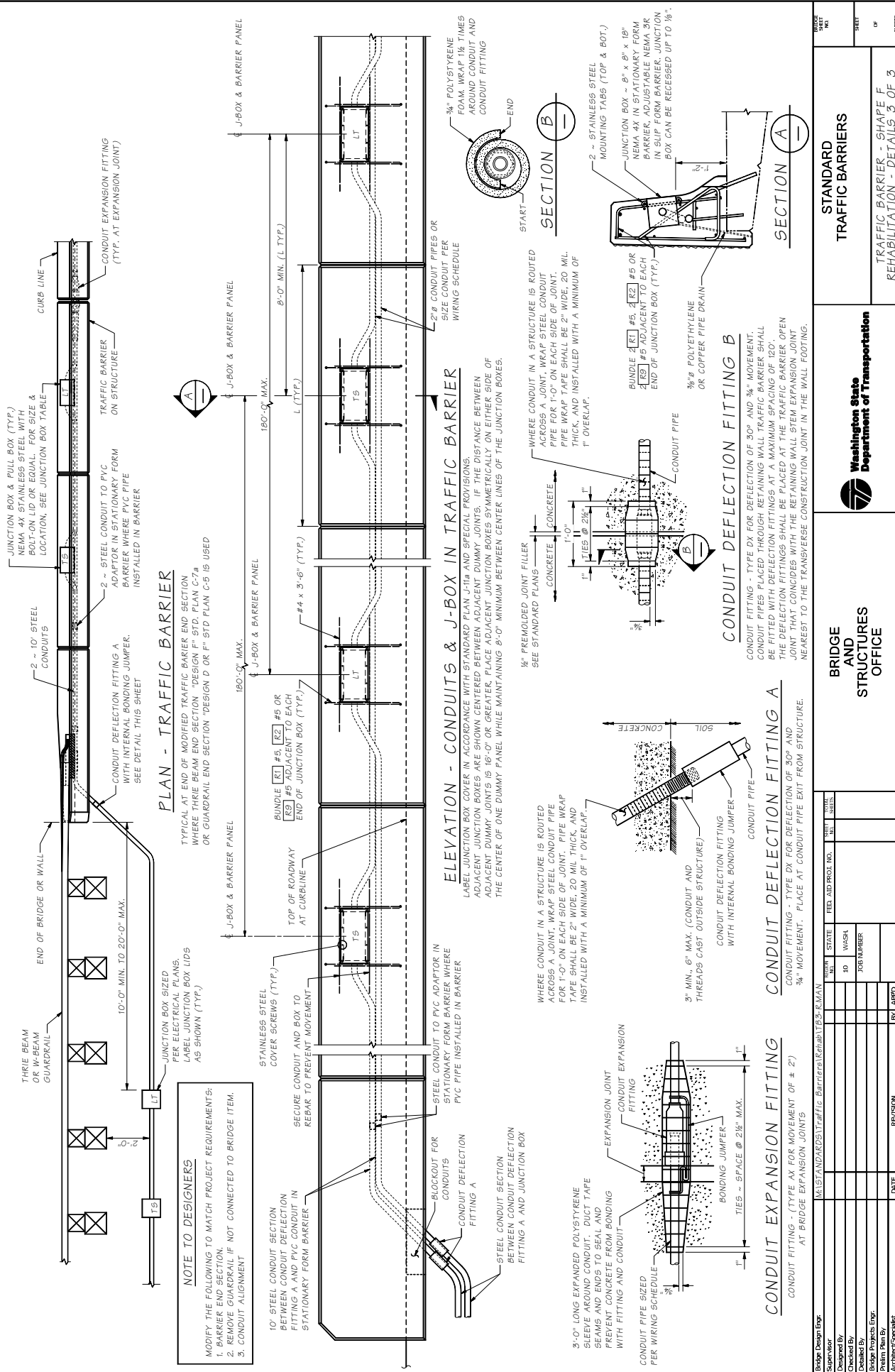
The Dec 10 13:58:33 2009

STANDARD TRAFFIC BARRIERS



BRIDGE AND STRUCTURES OFFICE

TRAFFIC BARRIER - SHAPE F
REHABILITATION - DETAILS 2 OF 3

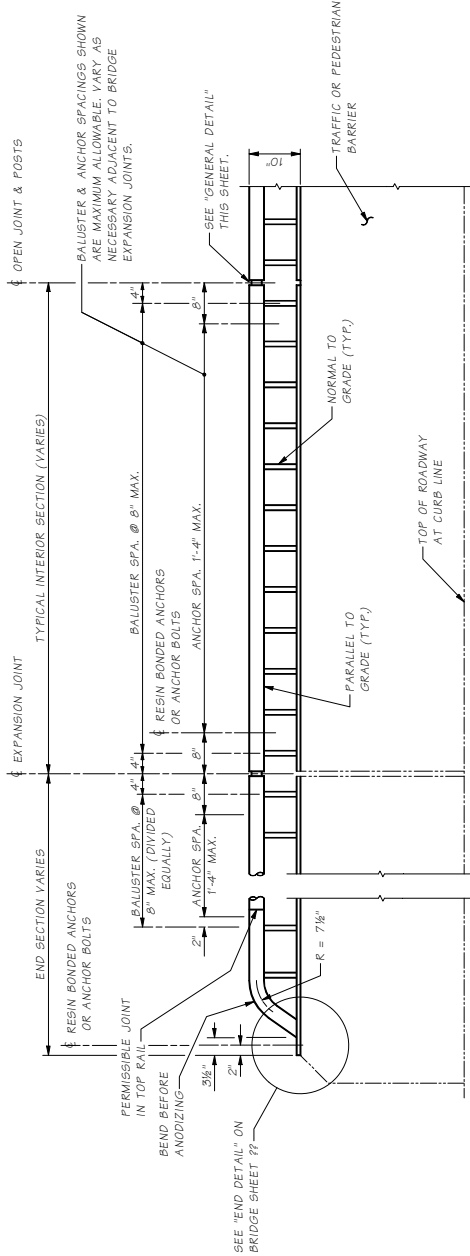


STANDARD TRAFFIC BARRIERS
TRAFFIC BARRIER - SHAPE F REHABILITATION - DETAILS 3 OF 3



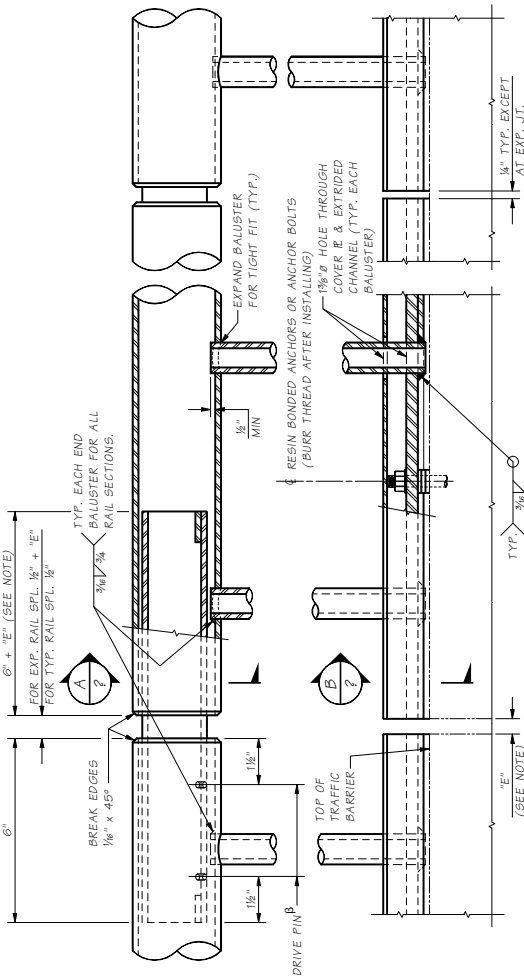
BRIDGE AND STRUCTURES OFFICE

Bridge Design Eng:	WASHSTANDARDS11#Fig BarrierRehabITF5-L1MAN	WORK NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor:		10	WASH			
Designed By:						
Checked By:						
Scale Projects Eng:						
Drawn (Rev. By):						
Checked/Sealed:						
DATE:	REVISION:					



ELEVATION

BALUSTER AND GUARDRAIL SECTION
ATTACHMENT DETAILS NOT SHOWN.



GENERAL DETAIL

NOTES

1. PIPE RAILING, PIPE RAILING SPLICES, COVER PLATES AND BOTTOM EXTRUDED CHANNELS SHALL BE BENT TO THE HORIZONTAL CURVE WHERE THE RADIUS OF CURVATURE IS LESS THAN 200 FEET. THESE ITEMS MAY BE HEATED TO NOT MORE THAN 400°F FOR A PERIOD NOT TO EXCEED 30 MINUTES TO FACILITATE FORMING OR BENDING TO HORIZONTAL CURVATURE.
2. SHOP DRAWINGS OF RAILING SHALL BE SUBMITTED FOR APPROVAL SHOWING COMPLETE DIMENSIONS AND DETAILS OF FABRICATION AND INCLUDING AN ERECTION DIAGRAM. MATERIAL BEING USED SHALL BE SPECIFIED IN THE SHOP DRAWINGS.
3. CUTTING SHALL BE DONE BY SAWING OR MILLING AND ALL CUTS SHALL BE TRUE AND SMOOTH. FLAME CUTTING WILL NOT BE PERMITTED.
4. WELDING OF ALUMINUM SHALL CONFORM TO STD. SPEC. SECTION 9-2014(3).
5. ALL ALUMINUM PARTS SHALL BE GIVEN A * (CLEAR OR BRONZE) ANODIC COATING OF AT LEAST 0.0006 INCHES THICK AND SEALED TO MEET THE REQUIREMENTS OF ASTM B 580 WITH A UNIFORM FINISH.
6. PIPE RAILING, PIPE BALUSTERS AND PIPE RAILING SPLICES SHALL BE ADEQUATELY WRAPPED TO INSURE SURFACE PROTECTION DURING HANDLING AND TRANSPORTATION TO THE JOB SITE.

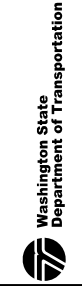
* NOTE TO DESIGNER:
Designer to choose color for their project in consultation with the Bridge Architect.

B LOCATE ON OPPOSITE SIDE OF TRAFFIC CURVE AND SHALL BE DRIVEN FLUSH WITH THE OUTSIDE FACE OF THE RAILING.

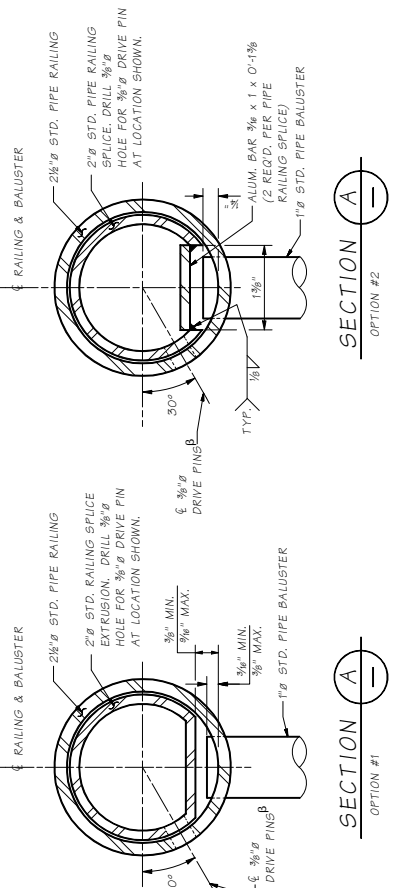
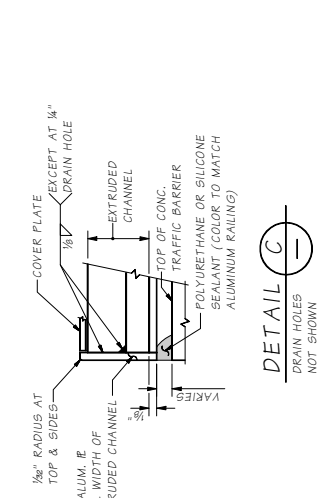
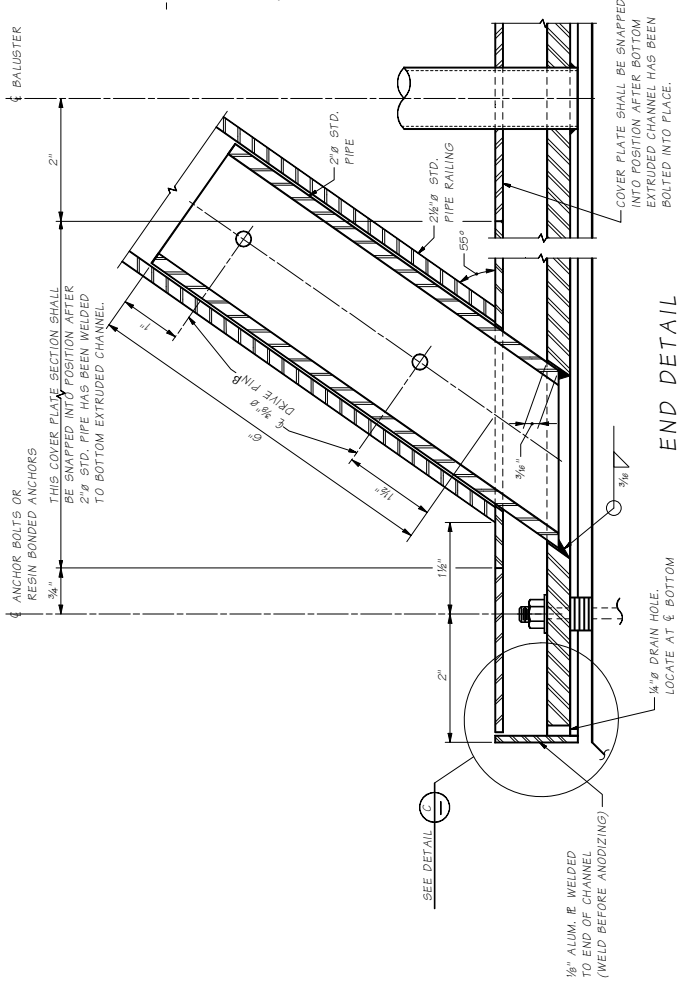
NOTE:
"E" DIMENSION TO MATCH OPENING OF ROADWAY EXPANSION JOINTS.

Bridge Design Dept:	MA/STANDARD/POST/BR/RAIL/PE/RAIL/MAIN	WORK NO.:	STATE:	FED. AID PROJ. NO.:	SHEET NO.:	TOTAL SHEETS:
Supervisor:		10	WASH			
Designed By:						
Checked By:						
Bridge Projects Eng.:						
Project Man. By:						
Checked/Spec'ed:						
DATE:						
REVISION:						
BY:						
APRD:						

BRIDGE AND STRUCTURES OFFICE



STANDARD RAILINGS
BRIDGE RAILING TYPE PEDESTRIAN
DETAILS 1 OF 2

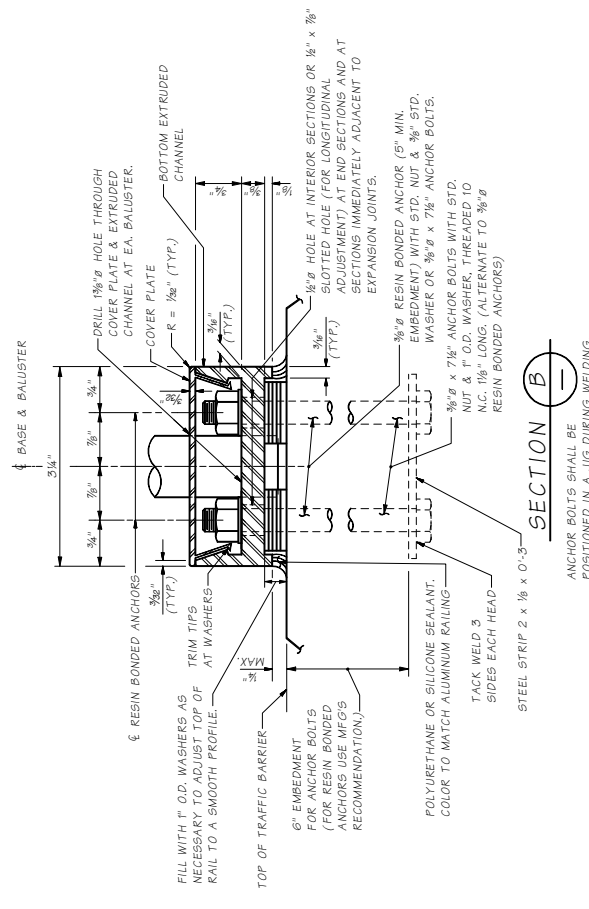


SECTION #1
OPTION A

LOCATE ON OPPOSITE SIDE OF TRAFFIC. DRIVE PINS SHALL BE DRIVEN FLUSH WITH THE OUTSIDE FACE OF THE RAILING.

SECTION #2
OPTION A

LOCATE ON OPPOSITE SIDE OF TRAFFIC. DRIVE PINS SHALL BE DRIVEN FLUSH WITH THE OUTSIDE FACE OF THE RAILING.



SECTION B

ANCHOR BOLTS SHALL BE POSITIONED IN A JIG DURING WELDING.

PART	MATERIAL SPECIFICATION
PIPES	ASTM B 221- 6005-15 ASTM B 241 OR B 429 6061-T6
EXTRUDED CHANNELS, COVER PLATES & BAR	ASTM B 221- 6005-15
ANCHOR BOLTS, NUTS & WASHERS	STANDARD SPECIFICATION SECTION 9-03.65(4) (GALVANIZE IN ACCORDANCE WITH ASHTO SPECIFICATION M 232)
STRIP	ASTM A 36
DRIVE PINS	ASTM A 276 TYPE 302 STAINLESS STEEL

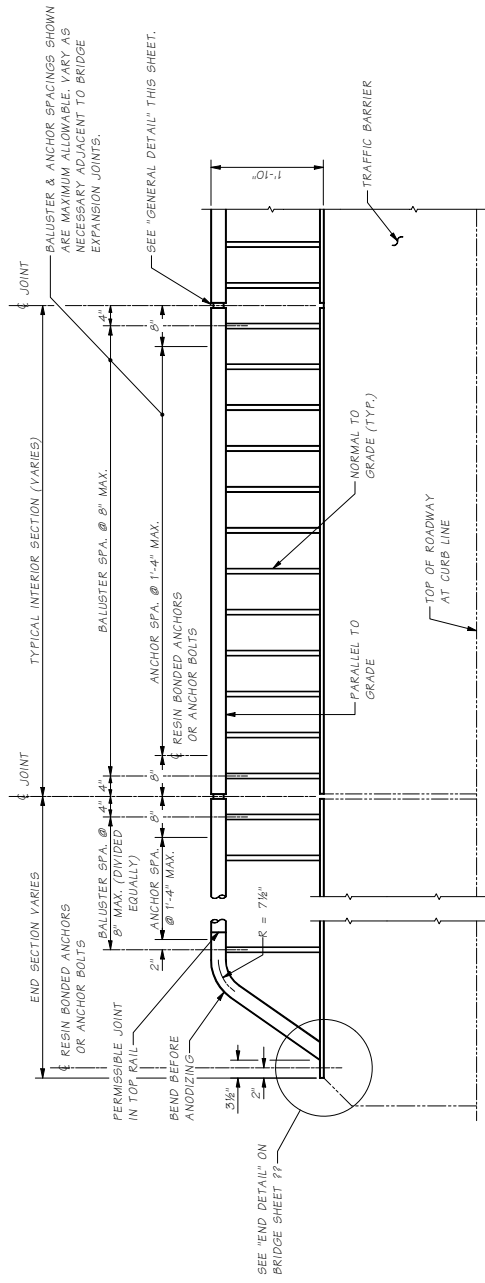
Bridge Design Eng.	MUSTAFA ANDRZEJCZAK, Esq./Dr. Eng./P.E./S.E./MAN
Supervisor	
Checked By	
Design Date	
Bridge Projects Eng.	
Checked By	
Design Date	
Checked By	
Design Date	

BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

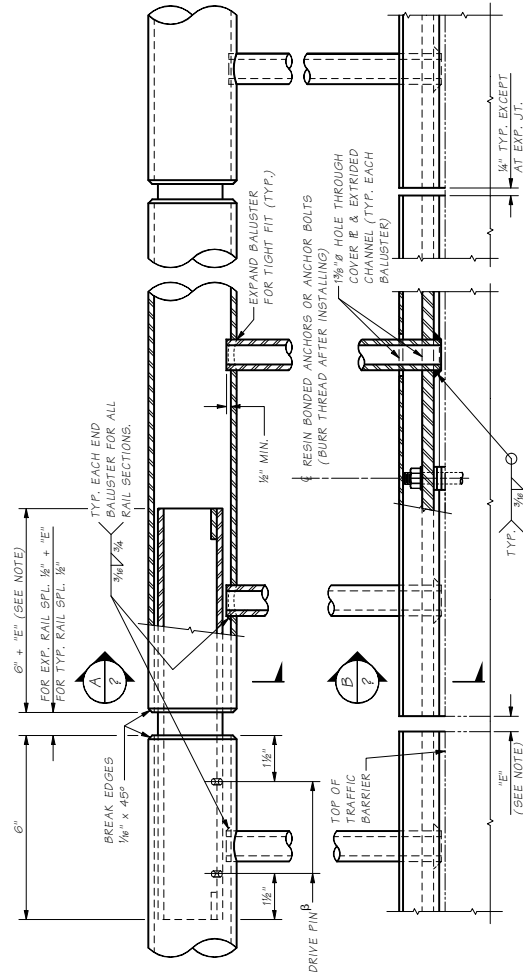
STANDARD RAILINGS

BRIDGE RAILING TYPE PEDESTRIAN
DETAILS 2 OF 2



ELEVATION

BALUSTER AND GUARDRAIL SECTION ATTACHMENT DETAILS NOT SHOWN.



GENERAL DETAIL

NOTES

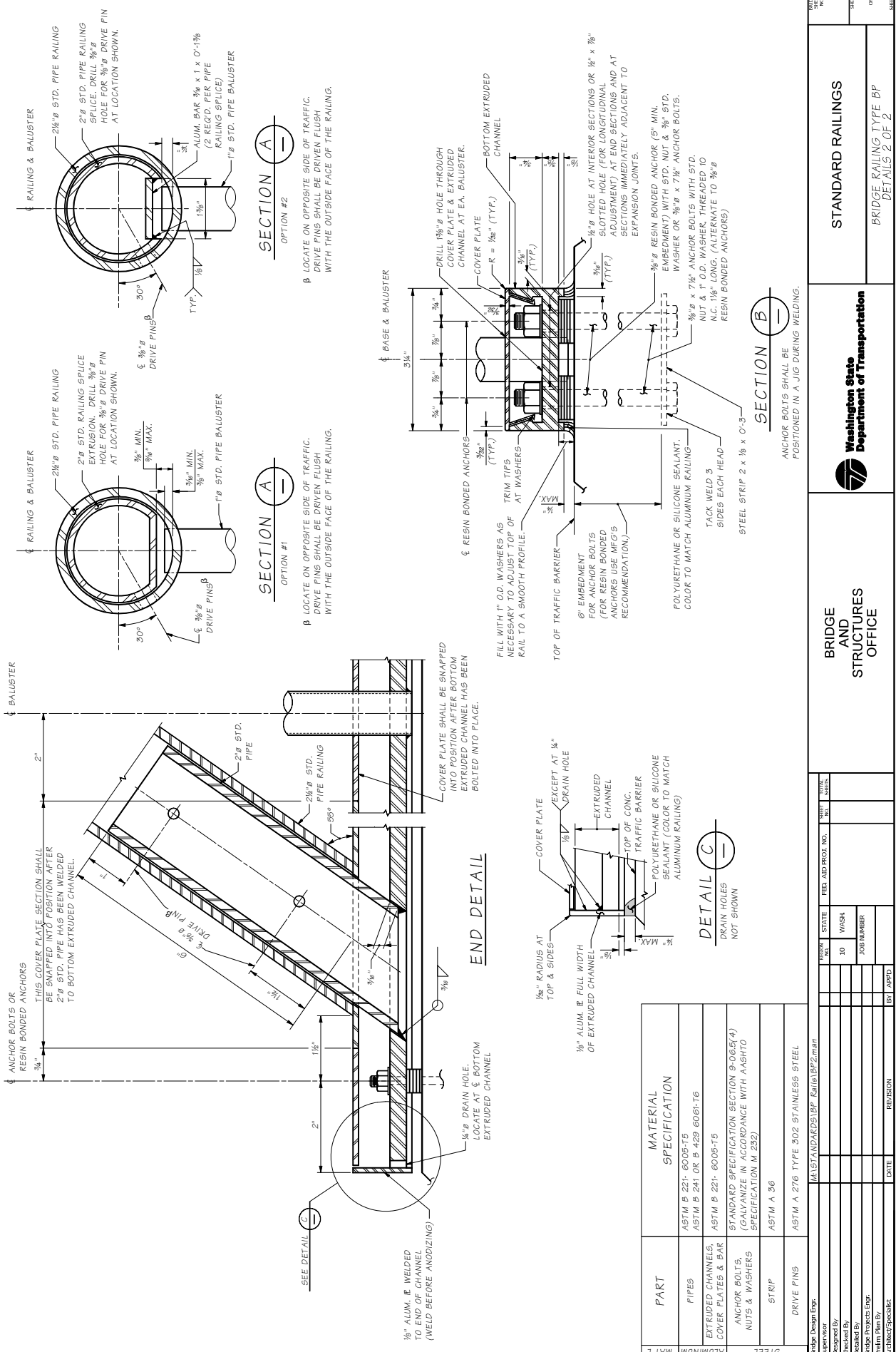
1. PIPE RAILING, PIPE RAILING SPLICES, COVER PLATES AND BOTTOM EXTRUDED CHANNELS SHALL BE BENT TO THE HORIZONTAL CURVE WHERE THE RADIUS OF CURVATURE IS LESS THAN 200'. THESE ITEMS MAY BE HEATED TO NOT MORE THAN 400°F FOR A PERIOD NOT TO EXCEED 30 MINUTES TO FACILITATE FORMING OR BENDING TO HORIZONTAL CURVATURE.
2. SHOP DRAWINGS OF RAILING SHALL BE SUBMITTED FOR APPROVAL SHOWING COMPLETE DIMENSIONS AND DETAILS OF FABRICATION AND INCLUDING AN ERECTION DIAGRAM. MATERIAL BEING USED SHALL BE SPECIFIED IN THE SHOP DRAWINGS.
3. CUTTING SHALL BE DONE BY SAWING OR MILLING AND ALL CUTS SHALL BE TRUE AND SMOOTH. FLAME CUTTING WILL NOT BE PERMITTED.
4. WELDING OF ALUMINUM SHALL CONFORM TO STD. SPEC. SECTION 9-2014(3).
5. ALL ALUMINUM PARTS SHALL BE GIVEN A *(CLEAR OR BRONZE) ANODIC COATING OF AT LEAST 0.0006\"/>

* NOTE TO DESIGNER:
Designer to choose color for their project in consultation with the Bridge Architect.

B LOCATE ON OPPOSITE SIDE OF TRAFFIC CURVE. DRIVEN FLUSH WITH THE OUTSIDE FACE OF THE RAILING.

NOTE:
"E" DIMENSION TO MATCH OPENING OF ROADWAY EXPANSION JOINTS.

Bridge Design Dept:		MAINT/STANDARD/OPS/BP/ Railing/BP/1.mmr		WORK SHEET NO.		STANDARD RAILINGS	
Supervisor:	State:	FED. AID PROJ. NO.:	SHEET NO.:	BRIDGE RAILING TYPE BP			
Designed By:	10 WASH			DETAILS 1 OF 2			
Checked By:	JOB NUMBER:						
Bridge Projects Eng.:	DATE:	REVISION:	BY:				
Project Man. By:			APRD:				
Checked/Specified:							
Wed Dec 16 13:25:24 2009							



PART	MATERIAL SPECIFICATION
PIPES	ASTM B 221- 6005-T5
EXTRUDED CHANNELS, COVER PLATES & BAR	ASTM B 241 OK B 429 6061-T6
ANCHOR BOLTS, NUTS & WASHERS	ASTM A 36
STRIP	ASTM A 36
DRIVE PINS	ASTM A 276 TYPE 302 STAINLESS STEEL

BRIDGE DESIGN ENGINEER	MASTAN, ANDRZEJ (P. 2/2009)	TOTAL SHEETS	10
SUPERVISOR		STATE	WA
DRAWN BY		FED. AID PROJ. NO.	
CHECKED BY		WASH	
DESIGNED BY		JOB NUMBER	
BRIDGE PROJECTS ENGINEER		DATE	
PREPARED BY		REVISION	
INCHES/SPECIES		BY	APD

BRIDGE AND STRUCTURES OFFICE
Washington State Department of Transportation

STANDARD RAILINGS
BRIDGE RAILING TYPE BP
DETAILS 2 OF 2

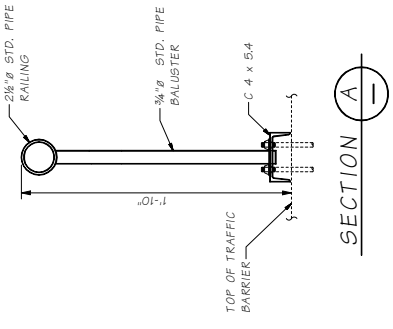
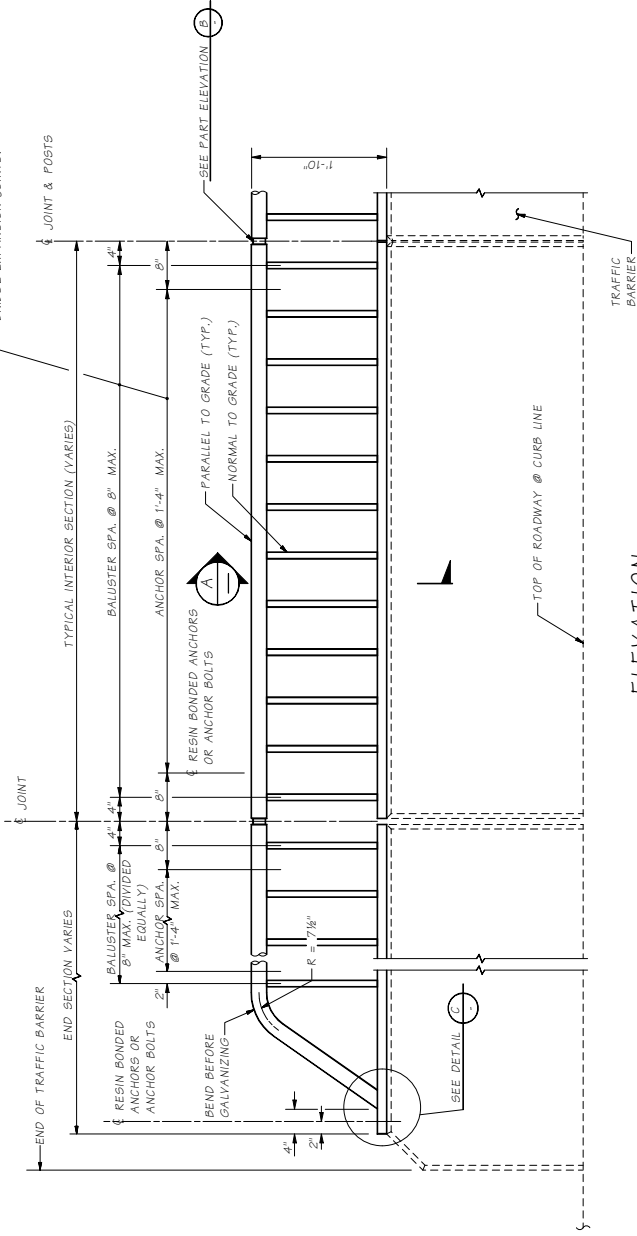
BRIDGE RAILING TYPE BP
DETAILS 2 OF 2

MATL.	PART	MATERIAL SPECIFICATION
STEEL	PIPES	ASTM A53 GRADE B SCHEDULE 40 (STD. PIPE), GALVANIZED IN ACCORDANCE WITH AASHTO M 111.
	WASHERS	ASTM A 193 GRADE B7 GALVANIZED IN ACCORDANCE WITH AASHTO M 232.
	PLATES/BAK CHANNELS	ASTM A 36 GALVANIZED IN ACCORDANCE WITH AASHTO M 111
	DRIVE PINS	ASTM A 276 TYPE 302 STAINLESS STEEL
	ANCHOR BOLTS	ASTM F 593 TYPE 302 STAINLESS STEEL
	NUTS	TAMPER-PROOF TYPE OF EITHER CLEAR ANODIZED ALUMINUM OR ZINC ALLOY

NOTES

1. PIPE RAILING, PIPE RAILING SPLICES, AND CHANNELS SHALL BE BENT TO THE HORIZONTAL CURVE WHERE THE RADIUS OF CURVATURE IS LESS THAN 200 FEET.
2. SHOP DRAWINGS OF RAILING SHALL BE SUBMITTED FOR APPROVAL SHOWING COMPLETE DIMENSIONS AND DETAILS OF FABRICATION, GALVANIZING AND INCLUDING AN ERECTION DIAGRAM. MATERIAL BEING USED SHALL BE SPECIFIED IN THE SHOP DRAWINGS.
3. THE BRIDGE RAILING SHALL BE HOT DIP GALVANIZED AFTER FABRICATION PER AASHTO M 111. ALL COMPONENTS OF RAIL PANEL, POSTS, AND SPLICE SLEEVES SHALL HAVE ALL SURFACES HOT DIP GALVANIZED PRIOR TO ASSEMBLY.
4. CUTTING SHALL BE DONE BY SAWING OR MILLING AND ALL CUTS SHALL BE TRUE AND SMOOTH.
5. PIPE RAILING, PIPE BALUSTERS, RAILING SPLICE AND CHANNELS SHALL BE ADEQUATELY WRAPPED TO ENSURE SURFACE PROTECTION DURING HANDLING AND TRANSPORTATION TO THE JOB SITE.
6. WELDING SHALL BE DONE IN ACCORDANCE WITH AWS D1.1.
7. PIPE RAILING AND SPLICES MAY BE HEATED TO FACILITATE FORMING OR BENDING.
8. THE CONTRACTOR SHALL REPAIR ALL GALVANIZED STEEL SURFACES DAMAGED BY FIELD OPERATIONS, BY PAINTING THE DAMAGED AREAS WITH TWO COATS OF PAINT CONFORMING TO FORMULA A-9-73 AS SPECIFIED IN SECTION 9-08.2 OF THE WASHINGTON STATE STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION.

BALUSTER & ANCHOR SPACINGS SHOWN ARE MAXIMUM ALLOWABLE. VARY AS NECESSARY ADJACENT TO BRIDGE EXPANSION JOINTS.



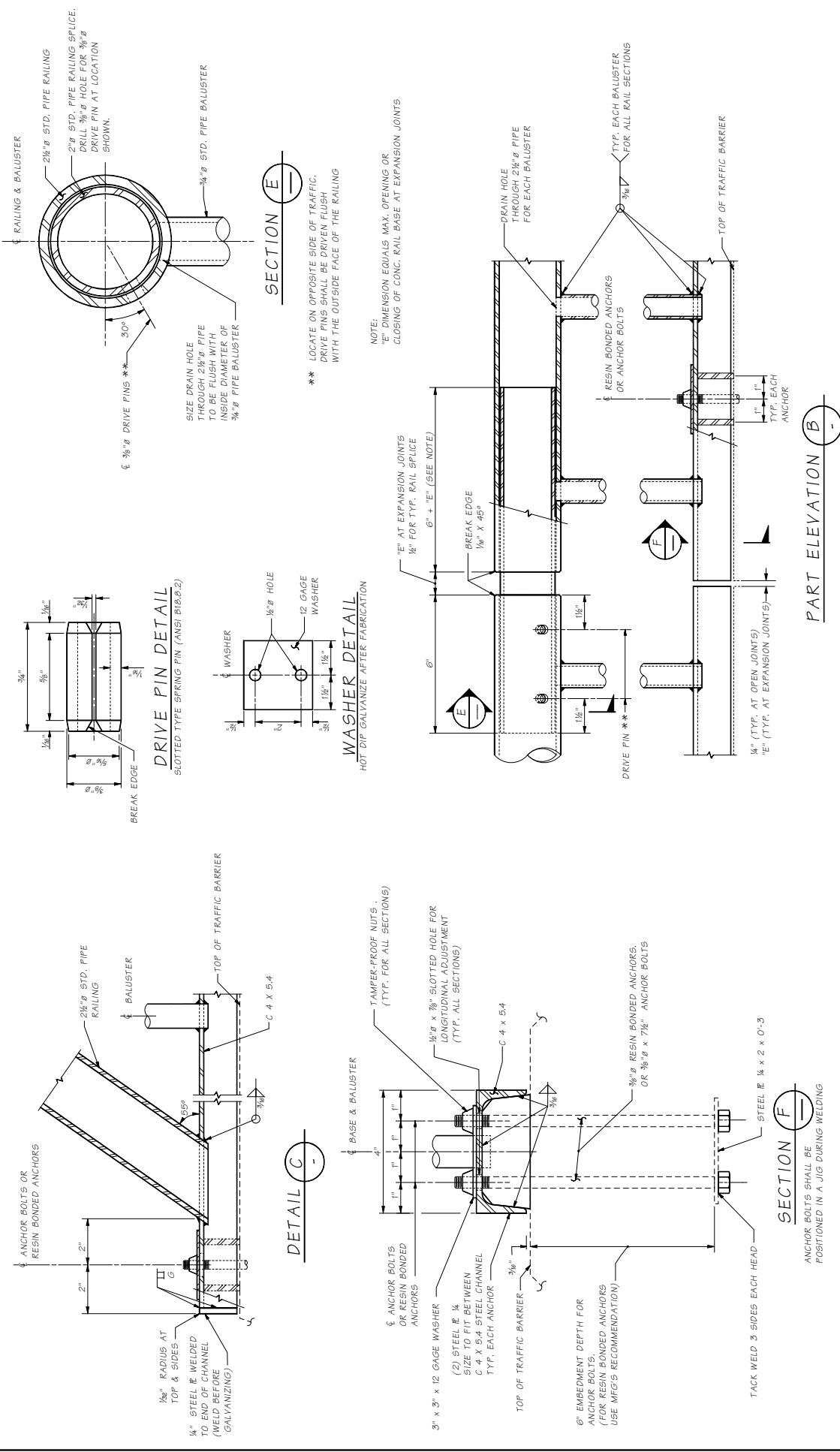
Bridge Design Dept:	MASTANDARDO/SBP	Rail/Steel Railing_BPT1.dwg	WORK NO:	STATE:	10	WASH	FED. AID PROJ. NO.:	SHEET NO.:	TOTAL SHEETS:
Supervisor:									
Designed By:									
Checked By:									
Bridge Projects Eng:									
Project Man By:									
Checked/Spec'ed:									
DATE:									
REVISION:									
<div style="display: flex; justify-content: space-between;"> Washington State Department of Transportation BRIDGE AND STRUCTURES OFFICE </div>									
STANDARD RAILINGS									
BRIDGE RAILING TYPE S-BP DETAILS 1 OF 2									

SHEET 1 of 2

JOB NO. SR 10.5-A3-1

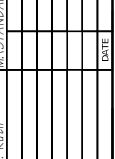
DATE: Wed Dec 16 13:25:32 2009

SHEET NO. 10.5-A3-2

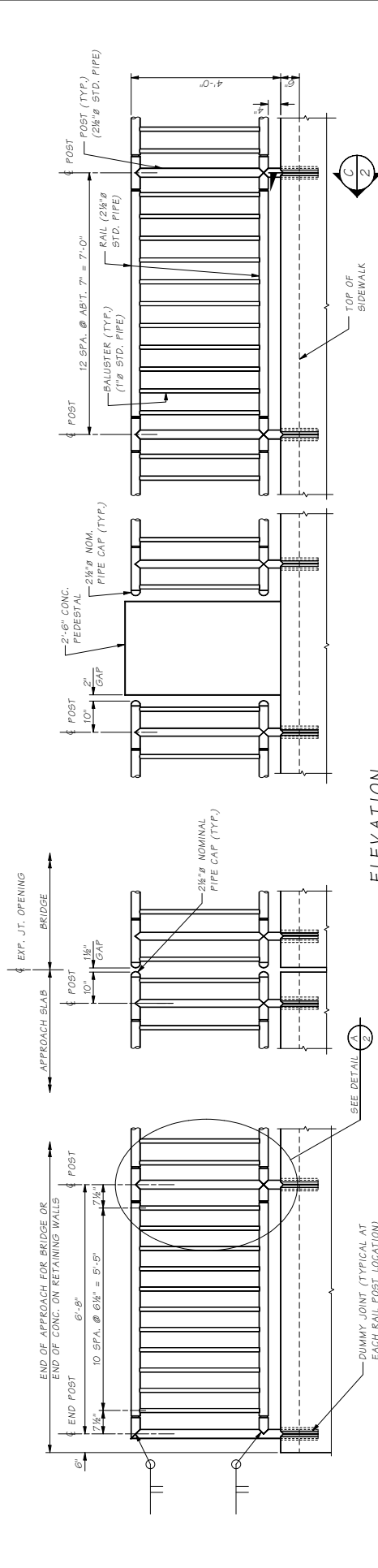


Bridge Design Eng. Charles C. Ruth	MAINTENANCE/REPAIR/REPLACE STEEL RAILING BP-2, PART 2	NO. OF SHEETS	TOTAL SHEETS
Supervisor	STATE	WASH	10
Checked By	JOB NUMBER		
Bridge Projects Eng.	DATE	REVISION	BY / APPD
Project Man By			
Architect/Specifier			

BRIDGE AND STRUCTURES OFFICE



STANDARD RAILINGS
BRIDGE RAILING TYPE S-BP
DETAILS 2 OF 2



ELEVATION

BALUSTERS NORMAL TO GRADE.
TOP & BOTTOM RAILS PARALLEL TO GRADE.

NOTES

1. PIPE RAILING, AND PIPE RAILING SPLICES, SHALL BE BENT TO THE HORIZONTAL CURVE WHERE THE RADIUS OF CURVATURE IS LESS THAN 200 FEET.
2. SHOP DRAWINGS OF RAILING SHALL BE SUBMITTED FOR APPROVAL SHOWING COMPLETE DIMENSIONS AND DETAILS OF FABRICATION AND INCLUDING AN ERECTION DIAGRAM. MATERIAL BEING USED SHALL BE SPECIFIED IN THE SHOP DRAWINGS.
3. PIPE RAILING, AND PIPE RAILING SPLICES, MAY BE HEATED TO NOT MORE THAN 400°F FOR A PERIOD NOT TO EXCEED 30 MINUTES TO FACILITATE FORMING OR BENDING HORIZONTAL CURVATURE.
4. CUTTING SHALL BE DONE BY SAWING OR MILLING, AND ALL CUTS SHALL BE TRUE AND SMOOTH. FLAME CUTTING WILL NOT BE PERMITTED.
5. WELDING OF ALUMINUM SHALL CONFORM TO STD. SPEC. SECTION 9-28.14(3).
6. AFTER FABRICATION, POSTS SHALL BE HEAT TREATED IN ACCORDANCE WITH SECTION 6.5 OF THE AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES, AND TRAFFIC SIGNALS DATED 2001 AND INTEREMS THROUGH 2003.
7. ALL ALUMINUM PARTS SHALL BE GIVEN A (CLEAR OR BRONZE)* ANODIC COATING OF AT LEAST 0.0006 INCHES THICK AND SEALED TO MEET THE REQUIREMENTS OF ASTM B 580 WITH A UNIFORM FINISH.
8. PIPE RAILING, PIPE BALUSTERS, PIPE RAILING SPLICES, SHALL BE ADEQUATELY WRAPPED TO INSURE SURFACE PROTECTION DURING HANDLING AND TRANSPORTATION TO THE JOB SITE.

PART	MATERIAL SPECIFICATION
PIPES	ASTM B 221-6005-T5 SCHEDULE 40 (STD. PIPE) ASTM B 241 OR B 429 6061-T6
BAR	ASTM B 221-6005-T5
DRIVE PINS	ASTM A 276 TYPE 302 STAINLESS STEEL

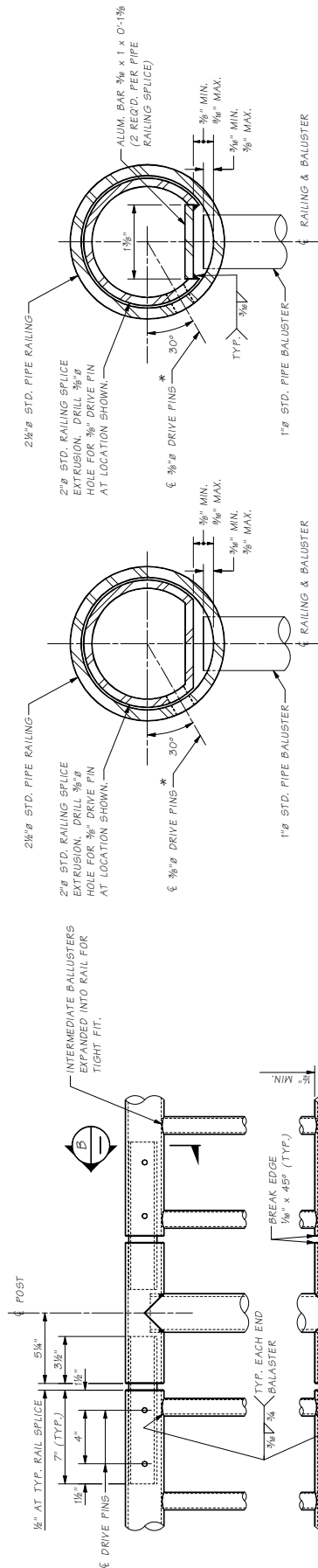
* NOTE TO DESIGNER:
Designer to coordinate with the Bridge Architect.

Bridge Design Dept:	MAINT/STANDARD/POST/BRG	RAILS/APP/ST/RAIL/ALUMIN	LMAN	WORK NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor:				10	WASH			
Designed By:								
Checked By:								
Bridge Projects Eng:								
Project Man By:								
Checked/Spec'ed:								
DATE:								
REVISION:								
BY:								
DATE:								

STANDARD RAILINGS
PEDESTRIAN RAILING
DETAILS 1 OF 2



BRIDGE AND STRUCTURES OFFICE



SECTION A
OPTION #1

* LOCATE ON OPPOSITE SIDE OF TRAFFIC. DRIVE PINS SHALL BE DRIVEN FLUSH WITH THE OUTSIDE FACE OF THE RAILING.

SECTION B
OPTION #2

* LOCATE ON OPPOSITE SIDE OF TRAFFIC. DRIVE PINS SHALL BE DRIVEN FLUSH WITH THE OUTSIDE FACE OF THE RAILING.

SECTION C

EXPANDED POLYSTYRENE IN BOTTOM OF POST

REINFORCING BARS (SEE BR. BHT. ?? FOR DETAILS)

16 GA. GALV. STEEL SLEEVE, FILL WITH EPOXY RESIN.

SECTION D

Bridge Design Eng. Supervisor Checked By Checked By Bridge Projects Eng. Prelim Plan By In-charge/Specialist	MUSTAFA ANDROSIEP, Engr./A.P.E. 10 DATE REVISION BY J.A.P.D.	FEDERAL PROJECT NO. STATE WASH JOB NUMBER	SHEET NO. TOTAL SHEETS	STANDARD RAILINGS PEDESTRIAN RAILING DETAILS 2 OF 2
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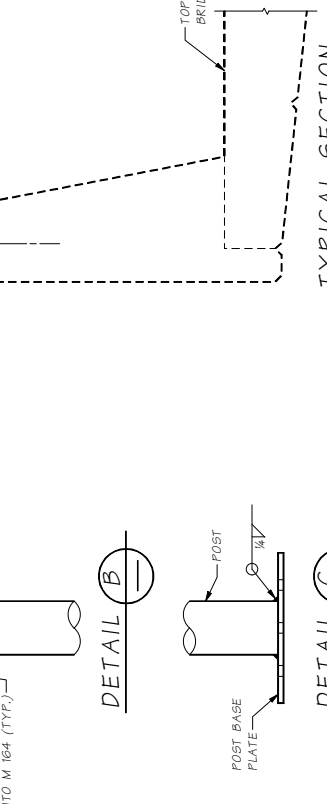
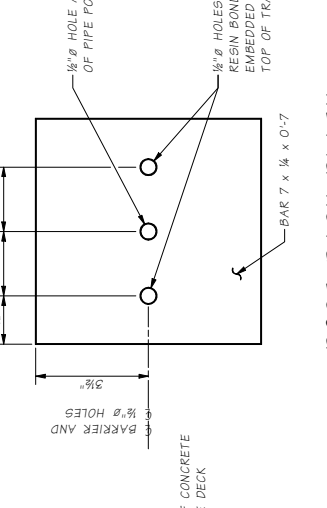
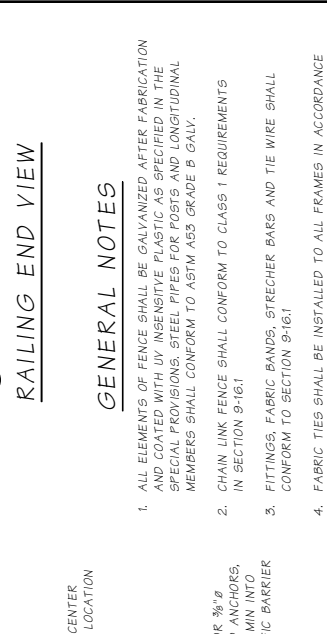
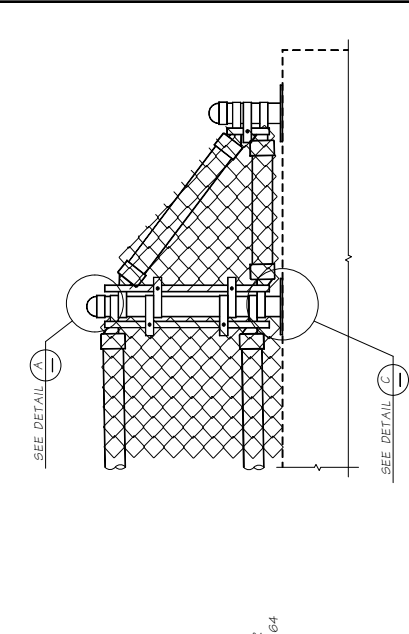
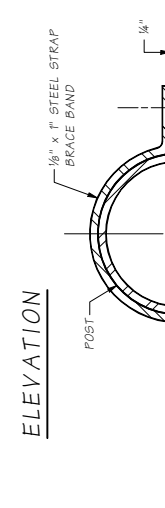
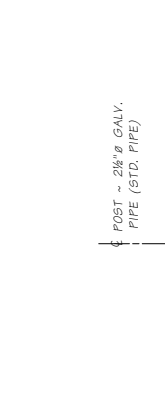
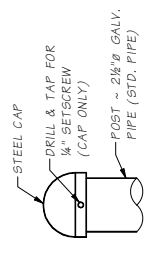
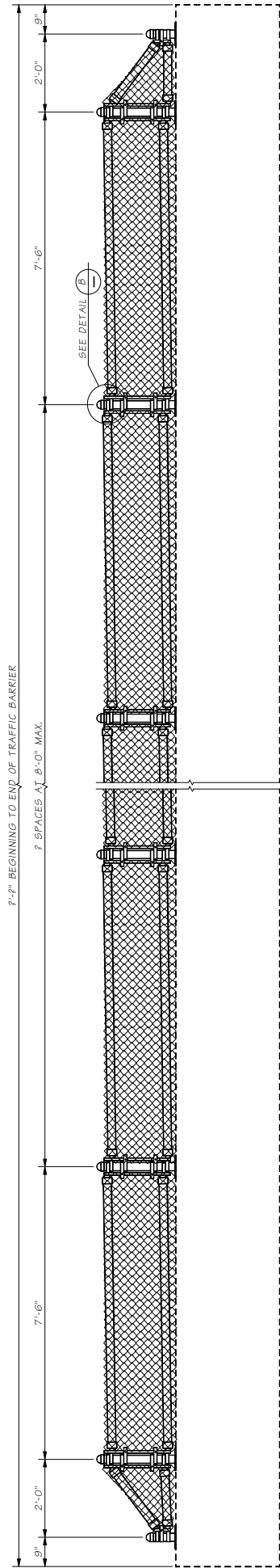
Washington State Department of Transportation

BRIDGE AND STRUCTURES OFFICE

10.5-A4-2

SR JOB NO.

WED Dec 16 13:25:45 2009

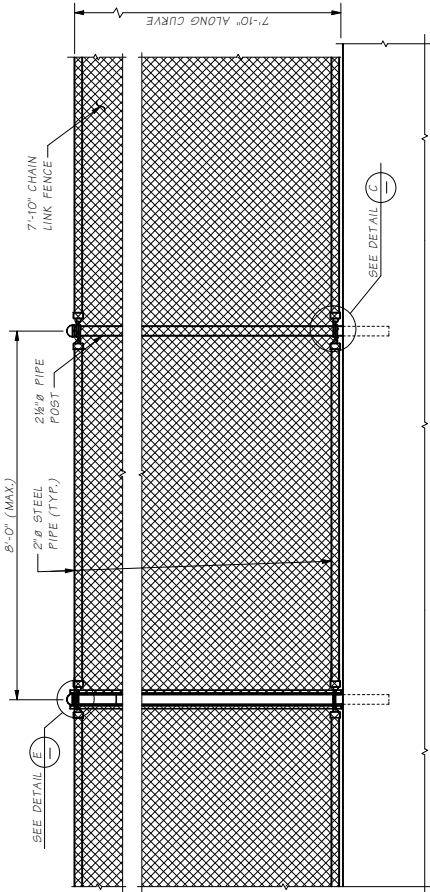


- GENERAL NOTES**
1. ALL ELEMENTS OF FENCE SHALL BE GALVANIZED AFTER FABRICATION AND COATED WITH AN INSENSITIVE PLASTIC AS SPECIFIED IN THE SPECIAL PROVISIONS. STEEL PIPES FOR POSTS AND LONGITUDINAL MEMBERS SHALL CONFORM TO ASTM A53 GRADE B GALV.
 2. CHAIN LINK FENCE SHALL CONFORM TO CLASS 1 REQUIREMENTS IN SECTION 9-16.1
 3. FITTINGS, FABRIC BANDS, STRECHER BARS AND TIE WIRE SHALL CONFORM TO SECTION 9-16.1
 4. FABRIC TIES SHALL BE INSTALLED TO ALL FRAMES IN ACCORDANCE WITH GOOD TRADE PRACTICES AT 1'-2" CENTERS MAXIMUM SPACING.
 5. BOLTS, NUTS AND WASHERS SHALL CONFORM TO SECTION 9-06.5(1) AND GALVANIZED IN ACCORDANCE WITH AASHTO M 252.

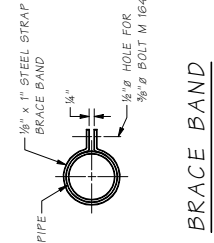
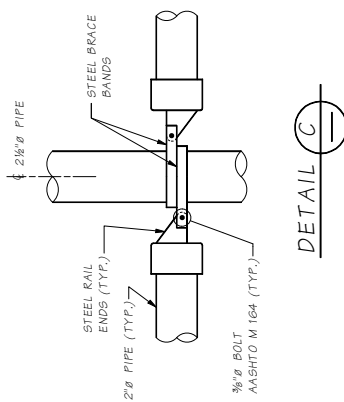
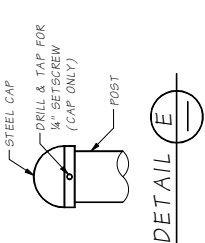
Bridge Design Engr.	MASTANDARDS/BJP	Katia/SNOW FENCE.MAN	NO.	DATE	REVISION	BY	APPD
Supervisor							
Designed By							
Checked By							
Detailled By							
Bridge Project Engr.							
Permit Plan By							
Architect/Specifier							
STATE	NO.	WASH	NO.	JOB NUMBER			
FED. AID PROJ. NO.							
STANDARD RAILINGS	Washington State Department of Transportation						
BRIDGE RAILING TYPE	CHAIN LINK SNOW FENCE						
BRIDGE RAILING TYPE	CHAIN LINK SNOW FENCE						

PROTECTIVE SCREENING NOTES

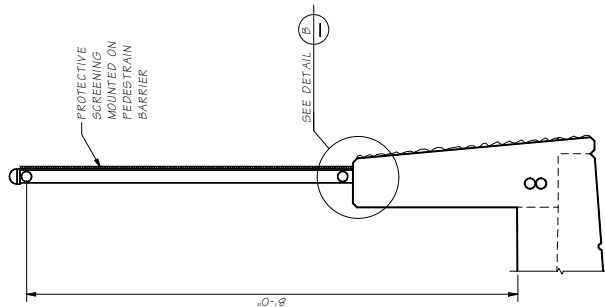
ALL ELEMENTS OF FENCE SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.
STEEL PIPES FOR POSTS AND LONGITUDINAL MEMBERS SHALL CONFORM TO ASTM SPECIFICATION A53 GRADE B GALV. PER AASHTO M 111.
ALL HARDWARE SHALL CONFORM TO AASHTO SPECIFICATION M 193 GALV. PER AASHTO M 111 & M232 UNLESS NOTED OTHERWISE.
FABRIC SHALL BE HEAVY DUTY ALUMINUM OF #9 GAGE WIRE WOVEN IN A 90 CHAIN LINK DIAMOND MESH.
FABRIC TIES SHALL BE INSTALLED TO ALL FRAMES IN ACCORDANCE WITH GOOD TRADE PRACTICES AT 395 CENTERS MAXIMUM SPACING.



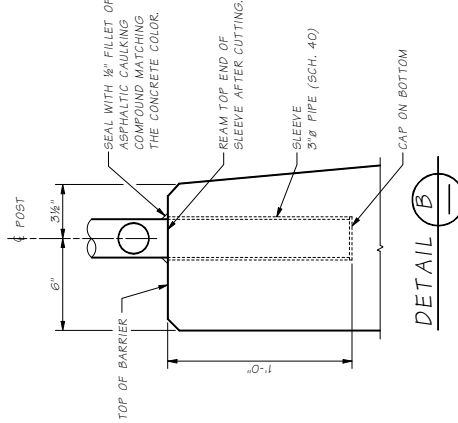
ELEVATION



BRACE BAND



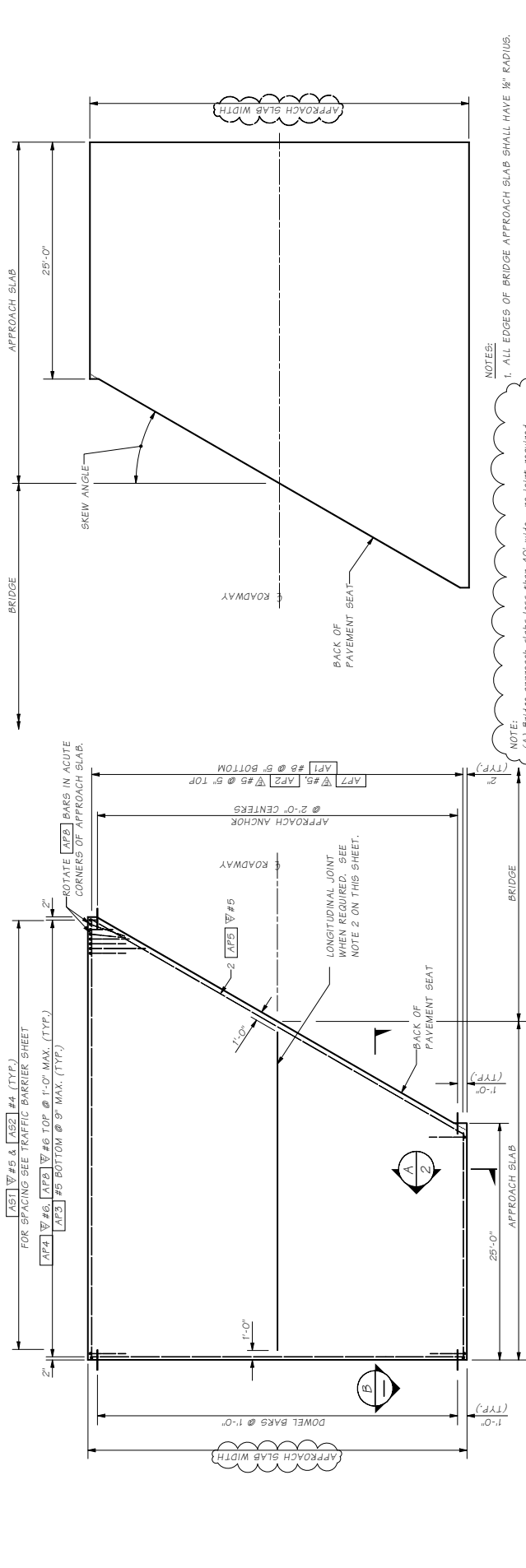
**TYPICAL SECTION
PROTECTIVE SCREEN**



NOTE: PLUG SLEEVE TO PREVENT INFILTRATION DURING CASTING OF CONCRETE.

Please coordinate approval with the Bridge Architect before providing designs with this fence type.

Bridge Design Dept:	WASH	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor:					
Designed By:					
Checked By:					
Bridge Projects Eng:					
Project Man By:					
Contract/Spec/Sheet:					
DATE:					
REVISION:					
BY:					
DATE:					
WASH STATE DEPT OF TRANSPORTATION	BRIDGE AND STRUCTURES OFFICE		STANDARD RAILINGS BRIDGE RAILING TYPE CHAIN LINK FENCE		



- NOTES:**
- ALL EDGES OF BRIDGE APPROACH SLAB SHALL HAVE 1/4" RADIUS.
 - LONGITUDINAL JOINTS SHALL BE PLACED ON LANE LINES AND SHALL BE CONSTRUCTED AND SEALED IN ACCORDANCE WITH STD. SPEC. SECTION 5-05.3(10). JOINTS MAY BE EITHER A SAWCUT CRACK CONTROL JOINT OR A CONSTRUCTION JOINT. SAWCUT JOINTS SHALL TERMINATE 1'-0" BEFORE REACHING EDGE OF SLAB AND MUST BE SAW CUT AS SOON AS POSSIBLE AFTER PLACEMENT OF CONCRETE.
 - THE MINIMUM LAP SPICE OF #5 IS 2'-0", #5 IS 2'-6", #6 IS 3'-0", AND #8 IS 3'-3". ALL LAP SPICES SHALL BE STAGGED SO THAT NO MORE THAN 50% OF REBAR IS SPLICED AT THE SAME LOCATION. LAP SPICES SHALL BE LOCATED WITHIN THE MIDDLE HALF OF THE BRIDGE APPROACH SLAB.
 - PLACE [AP9] #6 BETWEEN [AP4] #6 WHEN TRAFFIC BARRIER OR PEDESTRIAN BARRIER IS REQUIRED.

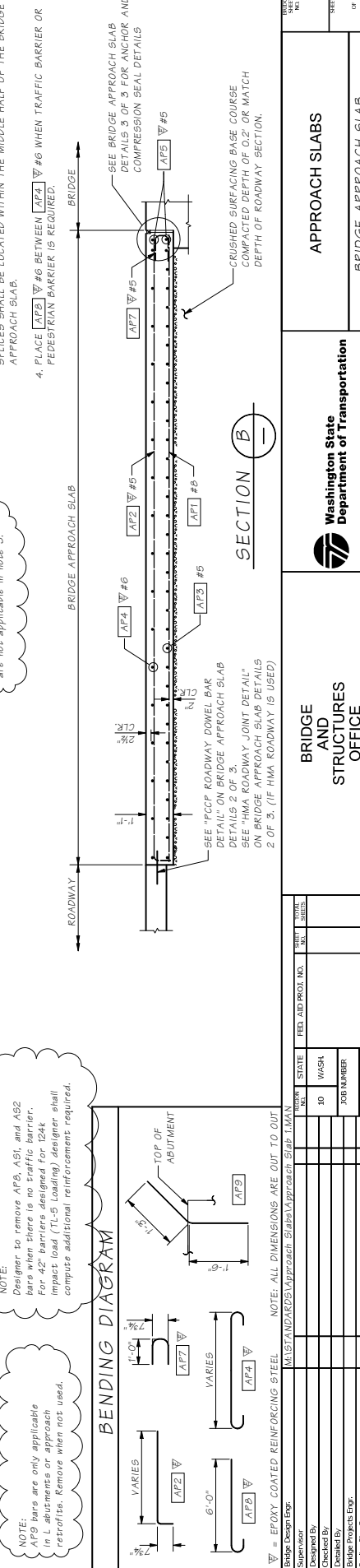
NOTE:
(A) Bridge approach slabs less than 40' wide - no joint required.
(B) Bridge approach slabs wider than 40' - one or more joints are required to divide the slab into approximately 24' wide sections.

NOTE:
Designer to remove call outs that are not applicable in note 3.

NOTE:
Designer to consult with Bridge Design Engineer for skews greater than 45 degrees.

NOTE:
AP9 bars are only applicable in L abutments or approach retrofits. Remove when not used.

NOTE:
Designer to remove AP8, AS1, and AS2 bars when there is no traffic barrier. For 42" barriers designed for 124k impact load (TL-5 Loading) designer shall compute additional reinforcement required.



- NOTES:**
- ALL EDGES OF BRIDGE APPROACH SLAB SHALL HAVE 1/4" RADIUS.
 - LONGITUDINAL JOINTS SHALL BE PLACED ON LANE LINES AND SHALL BE CONSTRUCTED AND SEALED IN ACCORDANCE WITH STD. SPEC. SECTION 5-05.3(10). JOINTS MAY BE EITHER A SAWCUT CRACK CONTROL JOINT OR A CONSTRUCTION JOINT. SAWCUT JOINTS SHALL TERMINATE 1'-0" BEFORE REACHING EDGE OF SLAB AND MUST BE SAW CUT AS SOON AS POSSIBLE AFTER PLACEMENT OF CONCRETE.
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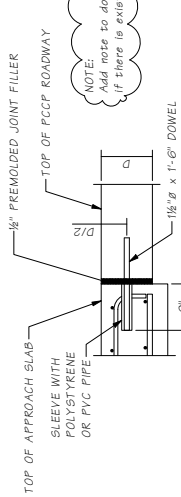
NOTE:
Designer to remove AP8, AS1, and AS2 bars when there is no traffic barrier. For 42" barriers designed for 124k impact load (TL-5 Loading) designer shall compute additional reinforcement required.



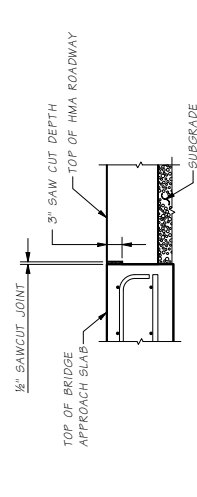
BRIDGE AND STRUCTURES OFFICE

APPROACH SLABS
BRIDGE APPROACH SLAB DETAILS 1 OF 3

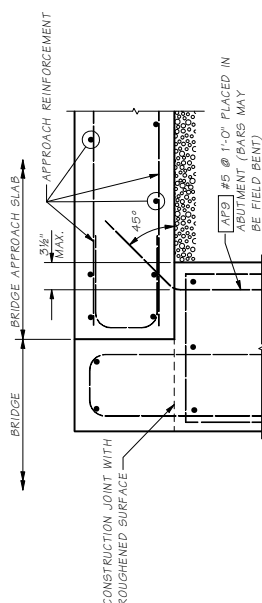
BRIDGE DESIGN ENGINEER	CHECKED BY	DATE	REVISION	BY	APP'D.



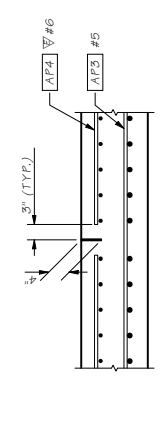
PCCP ROADWAY DOWEL BAR DETAIL
INSERT DOWELS PARALLEL TO CENTER LINE ALONG TRANSVERSE CONSTRUCTION JOINT.



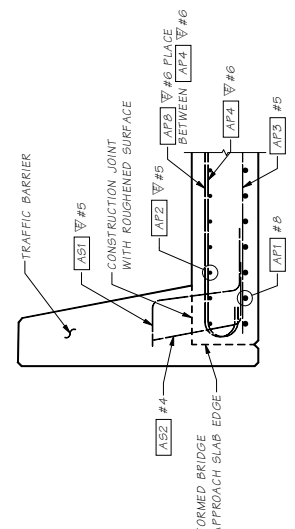
HMA ROADWAY JOINT DETAIL
SAWCUT SHALL BE FILLED WITH HOT-POURED COMPONENT IN ACCORDANCE WITH STANDARD SPECIFICATION SECTION 9-04.2(1) AND SEALED IN ACCORDANCE WITH STANDARD SPECIFICATION SECTION 5-05.3.(b).



ANCHOR DETAIL
(L type anchors)



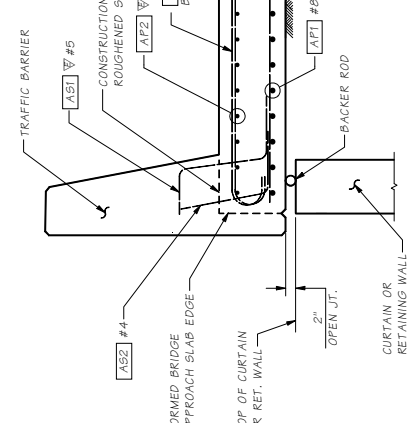
LONGITUDINAL JOINT DETAIL



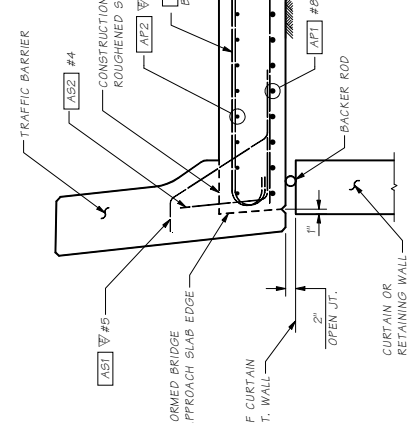
ALTERNATE LONGITUDINAL JOINT DETAIL
EDGE PRECEDING PLACEMENT ONLY WITH 1/8" RADIUS.

eliminate traffic barrier type that will not be used.

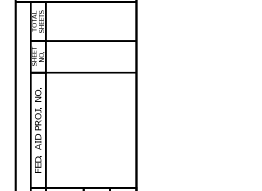
SECTION A



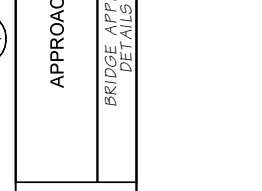
SECTION A



SECTION A

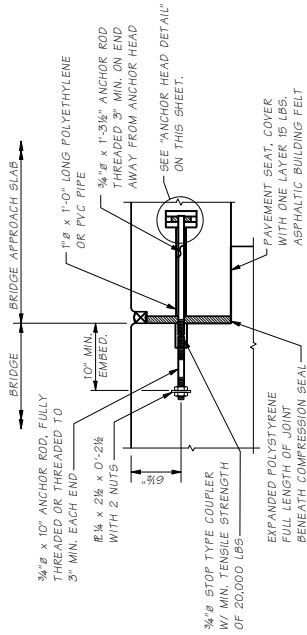


SECTION A



Bridge Design Eng.	Supervisor	Checked By	Design By	Bridge Projects Eng.	Printed By	DATE	REVISION	BY	APPD
WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BRIDGE AND STRUCTURES OFFICE APPROACH SLABS BRIDGE APPROACH SLAB DETAILS 2 OF 3									

BRIDGE DESIGN MANUAL	DECEMBER 2009	BRIDGE DESIGN MANUAL	DECEMBER 2009
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APPROACH ANCHOR - METHOD A

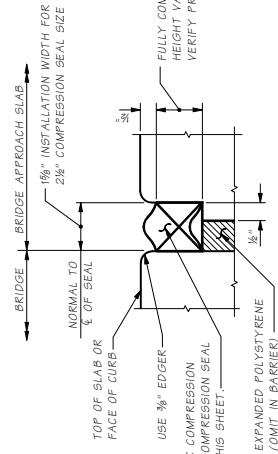
(Not for "L" type abutments)

NOTE:
PAINT METAL COMPONENTS OF APPROACH ANCHOR WITH ONE COAT OF INORGANIC ZINC PAINT CONFORMING TO EITHER SECTION 9-02.1(2)D OR 9-02.1(2)F, OR GALVANIZE APPROACH ANCHORS.

COMPRESSION SEAL TABLE

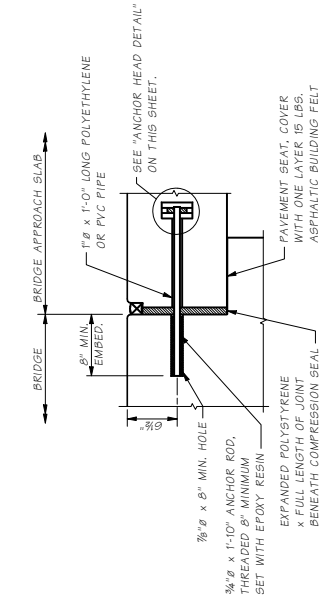
D.S. BRAND	WATSON BOWMAN
CV-2502	2 1/2" WA-250
	2 1/2" WA-250

TESTING SHALL BE PER AASHTO M-220 PRIOR TO USE.



COMPRESSION SEAL DETAIL

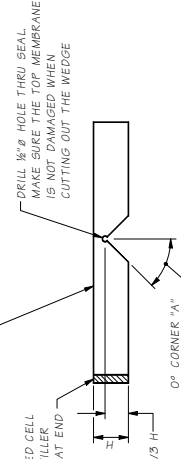
EXPANSION JOINT AT BACK OF PAV'T SEAT



APPROACH ANCHOR - METHOD B

(Not for "L" type abutments)

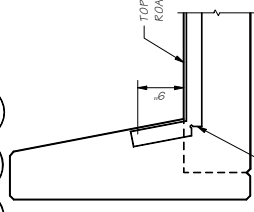
NOTE:
PAINT METAL COMPONENTS OF APPROACH ANCHOR WITH ONE COAT OF INORGANIC ZINC PAINT CONFORMING TO EITHER SECTION 9-02.1(2)D OR 9-02.1(2)F, OR GALVANIZE APPROACH ANCHORS.



SEAL CUTTING DETAIL

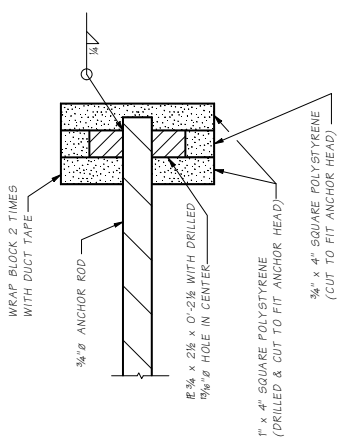
eliminate corner 'B' callout for single slope barrier.

NOTE:
Remove expansion joint in barrier details when there is no barrier on approach slab.



SECTION C

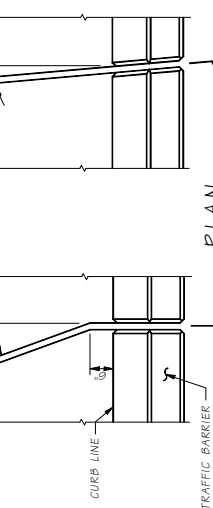
eliminate this detail for f slope barrier.



ANCHOR HEAD DETAIL

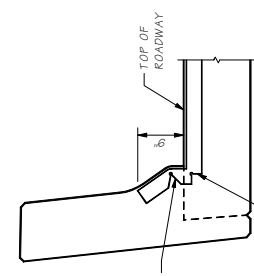
(Not for "L" type abutments)

NOTE:
PAINT METAL COMPONENTS OF APPROACH ANCHOR WITH ONE COAT OF INORGANIC ZINC PAINT CONFORMING TO EITHER SECTION 9-02.1(2)D OR 9-02.1(2)F, OR GALVANIZE APPROACH ANCHORS.



EXPANSION JOINT

NOTE:
Remove expansion joint in barrier details when there is no barrier on approach slab.



SECTION C

eliminate this detail for single slope barrier.

BRIDGE DESIGN ENGINE	DATE	REVISION	BY	APP'D.	WORK NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
						WA			
DESIGNED BY					10	WASH			
CHECKED BY									
BRIDGE PROJECTS ENGR.									
PROJECT MANAGER									
CHECKED/SPEC'KED									

Washington State Department of Transportation

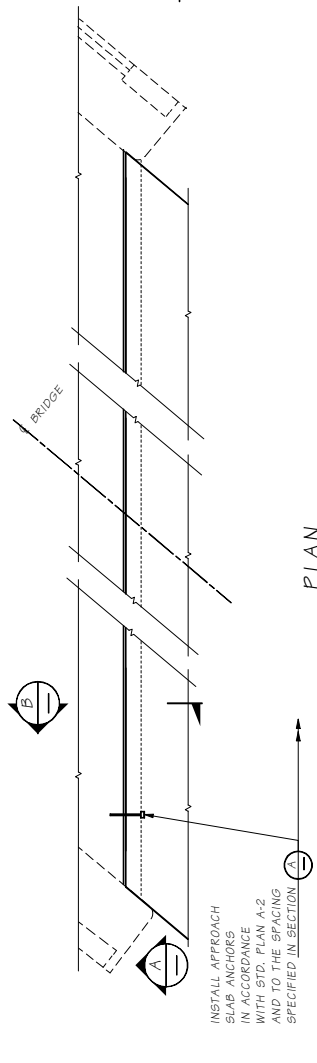
BRIDGE AND STRUCTURES OFFICE

APPROACH SLABS

BRIDGE APPROACH SLAB DETAILS 3 OF 3

DECEMBER 2009

Chapter 10



* THE DIMENSIONS SHOWN IN THE PLANS ARE BASED ON ORIGINAL CONSTRUCTION RECORDS TOGETHER WITH SURVEY DATA. THESE DIMENSIONS SHALL BE MEASURED IN THE FIELD BY THE CONTRACTOR PRIOR TO FABRICATION OF ANY COMPONENTS.

SECTION B
(EXISTING CONDITION)
TYPICAL FOR APPROACH SLABS

* THE DIMENSIONS SHOWN IN THE PLANS ARE BASED ON ORIGINAL CONSTRUCTION RECORDS TOGETHER WITH SURVEY DATA. THESE DIMENSIONS SHALL BE MEASURED IN THE FIELD BY THE CONTRACTOR PRIOR TO FABRICATION OF ANY COMPONENTS.

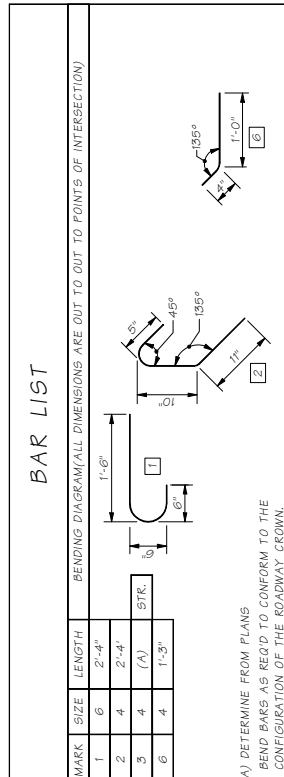
** ELASTOMERIC EXPANSION JOINT SEAL:
D.S. BROWN CY-2502 OR WATSON BOWMAN ACME WA 250 TESTING SHALL BE PER AASHTO M 220 PRIOR TO UBE. "D" DENOTES FULLY COMPRESSED SEAL HEIGHT. TEMPERATURE SHOWN REFERS TO THE TEMPERATURE OF THE SUPERSTRUCTURE.

APPROACH SLAB ANCHOR METHOD A @ 1'-0" SPA. IN ACCORDANCE WITH STANDARD PLAN A-2

APPROACH SLAB (SEE STD. PLAN A-2)

SYNTHETIC CLOSED CELL EXPANDED RUBBER JOINT FILLER CEMENTED TO JOINT SEAL (TYP. AT BOTH END)

SECTION A-A



(A) DETERMINE FROM PLANS
BEND BARS AS REQ'D TO CONFORM TO THE CONFIGURATION OF THE ROADWAY CROWN.

Bridge Design Dept:	WASH	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Designed By:				10	
Checked By:					
Bridge Projects Eng:					
Project Manager:					
Date:					
Revision:					
BY:					
APP'D:					

Washington State
Department of Transportation

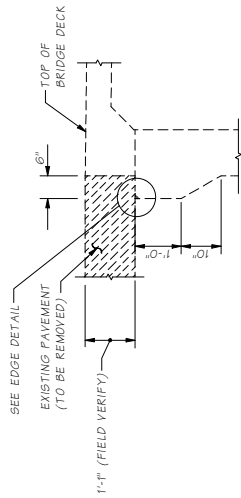
BRIDGE AND STRUCTURES OFFICE

PAVEMENT SEAT REPAIR

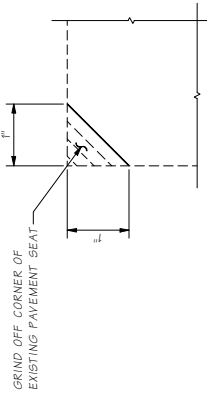
PAVEMENT SEAT REPAIR DETAILS

JOB NO. 1000 SHEET 3

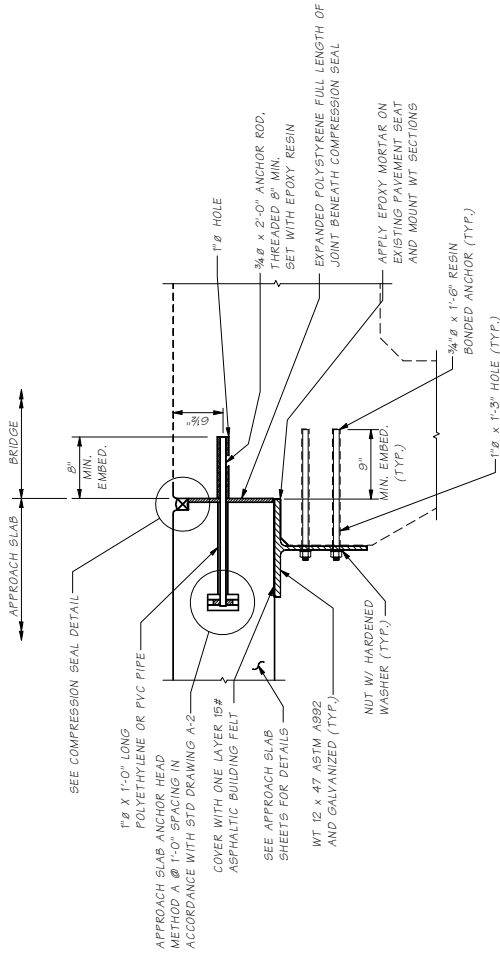
DATE: Tue Dec 22 09:00:04 2009



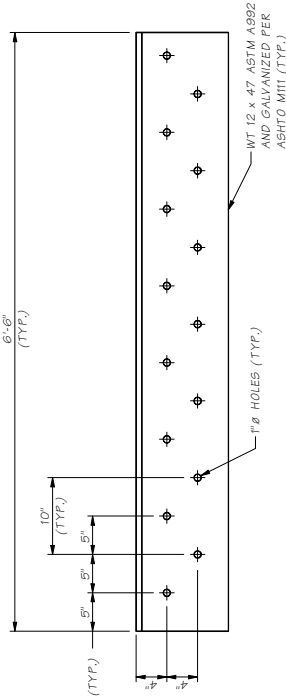
PAVEMENT REMOVAL DETAIL



EDGE DETAIL



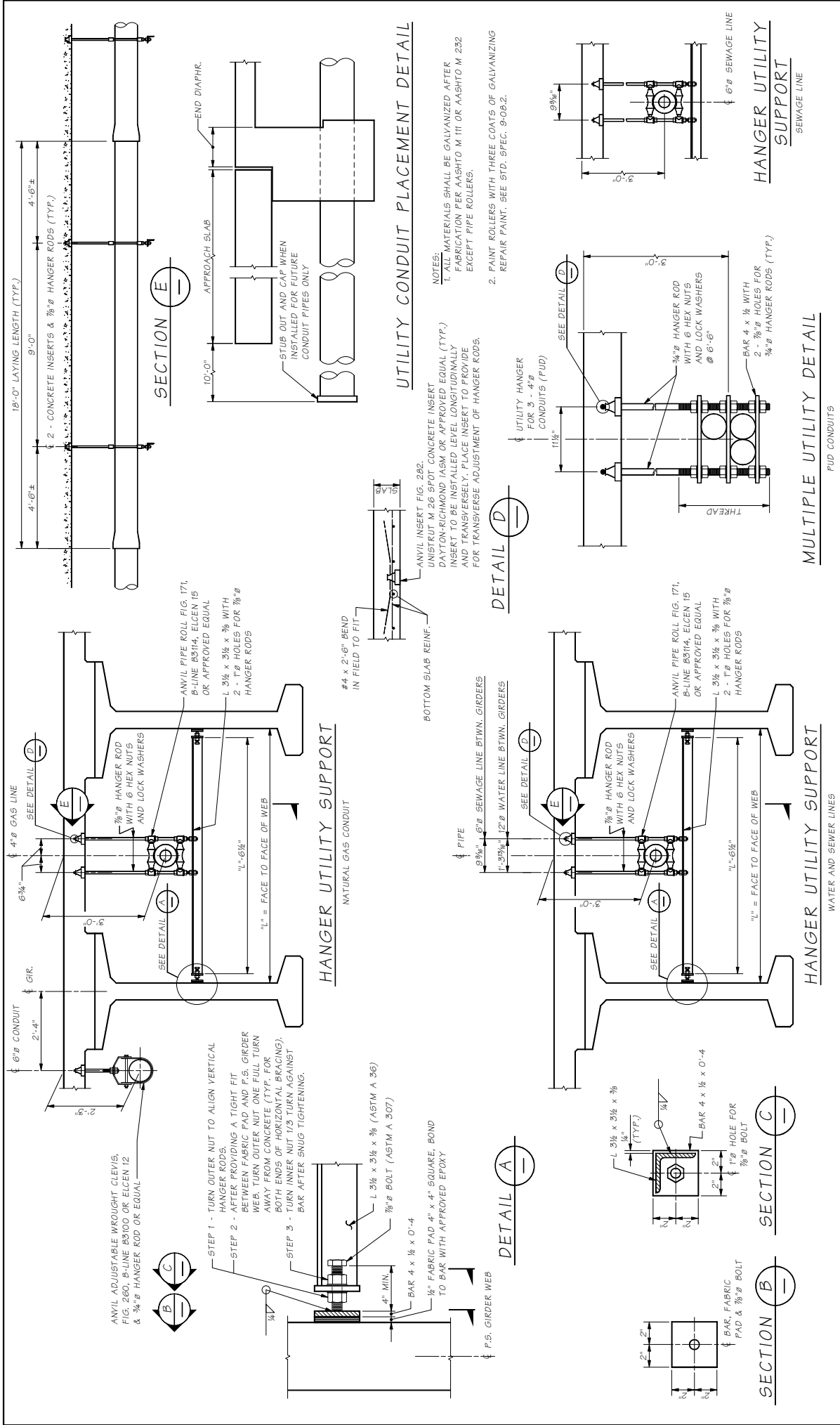
PAVEMENT SEAT REPLACEMENT



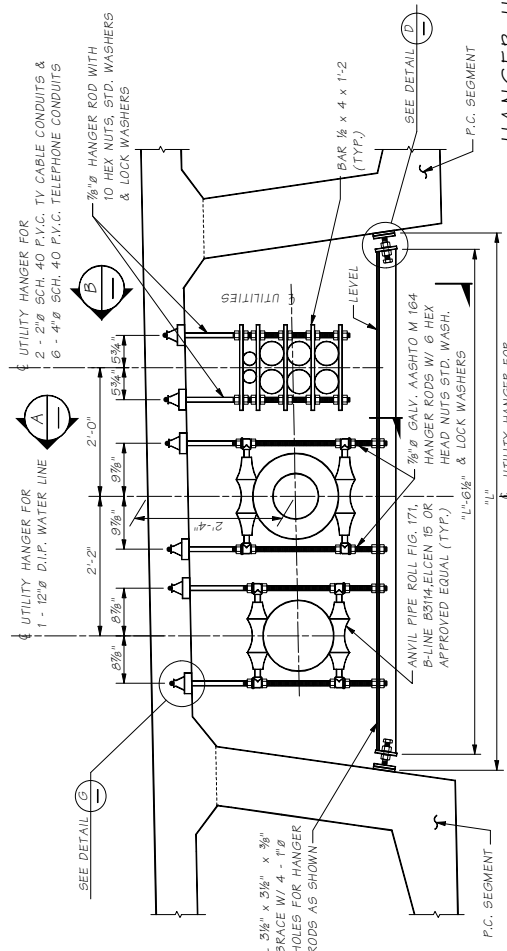
TYPICAL WT 12 SECTION DETAIL

NOTE:
REPAIR EXISTING PAVEMENT SEAT CONCRETE PRIOR TO INSTALLING WT SECTIONS.

Bridge Design Engr. Supervisor Designed By Checked By Drawn By Date	MAINT STANDARDS Approach: Submit SECTION PAVEMENT SEAT REPAIR MAN	COUNTY STATE	SHEET NO.
		FEDERAL PROJ. NO.	SHEET OF
JOB NUMBER 10 WASH JOINT NUMBER	BRIDGE AND STRUCTURES OFFICE	Washington State Department of Transportation	PAVEMENT SEAT REPAIR PAVEMENT SEAT REPAIR DETAILS
REGION DISTRICT COUNTY	BRIDGE AND STRUCTURES OFFICE	Washington State Department of Transportation	PAVEMENT SEAT REPAIR PAVEMENT SEAT REPAIR DETAILS

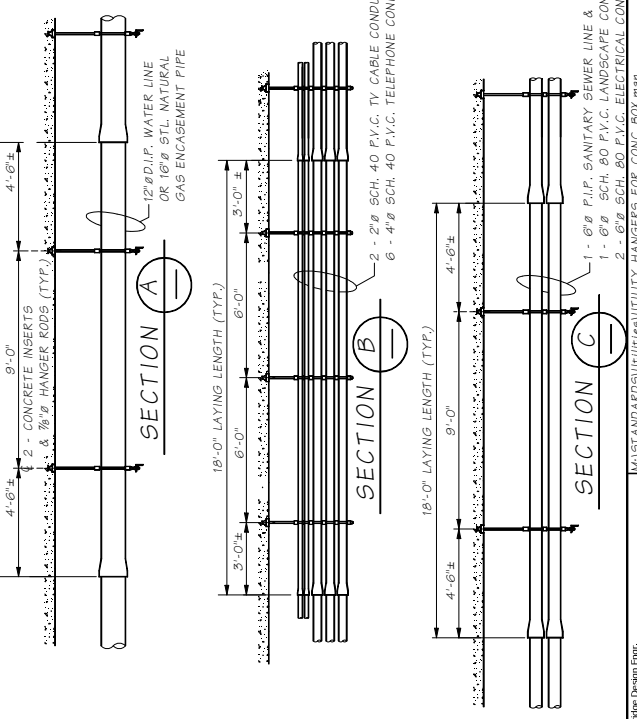


Bridge Design Engr.	DATE	REVISION	BY	APPROVED
Supervisor	DATE	REVISION	BY	APPROVED
Designed By	DATE	REVISION	BY	APPROVED
Checked By	DATE	REVISION	BY	APPROVED
Drawn By	DATE	REVISION	BY	APPROVED
Bridge Project Engr.	DATE	REVISION	BY	APPROVED
Print Plan By	DATE	REVISION	BY	APPROVED
Architect/Specifier	DATE	REVISION	BY	APPROVED
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr.	DATE	REVISION	BY	APPROVED
Supervisor	DATE	REVISION	BY	APPROVED
Designed By	DATE	REVISION	BY	APPROVED
Checked By	DATE	REVISION	BY	APPROVED
Drawn By	DATE	REVISION	BY	APPROVED
Bridge Project Engr.	DATE	REVISION	BY	APPROVED
Print Plan By	DATE	REVISION	BY	APPROVED
Architect/Specifier	DATE	REVISION	BY	APPROVED
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____		Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____		
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____		Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____		
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____		Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____		
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				
Bridge Design Engr. _____ Supervisor _____ Designed By _____ Checked By _____ Drawn By _____ Bridge Project Engr. _____ Print Plan By _____ Architect/Specifier _____				



HANGER UTILITY SUPPORT

NOTES:
1. ALL MATERIALS SHALL BE GALVANIZED AFTER FABRICATION PER AASHTO M 111 OR AASHTO M 232 EXCEPT PIPE ROLLERS.
2. PAINT ROLLERS WITH THREE COATS OF GALVANIZING REPAIR PAINT. SEE STD. SPEC. 9-08.2.



UTILITY CONDUIT PLACEMENT DETAIL

END DIAPHRAGM

APPROACH SLAB

STUB OUT AND CAP WHEN INSTALLED FOR FUTURE CONDUIT PIPES ONLY

LANDSCAPE CONDUIT, TV, CABLE CONDUIT & TELEPHONE CONDUIT

STEP 1 - TURN OUTER NUT TO ALIGN VERTICAL HANGER RODS.

STEP 2 - AFTER PROVIDING A TIGHT FIT BETWEEN FABRIC PAD AND BOX GIRDER WEB, TURN OUTER NUT ONE FULL TURN AWAY FROM CONCRETE (TYP. FOR BOTH ENDS OF HORIZONTAL BRACING).

STEP 3 - TURN INNER NUT 1/3 TURN AGAINST BAR AFTER SNUG TIGHTENING.

DETAIL G

DETAIL E

DETAIL D

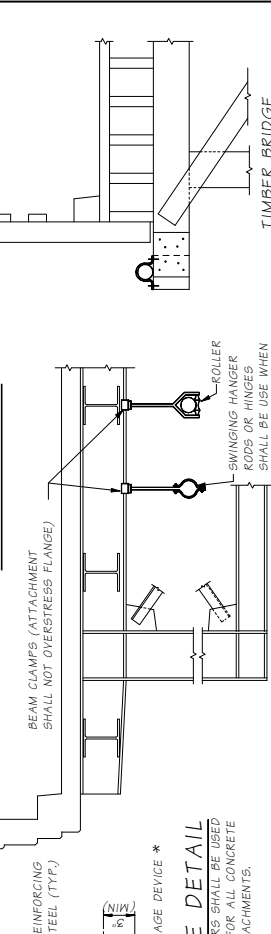
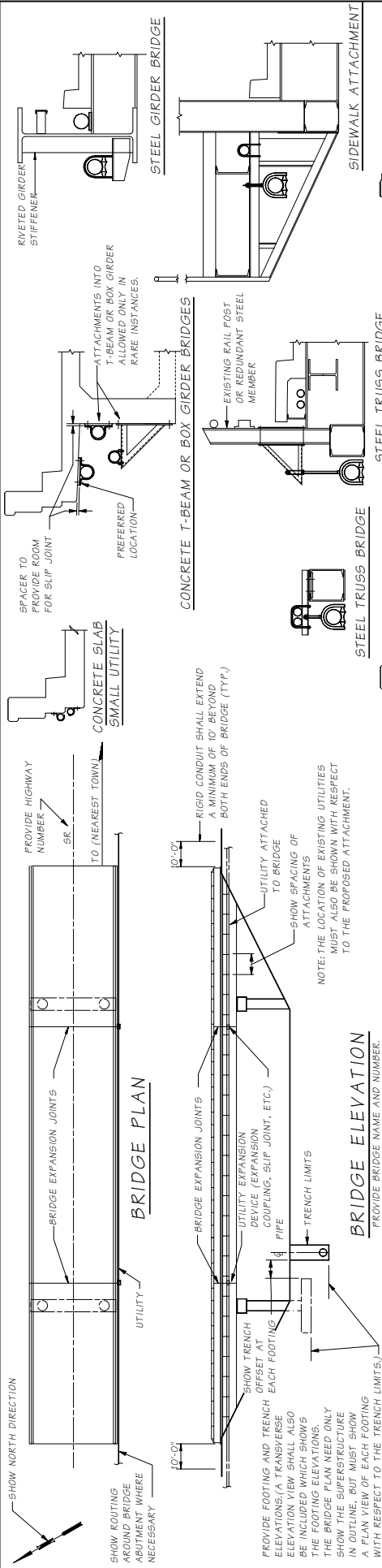
* LENGTH OF BOLT TO BE VERIFIED IN FIELD BY THE CONTRACTOR TO INSURE A TIGHT-FIT.

DESIGNED BY	CHECKED BY	DATE
PREPARED BY	REVISION	
PRIOR APPROVAL BY		
DATE		

	BRIDGE AND STRUCTURES OFFICE					UTILITY HANGER DETAILS FOR CONCRETE BOX STRUCTURES
	Washington State Department of Transportation					
MAINT./STANDARD/SURVEILLANCE/UTILITY HANGERS FOR CONCRETE BOX MAN	DATE	REV.	BY	REASON	DATE	BY

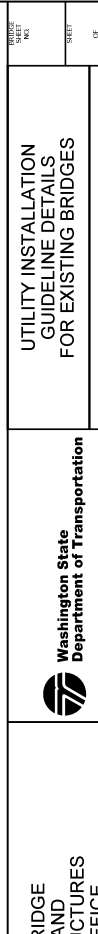
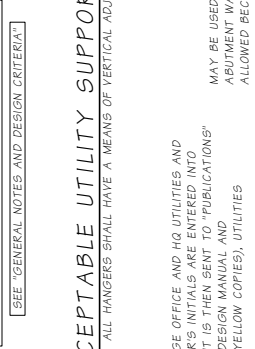
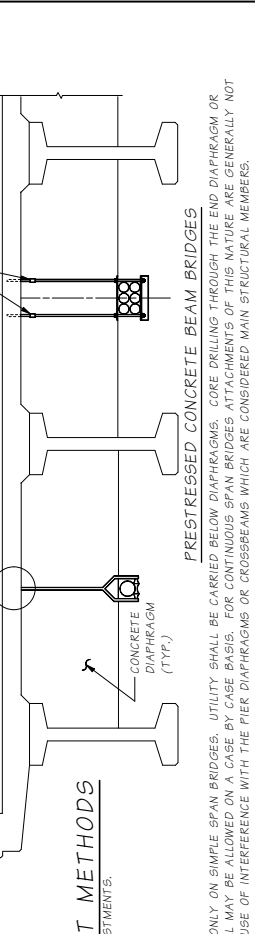
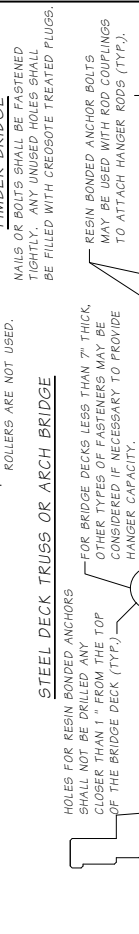
7/16/09 STATE 10 WASH JOB NUMBER

Printed By: jrc/2009/10-39-45 2009



THE DETAILS SHOWN HERE ARE PRESENTED AS A GUIDE ONLY. EACH PROPOSED UTILITY INSTALLATION SHALL BE SUBMITTED TO THE DEPARTMENT OF TRANSPORTATION FOR APPROVAL ON AN INDIVIDUAL BASIS. COMPLIANCE WITH THESE DETAILS DOES NOT ASSURE APPROVAL, NOR DOES VARIANCE FROM THESE DETAILS, FOR REASONABLE CAUSE, OR USE OF DETAILS NOT SHOWN HERE, NECESSARILY EXCLUDE APPROVAL.

SEE "GENERAL NOTES AND DESIGN CRITERIA"



UNACCEPTABLE UTILITY LOCATIONS AND CONNECTIONS

SUBMITTAL REQUIREMENTS FOR DISTRICT:

A MINIMUM OF 5 PRINTS OF A REPRODUCIBLE DRAWING OF THE ATTACHMENT DETAILS SHALL BE SUBMITTED WITH THE FRANCHISE APPLICATION. ATTACHMENT DETAIL DRAWINGS SHALL INCLUDE A BRIDGE PLAN AND ELEVATION SHOWING THE LOCATION OF THE UTILITY, SUPPORTS AND EXPANSION DEVICES, AND SHALL ALSO INCLUDE DETAILS OF ATTACHMENTS, A TYPICAL CROSS SECTION AND UTILITY ROUTING AT THE BRIDGE ABUTMENTS OR PIER FOOTINGS. BRAND NAMES FOR HANGERS AND ANCHORS SHALL ALSO BE INCLUDED.

NOTE:

DOT FORM 224-047, GENERAL NOTES AND DESIGN CRITERIA, (EXAMPLE 1-10 OF THE UTILITIES MANUAL), IS TO BE PART OF, AND INCLUDED BY REFERENCE, IN ANY PERMIT OR FRANCHISE CONTAINING A BRIDGE ATTACHMENT.

REVISIONS TO THIS GUIDE FOR UTILITY INSTALLATIONS MUST BE COORDINATED WITH BOTH THE BRIDGE OFFICE AND HQ UTILITIES AND SHALL BE APPROVED BY THE BRIDGE RETROFIT ENGINEER. THE REVISION NOTE, DATE AND ENGINEER'S INITIALS ARE ENTERED INTO THE BORDER REVISION BLOCK BY THE CADD OPERATOR AFTER APPROVAL. A FULL-SIZE PAPER PRINT IS THEN SENT TO "PUBLICATIONS" THROUGH THE HQ UTILITIES ENGINEER FOR REDUCTION TO 11X17" AND DISTRIBUTION TO ALL BRIDGE DESIGN MANUAL AND UTILITY MANUAL HOLDERS. CROSS REFERENCE: BRIDGE DESIGN MANUAL - SECTION B, APPENDIX A (YELLOW COPIES), UTILITIES MANUAL - CHAPTER 1, EXAMPLES SECTION (WHITE COPIES)

ACCEPTABLE UTILITY SUPPORT METHODS

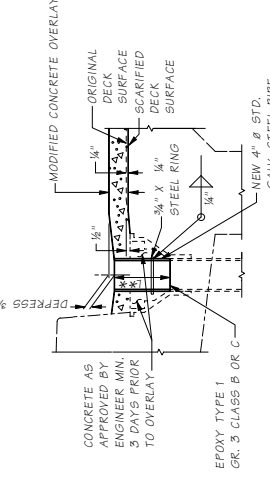
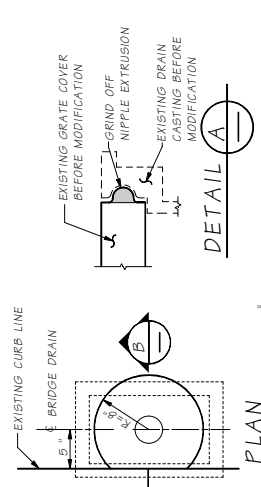
ALL HANGERS SHALL HAVE A MEANS OF VERTICAL ADJUSTMENTS.

UTILITY INSTALLATION GUIDELINE DETAILS FOR EXISTING BRIDGES

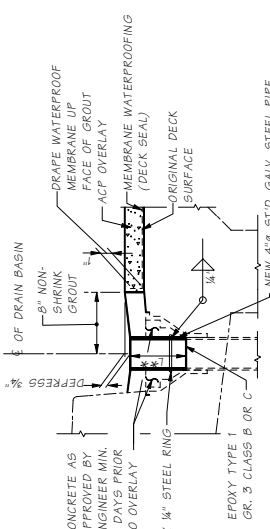
UTILITY HANGER DETAILS

Bridge Design Dept:	WASH	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor:					
Designed By:					
Checked By:					
Bridge Projects Eng:					
Project Man. By:					
Checked/Spec'ed:					
DATE:					
REVISION:					
BY:					
APRD:					

ALTERNATE MODIFICATION FOR BRIDGE DRAIN TYPES "1A", "1B" & "1C"

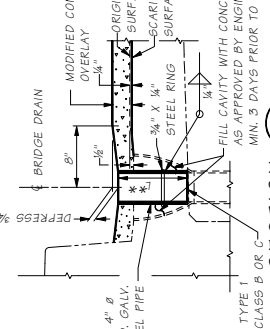
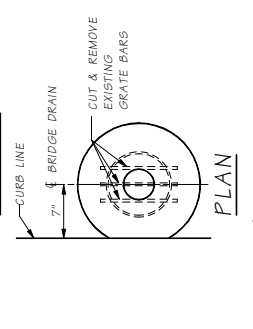


SECTION A
 MODIFIED CONCRETE OVERLAY SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.

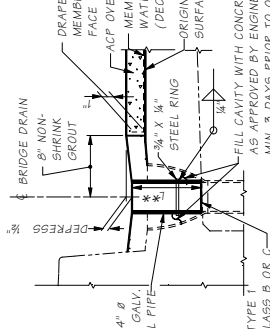


SECTION B
 FOR ACP MEMBRANE OVERLAY
 ** ACTUAL PIPE LENGTH (L) SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.

OVERLAY MODIFICATION FOR BRIDGE DRAIN TYPE 6



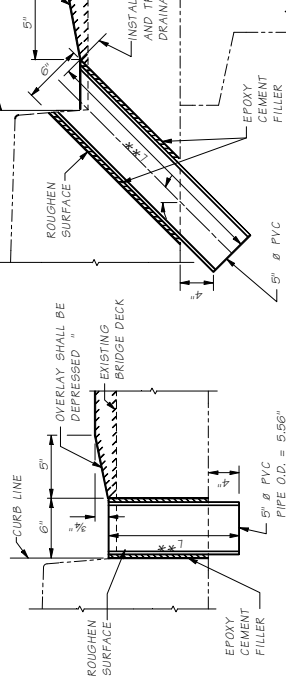
SECTION C
 MODIFIED CONCRETE OVERLAY SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.



SECTION D
 FOR ACP W/ MEMBRANE OVERLAY
 ** ACTUAL PIPE LENGTH (L) SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.

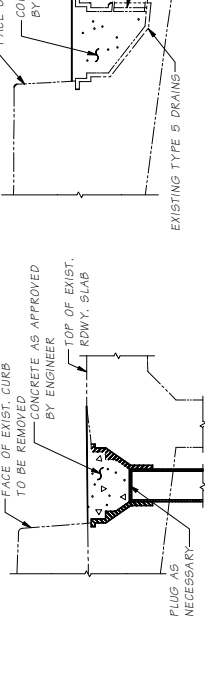
DRAIN MODIFICATION BY CORE DRILLING

THIS MODIFICATION MAY BE REQUIRED WHEN THE EXISTING DRAIN IS NOT FUNCTIONAL AND CANNOT BE MADE FUNCTIONAL OR WHEN THE EXISTING DRAIN MUST BE PERMANENTLY PLUGGED AND RELOCATED, AS WITH A WIDENING.



ELEVATION VIEW STRAIGHT DROP
 ** ACTUAL PIPE LENGTH (L) SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.

ELEVATION VIEW INCLINED DROP
 ** ACTUAL PIPE LENGTH (L) SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.



BRIDGE DRAIN PLUG DETAIL
 REMOVE DRAIN GRATING & GALV. STEEL CHAIN. FILL DRAIN WITH CONCRETE GROUT AFTER PLUGGING.



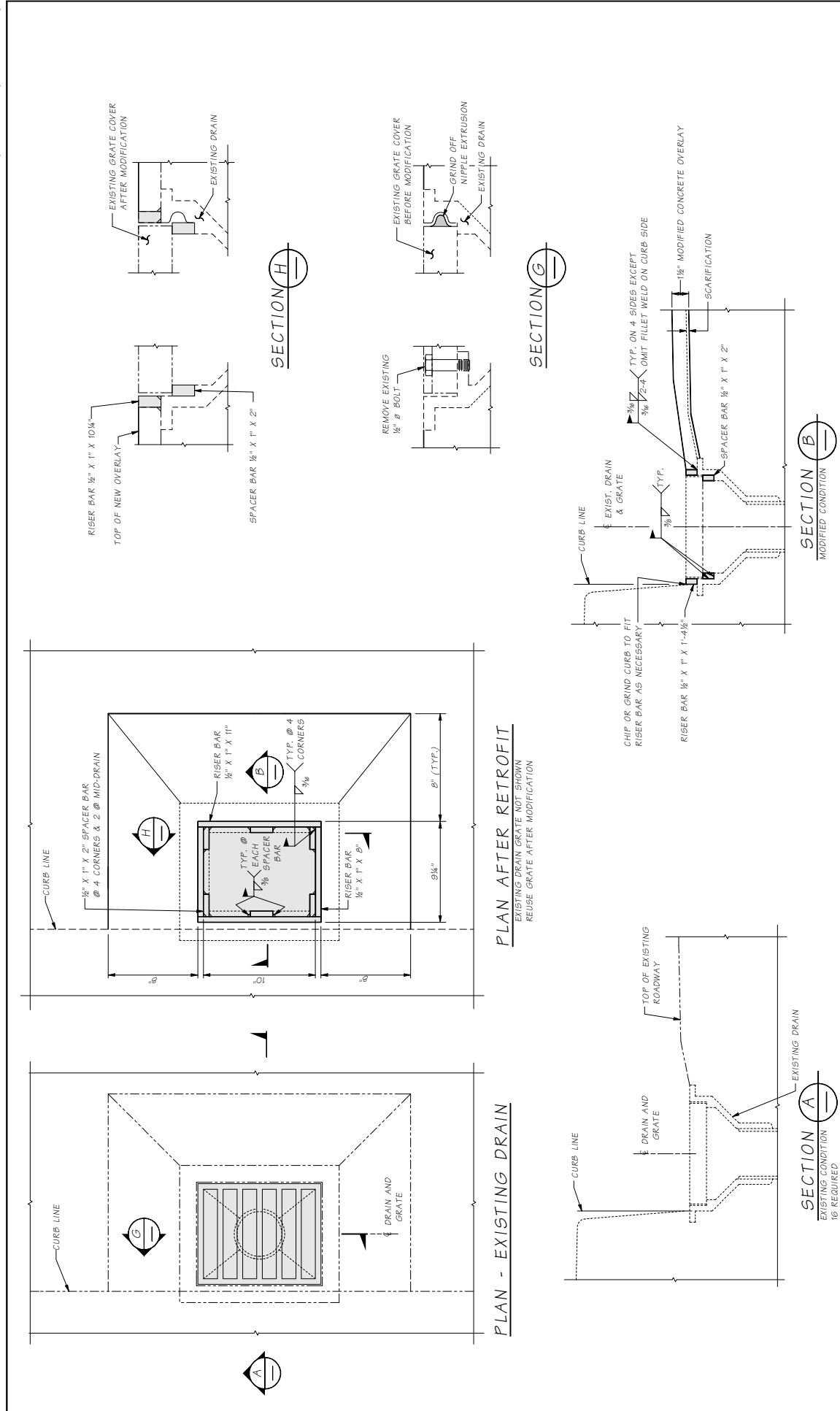
BRIDGE DRAIN PLUG DETAIL
 REMOVE DRAIN GRATING & GALV. STEEL CHAIN. FILL DRAIN WITH CONCRETE GROUT AFTER PLUGGING.

BRIDGE DESIGN ENGINE	DATE	REVISION	BY	APP'D.
DESIGNED BY				
CHECKED BY				
BRIDGE PROJECTS ENGR.				
PROJECT MAN. BY				
CHECKED/RECHECKED				

BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

WORK NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH			
JOB NUMBER	DATE	REVISION	BY	APP'D.



Bridge Design Dept:	WASH	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor:	10	WASH			
Designed By:					
Checked By:					
Bridge Projects Eng:					
Drawn By:					
Checked/Revised:					
DATE:					
REVISION:					
BY:					
DATE:					

WASHINGTON STATE
Department of Transportation

BRIDGE AND STRUCTURES OFFICE

BRIDGE DRAIN MODIFICATION
BRIDGE DRAIN TYPES 2 THRU 5
MODIFICATION FOR OVERLAY

10.10-A1-2

SHEET 1

SR JOB NO.

DATE: Jul 17 06:07:32 2008

Chapter 11 Detailing Practice

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11.1 Detailing Practice

The following is to provide basic information on drafting and the fundamentals of Bridge and Structures Office drafting practices.

11.1.1 Standard Office Practices

A. Purpose

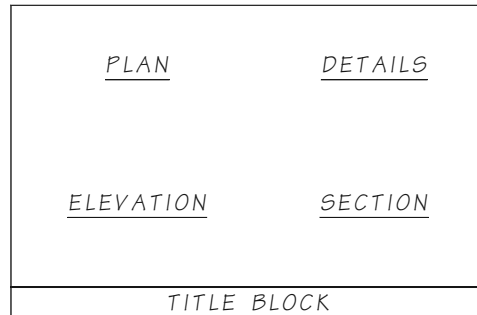
- The purpose of these standards is to enable the Bridge and Structures Office to produce **consistent** and **effective** plan sheets that will have uniform appearance and information.
- Designers and detailers are responsible for ensuring that these criteria are implemented.
- The Bridge Design Engineer must approve deviation from these standards.

B. Planning

- The designer and the structural detailer together coordinate the **scope** of the detailing work involved in each project. Time should be allotted for checking plans for accuracy and consistency with office practices.
- Similar bridge plans and details should be reviewed and kept as **examples** for maintaining consistent detailing practices. These examples should not be older than three years.

C. Drawing Orientation and Layout Control

- Standard bridge sheet format is 34 inches × 22 inches with the bottom 2 inches used for title block and related information.
- Contract plans are printed, sealed, signed and submitted, half size, on 11" × 17" paper.
- Drawings shall be carefully organized so the intent of the drawing is easily understood.
 - **North arrow** shall be placed on layouts and footing/foundation layouts.
 - **Related details** shall be grouped together in an orderly arrangement: lined up horizontally and vertically and drawn to the same scale.
 - Do not crowd the drawing with details.
 - The following is a standard sheet configuration when plan, elevation, and sectional views are required.
 - The Plan view layout of structures should be oriented from left to right in the direction of increasing state route mileposts. For retaining walls, see the second bullet under subsection I. For layouts of existing bridges undergoing widening, expansion joint or thrie beam retrofit, or other structural modification, this orientation requirement may result in the bridge layout being opposite from what is shown in the original plans. In such cases, the designer and detailer should review the Bridge Preservation Office inspection records for the bridge, and the bridge layout orientation and pier identification should be laid out to be consistent with the Bridge Preservation Office inspection records.



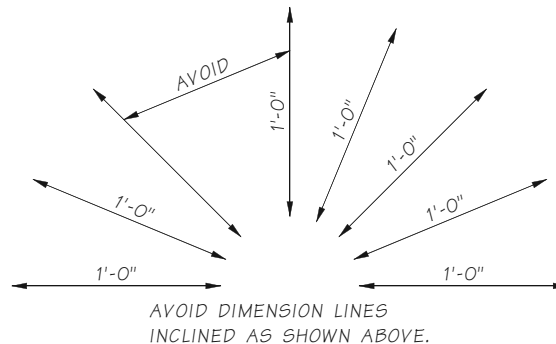
D. Lettering

1. General

- **Lettering** shall be upper case only, slanted at approximately 68 degrees. General text is to be approximately $\frac{1}{8}$ " high.
- Text shall be **oriented** so as to be read from the **bottom** or **right edge** of the sheet.
- **Detail titles** shall be a similar font as general text, about twice as high and of a heavier weight. Underline all titles with a single line having the same weight as the lettering.

2. Dimensioning

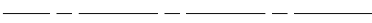
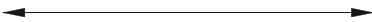

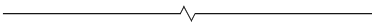


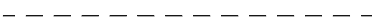
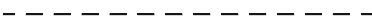



- A dimension shall be shown **once** on a drawing. Duplication and unnecessary dimensions should be avoided.
- All dimension figures shall be placed above the dimension line, so that they may be read from the bottom or the right edge of the sheet, as shown in the following detail:



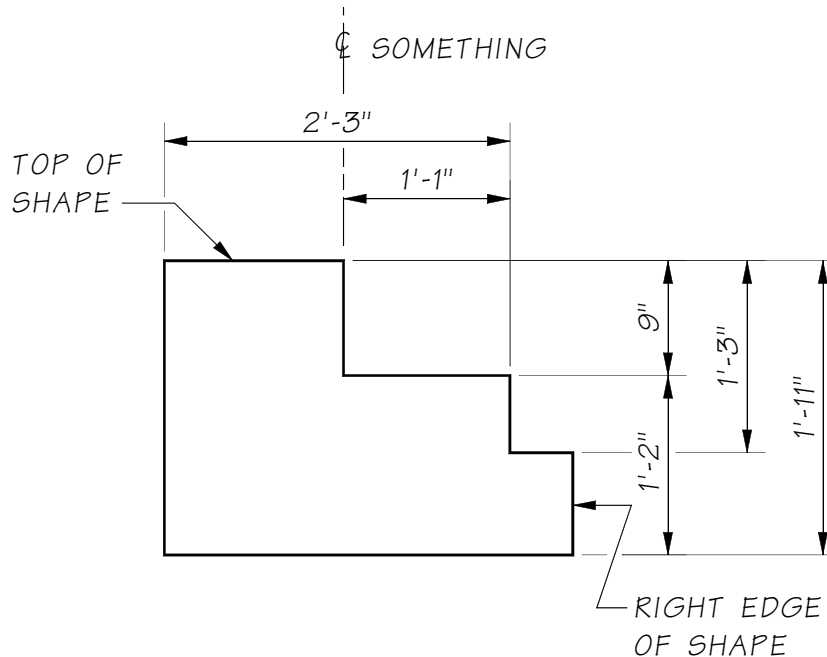
- When details or structural elements are complex, utilize two drawings, one for dimensions and the other for reinforcing bar details.
- Dimensions 12 inches or more shall be given in feet and inches unless the item dimensioned is conventionally designated in inches (for example, 16" pipe).
- Dimensions that are less than one inch over an even foot, the fraction shall be preceded by a zero (for example, 3'-0 $\frac{3}{4}$ ").
- Place dimensions outside the view, preferably to the right or below. However, in the interest of clarity and simplicity it may be necessary to place them otherwise. Examples of dimensioning placement are shown on Appendix 11.1-A1.

E. Line Work

- All line work must be of sufficient size, weight, and clarity so that it can be easily read from a print that has been reduced to 11" × 17" or one-half the size of the original drawing.
- The line style used for a particular structural outline, centerline, etc., shall be kept consistent wherever that line is shown within a set of bridge plans.
- Line work shall have appropriate gradations of width to give line contrast as shown below. Care shall be taken that the thin lines are dense enough to show clearly when reproduced.

<i>Centerline</i>		<i>Thin</i>
<i>Dimension</i>		<i>Thin</i>
<i>Leader</i>		<i>Thin</i>
<i>Break line</i>		<i>Thin</i>
<i>Extension line</i>		<i>Thin</i>
<i>Existing structure reference line</i>		<i>Medium</i>
<i>Existing structure hidden line</i>		<i>Thin</i>
<i>Hidden</i>		<i>Medium</i>
<i>Rebar</i>		<i>Medium</i>
<i>Section</i>		<i>Heavy</i>
<i>Outline or visible line</i>		<i>Heavy</i>

- When drawing structural sections showing reinforcing steel, the **outline** of the sections shall be a **heavier** line weight than the **rebar**.
- The order of **line precedence** (which of a pair of crossing lines is broken) is as follows:
 1. Dimension lines are never broken.
 2. Leader line from a callout.
 3. Extension line.



LINE PRECEDENCE DIAGRAM

THIS DIAGRAM DEMONSTRATES WHICH LINE IS TO BE BROKEN WHEN TWO LINES CROSS.

F. Scale

- Scales are not to be shown in the plans.
- When **selecting a scale**, it should be kept in mind that the drawing will be reduced. Generally, the minimum scale for a section detail with rebar is $\frac{3}{8}'' = 1'$. The minimum scale to be used on steel details will be $\frac{3}{4}'' = 1'$.
- The contract plan sheets are not to be used to take measurements in the field. They will, however, be drawn using **scales that can be found on any standard architectural or engineering scale**.
- Care should be taken that all structural elements are **accurately** drawn to scale.
- Sections and views may be enlarged to show more detail, but the number of different scales used should be kept to a minimum.

G. Graphic Symbols

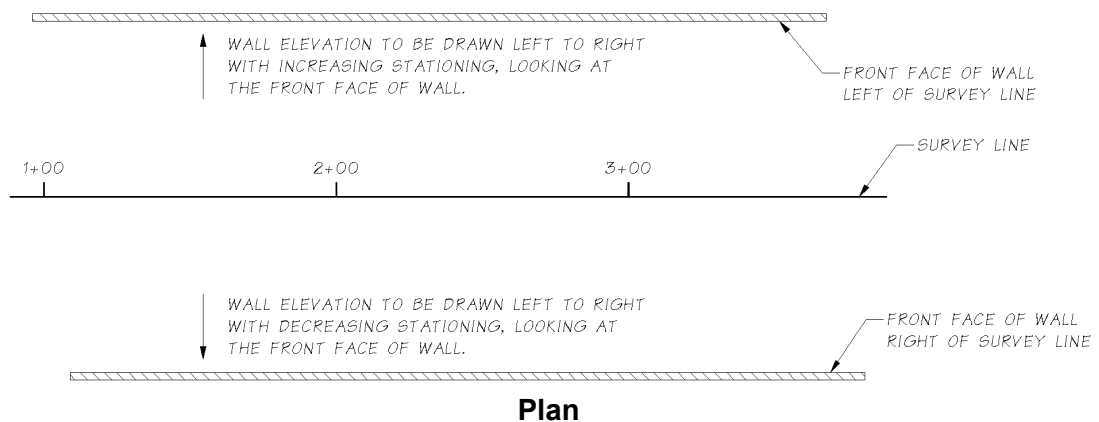
1. Graphic symbols shall be in accordance with the following:
 - a) Structural steel shapes: See also *AISC Manual of Steel Construction*.
 - b) Welding symbols: See Lincoln Welding Chart.
 - c) Symbols for hatching different materials are shown on Appendix 11.1-A2.

H. Structural Sections, Views and Details

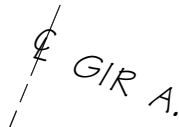
- A **section** cuts through the structure, a **view** is from outside the structure, a **detail** shows a structural element in more detail – usually a larger scale.
- Whenever possible, sections and views shall be taken looking to the **right, ahead on stationing, or down**.
- Care shall be taken to ensure that the **orientation** of a detail drawing is identical to that of the plan, elevation, etc., from which it is taken. Where there is a **skew** in the bridge any sections should be taken from **plan** views.
- The default is to be looking ahead on stationing. The only mention of view orientation is if the view is looking back on stationing.
- On plan and elevation drawings where there is insufficient space to show cut sections and details, the section and detail drawing should be on the plan sheet immediately following the plan and elevation drawing unless there are a series of related plans. If it is impractical to show details on a section drawing, a detail sheet should immediately follow the section drawing. In other words, the order of plan sheets should be from general plan to more minute detail.
- A circle divided into upper and lower halves shall identify structural sections, views, and details. Examples are shown in Appendix 11.1-A3.
- Breaks in lines are allowable provided that their intent is clear.

I. Miscellaneous


- **Callout arrows** are to come off either the beginning or end of the sentence. This means the top line of text for arrows coming off the left of the callout or the bottom line of text for arrows pointing right.
- Except for the Layout, **wall elevations** are to show the exposed face regardless of direction of stationing. The Layout sheet stationing will read increasing left to right. The elevation sheets will represent the view in the field as the wall is being built.



- Do not detail a bridge element in more than one location. If the element is changed there is a danger that only one of the details is updated.
- Centerline callouts shall be normal to the line itself approximately an eighth inch from the end of the line:



J. Revisions

- **Addendums** are made after general distribution and project ad but before the contract is awarded. Changes made to the plan sheets during this time shall be **shaded**. Subsequent addendums are shaded and the shading from previous addendums is removed.
- **Change orders** are made after the contract has been awarded. Changes will be marked with a number inside a circle inside a **triangle**.  Shading for any addendums is removed.
- All addendums and change orders will be noted in the **revision block** at the bottom of the sheet using font 25.

K. Title Block

- The project title is displayed in the contract plan sheet title block. The title consists of Line 1 specifying the highway route number(s), Line 2 and possibly Line 3 specifying the title verbiage. Bridge structures use a fourth line, in a smaller font, to specify the bridge name and number in accordance with the WSDOT Bridge List M-23-09 and BDM Sections 2.3.1.A and 2.3.2.A.
- The exact wording of Lines 1, 2, and 3 of the project title, including line arrangement, abbreviations, and punctuation, is controlled by the project definition as specified by legislative title and the Capital Program Management System (CPMS) database.
- The highway route number(s) in Line 1 shall be consistent with WSDOT naming practice. Interstate routes (5, 82, 90, 182, 205, 405, and 705) shall be specified as I-(number). US routes (2, 12, 97, 97A, 101, 195, 197, 395, and 730) shall be specified as US (number). All other routes shall be specified as SR (number). Projects including two highway routes shall include both route numbers in Line 1, as in "US 2 And I-5". Projects including three or more highway routes shall be specified with the lowest numbered route, followed by "Et Al", as in "SR 14 Et Al".
- The job number block just to the left of the middle of the title block shall display the PS&E Job Number assigned to the project by the Region Plans Office. The PS&E Job Number consists of six characters. The first two characters correspond to the last two digits of the calendar year. The third character corresponds to the letter designation assigned to the specific Region (NWR - A, NCR - B, OR - C, WSF and selected UCO projects - W, SWR - X, SCR - Y, and ER - Z). The final three characters correspond to the three digit number assigned to the specific project by the Region Plans Office.

L. Reinforcement Detailing

- Contract documents shall convey all necessary information for fabrication of reinforcing steel. In accordance with Standard Specification 6-02.3(24), reinforcing steel details shown in the bar list shall be verifiable in the plans and other contract documents.
- Reinforcement type and grade is specified in Standard Specification 9-07.2 and need not be provided elsewhere in the contract documents unless it differs.
- Size, spacing, orientation and location of reinforcement shall be shown on the plan sheets.
- Reinforcement shall be identified by mark numbers inside a rectangle. Reinforcing bar marks shall be called out at least twice. The reinforcement including the spacing is called out in one view (such as a plan or elevation). The reinforcement without the spacing is called out again in at least one other view taken from a different angle (such as a section).
- Epoxy coating for reinforcement shall be shown in the plans by noting an E inside a triangle.

- The spacing for reinforcement shall be on a dimension line with extension lines. Do not point to a single bar and call out the spacing. Reinforcement spacing callouts shall include a distance. If the distance is an unusual number, give a maximum spacing. Do not use “equal spaces” as in “23 equal spaces = 18'-9” (the steel workers should not have to calculate the spacing). Also, never use the word “about” as in 23 spaces @ about 10” = 18'-9” (this is open to too much interpretation). Instead these should read “23 spaces @ 10” max. = 18'-9”.
- Reinforcement geometry shall be clear in plan details. Congested areas, oddly bent bars, etc. can be clarified with additional views/details/sections or adjacent bending diagrams. In bending diagrams, reinforcement dimensions are given out-to-out. It may be necessary to show edges of reinforcement with two parallel edge lines to clearly show working points and dimensions.
- Reinforcement lengths, angles, etc. need not be called out when they can be determined from structural member sizes, cover requirements, etc. Anchorage, embedment and extension lengths of reinforcement shall be dimensioned in the plans.
- Standard hooks per AASHTO LRFD 5.10.2.1 need not be dimensioned or called out, but shall be drawn with the proper angle (90°, 135° or 180°). Seismic hooks per AASHTO LRFD 5.10.2.2 (used for transverse reinforcement in regions of expected plastic hinges) shall be called out on the plans whenever they are used.
- Splices in reinforcement are required when reinforcement lengths exceed the fabrication lengths in BDM 5.1.2.F. They may also be necessary in other locations such as construction joints, etc. The location, length and stagger of lap splices shall be shown on the plan sheets. Tables of applicable lap splice lengths are acceptable with associated stagger requirements. Type, location and stagger of mechanical and welded splices of reinforcement shall be shown.
- Where concrete cover requirements differ from those given in the standard notes or Standard Specification 6-02.3(24)C, they shall be shown in the plans. It shall be clear whether the cover requirement refers to ties and stirrups or the main longitudinal bars.
- Bar list sheets shall be prepared for plan sets including bridges. They shall be included at the end of each bridge plan set. They are not stamped. They are provided in the plans as a convenience for the Contractor and are to be used at their own risk. Despite this warning, Contractors sometimes use the bar list directly to fabricate reinforcement without confirming details from the plans. Designers should therefore strive for accuracy in the bar list. An accurate bar list also serves as a checking mechanism and a way to calculate reinforcement quantities.
- The reinforcing for some structural members such as approach slabs, shafts, piles, barrier, retaining walls, bridge grate inlets, sign structure foundations, precast SIP deck panels and precast girders are not shown in the bar list at the end of the bridge plan set but may include their own bar list on their plan sheets. These components typically have shop plans, include steel reinforcement within their unit costs and/or are constructed by separate sub-contractors.
- Other reinforcement detailing references include ACI 315-99 “Details and Detailing of Concrete Reinforcement”, ACI 318-08 “Building Code Requirements for Structural Concrete”, and CRSI “Manual of Standard Practice” May 2003.

11.1.2 Bridge Office Standard Drawings and Office Examples

A. General

- The Bridge Office provides standard drawings and example sheets of various common bridge elements.

B. Use of Standards

- The Standard Drawings are to be considered as nothing more than **examples** of items like girders or traffic barriers which are often used and are very similar from job to job.
- They are to be **copied** to a structure project and **modified to fit** the particular aspects of the structure. They are not intended to be included in a contract plan set without close scrutiny for applicability to the job.

C. Changes to Standards

- New standard drawings and revisions to existing drawings shall be approved by the Bridge Design Engineer and shall be made according to the same office practices as contract plan sheets.

11.1.3 Plan Sheets

Plan sheets should be assembled in the **order of construction** and include the items listed below. Phasing or large-scale projects may require more than one sheet to properly detail plan items.

- Layout
- Footing/Foundation Layout
- Abutment
- Pier/Bent
- Bearing Details
- Framing Plan
- Typical Section
- Girders
- Roadway Slab Reinforcement (Plan and transverse section)
- Expansion Joints (if needed)
- Traffic Barrier
- Approach Slab
- Barlist

A. Layout

- The Layout sheet shall contain, but is not limited to:
 - Plan View with ascending stations from left to right
 - Elevation View shown as an outside view of the bridge and shall be visually aligned with the plan view.
- The original preliminary plan will be copied to create the final layout. Views, data, and notes may be repositioned to improve the final product.
- Items on the preliminary plan, which should **not** appear on the final layout are as follows:
 - Typical roadway sections.
 - Vertical curve, Superelevation and curve data for other than the main line.
 - Other information that was preliminary or that will be found elsewhere in the plans.

- Items not normally found on the preliminary plan, which should be **added**:
 - **Test hole locations** (designated by $\frac{3}{16}$ inch circles, quartered) to plan view.
 - Elevation view of **footings, seals, piles**, etc. Show elevation at Bottom of footing and, if applicable, the type and size of piling.
 - **General notes** above legend on right hand side, usually in place of the typical section.
 - Title “LAYOUT” in the title block and sheet number in the space provided.
 - Other features, such as lighting, conduit, signs, excavation, riprap, etc. as determined by the designer.
- The preliminary plan checklist in Appendix A, Chapter 2 can be used for reference.

B. Footing Layout

- An abutment with a **spread footing** has a Footing Layout. An abutment with piles and pile cap has a Foundation Layout.
- The Footing Layout is a plan of the bridge whose details are limited to those needed to **locate the footings**. The intent of the footing layout is to minimize the possibility of error at this initial stage of construction.
- The Foundation Layout is a plan of the bridge whose details are limited to those needed to **locate the shafts or piles**. The intent of the Foundation layout is to minimize the possibility of error at this initial stage of construction.
- Other related information and/or details such as pedestal sizes, and column sizes are considered part of the pier drawing and **should not be included** in the footing layout.
- The Footing Layout should be shown on the layout sheet if space allows. It need not be in the same scale. When the general notes and footing layout cannot be included on the first (layout) sheet, the footing layout should be included on the second sheet.
- Longitudinally, footings should be located using the **survey line** to reference such items as the footing, centerline pier, centerline column, or centerline bearing, etc.
- When **seals** are required, their locations and sizes should be clearly indicated on the footing layout.
- The Wall Foundation Plan for retaining walls is similar to the Footing Plan for bridges except that it also shows dimensions to the front face of wall.
- Appendix 11.1-A4 is an example of a footing layout showing:
 - The basic information needed.
 - The method of detailing from the survey line.

C. Abutment

- Bridge elements that have not yet been built will not be shown. For example, the superstructure is not to be shown, dashed or not, on any substructure details.
- Elevation information for seals and piles or shafts may be shown on the abutment or pier sheets.
- Views are to be oriented so that they represent what the contractor or inspector would most likely see on the ground. Pier 1 elevation is often shown looking back on stationing. A note should be added under the Elevation Pier 1 title saying “Shown looking back on stationing”.

D. Pier/Bent

- Each pier shall be detailed separately as a general rule. If the intermediate piers are identical except for height, then they can be shown together.

E. Bearing Details**F. Framing Plan**

- Girder Lines must be identified in the plan view (Gir. A, Gir. B, etc.).

G. Typical Section

- Girder spacing, which is tied to the bridge construction baseline
- Roadway slab thickness, as well as web and bottom slab thicknesses for box girders
- “A” dimension
- Limits of pigmented sealer
- Profile grade and pivot point and cross slopes
- Utility locations
- Curb to curb roadway width
- Soffit and drip groove geometry

H. Girders

- Prestressed girder sheets can be copied from the Bridge Office library but they must be modified to match the project requirements.

I. Roadway Slab Reinforcement

- Plan and transverse section views

J. Expansion Joints**K. Traffic Barrier**

- Traffic barrier sheets can be copied from the Bridge Office library but they must be modified to match the project requirements.

L. Approach Slab

- Approach slab sheets can be copied from the Bridge Office library and modified as necessary for the project.

M. Barlist

- The barlist sheets do not require stamping because they are not officially part of the contract plan set.

11.1.4 Electronic Plan Sharing Policy

The following procedure describes the Bridge Design Office or WSDOT consultants' electronic plan sharing policy with other WSDOT offices, consultants, contractors and other agencies:

Plan sheets prepared by the Bridge Design Office or WSDOT consultants may be electronically sent out to other WSDOT offices, consultants, contractors and other agencies in DWG format only if all of the following steps are taken:

1. Entire information in the title block is removed from the plan sheet.
2. A disclaimer reading "FOR INFORMATION ONLY" is printed diagonally across each plan sheet; and
3. A letter of disclaimer is sent as a cover or an attachment to the plan sheet(s), indicating that attached plans are for information only and that WSDOT has no responsibility for accuracy of the contents.

Bridge Office plan sheets may also be electronically shared if requested in PDF format. PDF files need to only include the disclaimer noted in step 2 above. Examples of bridge plan sheets modified for electronic sharing are shown for clarity. Time spent modifying and submitting electronic plan sheets shall be charged to the job number provided by the construction PE's office.

This policy applies only to current projects under design or under contract. Historical or as-built plan sheets may only be shared in PDF format, and only if condition #3 is followed, as described above.

11.1.5 Structural Steel

A. General

- Flat pieces of steel are termed plates, bars, sheets or strips, depending on the dimensions.

B. Bars

- Up to 6 inches wide, 0.203 in. ($\frac{3}{16}$ inch) and over in thickness, or 6 inches to 8 inches wide, 0.230 in. ($\frac{7}{32}$ inch) and over in thickness.

C. Plates

- Over 8 inches wide, 0.230 in. ($\frac{7}{32}$ inch) and over in thickness, or over 48 inches wide, 0.180 in. ($\frac{11}{64}$ inch) and over in thickness.

D. Strips

- Thinner pieces up to 12 inches wide are strips and over 12 inches are sheets. A complete table of classification may be found in the AISC Manual of Steel Construction, 8th Ed. Page 6-3.

E. Labeling

- The following table shows the usual method of labeling some of the most frequently used structural steel shapes. Note that the inches symbol ("") is omitted, but the foot symbol (') is used for length including lengths less than a foot.

<p>PLATES</p> <p>GROUP SYMBOL: $\#$</p> <p>THICKNESS IN INCHES: $\frac{1}{2}$</p> <p>WIDTH IN INCHES: 34</p> <p>LENGTH IN FEET AND INCHES: $5'-6$</p>	<p>ANGLES</p> <p>GROUP SYMBOL: L</p> <p>LONG LEG IN INCHES: 6</p> <p>SHORT LEG IN INCHES: 5</p> <p>THICKNESS IN INCHES: $\frac{3}{4}$</p> <p>LENGTH IN FEET AND INCHES: $2'-1$</p>
<p>FLAT BARS</p> <p>GROUP SYMBOL: BAR</p> <p>WIDTH IN INCHES: 2</p> <p>THICKNESS IN INCHES: $\frac{3}{4}$</p> <p>LENGTH IN FEET AND INCHES: $0'-6$</p>	<p>RECTANGULAR HSS</p> <p>GROUP SYMBOL: HSS</p> <p>WIDTH IN INCHES: 6</p> <p>WIDTH IN INCHES: 5</p> <p>WALL THICKNESS IN INCHES: $\frac{1}{4}$</p> <p>LENGTH IN FEET AND INCHES: $3'-2$</p>
<p>SQUARE BARS</p> <p>GROUP SYMBOL: BAR</p> <p>SIZE IN INCHES: 2</p> <p>CONVENTION FOR "SQUARE": $\#$</p> <p>LENGTH IN FEET AND INCHES: $3'-4$</p>	<p>CIRCULAR HSS</p> <p>GROUP SYMBOL: HSS</p> <p>OUTSIDE DIAM. IN INCHES: 3.000</p> <p>WALL THICKNESS IN INCHES: 0.250</p> <p>LENGTH IN FEET AND INCHES: $2'-5$</p>
<p>ROUND BARS</p> <p>GROUP SYMBOL: BAR</p> <p>SIZE IN INCHES: 2</p> <p>CONVENTION FOR "ROUND": \emptyset</p> <p>LENGTH IN FEET AND INCHES: $0'-4$</p>	<p>PIPES</p> <p>NOMINAL DIAM. IN INCHES: $1\frac{1}{2}\emptyset$</p> <p>DESIGNATION: STD</p> <p>GROUP SYMBOL: $PIPE$</p>

11.1.6 Aluminum Section Designations

The designations used in the tables are suggested for general use.

SECTION	DESIGNATION	EXAMPLE
I-Beams	I <i>DEPTH</i> × <i>WT</i>	14 × 3.28
Wide-Flange Sections	WF <i>DEPTH</i> × <i>WT</i>	WF4 × 4.76
Wide-Flange Sections, Army-Navy Series	WF(A-N) <i>DEPTH</i> × <i>WT</i>	WF(A-N)4 × 1.79
American Standard Channels	C <i>DEPTH</i> × <i>WT</i>	C4 × 1.85
Special Channels	CS <i>DEPTH</i> × <i>WT</i>	CS4 × 3.32
Wing Channels	CS(WING) <i>WIDTH</i> × <i>WT</i>	CS(WING)4 × 0.90
Army-Navy Channels	C(A-N) <i>DEPTH</i> × <i>WT</i>	C(A-N)4 × 1.58
Angles	L <i>LL</i> × <i>LL</i> × <i>TH</i>	L3 × 3 × 0.25
Square End Angles	LS <i>LL</i> × <i>LL</i> × <i>TH</i>	LS2 × 2 × 0.187
Bulb Angles	BULB L <i>LL1</i> × <i>LL2</i> × <i>TH1</i> × <i>TH2</i>	BULB L4 × 3.5 × 0.375 × 0.375
Bulb Angle, Army-Navy Series	BULB L(A-N) <i>LL1</i> × <i>LL2</i> × <i>TH1</i> × <i>TH2</i>	BULB L(A-N) 3 × 2 × 0.188 × 0.188
Tees	T <i>DEPTH</i> × <i>WIDTH</i> × <i>WT</i>	T4 × 4 × 3.43
Army-Navy Tees	T(A-N) <i>DEPTH</i> × <i>WIDTH</i> × <i>WT</i>	T(A-N)4 × 4 × 2.27
Zees	Z <i>DEPTH</i> × <i>WIDTH</i> × <i>WT</i>	Z4 × 3.06 × 2.85
Plates	PL <i>TH</i> × <i>WIDTH</i>	PL $\frac{1}{4}$ × 8
Rods	RD <i>DIA</i>	RD 1
Square Bars	SQ <i>SDIM</i>	SQ 4
Rectangle Bars	RECT <i>TH</i> × <i>WIDTH</i>	RECT $\frac{1}{4}$ × 4
Round Tubes	ODIA <i>OD</i> × <i>TH WALL</i>	4OD × 0.125 WALL
Square Tubes	ODIM SQ × <i>TH WALL</i>	3SQ × 0.219 WALL
Rectangle Tubes	<i>DEPTH</i> × <i>WIDTH RECT</i> × <i>TH WALL</i>	4 × 1.5 RECT × 0.104 WALL

WT - WEIGHT in LB/FT based on density of 0.098

TH - THICKNESS, LL - LEG LENGTH, DIA - DIAMETER

ODIA - OUTSIDE DIAMETER, ODIM - OUTSIDE DIMENSION

SDIM - SIDE DIMENSION

All lengths in inches

11.1.7 Abbreviations

A. General

- Abbreviations, as a rule, are to be **avoided**.
- Because different words sometimes have identical abbreviations, the word should be spelled out where the meaning may be in doubt.
- A few **standard signs** are in common use in the Bridge and Structures Office. These are listed with the abbreviations.
- A **period** should be placed after all abbreviations, except as listed below.
- **Apostrophes** are usually not used. Exceptions: pav't., req'd.
- Abbreviations for **plurals** are usually the same as the singular. Exceptions: figs., no., ctrs., pp.
- No abbreviations in titles.

B. List of abbreviations commonly used on bridge plan sheets:

A

abutment	ABUT.
adjust, adjacent	ADJ.
aggregate	AGG.
alternate	ALT.
ahead	AHD.
aluminum	AL.
American Society for Testing and Materials	ASTM
American Association of State Highway and Transportation Officials	AASHTO
and	&
angle point	A.P.
approved	APPRD.
approximate	APPROX.
area	A
asbestos cement pipe	ASB. CP
asphalt concrete	AC
asphalt treated base	ATB
at	@ (used only to indicate spacing or pricing, otherwise spell it out)
avenue	AVE.
average	AVG.

B

back	BK.
back of pavement seat	B.P.S.
bearing	BRG.
begin horizontal curve (Point of Curvature)	P.C.
begin vertical curve	BVC
bench mark	BM
between	BTWN.
bituminous surface treatment	BST
bottom	BOT.
boulevard	BLVD.
bridge	BR.
bridge drain	BR. DR.

building	BLDG.
buried cable	BC
C	
cast-in-place	CIP
cast iron pipe	(C.I.P.)
center, centers	CTR., CTRS.
centerline	Ⓢ
center of gravity	CG
center to center	CTR. TO CTR., C/C
Celsius (formerly Centigrade)	C
cement treated base	CTB
centimeters	CM.
class	CL.
clearance, clear	CLR.
compression, compressive	COMP.
column	COL.
concrete	CONC.
conduit	COND.
concrete pavement	PCCP (Portland Cement Concrete Pavement)
construction	CONST. or CONSTR.
continuous	CONT. or CONTIN.
corrugated	CORR.
corrugated metal	CM
corrugated steel pipe	CSP
countersink	CSK.
county	CO.
creek	CR.
cross beam	X-BM.
crossing	XING
cross section	X-SECT.
cubic feet	CF or CU. FT. or FT. ³
cubic inch	CU. IN. or IN. ³
cubic yard	CY or CU. YD. or YD ³
culvert	CULV.
D	
degrees, angular	° or DEG.
degrees, thermal	C or F
diagonal(s)	DIAG.
diameter	DIAM. or ø
diaphragm	DIAPH.
dimension	DIM.
double	DBL.
drive	DR.

E

each	EA.
each face	E.F.
easement	EASE., ESMT.
East	E.
edge of pavement	EP
edge of shoulder	ES
endwall	EW
electric	ELECT
elevation	EL. or ELEV.
embankment	EMB.
end horizontal curve (Point of Tangency)	PT.
end vertical curve	EVC
Engineer	ENGR.
equal(s) or = (mathematical result)	EQ. (as in eq. spaces)
estimate(d)	EST.
excavation	EXC.
excluding	EXCL.
expansion	EXP., EXPAN.
existing	EXIST.
exterior	EXT.

F

Fahrenheit	F
far face	FF.
far side	F.S.
feet (foot)	FT. or '
feet per foot	FT./FT. or ' / or ' /
field splice	FT.
figure, figures	F.S.
flat head	FIG., FIGS.
foot kips	F.H.
foot pounds	FT-KIPS
footing	FT-LB
forward	FTG.
freeway	FWD.
	FWY.

G

gallon(s)	GAL.
galvanized	GALV.
galvanized steel pipe	GSP
gauge	GA.
General Special Provisions	GSP
girder	GIR.
ground	GR.
guard railing	GR

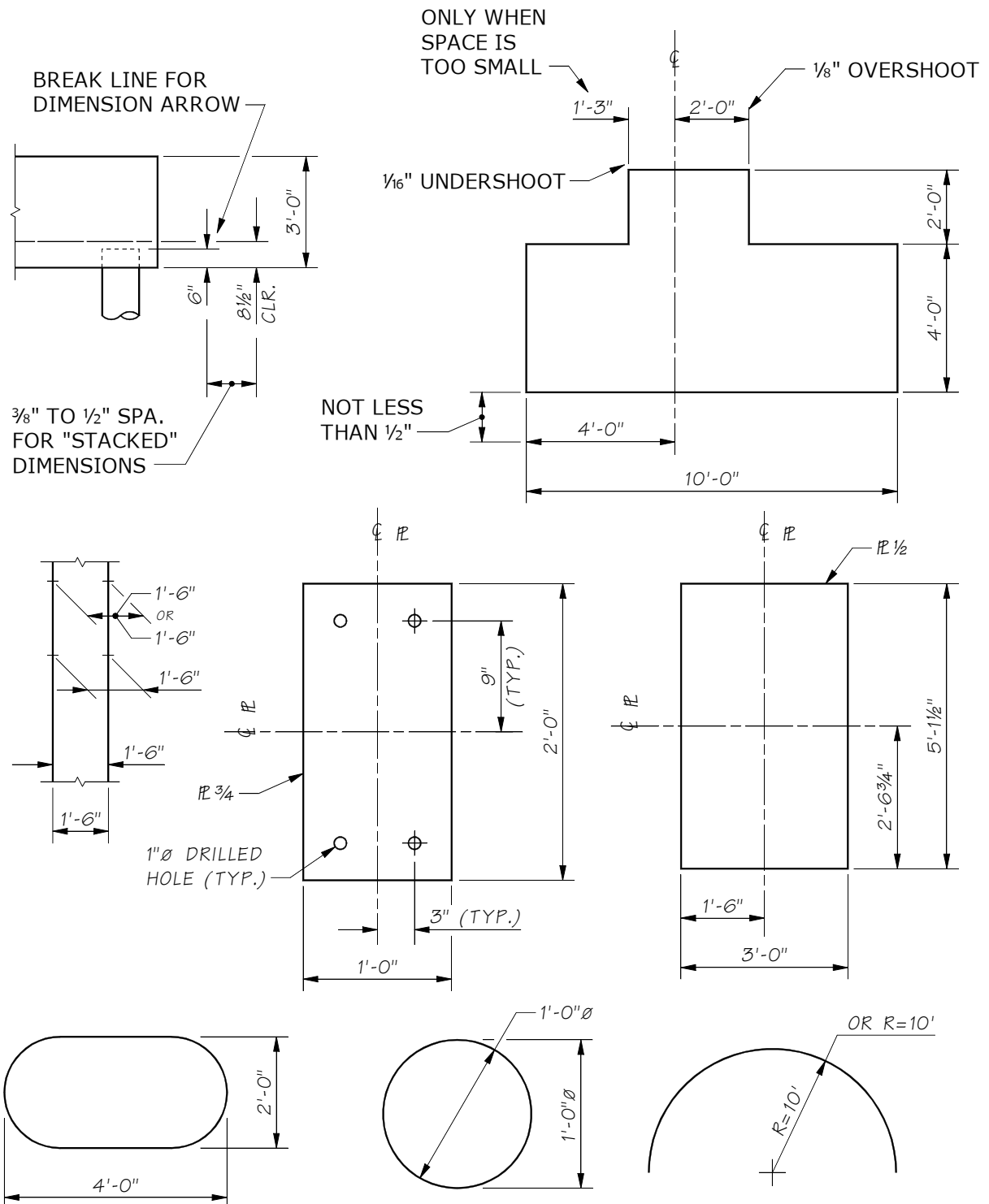
H		
	hanger	HGR.
	height	HT.
	height (retaining wall)	H
	hexagonal	HEX.
	high strength	H.S.
	high water	H.W.
	high water mark	H.W.M.
	highway	HWY.
	horizontal	HORIZ.
	hot mix asphalt	HMA
	hour(s)	HR.
	hundred(s)	HUND.
I		
	included, including	INCL.
	inche(s)	IN. or “
	inside diameter	I.D.
	inside face	I.F.
	interior	INT.
	intermediate	INTERM.
	interstate	I
	invert	INV.
J		
	joint	JT.
	junction	JCT.
K		
	kilometer(s)	KM.
	kilopounds	KIPS, K.
L		
	layout	LO
	left	LT.
	length of curve	L.C.
	linear feet	L.F.
	longitudinal	LONGIT.
	lump sum	L.S.
M		
	maintenance	MAINT.
	malleable	MALL.
	manhole	MH
	manufacturer	MFR.
	maximum	MAX.
	mean high water	MHW
	mean higher high water	MHHW
	mean low water	MLW
	mean lower low water	MLLW
	meters	M.
	mile(s)	MI.
	miles per hour	MPH

millimeters	MM.
minimum	MIN.
minute(s)	MIN. or ‘
miscellaneous	MISC.
modified	MOD.
monument	MON.
N	
National Geodetic Vertical Datum 1929	NGVD 29
near face	N.F.
near side	N.S.
North	N.
North American Vertical Datum 1988	NAVD 88
Northbound	NB
not to scale	NTS
number; numbers	#, NO., NOS.
O	
or	/
original ground	O.G.
ounce(s)	OZ.
outside diameter	O.D.
outside face	O.F.
out to out	O to O
overcrossing	O-XING
overhead	OH
P	
page; pages	P.; PP.
pavement	PAV'T
pedestrian	PED.
per cent	%
pivot point	PP
Plans, Specifications and Estimates	PS&E
plate	PL or PL
point	PT.
point of compound curve	PCC
point of curvature	P.C.
point of intersection	P.I.
point of reverse curve	PRC
point of tangency	PT.
point on vertical curve	PVC
point on horizontal curve	POC
point on tangent	POT
polyvinyl chloride	PVC
portland cement concrete	PCC
pound, pounds	LB., LBS., #
pounds per square foot	PSF, LBS./FT. ² , LBS./‘, or #/’
pounds per square inch	PSI, LBS./IN. ² , LBS./“, or #/”

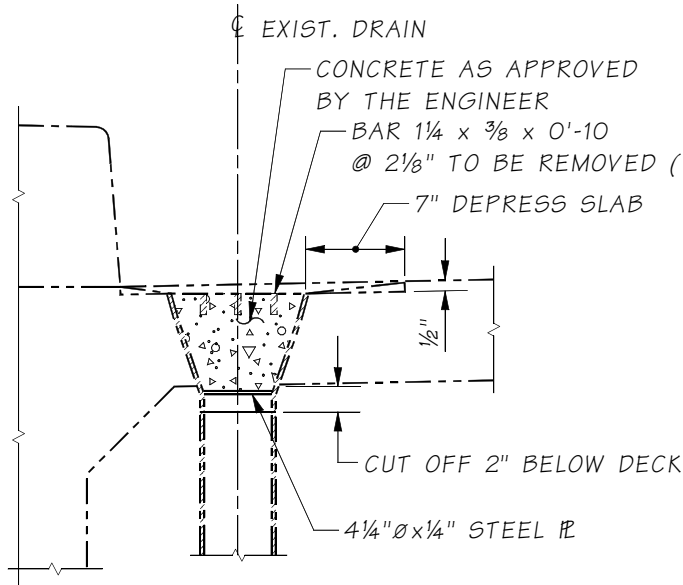
power pole	PP
precast	P.C.
pressure	PRES.
prestressed	P.S.
prestressed concrete pipe	P.C.P.
Puget Sound Power and Light	P.S.P.&L.
Q	
quantity	QUANT.
quart	QT.
R	
radius	R.
railroad	RR
railway	RWY.
Range	R.
regulator	REG.
reinforced, reinforcing	REINF.
reinforced concrete	RC
reinforced concrete box	RCB
reinforced concrete pipe	RCP
required	REQ'D
retaining wall	RET. WALL
revised (date)	REV.
right	RT.
right of way	R/W
road	RD.
roadway	RDWY.
route	RTE.
S	
seconds	SEC. or "
Section (map location)	SEC.
Section (of drawing)	SECT.
sheet	SHT.
shoulder	SHLD. or SH.
sidewalk	SW. or SDWK
South	S.
southbound	SB
space(s)	SPA.
splice	SPL.
specification	SPEC.
square foot (feet)	SQ. FT. or FT. ²
square inch	SQ. IN. or IN. ²
square yard	SY, SQ. YD. or YD. ²
station	STA.
standard	STD.
state route	SR
stiffener	STIFF.
stirrup	STIRR.

structure, structural	STR.
support	SUPP.
surface, surfacing	SURE.
symmetrical	SYMM.
T	
tangent	TAN. or T.
telephone	TEL.
temporary	TEMP.
test hole	T.H.
thick(ness)	TH.
thousand	M
thousand (feet) board measure	MBM
ton(s)	T.
total	TOT.
township	T.
transition	TRANS.
transportation	TRANSP.
transverse	TRANSV.
treatment	TR.
typical	TYP.
U	
ultimate	ULT.
undercrossing	U-XING
V	
variable, varies	VAR.
vertical	VERT.
vertical curve	V.C.
vitrified clay pipe	VCP
volume	VOL. or V
W	
water surface	W.S.
weight(s)	WT.
welded steel pipe	WSP
welded wire fabric	W.W.F.
West	W.
Willamette Meridian	W.M.
wingwall	W.W.
with	W/
without	W/O
Y	
yard, yards	YD., YDS.
year(s)	YR.

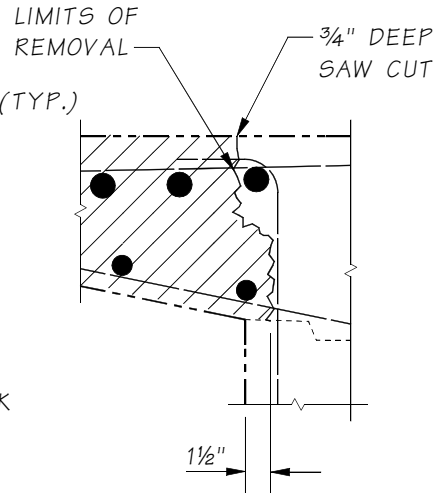
Appendix 11.1-A1



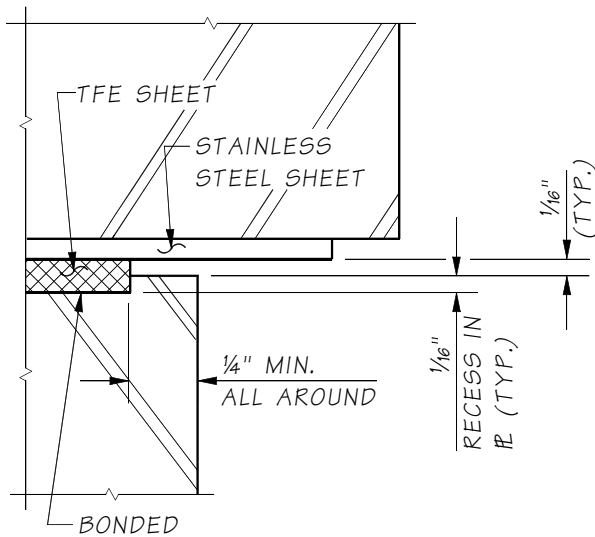
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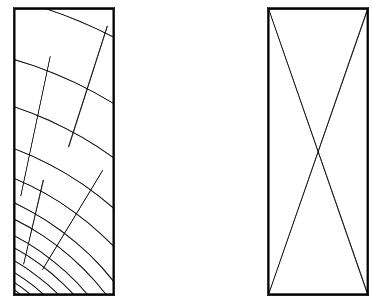
TYPICAL CONCRETE
DETAIL



TYPICAL REMOVAL
DETAIL



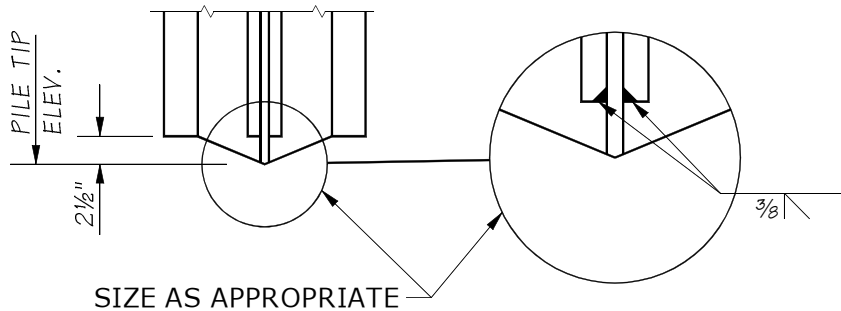
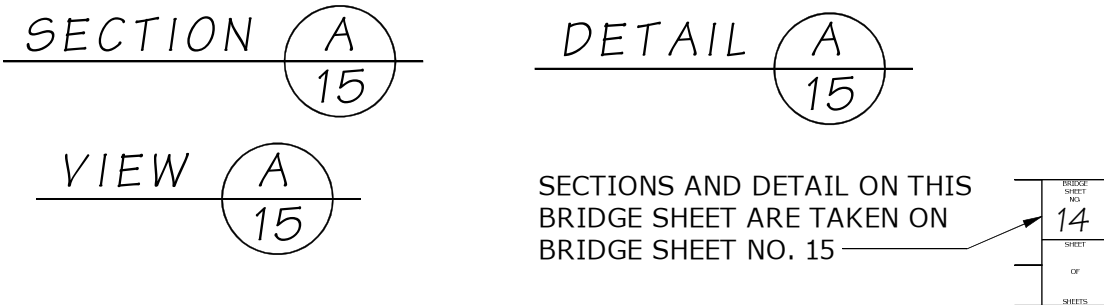
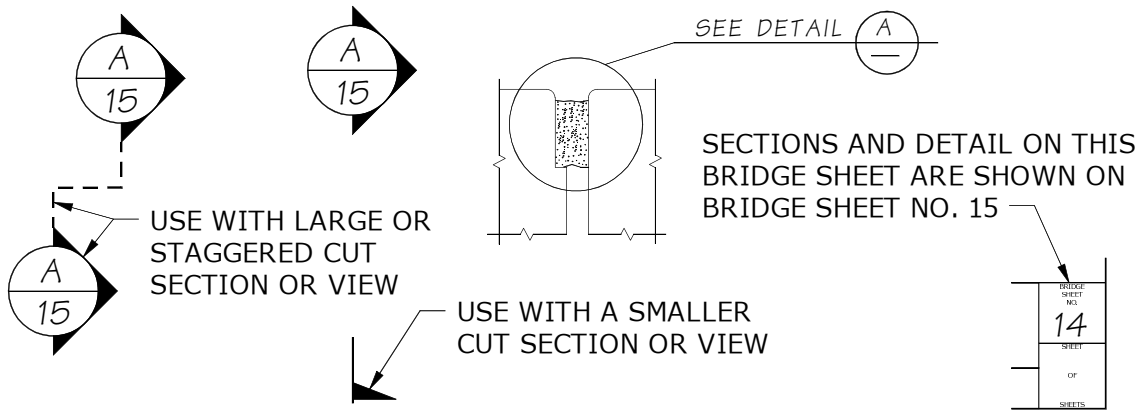
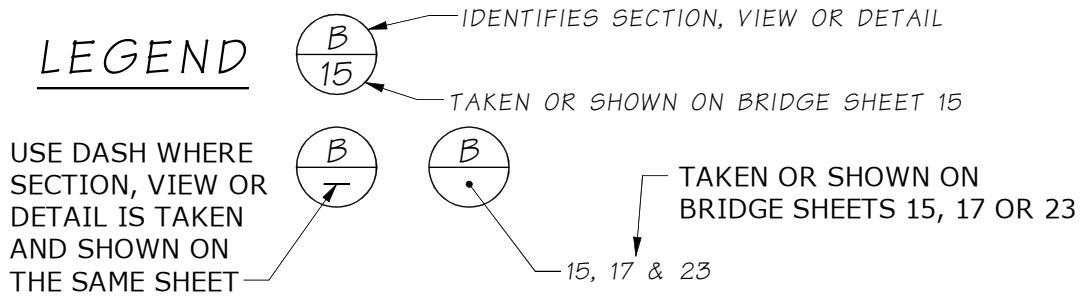
TYPICAL STEEL
DETAIL

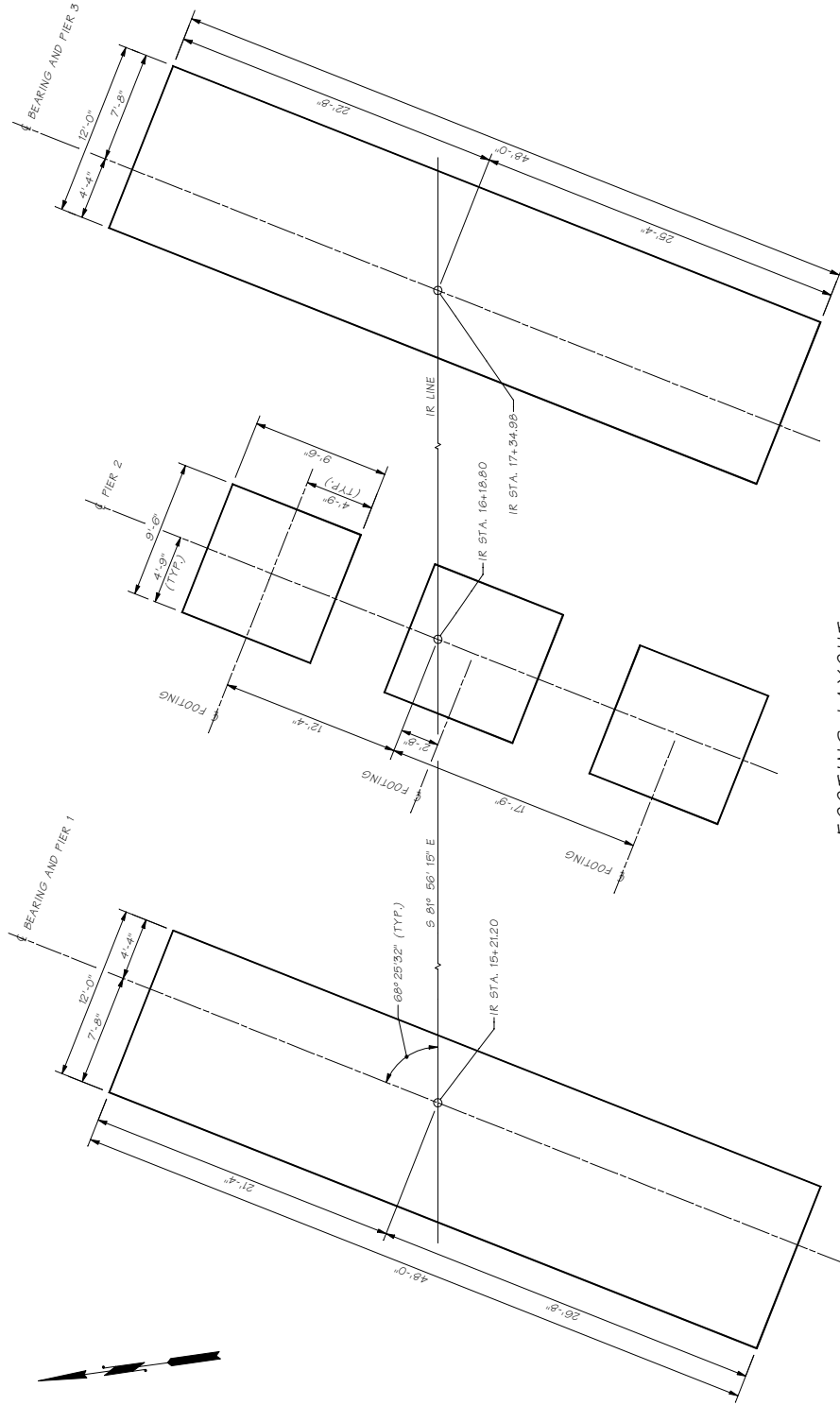


TYPICAL TIMBER
DETAIL

Appendix 11.1-A3

LEGEND





FOOTING LAYOUT

Figure 11.1-A4-1

Bridge Design Expr.																	
Supervisor																	
Designed By																	
Checked By																	
Drawn By																	
Project No.																	
Date																	
Revised																	
BY																	
APPD																	
Job Number	10																
State	WASH																
Fed. Aid Prod. No.																	
Sheet No.																	
Room																	

BRIDGE AND STRUCTURES OFFICE



FOOTING LAYOUT

DATE

