Chapter 2 Preliminary Design Contents

Chapter 2 Preliminary Design

2.1 Preliminary Studies

Different levels of preliminary studies are discussed below. Not all are applicable to a specific project. Bridge and Structures Office should participate in all applicable studies. Reports from the studies should be filed for future reference.

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, Cost-Risk Assessment (CRA) or Cost Estimate and Validation Process (CEVP) 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. If the cost for the rehabilitation is equal or greater than 60 percent of a new replacement bridge, a new replacement bridge is recommended.

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 Project Support Engineer and Specifications & Estimates Engineers (S&E) 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 Support 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 Project Support 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 Support 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. A letter of approval by FHWA of the TS&L study is the basis for advancing the project to the design stage. The need for Type, Size, and Location (TS&L) report will be determined by the Bridge and Structures and WSDOT Project offices.

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 Project Support 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 the *Design Manual* for the type of information required for a bridge site data submittal.

2.1.5.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 State Geotechnical Office 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 State Geotechnical Office 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 the Design Unit Managers 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, State Geotechnical Office, 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.

2.1.5.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.

2.1.5.B.1 *Cover, Title Sheet, and Index*

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

2.1.5.B.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.

2.1.5.B.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

2.1.5.B.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.

2.1.5.B.5 *Design Criteria*

The design criteria identify the LRFD-BDS and LRFD-SGS 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.

2.1.5.B.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."

2.1.5.B.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.

2.1.5.B.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.

2.1.5.C Reviews and Submittals

While writing the TS&L report, all major decisions should be discussed with the Design Unit Manager, who can decide if the State Bridge Design Engineer needs to be consulted. A peer review meeting with the State 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 Project Support Engineer, the State Bridge Design Engineer, and the State Bridge and Structures Engineer. The TS&L report is submitted with a cover letter to FHWA signed by the State Bridge and Structures Engineer.

2.1.6 Alternate Bridge Designs

Bridge site conditions or current market conditions may justify the creation of alternate bridge designs. WSDOT has successfully used alternate bridge designs in the past to obtain best-value bridge design and construction solutions for specific locations. Alternate bridge designs may be considered when the following conditions can be satisfied:

- Construction cost estimates for the alternate designs should be comparable (within 10 percent). Cost estimates should include anticipated life-cycle costs (painting, maintenance, inspection). Periods of market uncertainty, with associated structure cost fluctuations, can provide further justification for alternate bridge designs.
- Region staff must approve the design expenditures for the preparation of alternate bridge designs, including preliminary plans, final bridge plans, specifications and construction cost estimates.
- WSDOT Bridge Office staffing levels and design schedules should allow for the preparation of alternate bridge designs.
- Variations in pier location may be required in order to optimize superstructure design for different alternates. Environmental constraints, geotechnical, hydraulic and scour conditions all need to allow for variations in pier location.
- Construction staging and traffic control must be determined for the alternates.
- Alternate bridge design concepts must be reviewed and approved by the Bridge and Structures Architect.

2.2 Preliminary Plan

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

2.2.1 Development of the Preliminary Plan

2.2.1.A Process and Sequence of Development

2.2.1.A.1 Schedule

Development of the Preliminary Plan is the first milestone in the Structure design process. The Scope Of Work (SOW) agreement negotiated between the Region Design PEO and the Bridge and Structures Office at or shortly after the project kickoff establishes the deliverables (design submittals) to be produced and the due dates for the various deliverable review milestones for the specific project.

The Structural Submittal Expectations Matrix at www.wsdot.wa.gov/publications/fulltext/ProjectMgmt/DEM/Bridge.pdf outlines the expected content of the design submittal deliverables at specific stages of design development.

2.2.1.A.2 Structure Site Data

Structure Site Data is the background data and information developed by the Region Project Office and submitted to the Bridge and Structures Office for use in developing the Preliminary Plan. Development and content of Structure Site Data is defined by Chapter 710 of the WSDOT *Design Manual*.

Upon receipt by the Bridge and Structures Office, the Bridge Preliminary Plan Engineer and the Bridge Preliminary Plan Detailer in the Bridge Project Support Unit review the contents against the Structure Site Data checklist, Exhibit 710-01 of *Design Manual* Chapter 710, to ensure completeness of the submittal. Conformance with WSDOT CAD detailing protocol, especially geometric consistency, is also confirmed at this time.

If inconsistencies or omissions are discovered, the Region Project Office is contacted to revise and supplement the Structure Site Data submittal as necessary.

When the Structure Site Data is confirmed as complete, the development of the Preliminary Plan begins.

2.2.1.A.3 Preliminary Plan Design Assignment

Development of the Preliminary Plan within the Bridge and Structures Office generally occurs in two different ways.

The primary approach as project schedules allow, is for the Preliminary Plan to be developed by designers and detailers within the Bridge Project Support Unit.

An alternative approach is for the Preliminary Plan to be developed by designers and detailers within one of the Bridge Office Structural Design Units under the review guidance of the Bridge Preliminary Plan Engineer and the Bridge Preliminary Plan Detailer in the Bridge Project Support Unit.

The flowchart for alternative approach for the Preliminary Plan preparation is shown in Appendix 1.2-A1 Bridge & Structures Design Office Workflow.

2.2.1.A.4 *Preliminary Plan Development*

Preliminary Plan development includes initial steps outlined in Sections 2.2.1.B through 2.2.1.G, further development under Section 2.2.3 and Section 2.2.4, and the review, submittal, and approval process outlined in Section 2.2.6.

The development steps of Sections 2.2.1.B through 2.2.1.G and Section 2.2.3 lead to selection of a preferred Structure Alternative for structure type, configuration, and orientation. Through this process, the CAD details of plan, elevation, cross sections, and other pertinent details are developed to sufficient completeness and consistency to bring the Preliminary Plan to the Initial Internal Review milestone.

2.2.1.A.5 *Initial Internal Review*

Once the Preliminary Plan is developed and detailed to the point of presenting a complete concept solution, including an initial set of Notes To The Region questions, the plan is ready for circulation for an initial internal review.

At this point, the preliminary plan designer circulates a PDF file of the Preliminary Plan to the following:

- Region Project Office, including Designer(s), Team Leader, and Project Engineer and any other actively involved Project Office management staff
- The State Foundation Engineer of the State Geotechnical Office, or the Geotechnical Engineer assigned to the project, if assigned at that time
- The State Hydraulics Engineer
- The State Bridge and Structures Architect - see Section 2.2.6.A
- The appropriate Bridge and Structures Office structure design specialist for the structure material type - Steel Specialist for steel bridges, Concrete Specialist for concrete bridges and Buried Structures - see Section 2.2.6.A.
- The Bridge Project Support Unit Manager
- The Structure Design Unit Manager assigned to design the structure
- The designer in the Structure Design Unit assigned to lead the design (if assigned at that time)
- The State Bridge Design Engineer
- The Coast Guard Liaison Engineer when the bridge requires a US Coast Guard permit for navigation opening and clearance.
- The checker assigned to review the project - either another designer in the Bridge Project Support Unit or, in the case of a Preliminary Plan prepared in a Bridge Office Structural Design Unit, the Bridge Preliminary Plan Engineer in the Bridge Project Support Unit

The deadline for return of review comments is specified in the distribution email. The review period is conventionally two-weeks, but this may be adjusted as appropriate to account for holidays, project schedule status, and complexity of the project. Comments are reviewed and addressed as they are received. If comments received are significant enough to trigger changes in structure type, configuration, and orientation, there may be additional internal reviews at the discretion of the Bridge Preliminary Plan Engineer.

2.2.1.A.6 *Request for Geotechnical and Hydraulics Information*

Coincident with the initial internal review distribution, the Request for Geotechnical & Hydraulics Information for Bridge Preliminary Plan form (Appendix 2.2.A-5) is completed and distributed to the (1) the State Foundation Engineer or the Geotechnical Engineer assigned to the project, and, for waterway crossings (2) the State Hydraulics Engineer.

The Preliminary Plan designer completes the project name and location, and the survey line stations defining the structure limits. The geotechnical and hydraulic contacts are responsible to complete the tabular data in the form. The return of a completed form shall coincide with the end of the initial internal review.

The hydraulics information generated by this request pertains to how hydrology affects geotechnical aspects of the foundation design (scour and channel migration). This information is supplemental to the stream flow data provided with the Structure Site Data.

2.2.1.A.7 *Cost Estimate*

Once consensus is reached on the structure type, configuration, and orientation through the internal review process, and the Request for Geotechnical & Hydraulics Information form is completed and returned, the Preliminary Plan with the completed geotechnical and hydraulics Information form is presented to the Bridge Project Support Engineer, or designee, for preparation of the preliminary cost estimate. See Section 2.2.5.

2.2.1.A.8 *Distribution for Preliminary Plan Approval*

With the completion of the cost estimate, the Preliminary Plan is ready for distribution to the Region for approval. See Section 2.2.6.B and Section 2.2.6.C.

2.2.1.A.9 *Distribution of Final Preliminary Plan*

When consensus is reached with Region signature approval on the Preliminary Plan as distributed in accordance with Section 2.2.6.B and Section 2.2.6.C, the Preliminary Plan is ready for final distribution, to officially conclude the Preliminary Plan process and fully transfer design responsibility for the project to the Bridge Structural Design Unit. The distribution list for the Final Preliminary Plan remains the same as specified in Section 2.2.6.B.

2.2.1.B Responsibilities

In general, the responsibilities of the designer, checker, detailer, and Design Unit Manager are described in Section 1.2.2. The Preliminary Plan designer as defined in Section 2.2.1.A.3 is responsible for developing a Preliminary Plan for the bridge or buried structure. The Preliminary Plan must be compatible with the geometric, aesthetic, staging, geotechnical, hydraulic, and structural requirements and conditions at the bridge site as presented by the Structure Site Data.

The Structural Design Unit Manager shall be kept informed of progress on the Preliminary Plan so that the schedule can be monitored. If problems develop, the Structural Design Unit Manager can request adjustments to the schedule or allocate additional manpower to meet the schedule.

The Preliminary Plan designer keeps 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, as defined in Section 2-2.1.A.5, shall provide an independent review of the plan, verifying that it is in compliance with the Structure 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-A4) to ensure that all necessary information is shown. The checker reviews the plan for consistency with office design practice, detailing practice, and for constructability.

The Preliminary Plan shall be detailed using current office CAD equipment and software.

2.2.1.C Site Reconnaissance

The Structure Site Data submitted by the Region will include photographs, and in some cases 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, State Geotechnical Office, HQ Hydraulics Office, and Region Design PEO should be arranged through the Bridge Project Support Unit Manager.

2.2.1.D Coordination

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

One aspect of coordination with the Region Design PEO is review of the *Not Included In Bridge Quantities List* (NIBQ), DOT Form 230-038 - see Appendix 12.1-A1. The NIBQ itemizes elements shown in the Preliminary Plan that are not related to the structural design, but rather are of civil design context and as such are the design responsibility of the Region. Creation of the NIBQ helps to ensure that responsibility for all elements identified in the Preliminary Plan is clearly assigned and understood.

2.2.1.E Consideration of Alternatives

In the process of developing the Preliminary Plan, the designer brainstorms, develops, and evaluates 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 is usually limited to only an obvious few for most projects. For some smaller projects and most major projects, design alternatives merit development and close evaluation.

2.2.1.F Designer Recommendation

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, the designer selects the preferred alternative, and places justification of the selection in the job file. At this stage, the designer should discuss the recommendation with the Bridge Project Support Unit Manager.

2.2.1.G Concept Approval

For some projects, the presentation, in “F” above, to the Bridge Project Support Unit Manager satisfies 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 Project Support Unit Manager, the Structure Design Unit Manager assigned to design the project and the designer, if assigned at that time, and State Bridge Design Engineer for concurrence before Preliminary Plan development is completed.

2.2.1.H Consideration for Accelerated Bridge Construction

In the process of developing the Preliminary Plan, the designer develops, and evaluates to possibility of accelerated bridge construction (ABC). Preliminary design calculations shall be done to verify feasibility of ABC for some projects with consultation with the Region Development Engineer and Project office.

2.2.2 Documentation

2.2.2.A Job File

An official job file is created by the Bridge Preliminary Plan Detailer in the Bridge Project Support Unit when a Structure Site Data submittal is received by the Bridge and Structures Office from the Region Project 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.

2.2.2.B Structure Site Data

All Preliminary Plans are developed from Structure Site Data submitted by the Region Project Office. This submittal consists of a document describing the project with a bullet list itemization of the Structure Site Data components, forms, files, and data that are also attached to or linked by the email transmittal. See WSDOT *Design Manual* Chapter 710 and Exhibit 710-01. See also Section 2.2.1.A.2 and Appendices 2.2-A1, 2.2-A2, and 2.2-A3.

2.2.2.C Design Report or Design Summary and Value Engineering Studies

Some bridge and Buried Structure 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 project, the report will identify alternatives that have been studied and why the recommended alternative was chosen.

2.2.2.D 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.

2.2.2.E Notes

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 are discussed in appropriate detail in subsequent portions of this manual.

2.2.3.A Site Requirements

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

2.2.3.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

2.2.3.C Economic

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

2.2.3.D Structural

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

2.2.3.E Environmental

Site conditions (wetlands, sensitive areas, and cultural resources)
Environmental requirements
Mitigating measures
Construction access

2.2.3.F Aesthetic

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

2.2.3.G Construction

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

2.2.3.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 Buried Structure as an alternate solution
Permit requirements for navigation and stream work limitations

2.2.3.I Maintenance

Concrete vs. Steel
Expansion joints
Bearings
Deck protective systems
Inspection and Maintenance Access (UBIT clearances) (see Figure 2.3.11-1)

2.2.3.J Bridge Security

Mitigation measures for the inappropriate and illegal access to the bridge Employing the methods of Crime Prevention Through Environmental Design (CPTED).

2.2.3.K Alternatives

Process of developing alternative designs as described I Section 2.2.1-E.

2.2.3.L Other

Prior commitments made to other agency officials and individuals of the community Recommendations resulting from preliminary studies

2.2.4 Permits

2.2.4.A Coast Guard Waterway Jurisdiction and Navigation Permits for New Construction

For all waterway crossings, the US Coast Guard shall be contacted for determination and confirmation of waterway jurisdiction and any associated permit requirements or categorical assignment. When the Structural Clear Span parallel to the roadway centerline is less than or equal to 30 feet, this action is the responsibility of the Region, whether by the Region Design Project Office or the associated Region Environmental Services Office (ESO).

When the Structural Clear Span parallel to the roadway centerline is greater than 30 feet, this action is the responsibility of either the Region ESO, ideally as part of the project scoping phase, or the Bridge and Structures Office as part of the preliminary plan process.

Based on the response provided by the US Coast Guard, whether through the Region or through the Coast Guard Liaison Engineer, the preliminary plan identifies the waterway jurisdiction status in the left margin of the plan. The USCG block specifies whether the USCG has jurisdiction or not, along with the date that the USCG made the determination, and indicates whether a USCG navigation permit is required.

When the response received from the US Coast Guard indicates that a navigation permit is required, the Bridge and Structures Office is responsible for coordinating and applying for this permit, in accordance with *Design Manual* Section 710.03. The Coast Guard Liaison Engineer in the Bridge Project Support Unit of the Bridge and Structures Office is responsible for this.

See the *Design Manual*, chapter covering Environmental Permits and Approvals, or the *Environmental Manual* Chapter 500 for general permitting information.

Section 9 Coast Guard Permit – Information and Permitting procedures can be found at www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Marine-Transportation-Systems-CG-5PW/Office-of-Bridge-Programs/Bridge-Permit-Application-Process.

The work on developing the permit application should be started early in the preliminary plan process so that it is ready to be sent to the US Coast Guard at least eight months prior to the project ad date. The Coast Guard Liaison Engineer should be included in all distributions of the Preliminary Plan as outlined in Sections 2.2.1.A.5, 2.2.1.A.8, and 2.2.1.A.9. The Coast Guard Liaison Engineer uses these Preliminary Plans to develop the Coast Guard Application plan sheets, which become part of the permit.

2.2.4.B Coast Guard Temporary Regulation Adjustments for Construction Operations at Existing Structures

Existing bridges crossing navigable waters occasionally require construction or maintenance activities that impact navigation channels governed by USCG permits. For fixed span bridges, this may include construction or maintenance activities that infringe upon the horizontal and vertical navigation opening defined in the USCG permit. For movable bridges, in addition to the above, this may also include adjustments to existing bridge opening operating regulations.

Such temporary adjustments require coordination with the US Coast Guard, and the primary responsibility for this contact and coordination lies with the Region Design Project Office. The scope of such coordination varies depending on the extent of the infringement into the defined horizontal or vertical navigation clearance opening, the extent of the change to the bridge operation regulation, and the duration of the construction or maintenance activity.

This coordination activity may require the Design Project Office to conduct a survey of waterway users or to perform other background information tasks requested by the US Coast Guard. Projects with more extensive impacts may lie outside the approval authority of the local USCG Commander and may require review and action by US Coast Guard HQ in Washington, DC. In all cases, the earlier in the design process that the Region Design Project Office initiates these coordination efforts, the more likely the USCG can complete their regulatory process without impacting the project schedule.

2.2.4.C 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 is developed when the bridge type, foundation type, deck area and adjacent retaining walls are confirmed. At the Preliminary Plan stage the cost estimate is based on square-foot costs taken from the Chapter 12 and adjusted for structure specifics. Consult with the Bridge Project Support Engineer or designee.

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 percent, but 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.

As the Preliminary Plan is developed through the Initial Internal Review stage of Section 2.2.1.A.5, but before sending to the State Bridge Design Engineer for signature, the Preliminary Plan and completed Request For Geotechnical & Hydraulics Information form is submitted to the Bridge Project Support Engineer or designee. The information presented 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 Bridge Project Support Engineer or designee reviews the Preliminary Plan, prepares, signs, and dates a cost estimate summary sheet, and returns the package to the designer.

When the Preliminary Plan is presented to the State Bridge Design Engineer for signature (see Section 2.2.6.B), the submittal shall include the summary sheet prepared by the Bridge Project Support Engineer or designee. The summary sheet and backup data is then 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

2.2.6.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 Preliminary Plan designer. This is concurrent with the checking of the Preliminary Plan. The State Bridge and Structures Architect and specialist reviews, approves, signs and dates 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 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 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.

2.2.6.B Bridge and Buried Structures Design

The Bridge Project Support Unit Manager 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 State Bridge Design Engineer.

After the State Bridge Design 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. A PDF File of this Preliminary Plan and a cover memorandum signed by the State Bridge Design Engineer or designee is then sent to Region through the Region Project Office by email for review and approval by the Approving Authority in the Region.

The email includes the cover memorandum, the preliminary plan and the WSDOT Form 230-038 *Not Included in Bridge Quantities List* (NIBQ) and a brief explanation of the preliminary cost estimate. The cover memorandum is addressed to the Region Project Development Engineer/Engineering Manager or equivalent as the assigned Approving Authority.

The following individuals should be included in the email distribution list with attachments:

1. FHWA Washington Division Bridge Engineer
2. Region Project Engineer, Design Team Leader and Designer, and the Region Project Development Engineer/Engineering Manager or equivalent.
3. Bridge Project Support Unit Manager
4. Bridge Design Unit Manager assigned to design the structure,
5. Bridge Preliminary Plan Detailer in the Bridge Project Support Unit
6. State Foundation Engineer,
7. HQ Hydraulics Engineer (when it is a water crossing),
8. Bridge Asset Management Engineer (when it is a replacement),
9. Bridge Preservation Engineer,
10. HQ Design Office Railroad Liaison (when a railroad is involved), and Region Traffic Engineer (when ITS is required).
11. The Bridge Scheduling Engineer
12. Region and HQ Program Management Engineers.

2.2.6.C Region

The Region Project Office reviews the Preliminary Plan for compliance and agreement with the Structure Site Data. The Region Project Office answers any *"Notes to the Region"* that have been listed on the plan. When this review is complete, the Regional Project Development Engineer/Engineering Manager or equivalent position, or designee, signs the plan. The Region sends 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."

2.2.6.D Railroad

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

The railroad will respond with comments to the HQ Design Office Railroad Liaison. The comment form or email is then routed to the Project Office for coordination with the Bridge and Structures Office for a response to the railroad. The review process continues with the railroad until 100% plans have been accepted by the railroad as “No Exceptions Taken”. Railroads do not approve WSDOT bridge plans, but the notation allows the project to continue with an agreement and right of entry onto railroad property for construction. Please consult the *Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects* for additional requirements.

For design plans prepared within the Bridge and Structures Office, the Design Unit Manager or lead designer will be responsible for coordinating and providing shoring plans for structures adjacent to railroads. Shoring plans on railroad property or adjacent to track must conform to the railroads Guidelines for Temporary Shoring (UPRR and BNSF). 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 Design Unit Manager 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 Constructability Review stage.

At the Constructability Review stage or sooner if possible, especially for seismic retrofit project, the S&E Engineer will send copies of the layout, foundation plan, temporary shoring plans, and appropriate special provision section for structures adjacent to railroads to the HQ Design Office Railroad Liaison, who will submit this package to the appropriate railroad for review. The shoring plans shall show the pressure loading diagram and calculations to expedite the railroad’s review.

2.3 Preliminary Plan Criteria

2.3.1 Highway Crossings

2.3.1.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.

2.3.1.A.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-205 (followed by the bridge number).

2.3.1.A.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).

2.3.1.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 Manua*. For city and county arterials, the roadway geometrics are controlled by Chapter 42 of the *Local Agency Guidelines*.

2.3.1.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′ 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′ 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.

Figure 2.3.1-1 Horizontal Clearance to Incline Piers

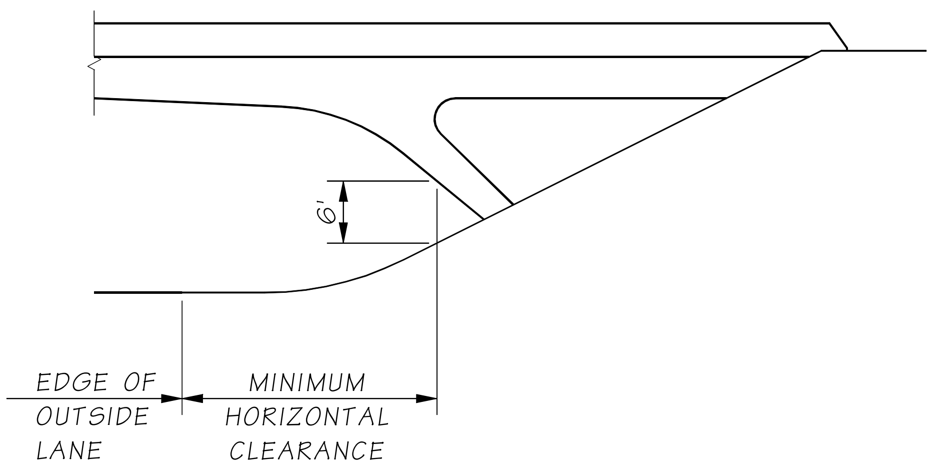
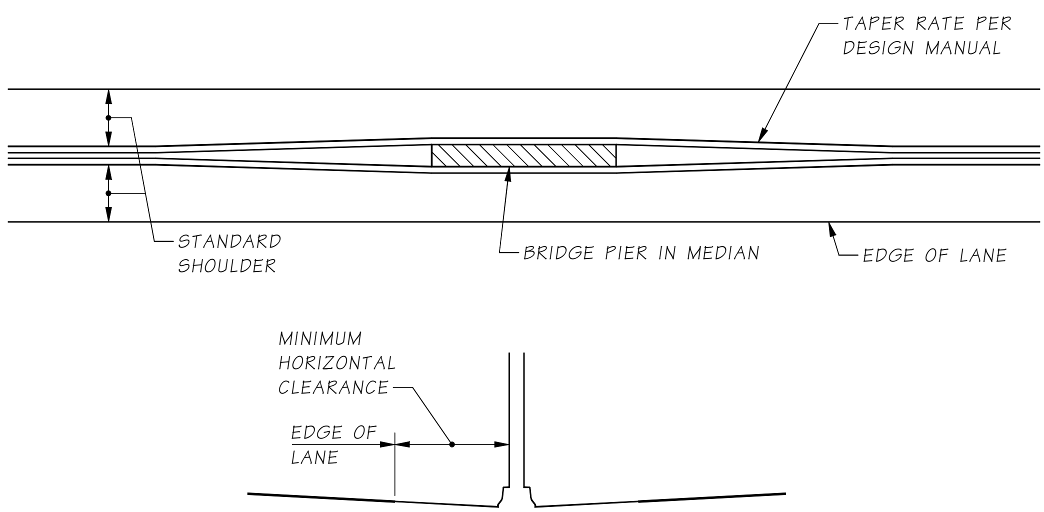


Figure 2.3.1-2 Bridge Pier in Narrow Median



2.3.1.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.

2.3.1.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.

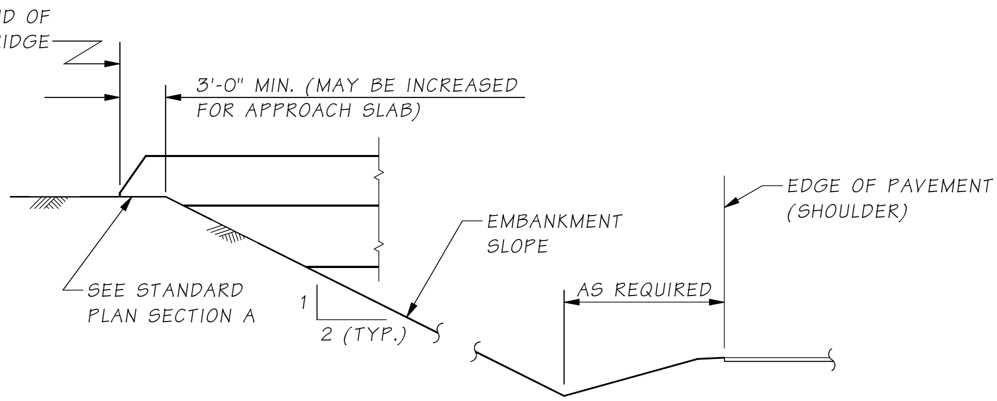
The State Geotechnical Office will recommend the minimum rate of end slope. This should be compared to the rate recommended in the Roadway Section and to existing site conditions (if applicable). The types of end slopes and bridge slope protection are discussed in the *Design Manual*. Examples of slope protection are shown in *Standard Plans* Section A.

2.3.1.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 Plans* Section A, the back of pavement seat, end of wing wall or end of retaining wall can be established at 3′ behind the slope intersection. See Figure 2.3.1-3.

Figure 2.3.1-3 Determination of Bridge Length



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.

2.3.1.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.

2.3.1.H Bridge Redundancy

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

Bridge substructures shall have the following number of columns to be considered to provide conventional levels of redundancy in accordance with LRFD-BDS Section 1.3.4.

- One column minimum for roadways 40′ wide and under.
- Two columns minimum for roadways over 40′ to 60′.
- Three columns minimum for roadways over 60′.

Collision protection or design for collision loads for piers with one or two columns shall be provided.

Bridge superstructures shall have the following number of webs to be considered to provide conventional levels of redundancy in accordance with LRFD-BDS 1.3.4:

- Three girders (webs) minimum for roadways 32′ and under.
- Four girders (webs) minimum for roadways over 32′.

See Bridge Standard Drawing 2.3-A2-1 for details.

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

2.3.2 Railroad Crossings

2.3.2.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 will involve negotiations with the railroad company concerning clearances, geometrics, utilities, and maintenance roads. The railroad's review and acceptance as "No Exceptions Taken" will be based on the completed 100% plans. Please consult the *Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects* for additional requirements.

2.3.2.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.

2.3.2.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. *Please consult the Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects* for additional requirements.

2.3.2.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′ 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, it is preferable to clear span the railroad right of way, with minimum horizontal clearances described in the *Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects*.

The actual minimum horizontal clearances shall be shown in the Plan view of the Preliminary Plan (to the nearest 0.1 foot).

2.3.2.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:

- The *Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects*
- The *AREMA Manual*
- The HQ Design Office Railroad Liaison

2.3.2.F Vertical Clearances

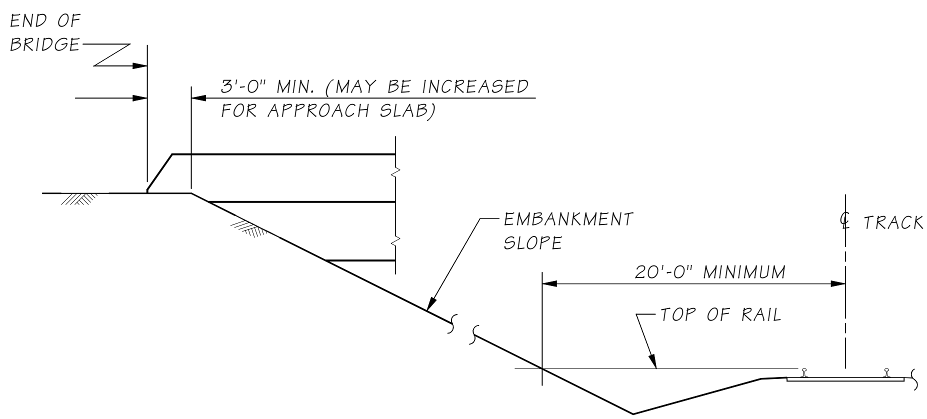
For railway over highway grade separations, the provisions of Section 2.3.1 pertaining to vertical clearances of highway crossings shall apply. For highway over railway grade separations, the minimum vertical clearance shall satisfy the requirements of the *Design Manual*.

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.

2.3.2.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.

Figure 2.3.2-1 Determination of Bridge Length For a Highway Over Railway Grade Separation



2.3.2.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′ or more below the elevation of the top of tie and shall not have less than 2′ of cover from the finished ground. The footing face shall not be closer than 10′ to the center of the track. Any cofferdams, footings, excavation, etc., encroaching within 10′ of the center of the track requires the approval of the railroad.

2.3.2.I Construction Openings

For railroad clearances, see *Design Manual*. The minimum horizontal construction opening is 15′ to either side of the centerline of track. The minimum vertical construction opening is 21′-6″ above the top of rail. 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 21′-6″ shall be coordinated with the HQ Design Office Railroad Liaison. For more information, please consult the *Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects*.

2.3.3 Water Crossings

2.3.3.A Bridge Width

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

2.3.3.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.

2.3.3.C Vertical Clearances

Water crossings structures shall provide vertical clearance for both freeboard, maintenance, hydraulic and, where applicable, shall satisfy navigation clearance requirements.

Bridges over navigable waters shall 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.

Minimum vertical clearances shall adhere to the requirements in *Design Manual* Chapter 800 and *Hydraulics Manual* Chapter 7. The roadway profile and the bridge superstructure depth shall accommodate all minimum vertical clearances provided.

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.

2.3.3.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 State Geotechnical Office will make preliminary recommendations as to the type and rate of end slope. The State Hydraulics Office will also review the Region's recommendation for slope protection.

2.3.3.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.

2.3.3.F Scour and Stream Migration

The State 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.).

The State Hydraulics Office will indicate the likelihood and severity of stream migration at the bridge piers. Where lateral stream migration is a possibility, the design shall include a reliability based estimate of the effects on the structure. The design requirements for stream migration is shown in Section 7.1.7.

2.3.3.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.

2.3.3.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 the 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.

Buried Structures that qualify as a bridge per National Bridge Inspection Standards (NBIS) shall be designed to meet above requirements for Water Crossings.

2.3.4 Bridge Widening

2.3.4.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.

2.3.4.B Traffic Restrictions

Bridge widening 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.

2.3.4.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 Temporary Bridges

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

2.3.5.A Bridge Width

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

2.3.5.B Live Load

For live load design criteria of temporary bridges, see Section 10.13.2.C.

2.3.5.C Temporary Bridge Type

Temporary bridge is typically designed by the Contractor per Contract Documents unless otherwise specified.

2.3.5.D Temporary Bridge Traffic Barrier

Temporary bridge traffic barrier shall be designed in accordance with Section 10.13.2.B.

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 730 of the *Design Manual*. The Bridge and Structures Office is responsible for all nonstandard walls (retaining walls and noise walls) as spelled out in the *Design Manual*.

2.3.7 Bridge Deck Drainage

The State Hydraulics Office provides a review of the Preliminary Plan with respect to the requirements for bridge deck drainage. A copy shall be provided to the State 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 State Hydraulics Branch 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 Hydraulics Office will provide details to handle drainage with bridge drains on the structure.

2.3.8 Bridge Deck Protection Systems

An appropriate Bridge Deck Protection System shall be selected for each bridge in accordance with Section 5.7.4. The Preliminary Plan shall note in the lower left margin the type of Bridge Deck Protective System to be utilized on the bridge.

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′ widths for the temporary unanchored concrete barriers, plus additional 3’ deflection distances behind the temporary barriers. For multi-span falsework openings, a minimum of 2′, and preferably 4′, shall be used for the interior support width. This interior support shall also have a 2′ lateral distance to the traffic side and 3’ on the back side of 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′-6″ 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 2.3.2.I.

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:

2.3.10.A Falsework Spans < 36′ and No Skews

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

W36X___ steel beam sections
¾″ camber strip
⅝″plywood
4 x 4 joists
6″ depth for segmental falsework release

2.3.10.B Falsework Spans > 36′ 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* Section 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* Section 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.

2.3.10.C Bridge Widening

For bridge widening 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.

2.3.10.D Bridge with Skews

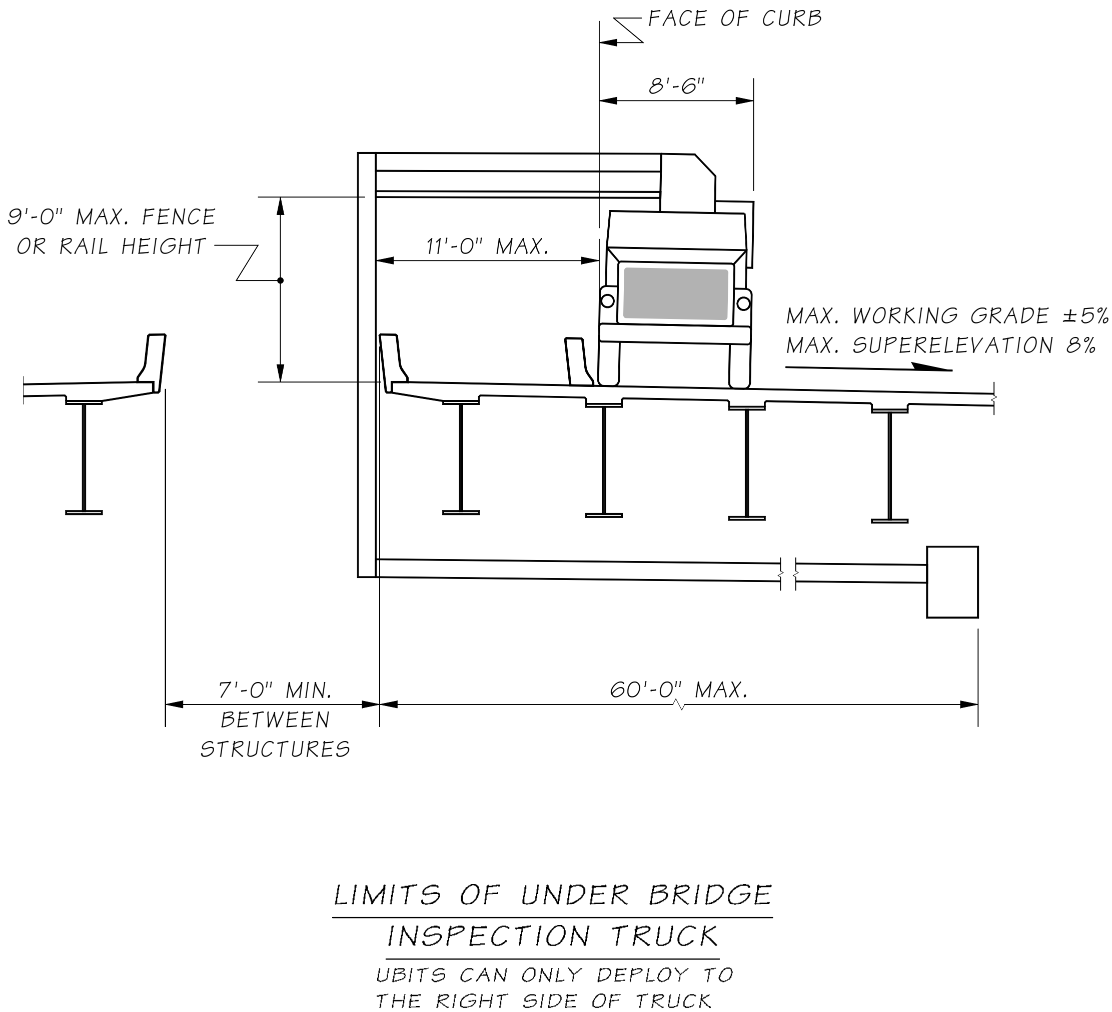
Falsework beams shall be laid out and designed for spans parallel to the bridge centerline or perpendicular to the main axis of bending. The centerline of falsework beams shall be located within 2′ of the bridge girder stems and preferably directly under the stems or webs in accordance with the *Standard Specifications* 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

2.3.11.A General

FHWA mandates that bridges be inspected every 24 months. The BPO inspectors are required to access bridge components to within 3′ 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.

Figure 2.3.11-1 Limits of Under Bridge Inspection Truck



2.3.11.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′ 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′ deep. On large trusses, large gusset plates (3′ 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.

2.3.11.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 average daily traffic (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.

2.3.11.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′ minimum). See Section 7.5.3 for additional information.

2.3.11.E Inspection Lighting and Access

2.3.11.E.1 *Reinforced Concrete Box and Post-Tensioned Concrete Box Girders*

Refer to Section 5.2.6 for design criteria.

2.3.11.E.2 *Composite Steel Box Girders*

- All steel box or tub girders shall have inspection lighting and access.
- Inside clear height shall be 5 feet or greater to provide reasonable inspection access.
- Refer to Section 6.4.9 for design criteria.

2.4 Selection of Structure Type

2.4.1 Bridge Types

The recommended minimum superstructure depth is determined during the preliminary plan development process. The LRFD-BDS Section 2.5.2.6.3 shows traditional minimum depths for constant depth superstructures. WSDOT has developed superstructure depth-to-span ratios based on past experience.

Live Load deflection criteria shall be checked in accordance with LRFD-BDS 2.5.2.6.2 and 3.6.1.3.2 and shall not be considered optional.

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 LRFD-BDS 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.

Refer to Sections 2.3.11 and 7.5.3 for inspection and maintenance access requirements. Superstructure depth may be influenced when inspection lighting and access is required for certain bridge types.

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.

The maximum depth of fill over the bridge deck to the finished grade shall not exceed 5 ft, including soil and roadway depth. All loads shall be evaluated for vertical and horizontal effects. Fill depths exceeding this limit shall be approved by the State Bridge Design Engineer and include design procedures for evaluating soil structure interaction. The placement of fill over the superstructure shall not eliminate the requirement for bridge decks or CIP toppings as required for bridges in Chapter 5.

2.4.1.A Reinforced Concrete Slab

2.4.1.A.1 *Application*

Used for simple and continuous spans up to 60′.

2.4.1.A.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.

2.4.1.A.3 *Depth/Span Ratios*

1. **Constant Depth**

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

2. **Variable Depth**

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

2.4.1.B Reinforced Concrete Tee-Beam

WSDOT restricts the use of cast-in-place reinforced concrete Tee-Beam girder for bridge superstructure. This type of superstructure may only be used for bridges with tight curvatures or irregular geometry upon State Bridge Design Engineer approval.

2.4.1.B.1 *Application*

This type of superstructure is not recommended for new bridges. It shall only be used for bridge widening and bridges with unusual geometry.

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

2.4.1.B.2 *Characteristics*

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

2.4.1.B.3 *Depth/Span Ratios*

1. **Constant Depth**

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

2. **Variable Depth**

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

2.4.1.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 State Bridge Design Engineer approval.

2.4.1.C.1 *Application*

This type of superstructure 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′ to 120′. Maximum simple span 100′ to limit excessive dead load deflections.

2.4.1.C.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.

2.4.1.C.3 *Depth/Span Ratios**

1. **Constant Depth**

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

2. **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.

2.4.1.D Post-tensioned Concrete Box Girder

2.4.1.D.1 *Application*

Normally used for continuous spans longer than 120′ or simple spans longer than 100′. Should be considered for shorter spans if a shallower structure depth is needed or for bridges with tight horizontal curvature.

2.4.1.D.2 *Characteristics*

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

2.4.1.D.3 *Depth/Span Ratios**

1. **Constant Depth**

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

2. **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.

2.4.1.E Prestressed Concrete Girder Sections

2.4.1.E.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:

1. WF100G, WF95G, WF83G, WF74G, WF58G, WF50G, WF42G, WF36G, W74G, W58G, W50G, and W42G precast, prestressed concrete I-girders requiring a cast-in-place reinforced concrete bridge 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 reinforced concrete bridge deck use for simple span up to 230-feet, and continuous span up to 250-feet with continuous post-tensioning over the intermediate piers.

2. U**G* and UF**G* precast, prestressed concrete tub girders requiring a cast-in-place reinforced concrete bridge 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 reinforced concrete bridge deck are used for simple span up to 160-feet and continuous span up to 200-feet.

3. W65DG, W53DG, W41DG, and W35DG precast, prestressed concrete decked bulb tee girders requiring UHPC closures and an overlay for permanent vehicular bridges.

4. W62BTG, W38BTG, and W32BTG precast, prestressed concrete bulb tee girders requiring a cast-in-place reinforced concrete bridge deck for simple spans up to 130-feet.

5. 12-inch, 18-inch, 26-inch, 30-inch, and 36-inch precast, prestressed slabs requiring a cast-in-place (CIP) reinforced concrete bridge deck used for spans less than 100-feet. The CIP reinforced concrete bridge deck minimum thickness shall be as required in Section 5.6.7.B.

6. WF36TDG, WF42TDG, WF50TDG, WF58TDG, WF66TDG, WF74TDG, WF83TDG, WF95TDG, and WF100TDG precast, prestressed concrete thin top flange girders requiring a cast in place (CIP) reinforced concrete bridge deck for simple spans up to 225-feet. The CIP reinforced concrete bridge deck thickness shall be as required in Section 5.6.7.F.

7. WF39DG, WF45DG, WF53DG, WF61DG, WF69DG, WF77DG, WF86DG, WF98DG, and WF103DG precast, prestressed concrete wide flange girders UHPC closures and an overlay for permanent vehicular bridges.

2.4.1.E.2 *Characteristics*

Superstructure design is quick for pre-tensioned 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.

2.4.1.F Composite Steel Plate Girder

1. **Application**

   Used for simple spans up to 260′ and for continuous spans from 120′ to 400′. 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	$1/20$

2.4.1.G Composite Steel Box Girder

2.4.1.G.1 *Use*

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

Inside clear height of less than 5 feet shall not be used because reasonable inspection access cannot be provided.

2.4.1.G.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.

2.4.1.G.3 *Depth/Span Ratios*

1. **Constant Depth**

   Simple spans $\frac{1}{22}$
   Continuous spans $\frac{1}{25}$

2. **Variable Depth**

   At Center of span $\frac{1}{40}$
   At Intermediate pier $\frac{1}{20}$

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

2.4.1.H Steel Truss (Through or Deck)

2.4.1.H.1 *Application*

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

2.4.1.H.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.

2.4.1.H.3 *Depth/Span Ratios*

1. Simple spans $\frac{1}{6}$
2. Continuous spans

   @ Center of span $\frac{1}{18}$
   @ Intermediate pier $\frac{1}{9}$

2.4.1.I Segmental Concrete Box Girder

2.4.1.I.1 *Application*

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

2.4.1.I.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.

2.4.1.I.3 *Depth/Span Ratios*

Variable depth
  At Center of span $\frac{1}{50}$
  At Intermediate pier $\frac{1}{20}$

2.4.1.J Railroad Bridges

2.4.1.J.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.

2.4.1.J.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.

2.4.1.J.3 *Depth/Span Ratios*

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

2.4.1.K Timber

2.4.1.K.1 *Use*

Generally used for spans under 40′. WSDOT restricts the use of timber girders for bridge superstructures to non-vehicle use bridges or temporary bridges.

2.4.1.K.2 *Characteristics*

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

2.4.1.K.3 *Depth/Span Ratios*

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

2.4.1.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, sound barrier 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 Section 8.1.

2.4.3 Buried Structure Types

Buried Structures may be used where required in accordance with specific site conditions. The process of selecting a type of Buried Structure should economically satisfy structural, functional, and aesthetic requirements and other considerations relevant to a specific site. Detailed discussion of the common types of Buried Structures, their characteristics and appropriate applications is found in Section 8.3.

Buried structures that qualify as a bridge per NBIS Standards shall be designed to meet requirements for Water Crossings per Section 2.3.3.

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 structurally efficient using the least material possible are generally visually 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

2.5.2.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′ wingwall (or curtain wall/retaining wall). However, there are instances where a 20′ 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′ wingwall shall be approved by the State Bridge Design Engineer and the State Bridge and Structures Architect.

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

2.5.2.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.

2.5.2.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.

2.5.2.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

2.5.4.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.

2.5.4.B Formliner Finishes

These finishes are 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.

2.5.4.C Pigmented Sealer

The use of a pigmented sealer is used to control graffiti and can also be an aesthetic enhancement. Most commonly it is always used in urban areas. The selection should be reviewed with the State Bridge and Structures Architect and the Region.

2.5.4.D Typical and Minimum Color and Finish Standards

Minimum WSDOT finish standards include fractured fin on back of barriers and smooth finish on abutment and retaining wall surfaces with Washington Gray pigmented sealer applied to typical limits.

Typical Project Colors and *Standard Concrete Finishes* listed in Standard Specifications are shown for visual reference in Appendix 2.5.4D-A1 and 2. *Fish Passage Aesthetic Guidance* visual document is shown in Appendix 2.5.4D-A3.

The selection of these should be reviewed with the State Bridge and Structures Architect.

2.5.4.E 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.

In special circumstances custom designs may be provided. Designs rising to the level of art shall be subject to the procedures outlined in the *Design Manual*.

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 l½: l 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 State Bridge Design 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, 252 kips is the maximum weight of a girder that may be hauled by truck.

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 Standards for Highway Bridges

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.

2.7.1.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.

2.7.1.B Substructure

End piers use the following details:

15-foot wingwalls with prestressed concrete 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 State Geotechnical Office Geotechnical Report.

Intermediate piers use the following details:

"Dropped" Crossbeams – The crossbeam below the girders is designed for the girder and bridge deck dead load, construction loads, live load, and superimposed dead loads. The minimum depth of the crossbeam shall be 3-feet. This crossbeam may be used for simple span continuous prestressed concrete girder bridges and continuous steel girder bridges.

"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.

Round Columns – Columns shall be 3-feet to 6-feet 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.

2.7.1.C Superstructure

Concrete Slab – 7½ inch minimum thickness with epoxy coated steel reinforcing bars in general with 5 inch minimum thickness for deck girders and 8 inch minimum thickness for steel girders.

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

Intermediate Diaphragms – Locate in accordance with Table 5.6.2-1 and Section 5.6.4.C. Provide full or partial depth in accordance with Section 5.6.4.C.4.

End Diaphragms – "End Wall on Girder" type.

Traffic Barrier – Use 3'-6" high "F-shape" or Single-sloped barrier to meet worker fall protection requirements.

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′–6″ overall height for pedestrian traffic. 4′–6″ 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.

Expansion Joints – refer to table in Section 9.1.1 for guidance regarding maximum bridge superstructure length beyond which the use of either intermediate expansion joints or modular expansion joints at the ends is required.

2.7.1.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 or Buried Structure 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 it's 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.

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 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.

2.8 Bridge Security

2.8.1 General

Security based bridge design and its direct correlation to modern social issues is addressed in this section. Criminal activity, illegal encampments, graffiti, hindrance to economic development and public eyesore create unwanted expensive. They also pose safety hazard for State Maintenance and Operations practices. The issue exists in urban areas as well as rural and recreational locales.

Bridges are dominant structures in landscapes. They are held to a higher standard of design due to their influence on communities, where economic and social settings are affected by their quality. Initial project cost savings may quickly be overshadowed by increased externalized costs. These externalized costs are born by local municipalities and businesses as well as other departments within WSDOT.

WSDOT bridge inspectors are required to inspect all bridges at least once every 24 months. The presence of the illegal encampments, as well as garbage, hypodermic needles, and feces often makes it impossible to do a close, hands-on inspection of the abutments and bearings of bridges. The Bridge Preservation Office has requested that maintenance clean up transient camps when it becomes difficult or impossible to do an adequate inspection of the bridges. Campfires set by the homeless have also caused damage to bridges.

Bridge Maintenance Crews also face the same difficulty when they need to do repair work on bridges in the urban area. Clean up requires (per law) posting the bridge seventy-two hours prior to any work. Material picked up is tagged, bagged, and stored for retrieval. Often the offenders are back the next day.

2.8.2 Design

Design is determined on a case by case basis using two strategies. These strategies are universally accepted best practices. The first, Crime Prevention through Environmental Design (CPTED), is a multi-disciplinary approach to deterring criminal behavior. The second, Context Sensitive Solutions (CSS), is also multi-disciplinary and focuses on project development methods. Multi-disciplinary teams consist of engineers and architects but may include law enforcement, local businesses, social service providers, and psychologists.

1. CPTED principals are based upon the theory that the proper design and effective use of the built environment can reduce crime, reduce the fear of crime, and improve the quality of life. Built environment implementations of CPTED seek to dissuade offenders from committing crimes by manipulating the built environment in which those crimes proceed from or occur. The six main concepts are territoriality, surveillance, access control, image/maintenance, activity support and target hardening. Applying all of these strategies is key when preventing crime in any neighborhood or right-of-way.

Natural surveillance and access control strategies limit the opportunity for crime. Territorial reinforcement promotes social control through a variety of measures. These may include enhanced aesthetics or public art. Image/maintenance and activity support provide the community with reassurance and the ability to stop crime by themselves. Target hardening strategies may involve fencing or concrete enclosures or they may include all techniques to resolve crime or chronic trespass into one final step.

2. WSDOT implements FHWA's CSS design development principles. The CSS methods require designers to consider the physical, economic, and social setting of a project. Stakeholder's interests are to be accounted for; including area residents and business owners.

2.8.3 Design Criteria

New bridges need to address design for the environment by basic criteria:

- Slopes under bridges need to be steep slope, and hardened with something like solid concrete so that flat areas cannot be carved into the hillside. Flat areas under bridge superstructures attract inappropriate uses and should be omitted.
- Illegal urban campers have been known to build shelters between the concrete girders. Abutment walls need to be high enough that they deny access to the superstructure elements. When it is not feasible to design for deterrence the sites need to be hardened with fencing buried several feet into the soil or with solid concrete walls. See Figures 2.8.3-1 and 2.8.3-2 for high security fence and concrete wall examples.
- Regular chain link is easy cut, therefore stouter material needs to be specified.
- Landscape design should coordinate with region or headquarters landscape architects. Areas need to be visible to law enforcement.

Figure 2.8.3-1 Bent Type Abutment Plan

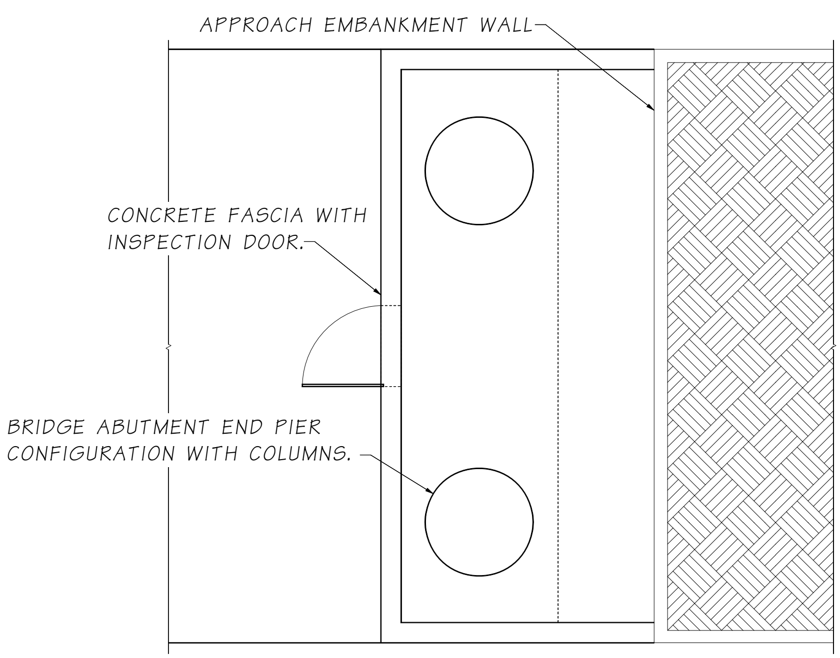
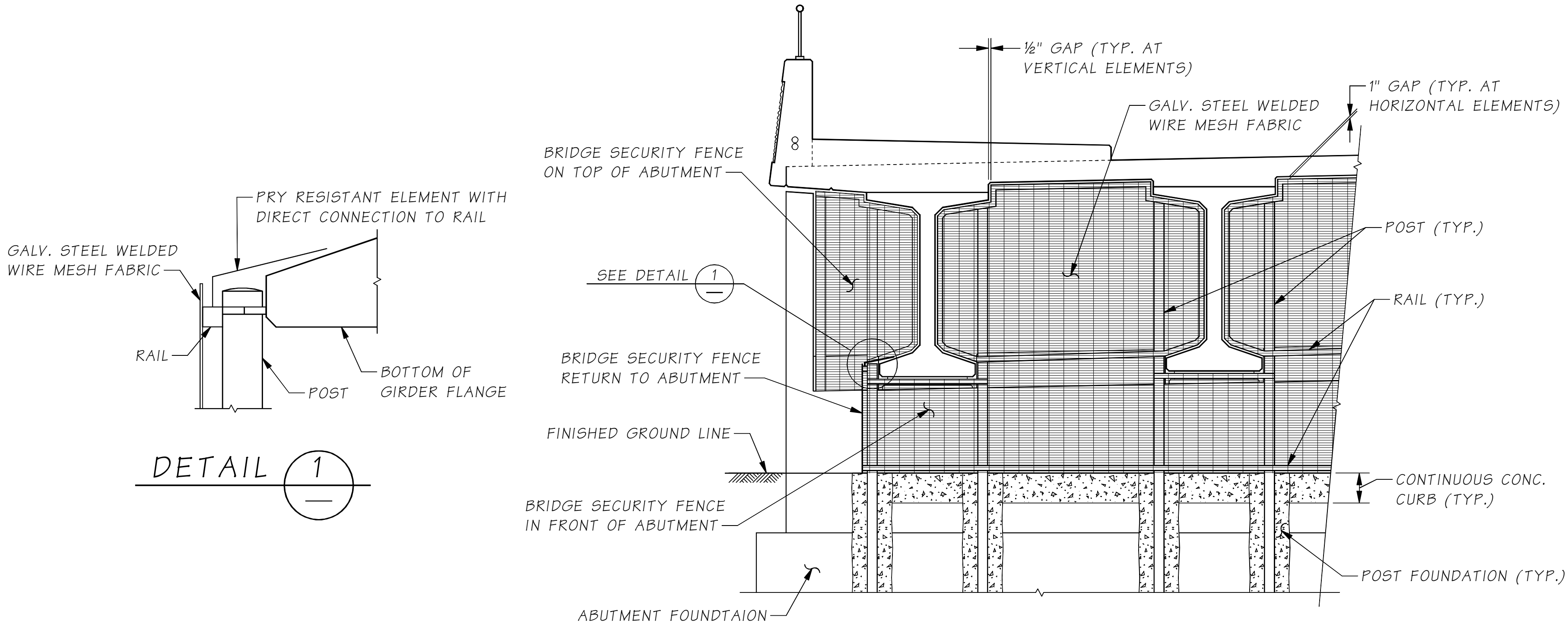


Figure 2.8.3-2


PRY RESISTANT ELEMENT WITH DIRECT CONNECTION TO RAIL
GALV. STEEL WELDED WIRE MESH FABRIC
RAIL
POST
BOTTOM OF GIRDER FLANGE
DETAIL 1
½" GAP (TYP. AT VERTICAL ELEMENTS)
1" GAP (TYP. AT HORIZONTAL ELEMENTS)
GALV. STEEL WELDED WIRE MESH FABRIC
BRIDGE SECURITY FENCE ON TOP OF ABUTMENT
SEE DETAIL 1
POST (TYP.)
RAIL (TYP.)
BRIDGE SECURITY FENCE RETURN TO ABUTMENT
FINISHED GROUND LINE
CONTINUOUS CONC. CURB (TYP.)
BRIDGE SECURITY FENCE IN FRONT OF ABUTMENT
POST FOUNDATION (TYP.)
ABUTMENT FOUNDTAION

2.9 Bridge Standard Drawings

2-B-1	Bridge Preliminary Plan Example - Precast Slab Bridge
2-B-2	Bridge Preliminary Plan Example - Temporary Bridge
2-B-3	Bridge Preliminary Plan Example - Bridge Cross Sections
2-B-4	Bridge Preliminary Plan Example - Precast Tub Girder Bridge
2-B-5	Bridge Preliminary Plan Example - Bridge Cross Section
2-B-6	Bridge Preliminary Plan Example - Roadway Data
2-B-7	Bridge Preliminary Plan Example - Precast Girder Bridge Widening
2-B-8	Bridge Preliminary Plan Example - Widened Bridge Cross Section
2-B-9	Bridge Preliminary Plan Example - Existing Roadway Survey Data
2.3-A1	Bridge Stage Construction Comparison
2.3-A2	Bridge Redundancy Criteria
2.7-A1	Standard Superstructure Elements

2.10 Appendices

Appendix 2.2-A1	Bridge Site Data General
Appendix 2.2-A2	Structure Site Data Rehabilitation
Appendix 2.2-A3	Structure Site Data Stream Crossings
Appendix 2.2-A4	Preliminary Plan Checklist
Appendix 2.2-A5	Request For Geotechnical & Hydraulic Information for Bridge Preliminary Plan
Appendix 2.5.4D-A1	Bridge & Structures Typical Project Colors
Appendix 2.5.4D-A2	Bridge & Structures Standard Concrete Finishes
Appendix 2.5.4D-A3	Bridge & Structures Fish Passage Aesthetic Guidance

Appendix 2.2-A1 Bridge Site Data General

Washington State Department of Transportation

Structure Site Data General

Region	Made By	Date

Structure Information

SR	Structure Name	Control Section	Project No.

Highway Section	Section, Township & Range	Datum

Roadway width between curbs	What are expected foundation conditions?
Will the structure be widened in a contract subsequent to this contract ? ☐ Yes ☐ No ☐ N/A Which side and amount ?	When can foundation drilling be accomplished?
Will the roadway under the structure be widened in the future? ☐ Yes ☐ No ☐ N/A	Is slope protection or riprap required for the structure end slope? ☐ Yes ☐ No ☐ N/A
Stage construction requirements? ☐ Yes ☐ No ☐ N/A	Are sidewalks to be provided? ☐ Yes ☐ No ☐ N/A If Yes, which side and width?
Should the additional clearance for off-track railroad maintenance equipment be provided?	Will there be bicycle traffic using this structure? ☐ Yes ☐ No ☐ N/A If Yes, which side(s)?
Can a pier be placed in the median? ☐ Yes ☐ No ☐ N/A	Will signs or illumination be attached to the structure? ☐ Yes ☐ No ☐ N/A
What are the required falsework or construction opening dimensions ?	Will utility conduits be incorporated in the bridge? ☐ Yes ☐ No ☐ N/A
Are there detour or shoofly requirements? (If Yes, attach drawings) ☐ Yes ☐ No ☐ N/A	What do the traffic barriers on the structure transition to?
Can the R/W be adjusted to accommodate toe of approach fills? ☐ Yes ☐ No ☐ N/A	
What is the required vertical clearance?	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 available depth for superstructure?	
Are overlays planned for a contract subsequent to this contract? ☐ Yes ☐ No ☐ N/A	Are there security issues, such as the presence of illegal campers, that require design considerations?
Can profile be revised to provide greater or less clearance? ☐ Yes ☐ No ☐ N/A If Yes, which line and how much?	Any other data relative to selection of type, including your recommendations?
Will structure be constructed before, with or after approach fill? ☐ Before ☐ With ☐ After ☐ N/A	

Attachments

- ☐ Vicinity Map
- ☐ Structure Site Contour Ma
- ☐ Specific Roadway sections at structure site and approved roadway sec
- ☐ Vertical Profile Data
- ☐ Horizontal Curve Data
- ☐ Superelevation Transition Diagrams
- ☐ Tabulated field surveyed and measured stations, offsets, and elevations of existing roadways (See Design Manual M 22-01, Cha
- ☐ Photographs and video of structure site, adjacent existing structures and surrounding terrain
- ☐
- ☐

DOT Form 235-002
Revised 07/2024

Appendix 2.2-A2 Structure Site Data Rehabilitation

Washington State Department of Transportation

Structure Site Data Rehabilitation

Region	Made By	Date

Structure Information

SR	Structure Name	Control Section	Project No.

Highway Section	Section, Township & Range	Vertical Datum

Existing roadway width, curb to curb ________ Left of ℄ ________ Right of ℄ ________

Proposed roadway width, curb to curb ________ Left of ℄ ________ Right of ℄ ________

Existing wearing surface *(concrete, HMA, HMA w /membrane, MC, epoxy, other)* ________ Thickness ________

Existing drains to be plugged, modified, moved, other? ________

Proposed overlay *(HMA, HMA w /membrame, MC, epoxy)* ________ Thickness ________

Is traffic barrier/railing to be modified? ☐ Yes ☐ No

Existing rail type ________

Proposed rail replacement type ________

Will terminal design “F” be required? ☐ Yes ☐ No

Will utilities be placed in the new barrier? ☐ Yes ☐ No

Will the structure be overlayed with or after rail replacement? ☐ With Rail Replacement ☐ After Rail Replacement

Condition of existing expansion joints ________

Existing expansion joints watertight? ☐ Yes ☐ No

Measure width of existing expansion joint, normal to skew. @ curb line ________ Inch @ ℄ 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

☐ Video tape of project

☐ Sketch indicating points at which expansion joint width was measured.

☐ Photographs of existing expansion joints.

☐ Existing deck chloride and delamination data.

☐ Roadway deck elevations at curb lines (10-foot spacing)

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Revised 07/201

Appendix 2.2-A3 Structure Site Data Stream Crossings

Washington State Department of Transportation

Structure Site Data Stream Crossings

Region	Made By	Date

Structure Information

SR	Structure Name	Control Section	Project No.

Highway Section	Section, Township & Range	Datum (e.g. NGVD29, NAVD88, USGS)

Name of Stream	Tributary of

Elevation of W.S. *(@ Date/Time of survey)*

____

Streambed Material

☐ Fines ☐ Gravel ☐ Boulder
☐ Sand ☐ Cobble

☐ **Non-Tidal**

	Flow (CFS)	WSE (ft)
2-YR	______	______
100-YR	______	______
500-YR	______	______

☐ **Tidal**

	Flow (CFS)	WSE (ft)
2-YR	______	______
100-YR	______	______
500-YR	______	______
MLLW		______
MHHW		______

Amount and Character of Drift

____

Manning's "N" Value *(Est.)*

____

Attachments

☐ Site Contour Map *(See Sect. 710.04 WSDOT Design Manual)*

☐ Highway Alignment and Profile *(refer to base map and profiles)*

☐ Streambed: Profile and Cross Sections defining bankfull width and bank shelf widths and slopes *(See Sect. 710.03 WSDOT Design Manual)*

☐ Photographs

☐ Character of Stream Banks *(e.g., rock, silt.)* / Location of Solid Rock

☐ Other Data Relative to Selection of Type and Design of Structure, Including your Recommendations *(e.g., requirements of riprap, permission of piers in channel.)*

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Revised 11/2019

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
_____ Bridge Inspection Lighting and Access

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

Appendix 2.2-A5 Request For Geotechnical & Hydraulic Information for Bridge Preliminary Plan

Request For Geotechnical & Hydraulics Information For Bridge Preliminary Plans

Date:

Requested By:

Geotech Info Rovided By:

Hydraulics Info Provided By:

Project Name & Location:

Back Of Pavement Seat Stations (Bridge Or Structure Limits):

Geotechnical Information Requested	PIER: STA:	PIER: STA:	PIER: STA:	PIER: STA:	PIER: STA:
Anticipated foundation type: shallow, deep, or complex/very deep					
If shallow, expect seal/coffer dams: Yes or No					
If deep, expected type: pile, shaft, unknown					
If shaft casing requirements: permanent, temporary, both, unknown					
Bridge and slopes: 2:1 or other (fill in)					
Landslide risk: Yes or No					
Liquefaction/lateral spread risk: Yes or No					
Anticipate soil improvement: Yes or No					
Early boring(s) recommended: Yes or No					
Any additional comments or concerns:					

Hydraulics Information Requested					
Scour potential: Yes or No					
Channel migration risk: High or Low					
Early boring(s) recommended: Yes or No					
Any additional comments or concerns:					

Appendix 2.5.4D-A1 Bridge & Structures Typical Project Colors

WSDOT BRIDGE AND STRUCTURES OFFICE
STATE BRIDGE AND STRUCTURES ARCHITECT

BRIDGE AND STRUCTURES TYPICAL PROJECT COLORS

WSDOT uses four custom colors as well as referencing AMS Standard 595 Colors. These are used to obscure visual differences between concrete mixes, aid in maintenance control of graffiti and provide a more 'finished look'. The warm taupe browns are neutral hues that blend with the pre-existing built infrastructure.

WSDOT's four standard custom colors are:

- **Washington Gray: used in the majority of applications.**
- **Mt. St. Helens Gray: used for noise walls well off the roadway and in landscaped or forested areas.**
- **Mt. Baker Gray: I 405 CSS color used for dark gray accents.**
- **Cascade Green: I 405 CSS color for superstructures, railing and miscellaneous steel structures.**

WSDOT uses typical colors for sign bridges.

- **AMS Standard 595 Color 35237: Blue gray for standard installations**
- **AMS Standard 595 Color 30045: Dark brown on US 2, US 12, US 97, SR 20, SR 410, Eastern portions of I 90 and in the National Forests**
- **AMS Standard 595 Color 30040: Very dark brown/bronze updated from 37056 in *I 90 Architectural Design Standards December 1986.***
- **Cascade Green: Evergreen color used on I 405 CSS corridor**

WSDOT uses one color for ROW fences, and accents requiring a brown hue.

- **AMS Standard 595 Color 20045 dark brown**

In rare cases, such as urban areas tying into existing municipality fences, WSDOT may use AMS Standard 595 Color 27038 black.

WSDOT uses a limited palette for repainting steel bridges. Existing steel bridges are repainted in original contract colors found in the Bridge Preservation data base. The AMS Standard 595 Color series is used.

New steel bridges are typically painted Washington Gray to blend with adjacent concrete bridges and match state corridors. Where required for inspection the interiors of cells of steel box girders may be painted AMS Standard 595 Color 17925 white.

Washington State Department of Transportation

Mathew Rochon PE AIA April 2024

WSDOT BRIDGE AND STRUCTURES OFFICE
STATE BRIDGE AND STRUCTURES ARCHITECT

BRIDGE AND STRUCTURES TYPICAL PROJECT COLORS

Samples of WSDOT's four standard custom colors :

- **Washington Gray**
- **Mt. St. Helens Gray**
- **Mt. Baker Gray**
- **Cascade Green**

These samples are approximations of the actual paint color and are not to be used for construction. See WSDOT Standard Specifications Section 9-08.3(1) for Pigmented Sealer applications and Section 9-08.1(2)H for steel top coat color equivalent. The Bridge & Structures Architect should be contacted for appropriate applications.

Washington State Department of Transportation

Mathew Rochon PE AIA April 2024

Appendix 2.5.4D-A2 Bridge & Structures Standard Concrete Finishes

WSDOT

Standard Concrete Finishes

For Bridge & Structure Construction in Highway Projects

Matt Rochon PE AIA
State Bridge and Structures Architect

Paul Kinderman PE AIA
State Bridge and Structures Architect, Retired

February 09, 2023

WSDOT Standard Concrete Finishes

with Premanufactured Form Liners

- Fractured Basalt Finish
- Fractured Fin Finish
- Fractured Granite Finish
- Variable Depth Random Board Finish
- (¾”) Random Board Finish
- Ribbed Finish
- Striated Finish
- Ashlar Stone Finish
- Block Finish
- Split Face Finish
- River Rock Finish
- Cascadian Stone Finish

February 09, 2023

Context Sensitive Solutions

- These finishes have been selected based on their continued use in WSDOT construction projects.
- Aesthetic features are for the community and corridor roadway sides, depending on the project.
- The State Bridge and Structures Architect is required to approve concrete surface treatments.
- Concrete surface treatments are typically chosen in collaboration with Region or H.Q. Landscape Architects.

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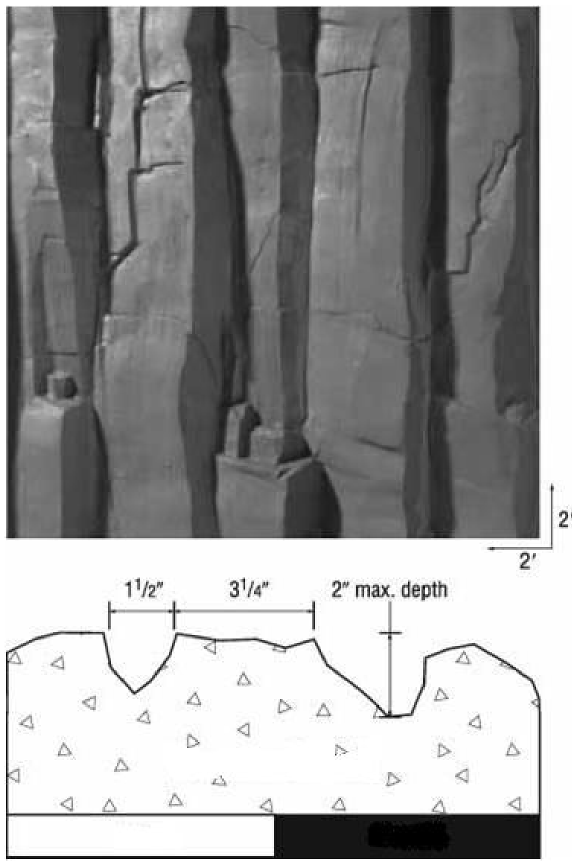
Fractured Basalt Finish



- Blends with natural columnar basalt rock formations found in Eastern Washington

Typical uses:

- North Spokane Corridor, Yakima I-82 Corridor, other rural settings

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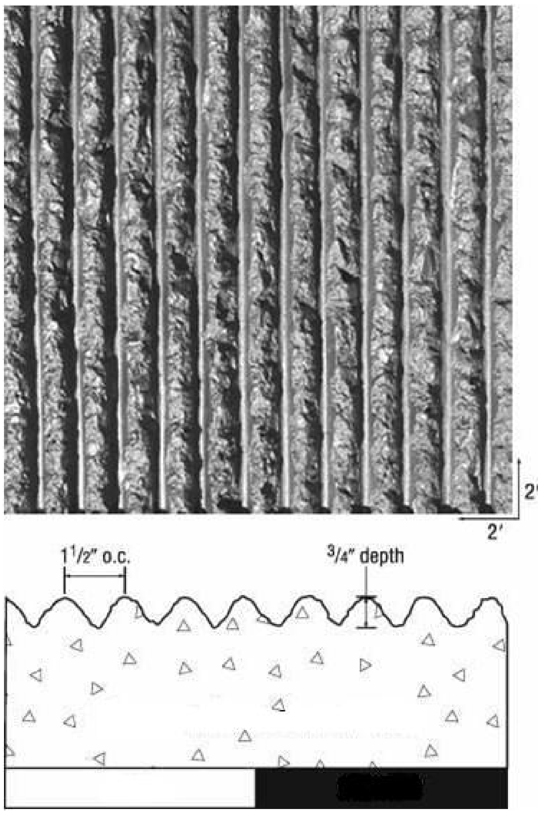
Fractured Fin



- The original fractured fin was produced in 1970.
- This 40 years old finish is one of the most specified surface treatments for concrete work.

Typical uses:

- I-90, I-5, Statewide classic

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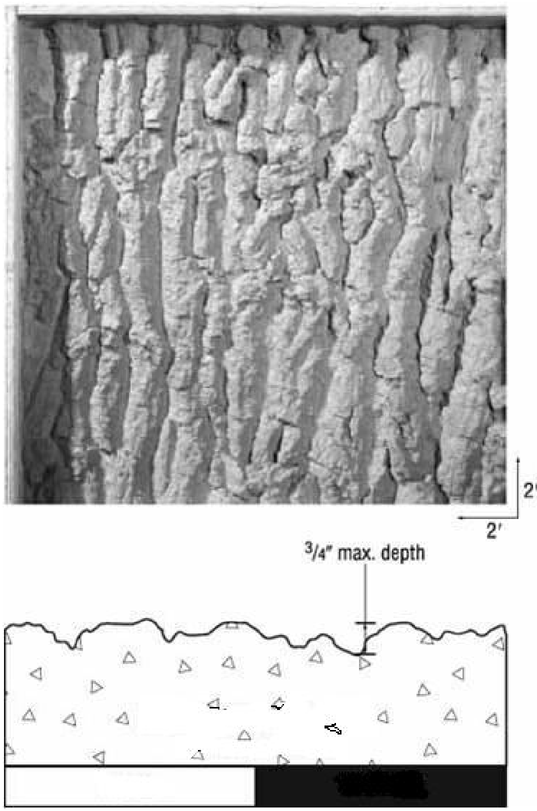
Fractured Granite



- Surface treatment resembles bark or fractured granite.

Typical uses:

- Selected areas, Everett HOV I-5, Mill creek

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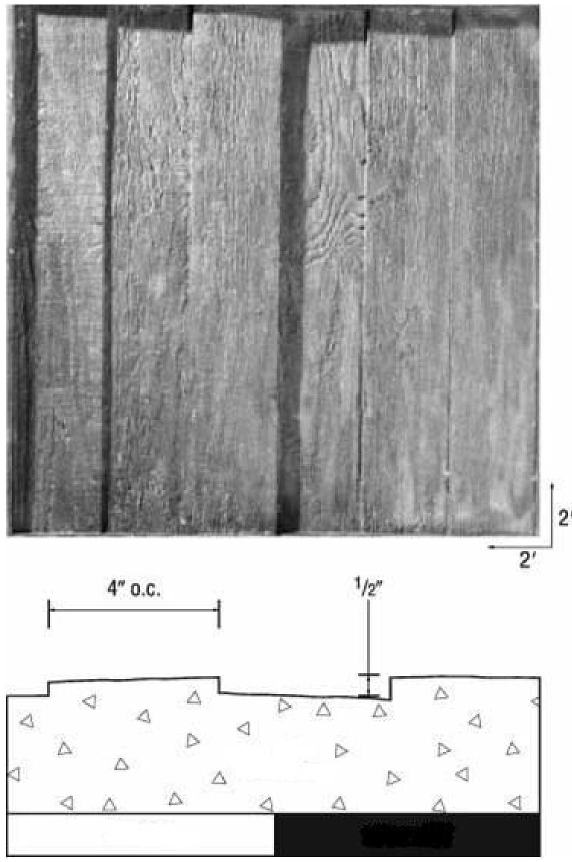
Variable Depth Random Board Finish



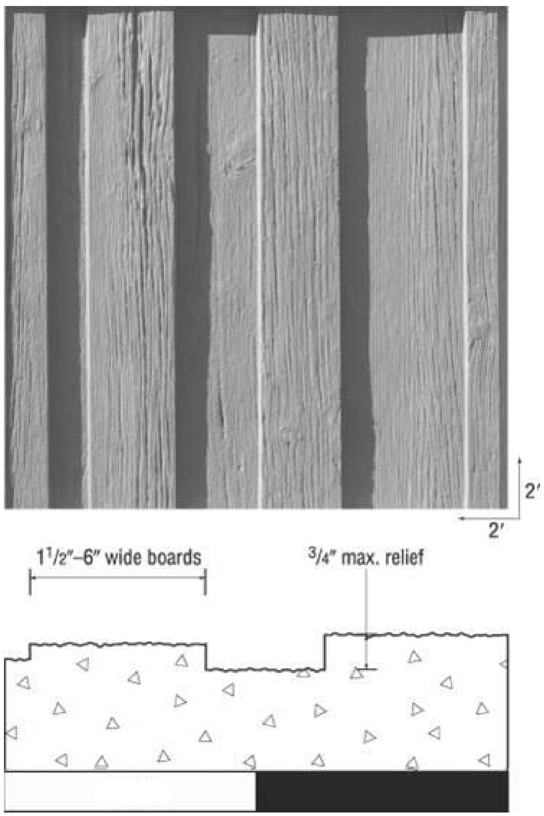
- Natural looking, rough-cut wood textures.

Typical uses:

- Similar to SR 16, I-5, I-90, SR 18, SR 520

February 09, 2023

¾” Random Board Finish



- Natural looking, rough-cut wood textures.

Typical uses:

- SR 16, I-5, I-90, SR 18, SR 520

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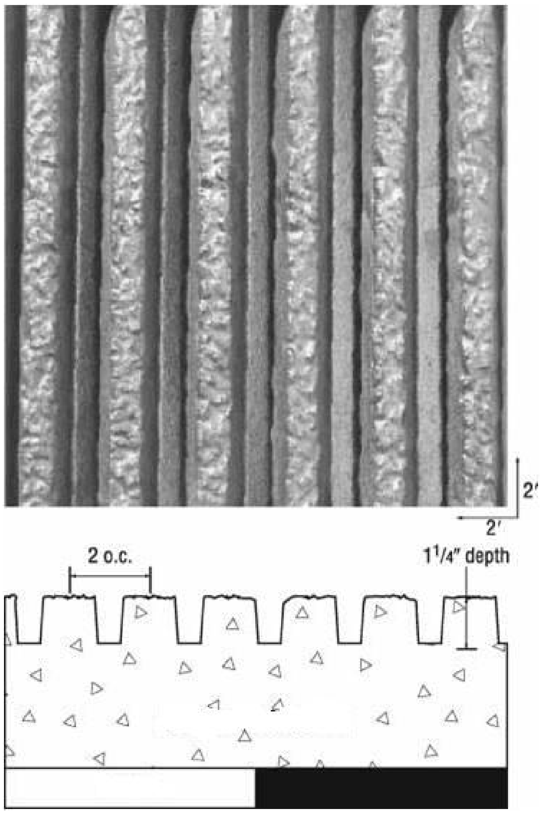
Ribbed Finish



Typical uses:

- Selected areas for accents

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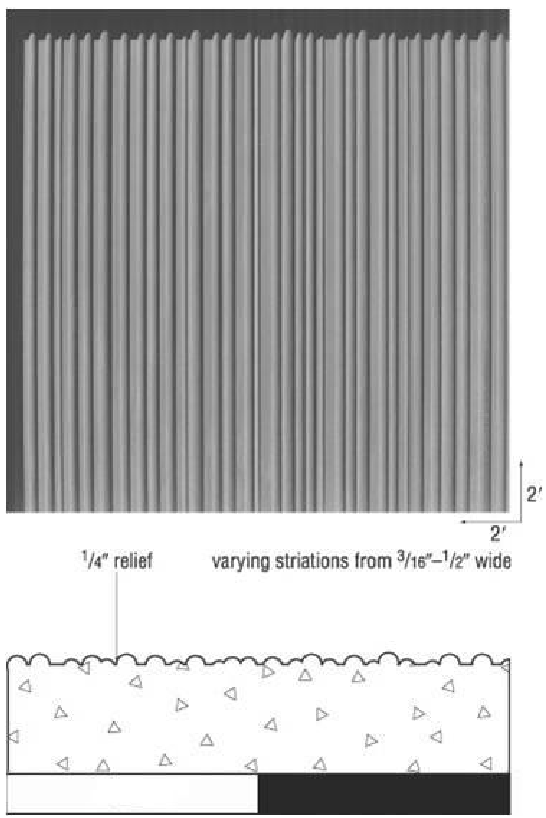
Striated Finish



- 1960’s Transportation classic. Used during the Interstate expansion after the second world war.

Typical uses:

- I-5 alternating raised panel designs

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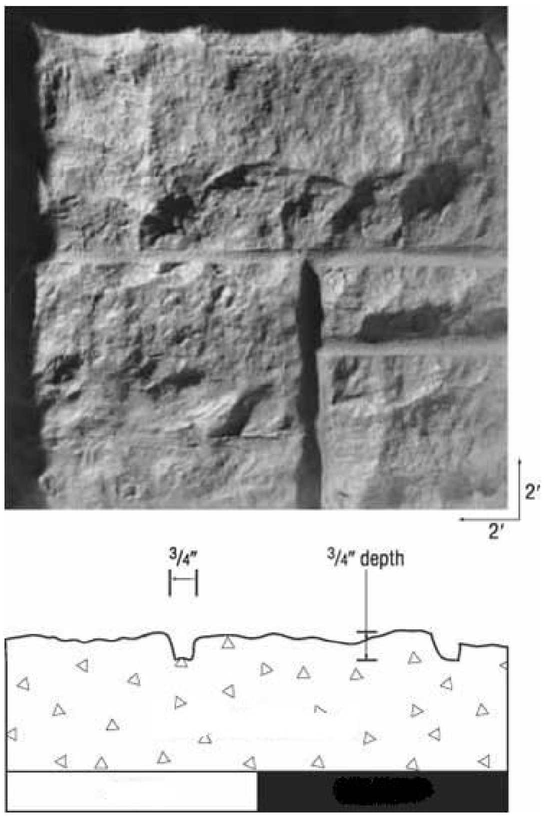
Ashlar Stone Finish

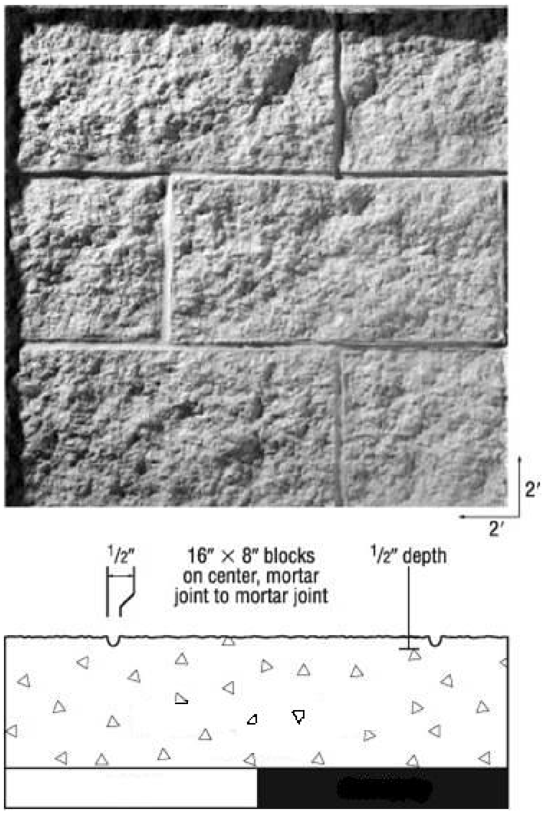


- Random cut stone texture.
- Ideal use in projects requiring stone finish of concrete surfaces.

Typical uses:

- I-405, Neighborhood side of Noise Barriers in Urban areas

Block Finish



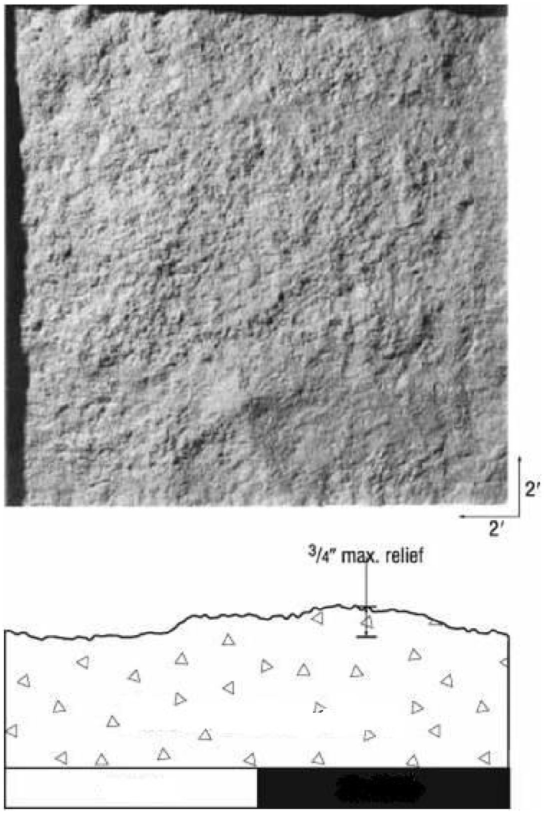
- Blends with modular block structural earth walls.

Typical uses:

- I-5 Lewis County, SR 303 Silverdale, SR 18

February 09, 2023

Split face Finish



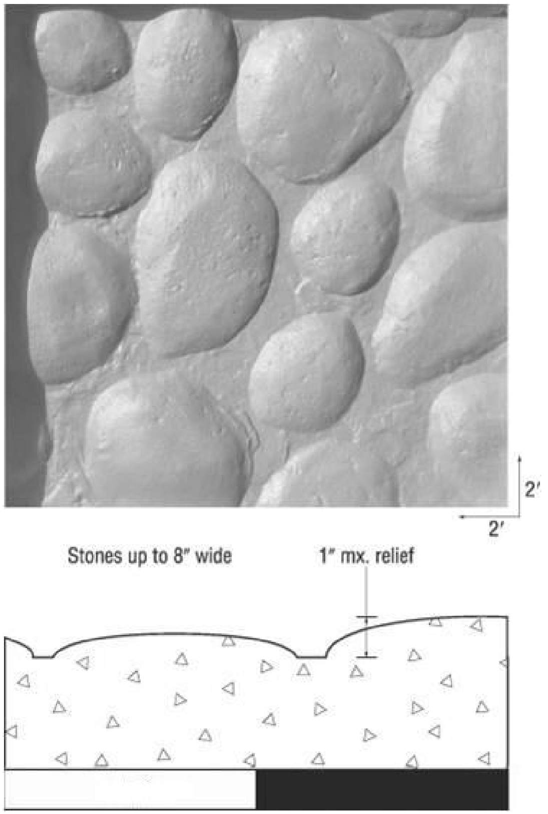
- Appearance of split stone.

Typical Uses:

- I-5 Lewis County, SR 18, & North Spokane Corridor

February 09, 2023

River Rock Finish



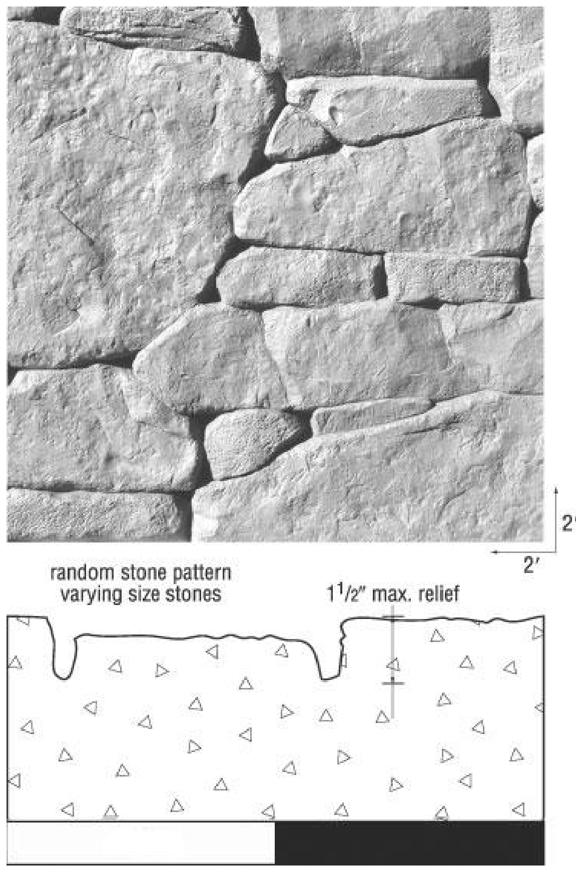
- Used in rural areas with natural settings.

Typical uses:

- NWR selected areas, parts of US 101, good for river vicinities

February 09, 2023

Cascadian Stone Finish



- Surface creates a Random Rubble Stone appearance

Typical uses:

- I-90 Snoqualimie Pass,
  Projects in the USFS

February 09, 2023

WSDOT

- For approved products and procedures, please consult WSDOT Standard Specifications and the Qualified Products List.
  - Standard Specifications 6-02.3(14)D
  - Qualified Products List 6-02.3(14)D
- Contact WSDOT Bridge and Structures Architect for questions.

February 09, 2023

FISH PASSAGE AESTHETICS GUIDANCE

WSDOT BRIDGE AND STRUCTURES OFFICE

The *WSDOT FISH PASSAGE AESTHETICS GUIDANCE* provides three levels of importance to structures. 1.) Basic designs, 2.) Enhanced designs, 3.) Refined designs are used depending on context. The document will be used to facilitate collaboration between the WSDOT Bridge and Structures Office, region staff and stakeholders in complying with Context Sensitive Design principles.

Context Sensitive Design & The Federal Highway Administration

The Washington State Department of Transportation implements the Federal Highway Administration's Context Sensitive Design (CSS) principles in the design of this project. CSS is a model for transportation project development that has received broad acceptance. Its essence is that a proposed transportation project must be planned not only for it's physical aspects as a facility serving specific transportation objectives. It must be designed also for its effect on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting.

WSDOT endorsed CSS for all projects, large and small by Executive Order 1028 in 2003. under Secretary of Transportation Douglas McDonald. After that Secretary Paula Hammond continued the practice and resigned an edited order. Standing Secretary of Transportation Lynn Peterson is currently redoubling these efforts. Secretary Roger Millar rescinded Executive Order 1028 April 13, 2018 after integrating the CSS process into the text of Design Manual M 22-01. See the link Design Policy-Context Sensitive Design for current guidance.

Aesthetic Design

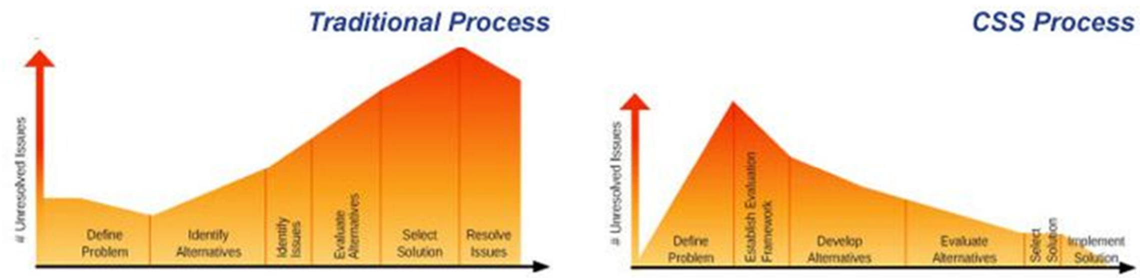
The goal of the recommendations is to influence the production of the aesthetic design. These will guide future designers as the fish passage designs are built out.

The recommendations are developed to aide in design. They are conceptual and outline typical situations. Throughout each phase of design and construction exceptional situations may arise in which a standard solution is not applicable. Specific situations must be assessed individually so that alternatives harmonize with the project as a whole.

Matt Rochon PE AIA
State Bridge and Structures Architect

Paul Kinderman PE AIA
State Bridge and Structures Architect, Retired

Context Sensitive Design



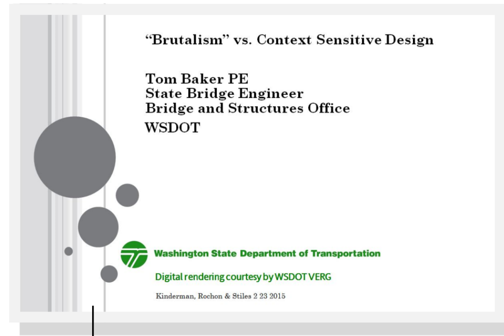
CSS delivers projects efficiently by addressing stakeholder issues early.

Design Policy - Context Sensitive Design

Context Sensitive Design is a model for transportation project development. Proposed transportation projects must be planned not only for its physical aspects as a facility serving specific transportation objectives, but also for its effects on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting. Projects designed using this model:

- Optimize safety of the facility for both the user and the community.
- Are in harmony with the community, and preserve the environmental, scenic, aesthetic, historic, and natural resource values of the area.
- Are designed and built with minimal disruption to the community.
- Involve efficient and effective use of the resources (time, budget, community) of all involved parties.
- Context Sensitive Solutions Executive Order 1028.02 (for historical reference)

Context Sensitive Designs



Reference: Tom Baker PE presentation identifying three levels of aesthetics.

Strategy: Three Level Architecture

Basic Designs:

⇒ Class two smooth concrete with no pigmented sealer
⇒ No wall structural type or finish requirements
⇒ Galvanized fall protection with no top coat finish color
⇒ Seen by almost no one.

Enhanced Designs:

⇒ Contextual use of QPL/Standard form-liners for concrete finish with Standard WSDOT pigmented sealer colors.
⇒ Wall structural type and finish requirements consistent with corridor aesthetics and WSDOT Standards
⇒ Brown AMS SAE Std Color 20045 top coat fall protection
⇒ Highly visible settings.

Refined Designs:

⇒ Community Input/Public Art for contextual concrete finish with Standard WSDOT or custom pigmented sealer colors.
⇒ Wall structural type and finish requirements consistent with respective corridor aesthetic guidelines.
⇒ Brown AMS SAE Std Color 20045 or context specific top coat color fall protection
⇒ High profile settings.

Basic Design:

Yarrow Creek Structures

Class two finish as described in *WSDOT Standard Specifications* 6-02.3(14)B.

The use of pigmented sealer is dependent on risk of graffiti.

Class two smooth concrete

Basic Designs:

Basic Designs:

⇒ Class two smooth concrete with no pigmented sealer
⇒ No wall structural type or finish requirements
⇒ Galvanized fall protection with no top coat finish color
⇒ Seen by almost no one.

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Cascadian Stone QPL formliner

Enhanced Design:

Existing SR 520 Corridor random board pattern

Cascadian Stone QPL formliner

Enhanced Design:

Twanoh Falls Creek

Showing WSDOT cost effective QPL concrete surface treatments.

Enhanced Designs

Enhanced designs are accomplished with common construction methods and materials.

Enhanced Designs:

⇒ Contextual use of QPL/Standard form-liners for concrete finish with Standard WSDOT pigmented sealer colors.

⇒ Wall structural type and finish requirements consistent with corridor aesthetics and WSDOT Standards.

⇒ Brown AMS SAE Std Color 20045 top coat fall protection

⇒ Highly visible settings.

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SR 202 Sahale Way
existing tree pattern

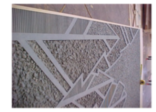
Artist Design Example
applied to basic design

Refined Designs

Design Example:
Roads and Bridges Magazine

Artist Design Example:
modernist stylized fish design
applied to basic design

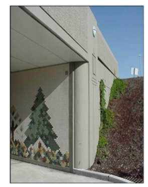
Refined Designs



Various examples of WSDOT built work.

Specific projects require compliance with Design Manual chapter 950 Public Art.

Refined Designs



Refined designs are accomplished with common construction methods and materials, however with custom designs.

Refined Designs:

⇒ Community Input/Public Art for contextual concrete finish with Standard WSDOT or custom pigmented sealer colors.

⇒ Wall structural type and finish requirements consistent with respective corridor Aesthetic Guidelines.

⇒ Brown AMS SAE Std Color 20045 or context specific top coat color fall protection

⇒ High profile settings.

Washington State Department of Transportation   Fish Passage Aesthetics Guidance   Bridge and Structures Office   02-10-2023
mjr

2.99 References

1. See Section 1.99.
2. 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.
3. WAC480-60 *Railroad Companies - Clearances*
4. 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.
5. WSDOT *Local Agency Guidelines*
6. *Union Pacific Railroad-BNSF Railway Guidelines for Railroad Grade Separation Projects*
7. WSDOT *Context Sensitive Solutions Executive Order* E 1028
8. Newman, O. Defensible Space: Crime Prevention Through Urban Design. New York: Macmillan. 1972
9. Jacobs, Jane. The Death and Life of Great American Cities. New York: Random House. 1961