Washington State
Department of Transportation

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Remarks and Instructions

The complete manual, revision packages, and individual chapters can be accessed at www.wsdot.wa.gov/publications/manuals/m23-50.htm.

Please contact Joe Fahoum at 360-705-7193 or fahoumj@wsdot.wa.gov with comments, questions, or suggestions for improvement to the manual.

For updating printed manuals, page numbers indicating portions of the manual that are to be removed and replaced are shown below.

Chapter	Remove Pages	Insert Pages
Title Page	i–ii	i–ii
Chapter 2 Preliminary Design	2-B-7 – 2-B-8	2-B-7 – 2-B-8
Chapter 7 Substructure Desing	7.5-5 – 7.5-6	7.5-5 – 7.5-6
Chapter 10 Signs, Barriers, Approach Slabs & Utilities	10.1-1 – 10.1-2	10.1-1 – 10.1-2
Chapter 11 Detailing Practice	11.1-5 – 11.1-6	11.1-5 – 11.1-6

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Joe Fahoum
Approved By

Signature

Washington State
Department of Transportation

TECHNICAL MANUAL

Bridge Design Manual (LRFD)

M 23-50.05

May 2011

Bridge and Structures Office
Engineering and Regional Operations

Americans with Disabilities Act (ADA) Information

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

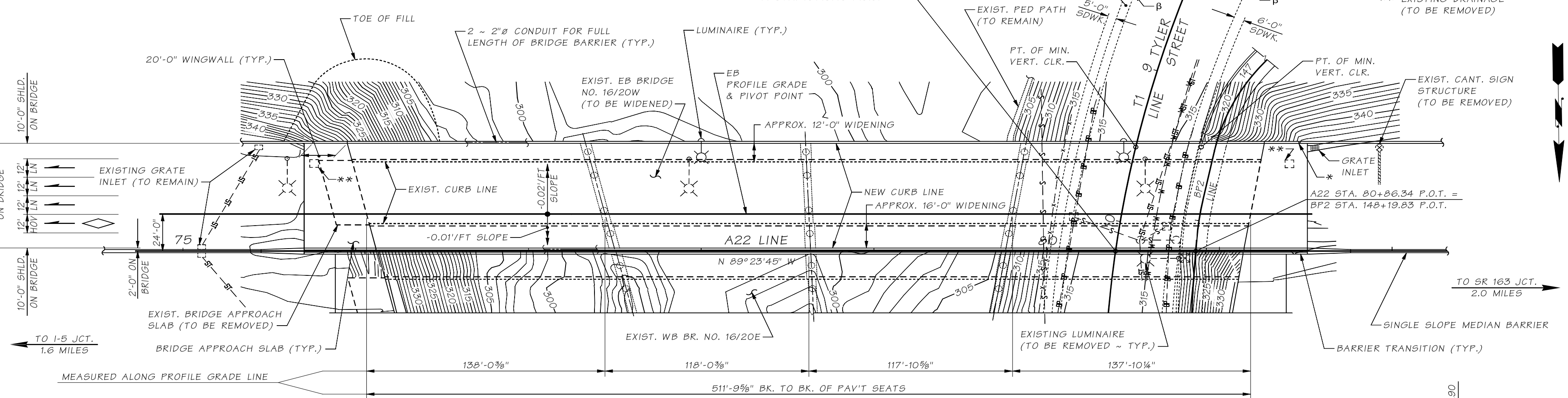
SEC. 12, T.20N., R.2E., W.M.
CITY OF TACOMA

SR 16

* CONNECTION TO CONC. SINGLE SLOPE BARRIER (TYP.)
** EXISTING DRAINAGE (TO BE REMOVED)

POINT OF MINIMUM VERTICAL CLEARANCE:
A22 STA. 80+51.6 (67.4' LT) = T1 STA. 9+51.0 (℄)
A22 STA. 80+83.0 (67.0' LT) = BP2 STA. 147+53.0 (8.0' RT)

COAST GUARD LIAISON
COAST GUARD PERMIT NOT REQ'D
PERMIT TARGET DATE



PLAN ~ EB BRIDGE (16/20W) WIDENING

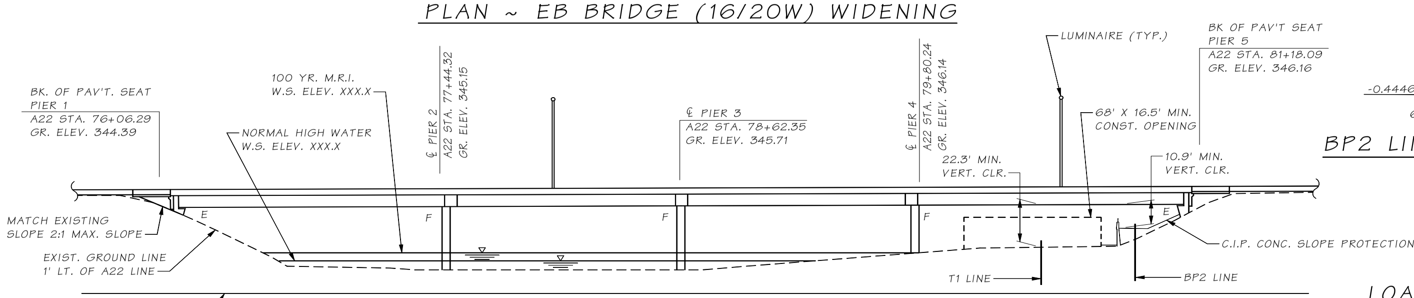
FIELD MEASURED BEARINGS

PIER	BEARING
1	N 13°05'04" W
2	N 13°12'10" W
3	N 01°46'13" W
4	N 10°18'06" E
5	N 10°23'00" E

V.P.I.
A22 STA. 77+59.24
ELEV. 345.32
+0.6116 % +0.3923 %
331.50' V.C.

V.P.I.
A22 STA. 82+00.00
ELEV. 347.05
+0.3923 % -1.2804 %
550.00' V.C.

EB PROFILE GRADE



V.P.I.
BP2 STA. 149+24.90
ELEV. 326.30
-0.4446 % -1.9989 %
60.00' V.C.

BP2 LINE PROFILE

REFERENCE LINE
ELEVATION 290.0

NOTE: 500 YR MRI
W.S. ELEV. XXX.X

ELEVATION ~ EB BRIDGE
(16/20W) WIDENING

SEE STD. PLAN A-50.20-01 FOR EMBANKMENT WIDENING AT BRIDGE ENDS. GRADE ELEVATIONS SHOWN ARE FINISH GRADES 24'-0" LT. OF A22 LINE AND ARE EQUAL TO THE PROFILE GRADE.

P.C. GIRDERS (W74G) WIDENING
CONTINUOUS FOR LIVE LOAD

LOADING : HS-25
OR
TWO 24 K AXLES
@ 4' CTR'S

BRIDGE WITH APPROACH FILLS
W74G P.C. GIRDERS
"A" DIMENSION = 11⅛" (PRELIMINARY ~ NOT FOR DESIGN)
CAST-IN-PLACE CONC. SHALL BE 4000 PSI
DECK PROTECTIVE SYSTEM 1 (EPOXY COATED REBARS)

SR ___ JOB NO. ___ SHEET ___

PLAN APPROVED BY:
BRIDGE AND STRUCTURES ENGINEER
PROJECT DEVELOPMENT ENGINEER

DATUM
NAVD 1988

Bridge Design Engr.	M:\BRIDGELIB\BDM\Chapter 2\window files\S2B7.wnd			STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
Supervisor							
Designed By			10	WASH.			
Checked By							
Detailed By			JOB NUMBER				
Bridge Projects Engr.							
Prelim. Plan By							
Architect/Specialist	DATE	REVISION	BY	APP'D			

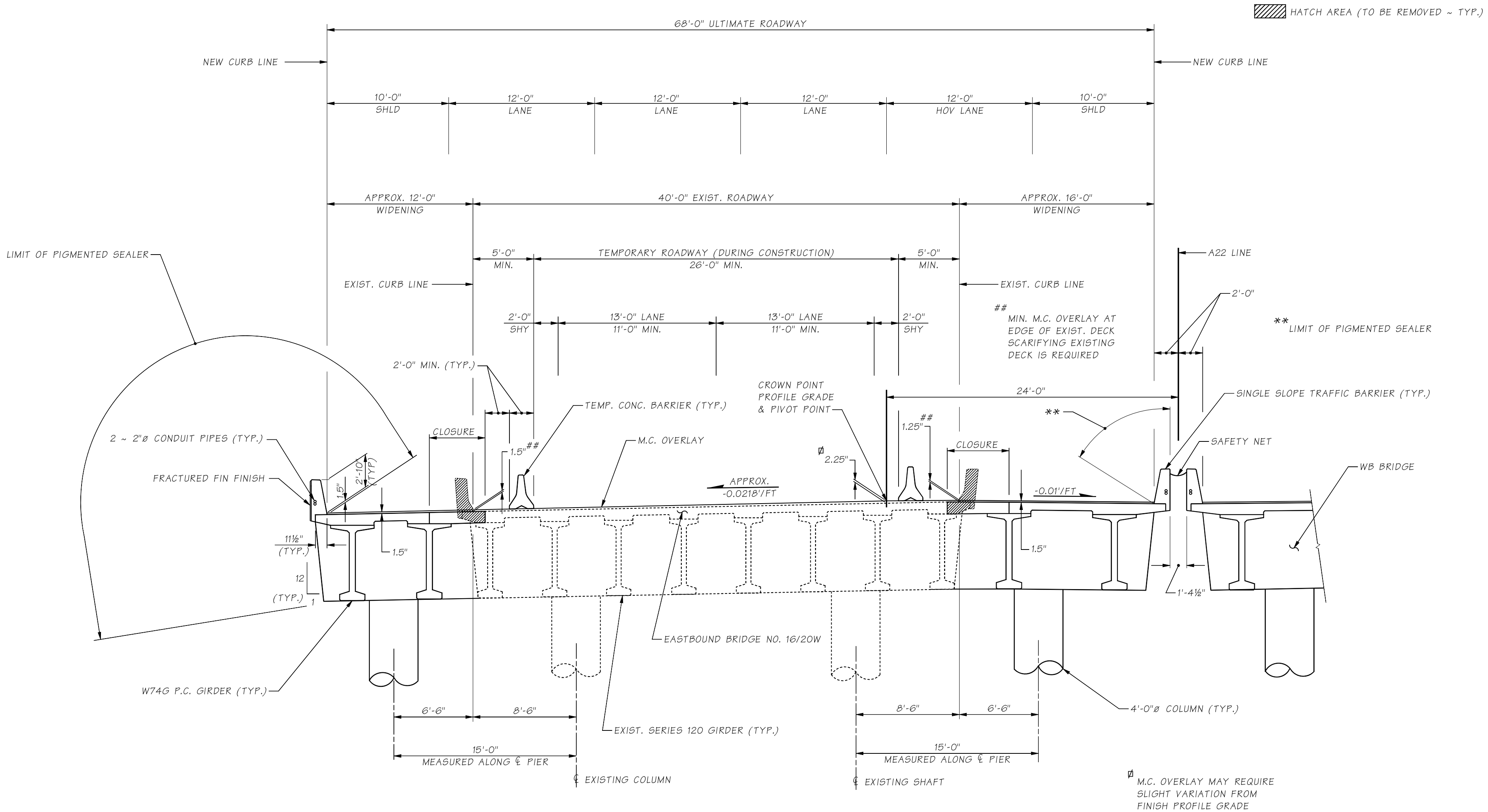
BRIDGE
AND
STRUCTURES
OFFICE

Washington State
Department of Transportation

BRIDGE SHEET NO.
SHEET OF SHEETS

Wed May 04 08:37:54 2011

C.S. 2704 ~ PROJ. NO. XL1200 ~ OLYMPIC REGION ~ SR 16 ~ UNION AVE. TO PEARL ST. ~ SNAKE LAKE NORTH BRIDGE NO. 16/20W WIDENING



TYPICAL SECTION ~ EB BRIDGE

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

Bridge Design Engr.	M:\BRIDGELIB\BDM\Chapter 2\window files\S2B8.wnd				
Supervisor					
Designed By					
Checked By					
Detailed By					
Bridge Projects Engr.					
Prelim. Plan By					
Architect/Specialist	DATE	REVISION	BY	APP'D	

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			
JOB NUMBER				

BRIDGE
AND
STRUCTURES
OFFICE

Washington State Department of Transportation

PRELIMINARY PLAN

BRIDGE SHEET NO. 2
SHEET OF SHEETS

C.S. 2704 ~ PROJ. NO. XL1200 ~ OLYMPIC REGION ~ SR 16 ~ UNION AVE. TO PEARL ST. ~ SNAKE LAKE NORTH BRIDGE NO. 16/20W WIDENING

SR JOB NO. SHEET

Fri Sep 03 14:07:31 2010

When the force transmitted through the bearing pads is very large, the designer should consider increasing the bearing pad thickness, using TFE sliding bearings and/or utilizing the flexibility of the abutment as a means of reducing the horizontal design force. When the flexibility of the abutment is considered, it is intended that a simple approximation of the abutment deformation be made.

B. Bearing Seats

The bearing seats shall be wide enough to accommodate the size of the bearings used with a minimum edge dimension of 3″ and satisfy the requirements of LRFD Section 4.7.4.4. On L abutments, the bearing seat shall be sloped away from the bearings to prevent a build up or pocket of water at the bearings. The superelevation and profile grade of the structure should be considered for drainage protection. Normally, a ¼″ drop across the width of the bearing seat is sufficient.

C. Transverse Girder Stops

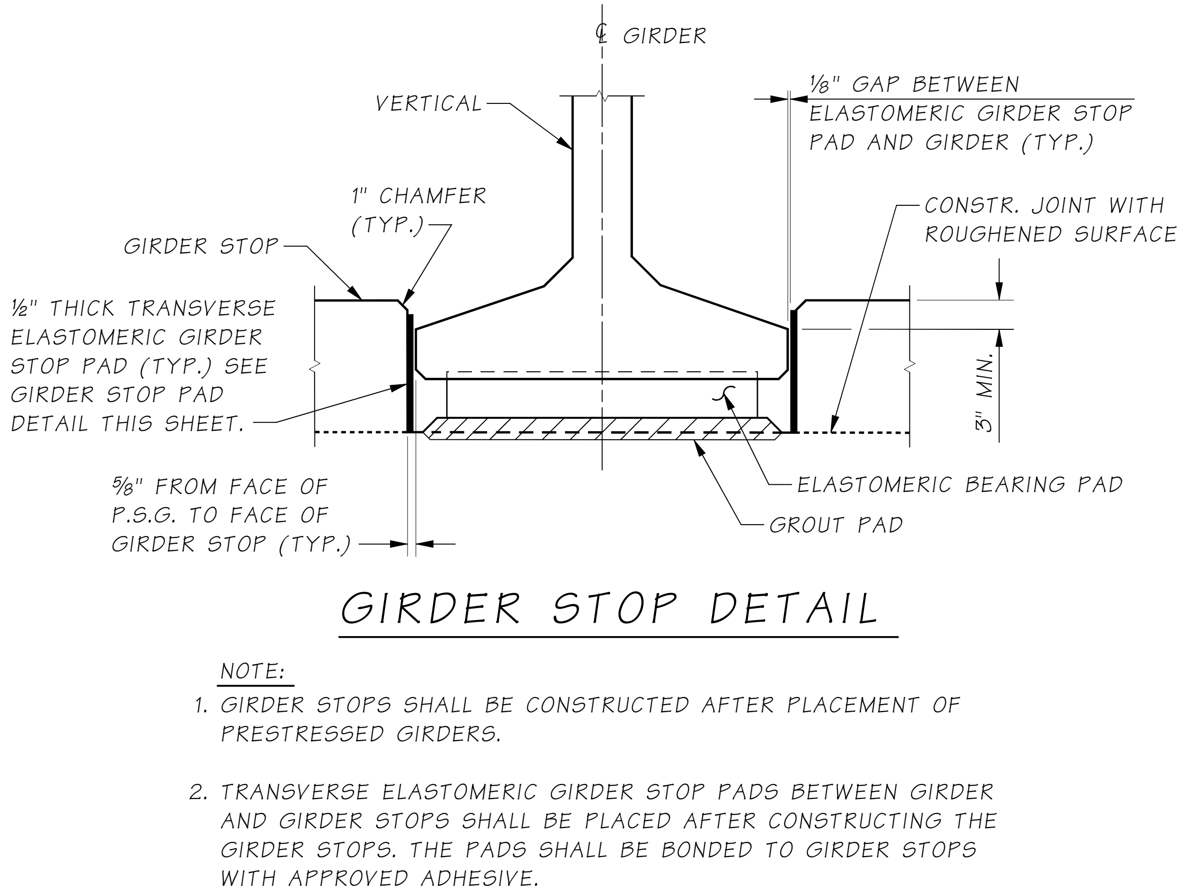
Transverse girder stops are required for all abutments in order to transfer lateral loads from the superstructure to the abutment. Abutments shall normally be considered as part of the Earthquake Resisting System (ERS). Girder stops shall be full width between girder flanges except to accommodate bearing replacement requirements as specified in Chapter 9 of this manual. The girder stop shall be designed to resist loads at the Extreme Limit State for the earthquake loading, Strength loads (wind etc.) and any transverse earth pressure from skewed abutments, etc. Girder stops are designed using shear friction theory and the shear strength reduction factor shall be $\varphi s = 0.9$. The possibility of torsion combined with horizontal shear when the load does not pass through the centroid of the girder stop shall also be investigated.

In cases where the WSDOT Bridge Design Engineer permits use of ERS #3 described in Section 4.2.2 of this manual, which includes a fusing mechanism between the superstructure and substructure, the following requirements shall be followed:

- The abutment shall not be included in the ERS system, the girder stops shall be designed to fuse, and the shear strength reduction factor shall be $\varphi s = 1.0$.
- If a girder stop fusing mechanism is used on a pile supported abutment, the combined overstrength capacity of the girder stops per AASHTO Seismic 4.14 shall be less than the combined plastic shear capacity of the piles.

The detail shown in Figure 7.5.5-1 may be used for prestressed girder bridges. Prestressed girders shall be placed in their final position before girder stops are cast to eliminate alignment conflicts between the girders and girder stops. All girder stops shall provide ⅛″ clearance between the prestressed girder flange and the girder stop.

For skewed bridges with semi-integral or end type A diaphragms, the designer shall evaluate the effects of earth pressure forces on the transverse girder stop pads. The performance of girder stop bearings shall be investigated at Service Limit State. These bearings are placed vertically against the girder stop to transfer the skew component of the earth pressure to the abutment without restricting the movement of the superstructure in the direction parallel to centerline. In some cases bearing assemblies containing sliding surfaces may be necessary to accommodate large superstructure movements.



Girder Stop Details
Figure 7.5.5-1

7.5.6 Abutment Expansion Joints

For structures without expansion joints, the earth pressure against the end diaphragm is transmitted through the superstructure. The compressibility of the expansion joint shall be considered in the design of the abutment for earthquake, temperature, and shrinkage when these forces increase the design load.

7.5.7 Open Joint Details

Vertical expansion joints extending from the top of footings to the top of the abutment are usually required between abutments and adjacent retaining walls to handle anticipated movements. The expansion joint is normally filled with premolded joint filler which is not water tight. There may be circumstances when this joint must be water tight; ⅛ butyl rubber may be used to cover the joint. The open joint in the barrier shall contain a compression seal to create a watertight joint. Figure 7.5.7-1 shows typical details that may be used. Aesthetic considerations may require that vertical expansion joints between abutments and retaining walls be omitted. This is generally possible if the retaining wall is less than 60 feet long.

The footing beneath the joint may be monolithic or cast with a construction joint. In addition, dowel bars may be located across the footing joint parallel to the wall elements to guard against differential settlement or deflection.

On abutments with the end diaphragm cast on the superstructure, the open joints must be protected from the fill spilling through the joint. Normally butyl rubber is used to seal the openings. See the end diaphragm details in the Appendices of Chapter 5 for details.

10.1 Sign and Luminaire Supports

10.1.1 Loads

A. General

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

B. Dead Loads

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

C. Wind Loads

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

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

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

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

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

10 years for roadside sign structures.

E. Ice Loads

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

Walk-through VMS shall not be installed in areas where appreciable snow loads may accumulate on top of the sign, unless positive steps are taken to prevent snow build-up.

F. Fatigue Design:

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

Fatigue Category I for overhead cantilever sign structures (maximum span of 30 ft. and no VMS installation), high level (high mast) lighting poles 100 ft. or taller in height, bridge-mounted sign brackets, and all signal bridges.

Fatigue Category II for high level (high mast) lighting poles between 51 ft. and 99 ft. in height.

Fatigue Category III for lighting poles 50 ft. or less in height with rectangular, square or non-tapered round cross sections, and overhead cantilever traffic signals at intersections (maximum cantilever length 65 ft.). If vehicle speeds are posted at 45 mph or greater, then overhead cantilever traffic signal structures shall be designed for Fatigue Category I.

Sign bridges, cantilever sign structures, signal bridges, and overhead cantilever traffic signals mounted on bridges shall be either attached to substructure elements (e.g. crossbeam extensions) or to the bridge superstructure at pier locations. Mounting these features to bridges as described above will help to avoid resonance concerns between the bridge structure and the signing or signal structure.

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

G. Live Load:

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

F. Group Load Combinations:

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

Group Load	Load Combination	Percent of *Allowable Stress
I	DL	100
II	DL+W**	133
III	DL+Ice+½(W**)	133
IV	Fatigue	See AASHTO Section 11 for Fatigue loads and stress range

* No load reduction factors shall be applied in conjunction with these increased allowable stresses.
** W—Wind Load

10.1.2 Bridge Mounted Signs

A. Vertical Clearance

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

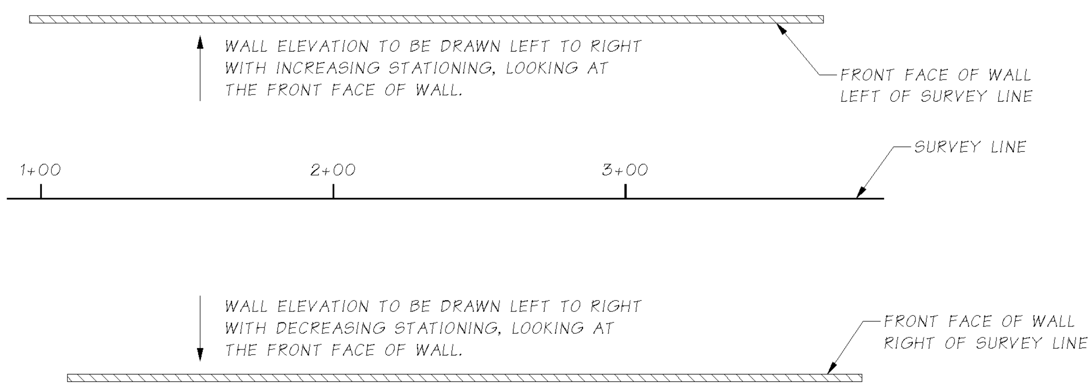
Bridge mounted sign brackets shall be designed to account for the weight of added lights, and for the wind affects on the lights to ensure bracket adequacy if lighting is attached in the future.

H. **Structural Sections, Views and Details**

- A **section** cuts through the structure, a view is from outside the structure, a **detail** shows a structural element in more detail – usually a larger scale.
- Whenever possible, sections and views shall be taken looking to the **right, ahead on stationing**, or **down**.
- Care shall be taken to ensure that the **orientation** of a detail drawing is identical to that of the plan, elevation, etc., from which it is taken. Where there is a **skew** in the bridge any sections should be taken from **plan** views.
- The default is to be looking ahead on stationing. The only mention of view orientation is if the view is looking back on stationing.
- On plan and elevation drawings where there is insufficient space to show cut sections and details, the section and detail drawing should be on the plan sheet immediately following the plan and elevation drawing unless there are a series of related plans. If it is impractical to show details on a section drawing, a detail sheet should immediately follow the section drawing. In other words, the order of plan sheets should be from general plan to more minute detail.
- A circle divided into upper and lower halves shall identify structural sections, views, and details. Examples are shown in Appendix 11.1-A3.
- Breaks in lines are allowable provided that their intent is clear.

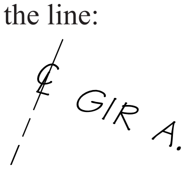
I. **Miscellaneous**

- **Callout arrows** are to come off either the beginning or end of the sentence. This means the top line of text for arrows coming off the left of the callout or the bottom line of text for arrows pointing right.
- Except for the Layout, **wall elevations** are to show the exposed face regardless of direction of stationing. The Layout sheet stationing will read increasing left to right. The elevation sheets will represent the view in the field as the wall is being built.



Plan

- Do not detail a bridge element in more than one location. If the element is changed there is a danger that only one of the details is updated.
- Centerline callouts shall be normal to the line itself approximately an eighth inch from the end of the line:



J. **Revisions**

- **Addendums** are made after general distribution and project ad but before the contract is awarded. Changes made to the plan sheets during this time shall be **shaded** or clouded in accordance with the WSDOT *Plans Preparation Manual* M 22-31 Appendix 5 (note that all table entry revisions shall be shaded). Subsequent addendums are shaded and the shading from previous addendums is removed.
- **Change orders** are made after the contract has been awarded. Changes will be marked with a number inside a circle inside a **triangle**.  Shading for any addendums is removed.
- All addendums and change orders will be noted in the **revision block** at the bottom of the sheet using font 25.

K. **Title Block**

- The project title is displayed in the contract plan sheet title block. The title consists of Line 1 specifying the highway route number(s), Line 2 and possibly Line 3 specifying the title verbiage. Bridge structures use a fourth line, in a smaller font, to specify the bridge name and number in accordance with the WSDOT *Bridge List* M 23-09 and BDM Sections 2.3.1.A and 2.3.2.A.
- The exact wording of Lines 1, 2, and 3 of the project title, including line arrangement, abbreviations, and punctuation, is controlled by the project definition as specified by legislative title and the Capital Program Management System (CPMS) database.
- The highway route number(s) in Line 1 shall be consistent with WSDOT naming practice. Interstate routes (5, 82, 90, 182, 205, 405, and 705) shall be specified as I-(number). US routes (2, 12, 97, 97A, 101, 195, 197, 395, and 730) shall be specified as US (number). All other routes shall be specified as SR (number). Projects including two highway routes shall include both route numbers in Line 1, as in "US 2 And I-5". Projects including three or more highway routes shall be specified with the lowest numbered route, followed by "Et Al", as in "SR 14 Et Al".
- The job number block just to the left of the middle of the title block shall display the PS&E Job Number assigned to the project by the Region Plans Office. The PS&E Job Number consists of six characters. The first two characters correspond to the last two digits of the calendar year. The third character corresponds to the letter designation assigned to the specific Region (NWR - A, NCR - B, OR - C, WSF and selected UCO projects - W, SWR - X, SCR - Y, and ER - Z). The final three characters correspond to the three digit number assigned to the specific project by the Region Plans Office.

L. **Reinforcement Detailing**

- Contract documents shall convey all necessary information for fabrication of reinforcing steel. In accordance with *Standard Specification* 6-02.3(24), reinforcing steel details shown in the bar list shall be verifiable in the plans and other contract documents.
- Reinforcement type and grade is specified in *Standard Specification* 9-07.2 and need not be provided elsewhere in the contract documents unless it differs.
- Size, spacing, orientation and location of reinforcement shall be shown on the plan sheets.
- Reinforcement shall be identified by mark numbers inside a rectangle. Reinforcing bar marks shall be called out at least twice. The reinforcement including the spacing is called out in one view (such as a plan or elevation). The reinforcement without the spacing is called out again in at least one other view taken from a different angle (such as a section).
- Epoxy coating for reinforcement shall be shown in the plans by noting an E inside a triangle.