OHIO DEPARTMENT OF TRANSPORTATION

CENTRAL OFFICE, 1980 W. BROAD ST., COLUMBUS, OHIO 43216-0899

January 16, 2015

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Assistant Administrator, Office of Structural Engineering

Re: 2015 First Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, July 2007. These revisions shall be implemented on all Department projects begin Stage 2 plan development date after January 16, 2015. Implementation of some or all of these revisions for projects further along the development process should be considered on a project-by-project basis.

This package contains the revised pages. The revised pages have been designed to replace the corresponding pages in the book and are numbered accordingly. Revisions, additions, and deletions are marked in the revised pages by the use of one vertical line in the right margin. The header of the revised pages is dated accordingly.

To keep your Manual correct and up-to-date, please replace the appropriate pages in the book with the pages in this package.

To ensure proper printing, make sure your printer is set to print in the 2-sided mode.

The July 2007 edition of the Bridge Design Manual may be downloaded at no cost using the following link:

http://www.dot.state.oh.us/Divisions/Engineering/Structures/Pages/default.aspx

Attached is a brief description of each revision.

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Summary of Revisions to the July 2007 ODOT BDM

BDM Section	Affected Pages	Revision Description
203.4	2-24 through 2-24.1	These revisions to the Bridge and Waterway Permits section of the BDM add information about the Nationwide Permits (NWP) which were previously omitted.
203.5	2-24.1 through 2-24.2	This revision corrects an error that identified on the USACE as the only permitting agent.
209.5	2-40 through 2-41	Revisions to the Approach Slab section were necessitated by the release of new Standard Bridge Drawing, AS-2-15 and revision of Standard Bridge Drawing, AS-1-15.
209.6	2-41 through 2-41.2	Revisions to the Pressure Relief Joint section were necessitated by the release of new Standard Bridge Drawing, AS-2-15. The Type A Pressure Relief Joint will no longer be required.
Figure 203.5-2		Minor revisions to the Bridge and Waterway Permits checklist make the list usable for NWP's and the latest ODOT RGP.
301.2	3-2	The Office of Structural Engineering has made bridge plan review checklists available as a quality control check for plan review. These checklists are available from the office website.
302.2.7.2.c	3-17.8	The assumed weight of the finishing machine was increased to better reflect industry practice.
304.2	3-74	The SBR-2-13 unreinforced median barrier was incorrectly identified as a TL-3. SBR-2-13 is a TL-5 barrier whether reinforced or unreinforced.
306.2.1	3-82	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15. Also, the Plan Insert Sheet, Abutment Joints in Bituminous Concrete Box Beam Bridges has been replaced with C&MS Item 409.
306.2.2	3-83	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.
306.3.1	3-85	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.

BDM Section	Affected Pages	Revision Description
306.3.2	3-86	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.
306.3.3	3-86	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.
306.3.4	3-87	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.
306.3.5	3-87	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.
306.3.6	3-88	Reference to the approach slab standard bridge drawing was updated from AS-1-81 to AS-1-15 to reflect the release of AS-1-15.
610.7.2	6-26	Note [610.7.2-1] was modified in accordance with the revision for finishing machine loads in BDM Section 302.2.7.2.c.
1003 S3.*6.5.1*	10-7	With this revision, ODOT applies the pier protection requirements of the AASHTO LRFD Bridge Design Specifications to non-redundant piers only. For redundant piers, the protection provided by the ODOT Location & Design Manual, Volume 1 is sufficient.
Figure S*3.6.5.1*		This figure clarifies the effects of Clear Zone, Design Speed and Substructure Redundancy on determination of pier protection requirements.

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203.4 BRIDGE AND WATERWAY PERMITS

Impacts to bridges or waterways may require legal authorization in the form of permits or certifications issued by various regulatory agencies, including:

A. U.S. Army Corps of Engineers .....Section 404 and/or Section 10 Permit

B. U.S. Coast Guard .....Section 9 Bridge Permit

C. Ohio EPA ..... Section 401 Water Quality Certification and/or Isolated Wetland Permit

The jurisdictional limit of the U.S. Army Corps of Engineers (USACE) is termed the "Waters of the United States" and, as noted in ODOT CMS 101.03, includes: rivers, streams, lakes and wetlands. For rivers and streams, the jurisdiction begins below the Ordinary High Water Mark (OHWM). The OHWM is defined as the elevation on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

The ODOT Office of Environmental Services – Waterway Permits Unit (OES-WPU) assumes the responsibility for different types of waterway permits, such as, but not limited to, Nationwide Permits (NWP) or ODOT's Regional General Permit (RGP). The designer and project manager shall coordinate with the DEC and the OES-WPU throughout the permit determination process to ensure that the final waterway permit applications are indicative of the final project design. For more information refer to the Waterway Permits Manual available from the ODOT Office of Environmental Services.

Special Provisions are the method ODOT uses to attach the waterway permits and certifications to the project construction plans. The waterway permits Special Provisions Package (SPP) is prepared by the OES-WPU and may contain the following:

A. All pertinent waterway permits, certifications and related conditions

B. Drawings and/or mapping submitted with a permit application

C. Specialized conditions associated with the waterway permits

The designer and the project manager shall confirm that the bridge design plans meet the requirements in the project waterway SPP (e.g. Sections 404 and 401 conditions, and infrequently Sections 9 and 10) and shall ensure the project waterway SPP is submitted with the Final Plan Package.

203.5 TEMPORARY ACCESS FILLS

A Temporary Access Fill (TAF) is a fill or structure that allows a contractor access to work on roads or bridges located within bodies of water. Examples of TAF's include: cofferdams; temporary structures for maintaining traffic; causeways and workpads; and demolition debris. The placement of all TAF's in "Waters of the United States" must be performed in accordance with the special provisions for waterway permits.

A contractor's means and methods of construction will dictate the TAF required for a project. However, the Department must estimate the potential impacts to "Waters of the United States" during project development to ensure all permits are in-place during contract letting. Furthermore, it is incumbent upon the Department that these permits provide all bidding contractors the ability to construct the project without resulting in expensive delays, change orders or fines. To that end, the Department partnered with the Ohio Contractor's Association to develop the following guidance to estimate the size of TAF's:

A. The TAF shall provide access to all piers located within the Ordinary High Water Mark (OHWM) of the waterway from at least one bank of the waterway.

   Access may be provided by construction staging of the TAF. When considering the constructability of staged TAF's, typical superstructure erection plans for lifting lengths of 50-ft or more require two cranes. Unless the access for member delivery is from an adjacent structure, the TAF must provide access to each end of the lift from one bank. In the case of staging, the permit application shall reflect the construction stage that impacts the largest area of the waterway.

B. The TAF shall be located directly beneath the superstructure. The surface width of the TAF shall be equal to the out-to-out width of the superstructure plus 50'-0" outboard on one side of the structure and 20'-0" outboard on the other side of the structure.

C. The TAF shall extend at least 40'-0" beyond the furthest pier accessed by the TAF.

D. Side slopes of the TAF shall be no steeper than 1.5:1 (H:V).

E. The top surface of the TAF shall be located 1'-0" above the OHWM.

F. The TAF shall be designed to maintain a flow equal to two times the highest average monthly flow (i.e. the largest of Q1, Q2, Q3, …Q12), as reported by the USGS web based application StreamStats (see L&D Vol. 2), such that no rise in the backwater above OHWM

is permitted.

This information is intended for permit application purposes only and should not be included in the project plan set. However, to assist the OES-WPU in the determination process, Designers should use the guidance above to develop a plan view and cross-section and determine waterway impacts of a TAF. An example plan view and cross-section are shown in Figure 203.5-1. These details should be provided to the DEC along with a completed copy of the checklist shown in Figure 203.5-2. The minimum flow to be maintained during construction should be calculated according to item F above. Designers will need to estimate whether this flow can be maintained through conduits or if open channels will be required.

204 SUBSTRUCTURE INFORMATION

204.1 FOOTING ELEVATIONS

Substructure footing elevations should be shown on the Final Structure Site Plan. The top of footing should be a minimum of one foot [0.3 meters] below the finished ground line. The top of footing should be at least one foot [0.3 meters] below the bottom of any adjacent drainage ditch. The bottom of footing shall not be less than four feet [1.2 meters] below and measured normal to the finished groundline.

The number of scuppers used for collecting the deck surface drainage should be minimized or eliminated if possible. The allowable spread of flow, which is used to help determine the need for scuppers, can be computed by the procedures as described in Section 1103 of the ODOT Location and Design Manual. Scuppers when provided, should preferably be located inside the fascia beam.

Drainage collection systems should be sloped as steeply as practical, generally not less than 15 degrees. The system should have a minimum bend radius of 18 inches [450 mm], no 90 degree bends, adequate pipe supports and cleanouts at the low ends of runs. The cleanout plugs should be easily and safely accessible. The necessary deck drainage outlet locations should be included in the Structure Type Study, Hydraulics Report.

Scuppers with drainage collection systems should be placed as closely as possible to the substructure unit which drains them. Uncollected scupper downspouts should be as far away from any part of the structure as possible.

When the deck drainage is to flow off the ends of the bridge, provisions must be made to collect and carry away this run-off. Refer to the ODOT Location and Design Manual, Volume 2, Section 1113.1 for more information.

Control of drainage is especially critical at abutments with MSE walls. On structures with MSE walls at the abutments, a barrier shall be provided on the approach slab with a standard inlet, SCD I-2.3 to collect the drainage. Where possible, the inlet shall be located at least 25-ft beyond the limits of the MSE wall soil reinforcement. Continue the barrier 10-ft past the catch basin. Refer to BDM Figure 209.3-1 for more information.

For bridges that have deck joints consisting of finger joints or sliding plates with a trough collector system scuppers should be considered near the joint to minimize the amount of deck drainage flow across the joint.

For bridges that have over the side drainage a stainless steel drip strip should be provided to protect the deck edge and beam fascia from the deck surface run-off.

209.4 SLOPE PROTECTION

For structures of the spill-thru type where pedestrian traffic adjacent to the toe of the slope is

anticipated or the structure is located in an urban area within an incorporated city limit, the slope under the structure shall be paved with Concrete slope protection, CMS 601.07. Consideration of slope protection should be given to all areas under freeway bridges over city streets not covered by pavement or sidewalk. Drainage discharge from the bridge should be checked to ensure that discharge is not crossing sidewalks, etc. so that ice, dirt and debris build-ups are prevented.

On spill-thru slopes under grade separation structures, areas that are not protected by concrete slope protection, shall be protected by crushed aggregate material as provided in CMS 601.06.

The slope protection, either concrete or rock, shall extend from the face of the abutment down to the toe of the slope and shall extend in width to 3 feet [1 meter] beyond the outer edges of the superstructure, except that at the acute corners of a skewed bridge the outside edge of the slope protection shall intersect the actual or projected face of the abutment 3 feet [1 meter] beyond the outer edge of the superstructure and shall extend down the slope, normal to the face of the abutment, to the toe of the slope. The base of the slope protection shall be toed in. Note that the natural vegetation on the slopes when shaded by a new structure will die out. For this case additional slope protection should be considered.

209.5 APPROACH SLABS

Approach slabs should be used for all ODOT bridges.

209.5.1 STANDARD BRIDGE DRAWING – AS-1-15

Standard Bridge Drawing, AS-1-15, provides contract ready designs and details of skewed and non-skewed approach slabs on tangent alignments with lengths of 15-ft, 20-ft, 25-ft and 30-ft under phased or non-phased construction.

Determine the length of the approach slab using the following formula:

$L = [1.5(H + h + 1.5)] \div \text{Cos}\ \theta \leq 30\text{-ft}$

Where:
- L = Length of the approach slab measured along the centerline of the roadway rounded up to the nearest 5-ft
- H = Height of the embankment measured from the bottom of the footing to the bottom of the approach slab (ft)
- h = Width of the footing heel (ft)
- θ = Skew angle

For four lane divided highways on new embankment, the minimum approach slab length shall be 25-ft (measured along the roadway centerline). For structures with MSE walls at the abutments, the minimum approach slab length shall be 30-ft. For all other structures the minimum length shall be 15-ft.

209.5.1.1 PLAN REQUIREMENTS FOR STANDARD APPROACH SLABS

For bridges that specify AS-1-15, the design plans shall:

A. Reference Standard Bridge Drawings: AS-1-15 and AS-2-15

B. Provide a plan view of the approach slab that includes: all width and length dimensions; skew angle; curb and barrier locations; and the final approach slab surface elevations at each transverse grade break line; phased construction line; and curbline/slab edge at each end of the approach slab.

C. Include the D801 or D802 bars in the reinforcing steel list for payment under Item 509.

D. Include the appropriate pay item: Item 526 – Reinforced Concrete Approach Slab (T=__) or Item 526 – Reinforced Concrete Approach Slab with QC/QA (T=__)

E. Include pay Item 526 – Type __ Installation

F. Include, as necessary, pay Item 848 – Polymer Modified Asphalt Expansion Joint System or Item 516 – Armorless Preformed Joint Seal

For bridge replacement projects, when the existing approach slab is to be removed, the Designer shall include Item 202 - Approach Slab Removed in the structures estimated quantities.

209.5.1.2 PLAN REQUIREMENTS FOR NON-STANDARD APPROACH SLABS

Examples of non-standard approach slabs include approach slabs that are: a non-standard length; tapered; curved; a non-uniform width or other such variation. In addition to the plan requirements listed in 209.5.1.1.B provide all geometry and the reinforcement layout for the non-standard approach slab. Include these detail drawings in the structure plans for review during the detail design review stage. Include the appropriate pay item: Item 526 – Reinforced Concrete Approach Slab (T=__), As Per Plan or Item 526 – Reinforced Concrete Approach Slab with QC/QA (T=__), As Per Plan.

209.5.2 STANDARD BRIDGE DRAWING – AS-2-15

Standard Bridge Drawing, AS-2-15, provides contract ready installation details for standard approach slabs. Refer to the Designer Supplement to AS-2-15 for additional information.

209.6 PRESSURE RELIEF JOINTS

When the approach roadway pavement is rigid concrete and the approach slab Installation is Type C, specify a Type B pressure relief joints at a location 50-ft from the end of the sleeper

slab. Alternatively, a 25-ft length of full depth asphalt pavement may be specified between the sleeper slab and the rigid pavement.

The pressure relief joints are detailed on Standard Construction Drawing BP-2.4, Pressure Relief Joint Types B, C, & D.

209.7 AESTHETICS

209.7.1 GENERAL

Each structure should be evaluated for aesthetics. Normally it is not practical to provide cost premium aesthetic treatments without a specific demand; however careful attention to the details of the structure lines and forms will generally result in a pleasing structure appearance.

Some basic guidelines that should be considered are as follows:

A. Avoid mixing structural elements, for example concrete slab and steel beam superstructures or cap and column piers with wall type piers.

B. In general, continuous superstructures shall be provided for multiple span bridges. Where intermediate joints cannot be avoided, the depth of spans adjacent to the joints preferably should be the same. Avoid the use of very slender superstructures over massive piers.

C. Abrupt changes in beam depth should be avoided when possible. Whenever sudden changes in the depth of the beams in adjacent spans are required, care should be taken in the development of details at the pier.

D. The lines of the structure should be simple and without excessive curves and abrupt changes.

E. All structures should blend in with their surroundings.

One of the most significant design factors contributing to the aesthetic quality of the structure is unity, consistency, or continuity. These qualities will give the structure an appearance of a design process that was carefully thought out.

The aesthetics of the structure can generally be accomplished within the guidelines of design requiring only minimum special designs and minor project cost increase. As special situations

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arise preliminary concepts and details should be developed and coordinated with the Office of Structural Engineering.

If formliners are being considered, the depth of the projections should be as deep as possible in order to have the desired visual effect. Using shallow depths, such as 3" to 2" [6 to 13 mm], provides very little, if any, visual effect (relief) when viewed from a distance. The depth of the formliner shall not be included in the measurement of the concrete clear cover.

The use of colored concrete, where the color is integral with the concrete mix, should generally not be used since the final visual appearance of the concrete is not uniform. The color varies greatly due to the aggregate, cement type, cement content and the curing of the concrete. None of these items are reasonably controlled in the field to a sufficient enough degree to insure a uniform final appearance. If color is required, a concrete coating should be used which will not only produce the required color but will also provide the necessary sealing of the concrete as required in Section 300 of this Manual.

The use of formliners and/or coloring of the concrete should be evaluated on a cost basis and submitted as part of the Structure Type Study, Cost Analysis.

For additional guidance, refer to the Department's document entitled "Aesthetic Design Guidelines" available at the Design Reference Resource Center on the Department's website.

209.7.2 LETTERING AND LOGO POLICY ON ODOT FACILITIES

All lettering and logos to be placed on a bridge shall be approved by the Office of Structural Engineering. All lettering and logos to be placed on noise walls shall be approved by the Office of Environmental Services. All lettering and logos to be placed on ODOT facilities through sponsorship naming proposals will be approved by the Division of Innovative Delivery.

The following criteria are required in order for lettering and logos to be approved for use on Bridges and Noise Walls.

A. City names and City logos will be permitted provided the bridge or noise wall is within the territorial jurisdiction of that City.

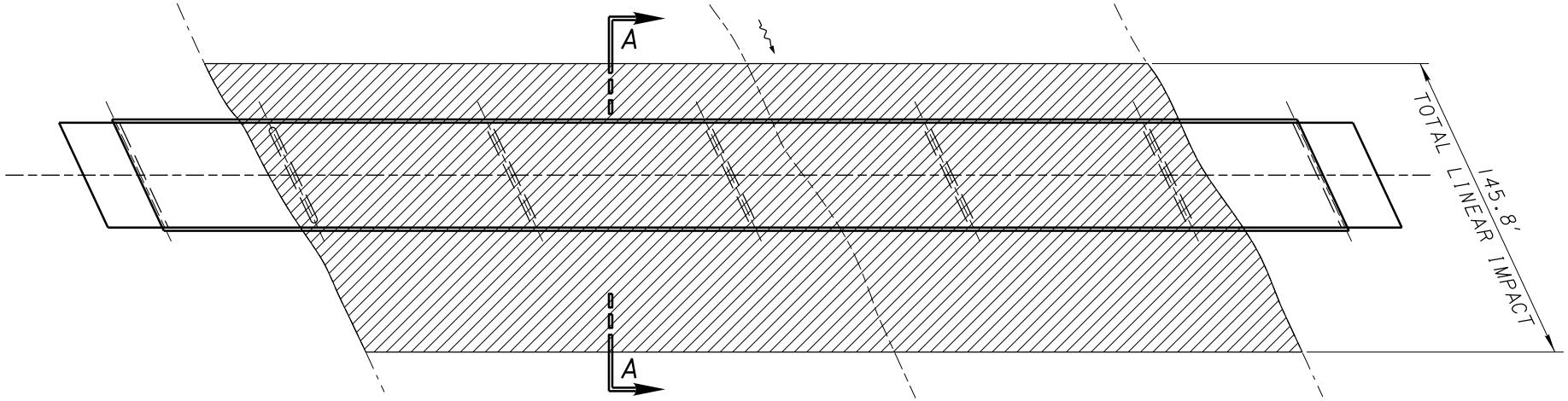
B. County names and County logos will be permitted provided the bridge or noise wall is within the territorial jurisdiction of that County.

C. Street names and Path names will be permitted provided the bridge carries that public street or public path. Private street names or private path names are not permissible.

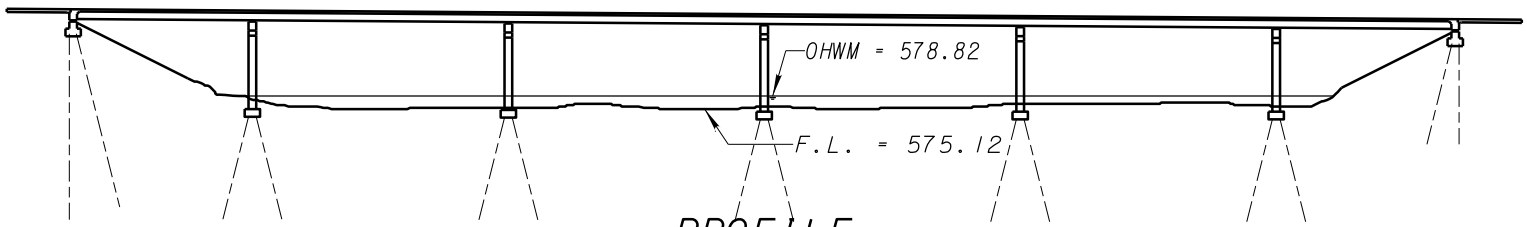
D. FHWA approval may also be required.

E. Lettering or logos may not extend above the top of bridge railing, barrier, or fence. Lettering or logos may not extend below the normal lines of the bridge superstructure.

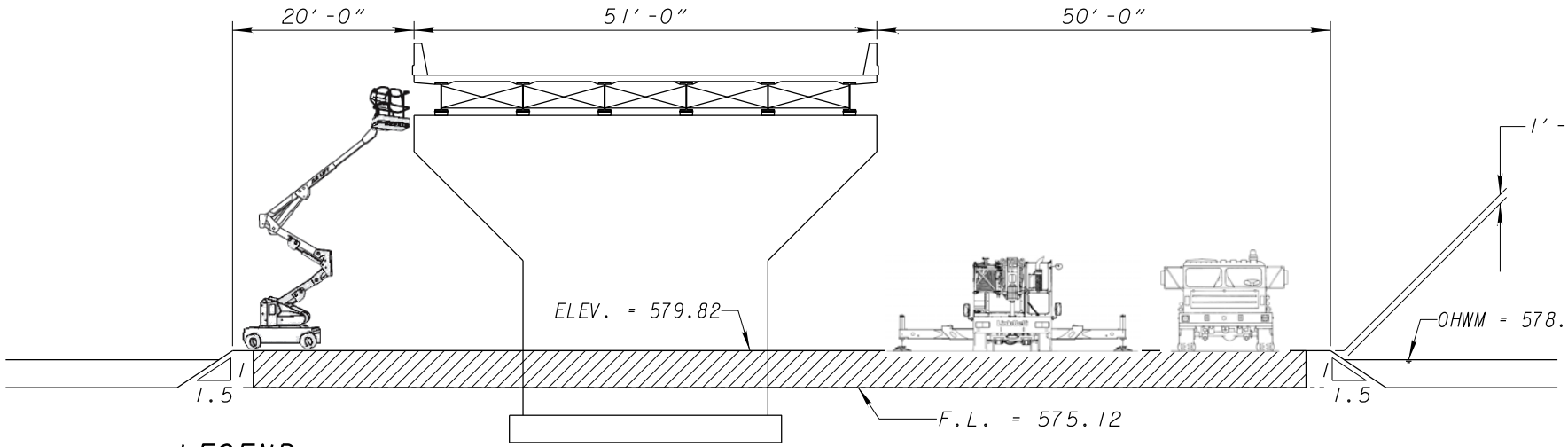
F. Lettering or logos on bridge substructure units must be placed within the normal limits of those units. No extraneous elements may be added for the sole purpose of displaying



PLAN



PROFILE



LEGEND

OHWM = ORDINGARY HIGH WATER MARK
F.L. = FLOW LINE ELEV.
= TEMPORAY ACCESS FILL

SECTION A-A

The temporary access fill shall accommodate a flow rate (Q) equal to twice the highest mean monthly flow such that the backwater elevation does not exceed the OHWM. Q for this location is XXXX cfs.

Figure 203.5-1

Temporary Construction, Access and Dewatering Activities

Permit Determination Checklist

The purpose of this form is to aid the Office of Environmental Services – Waterway Permits Unit (OES-WPU) in the permit determination process. This form shall be completed by the project designer and reflect the anticipated needs for temporary fill. If the type and amount of temporary fill is unknown, assume a worst case scenario of what could be needed. A completed copy of this form and a temporary construction access plan shall be forwarded to the DEC to be included in the Permit Determination Request Package submitted to OES-WPU.

Co-Rte-Sec: _____PID: _____

Description:_____

During the construction of this project, the following activities in the waters of the United States are anticipated: (check all that apply)

- ☐ Temporary structure for maintaining traffic
- ☐ Cofferdams
- ☐ Temporary access fill (e.g. causeways and work pads)
- ☐ Demolition and debris removal
- ☐ Dams, sumps, and pumping

ODOT requires that temporary activity to accommodate a minimum flow equal to twice the highest mean monthly flow without creating a rise in backwater above the OHWM. **The minimum flow to be maintained throughout construction for this location is _____ cfs**. The means that will most likely be implemented by the Contractor to maintain this flow will be:

- ☐ Conduit(s)
- ☐ Open channel(s)\Temporary Bridge

Different 404 permit types have different limitations and requirements. Please read the limitations and provide the required measurements and answers as it applies for this project.

- ☐ The maximum length of temporary impact, as measured upstream to downstream along one bank, cannot exceed 300-ft. **Proposed impact length for this project is ____ ft.**
- ☐ The duration of the impact to waters of the United States cannot exceed 2 years. **Proposed temporary impact duration is ___ years.**
- ☐ The proposed temporary fill is within the flowage easement of a flood control facility*. ___YES ____NO

*Only applies to federal flood control facilities. Flowage easements associated with these facilities can occur several miles away from the facility. If uncertain that the project is in a flowage easement area, please contact OES and consult your district's real estate office for assistance.

cc. District Environmental Coordinator (DEC)

A complete copy of the RGP with the OEPA conditions may be downloaded at the following website:
http://www.dot.state.oh.us/Divisions/Planning/Environment/Ecological_Resources_Permits/WATERWAY_PERMITS/Pages/default.aspx

Figure 203.5-2

SECTION 300 – DETAIL DESIGN

301 GENERAL

301.1 DESIGN PHILOSOPHY

Section 300 of this Manual establishes general design guidelines, details, special requirements and reasonable alternatives, which, when incorporated by the engineer in a set of bridge plans, will provide a bridge structure that meets load requirements, provides structural integrity, provides structural efficiency and reduces long term maintenance to a minimum level.

301.2 DETAIL DESIGN REVIEW SUBMISSIONS

The detail design review for structures is conducted as part of the Stage 2 and Stage 3 review submission.

The Stage 2 Detail Design submission should include an updated cost estimate and the items listed below. Not every item listed will apply to every project.

A. Bridge Plans generally consisting of the following:
   1. Site Plan in compliance with all Stage 1 review comments
   2. General Plan (if required)
   3. General Notes
   4. Phase Construction Details
   5. Foundation Plan
   6. Abutment Details with all dimensioning, bar marks and bar spacings properly shown
   7. Pier Details with all dimensioning, bar marks and bar spacings properly shown
   8. Superstructure Details with all dimensioning, bar marks and bar spacings properly shown
   9. Other Details as necessary

B. Retaining Wall Plans generally consisting of the following:
   1. General Notes
   2. Retaining wall details
   3. Other Details as necessary

C. Noise Barrier Plans generally consisting of the following:
   1. General Notes
   2. Plan and Profile Views

3. Noise Barrier Details
4. Foundations Table
5. Subsurface Investigation Plan Sheets
6. Other Details as necessary

D. Special Provisions
E. Load Rating Reports for bridges (Major and Minor PDP)
F. Signed Office of Structural Engineering Bridge Stage 2 Plan Review Checklist

The Stage 3 Detail Design plan submission should include an updated cost estimate and the following:

A. Stage 2 Detail Design plans in compliance with all Stage 2 review comments.
B. Completed Estimated Quantities Table
C. Completed Reinforcing Steel Schedule
D. Estimated Quantities calculations
E. Load Rating Reports for bridges (Minimal PDP only)
F. Signed Office of Structural Engineering Bridge Stage 3 Plan Review Checklist

Refer to Section 1400 of the ODOT Location and Design Manual, Volume Three, for additional staged review submission requirements.

For structures with non-redundant and/or fracture critical design details, a complete Stage 2 Detail Design Review Submission shall be made to the Office of Structural Engineering for concurrent review and comment. The Office of Structural Engineering will forward all comments to the responsible District Office or LPA.

301.3 DESIGN METHODS

Ohio Department of Transportation bridge designs are to be developed in general conformance with the latest edition of the American Association of State Highway and Transportation Officials' (AASHTO) LRFD Bridge Design Specifications, including all interims. ODOT exceptions to the AASHTO LRFD specifications are documented in BDM Section 1000.

When site conditions require the use of a superstructure type that exceeds the recommended limits set forth by AASHTO and/or this Manual, a special design method may be required using a two-dimensional or three-dimensional model and some type of numerical analysis to solve the model. When this occurs, the designer should place a note in the General Notes section of the detail construction plans listing the type of model used, method of analysis and assumptions made during the design. Examples of special design methods include grillage, finite element, finite strip and classical plate solutions. A sample note can be found in Section 600 of this Manual.

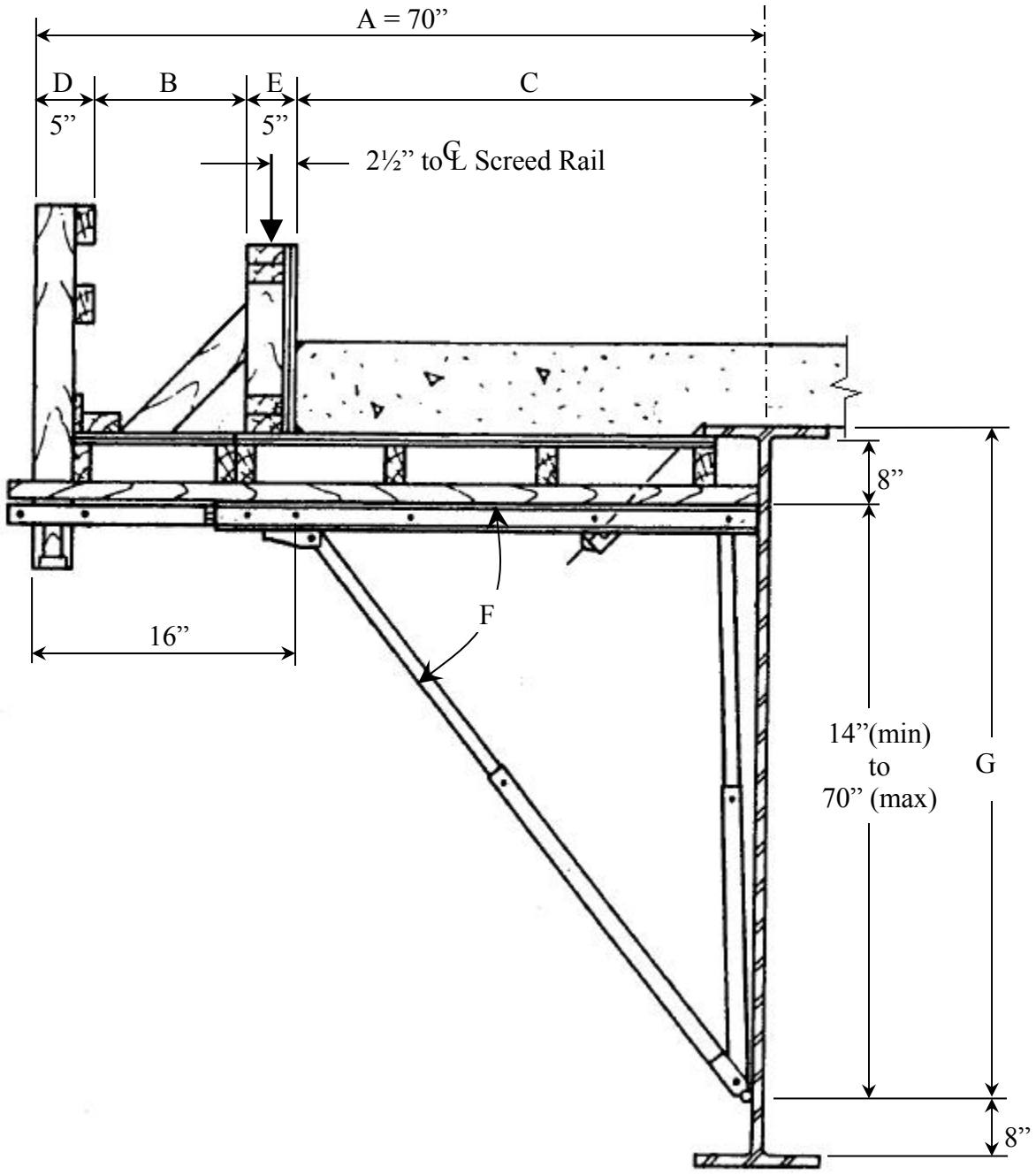
For design of Temporary Structures see Section 500 of this Manual.

Skew Angle	Rail-to-Rail Length, ft.	Extra End Length, ft.
0	1.00 W	0.0
15	1.04 W	5.0
20	1.06 W	5.5
25	1.10 W	6.5
30	1.15 W	7.0
35	1.22 W	8.0
40	1.31 W	9.0
45	1.41 W	10.5
50	1.56 W	11.5
55	1.74 W	13.5

For total machine lengths of 36 ft. and less, assume a maximum wheel load of 2.2 kip. Add 0.012 kip for each additional foot of machine length required above 36 ft. The maximum total machine length shall not exceed 120-ft. If greater lengths are required, consult the Office of Structural Engineering for recommendations.

F. Bracket Data:

1. Refer to the following figure to determine TAEG dimensions A, B, C, D, E, F and G.
2. Designers may assume a center-to-center bracket spacing of 48.0 in.
3. Designers may assume a bracket weight of 50 lbs.



Assumptions for TAEG Bracket Data Input

Bridge Railing Testing Criteria	Acceptance Equivalencies					
NCHRP 350	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6
NCHRP 230		MSL-1 MSL-2		MSL-3		
AASHTO Guide Specification		PL-1		PL-2	PL-3	

The AASHTO Guide Specification provides a Performance Level Selection Criteria for bridge railings that is considered an acceptable alternative to NCHRP Report 350 and may be used for railing designs on any project.

Section 304.2 of this Manual lists standard ODOT bridge railing types available along with the corresponding NCHRP 350 level of acceptability. For non-standard railing designs, a review submission, concurrent with the Structure Type Study, shall be made to the Office of Structural Engineering as stated in Section 201 of this Manual. The design of all non-standard railing systems shall be based on the NCHRP 350 or MASH level of acceptability. Designers may be required to submit actual crash test report data to verify the level of acceptability of a proposed design.

Modifications to the ODOT standard railing types or other NCHRP 350 or MASH approved railing system should be avoided. Additional structural steel tubing added to satisfy pedestrian concerns does not require additional crash testing provided these elements do not protrude nearer to the roadway than the rail elements on the tested design and they do not present any type of snagging potential to an impacting vehicle. If an accepted crash tested railing system is modified, the face geometry (i.e. offset, rail height, spacing, etc.) shall match the tested design and the static strength and deflections shall remain at least equal to the tested design. Include with the preliminary design submission to the Office of Structural Engineering, strength and deflection calculations to support these modifications. The calculations shall follow the procedure defined in the *AASHTO LRFD Bridge Design Specifications, Sections A13.1-3*. The intent of any modification shall be to maintain the original NCHRP 350 or MASH acceptability level.

All railing elements fabricated with ASTM A500 steel tubing shall specify a drop-weight tear test per CMS 707.10. Provisions shall be made at tube splices for expansion and contraction. Steel railing systems shall also allow for structural movement at expansion joints without adversely affecting the system's level of acceptability.

Aesthetically pleasing railing systems have been successfully crash tested but are for use only where TL-2 acceptability requirements are allowed. These systems include the Texas Classic Traffic Railing, Type T411 with open windows, a smooth stone masonry barrier with reinforced concrete core wall and an artificial stone precast concrete barrier. Detailed information regarding the latter two systems may be found in FHWA Report No. FHWA-RD-90-087 "Guardrail Testing Program: Final Report", June 1990 and FHWA Report No. FHWA-SA-91-051 "Summary Report on Selected Aesthetic Bridge Rails and Guardrails", June 1992.

The recommended railing design for bridges with combination vehicular and pedestrian traffic is detailed in Standard Bridge Drawing BR-2-98. Other designs are allowed as previously mentioned above, provided the following requirements are met:

A. The curb height shall be 8".

B. The sidewalk width shall be 5'-0" or greater.

A pedestrian railing may be used in lieu of a crash tested barrier at the deck edge provided a crash tested barrier system meeting the minimum requirements for the specific location is used to separate the vehicular and pedestrian traffic. Pedestrian railing shall be designed in accordance with AASHTO.

304.2 STANDARD RAILING TYPES

Drawing No.	Description	NCHRP Level
BR-1-13	36" New Jersey Shape Concrete Bridge Railing	TL-4
	42" New Jersey Shape Concrete Bridge Railing	TL-5
BR-2-98	Bridge Sidewalk Railing with Concrete Parapet	TL-4
DBR-2-73	Deep Beam Bridge Guardrail	TL-2
DBR-3-11	Deep Beam Bridge Retrofit Railing	TL-3
PCB-91	Portable Concrete Barrier (Fully Anchored)	TL-4
	Portable Concrete Barrier (Unanchored)	TL-3
SBR-1-13	42" Single Slope Concrete Bridge Railing	TL-5
SBR-2-13	57” Single Slope Concrete Median	TL-5
TST-1-99	Twin Steel Tube Bridge Railing	TL-4

304.3 WHEN TO USE

304.3.1 PARAPET TYPE (BR-1-13, SBR-1-13 & SBR-2-13)

The Department currently has three (3) standard concrete parapet type bridge railing systems for

C_h	Height (ft)	Height (mm)
0.8	0 - 15	0 - 4500
1.0	15 - 30	4500 - 9000
1.1	30 - 50	9000 - 15 000
1.25	50 - 100	15 000 - 30 000
1.40	100 - 150	30 000 - 46 000
1.50	150 - 200	46 000 - 61 000

The centroid of the horizontally projected area of the fence is to be used to determine the height above normal terrain and the value of C_h.

The projected area for wind forces on 11 gage [3.05 mm] polyvinyl chloride coated one inch [25 mm] wire mesh shall be 20% of the gross horizontally projected area.

Additional area for posts, rails and other hardware need not be considered.

Ref. **(1)** Specifications for the Design and Construction of Structural Supports for Highway Signs, AASHTO.

Ref. **(2)** Isotach's of the U.S. The 80 mph [129 km/h] line covers the northwestern portion of Ohio and shall be used herein for all of Ohio.

306 EXPANSION DEVICES

306.1 GENERAL

Expansion devices should provide a total seal against penetration and moisture. Standard bridge drawings are available for expansion devices for typical bridge superstructure types.

For fabricated steel expansion devices, the designer should specify the type of steel required. Type of steel should be included as a plan note if requirements in the plans are not covered by a selected standard bridge drawing.

To protect steel expansion devices, metallizing of the exposed surfaces with a 100% zinc coating shall be specified. Standard bridge drawings define the requirements for metallizing. The design agency will need to develop plan notes for special expansion devices, such as finger joints and modular joints. Use the note for shop-applied metallizing located in the appendix as a guideline. Consult the Office of Structural Engineering for recommendations prior to completion of the project plans.

306.1.1 PAY ITEM

Expansion devices, except as specifically listed in this section, shall be paid for as Item 516.

For sealed expansion devices the elastomeric seal, either strip or compression, shall be included in the pay Item 516.

The plans shall clearly show what components are included with the expansion devices, Item 516. As an example, cross frames, which are field welded to both the superstructure girders and the expansion devices, are part of the 513 structural steel item. The seal is considered part of the expansion device and should be included in the 516 pay item.

306.1.2 EXPANSION DEVICES WITH SIDEWALKS

On structures with sidewalks, the expansion devices shall be the same type as furnished for main bridge deck expansion joint.

Sidewalk details for standard expansion devices (strip seals) are shown on the standards. For non-standard devices, a curb plate and sidewalk cover plate will be required. The Curb and sidewalk plates should be separated at the interface of the sidewalk and curb. See details on Standard Bride Drawings: EXJ-2-81, EXJ-3-82, EXJ-4-87, EXJ-5-93 and EXJ-6-95 for sidewalk plates.

306.1.3 EXPANSION DEVICES WITH STAGE CONSTRUCTION

On projects involving stage construction, joints in the seal armor must be located and shown in the plans. At the stage construction lines, expansion devices should require complete penetration welded butt joints. If butt welds will be in contact with a sealing gland the butt-welded joint shall be ground flush at the contact area.

306.2 EXPANSION DEVICE TYPES

306.2.1 ABUTMENT JOINTS IN BITUMINOUS CONCRETE, BOX BEAM BRIDGES

This poured joint seal system is capable of small expansion movements, up to 3/16". Refer to AS-1-15 Sheet 2, Detail A. This joint system requires including the following bid item in the structure estimated quantities: Item 409 - Sawing and Sealing Bituminous Concrete Joints.

306.2.2 ABUTMENT JOINTS AS PER AS-1-15

A group of no or small movement joints used for sealing and rotational purposes are detailed on Standard Bridge Drawing, AS-1-15.

306.2.3 EXPANSION JOINTS USING POLYMER MODIFIED ASPHALT BINDER

This device is for use on structures with concrete or asphalt overlays and where total expected movement is 0 to 1½". The Department has a Supplemental Specification for the Polymer Modified Asphalt Expansion Joint System.

Thickness of the polymer-modified joint shall be between 2" and 5”. The design plans shall show a plan view and cross-section of each polymer modified asphalt expansion joint location on the bridge. The plan view shall provide the station of the joint centerline at the centerline of construction, skew angle and dimension its length as measured along the centerline of the joint. The cross-section shall dimension the width and thickness of the joint, width of the expansion gap and other significant joint details.

306.2.4 STRIP SEAL EXPANSION DEVICES

The seal size is limited to a 5" [125 mm] maximum. Unpainted A588[M] weathering steel should not be used in the manufacture of this type expansion device as A588[M] does not perform well in the atmospheric conditions an expansion device is subjected to. Standard Bridge Drawings, EXJ-4-87, EXJ-5-93 and EXJ-6-95, are available. The designer must ensure that all details are covered in the plans because the standard drawing is not inclusive for all structure types.

The strip seal shall be of one piece across the total width of the structure. No splices will be acceptable.

306.2.5 COMPRESSION SEAL EXPANSION DEVICES

Maximum allowable seal size is 4" [100 mm]. A 5" [125 mm] wide seal shall not be used since installation problems have been encountered. Compression seal expansion devices are limited to structures with a maximum skew of 15 degrees. Movement should be limited so that the seal is not compressed greater than 60 percent or less than 20 percent.

The compression seal shall be of one piece across the total width of the structure. No splices will be acceptable. Standard Bridge Drawings EXJ-2-81 & EXJ-3-82 give generally used details.

306.2.6 STEEL SLIDING PLATE ENDDAMS, RETIRED STANDARD DRAWING SD-1-69

In general steel sliding plate enddams are not recommended for new structures. This expansion device is limited to total movement of 4" [100 mm], including movement in both directions.

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Sliding plates should be configured to prevent binding and bearing when the superstructure is supported on elastomeric bearings.

Unpainted A588[M]/A709[M] Grade 50W materials are not recommended for construction of this type of joint.

306.2.7 MODULAR EXPANSION DEVICES

Modular expansion devices may be required for structures when total required movements exceed movement capacity of a strip or compression seal. Consult the Office of Structural Engineering for recommendations prior to completion of the project plans.

Modular devices main load bearing beams, support beams and welds shall be designed for fatigue.

The manufacturer of the expansion device shall be required by plan note to submit design calculations showing that the device can meet the impact and fatigue design requirements.

Modular devices have been known to fail at connections due to welding and fatigue. Therefore it is recommended the following general requirements be included in any project plan notes:

A. Spacing of support beams shall be limited to 3'-0" [1000 mm] centers under main load bearing beams unless fatigue testing of the actual welding connection details has been performed to show that a greater spacing is acceptable. Fatigue resistance shall be determined according to *LRFD 6.6.1.2.5* and BDM Section S*6.6.1.2.5*.

B. Shop or field welds splicing main beams, or connections to the main beams shall be full penetration welded and 100 percent non-destructively tested in accordance with AWS D1.5 Bridge Welding Code. Any required field splices or joints and non-destructive testing shall be located and defined in the plans.

C. Fabricators of modular devices shall be pre-qualified 513 Level UF fabricators. Review Section 302.4.1.3 and contact the Office of Structural Engineering for recommendations.

D. Approved manufacturer/fabricator shall supply a qualified technical representative to the jobsite during all installation procedures.

E. Seals shall be one continuous piece through the total length of the structure.

Design of support for the modular device and deck thickness should allow for multiple styles or designs of modular devices. Contact suppliers and become familiar with the modular devices available.

Contact the Office of Structural Engineering for sample notes used on other projects.

306.2.8 TOOTH TYPE, FINGER TYPE OR NON-STANDARD SLIDING PLATE EXPANSION DEVICES

Finger or sliding plate joints are another alternative type of expansion device where movements exceed the capacity of either strip or compression seal devices. This type of expansion device generally competes against Modular joints. Their advantage is their simplicity of design. Their disadvantage is their inability to seal against intrusion of water and debris. Consult the Office of Structural Engineering for recommendations prior to completion of the project plans. Example plan notes are provided in the appendix.

Use of a tooth type expansion device also requires neoprene drainage troughs and a suitable drainage system to carry away the water. Both the neoprene trough and downspout to drainage trough connection must be detailed completely. Special attention should be paid to developing a complete seal at the downspout to trough connection.

Vulcanization is recommended over adhesive for sealing.

Finger devices shall be designed for fatigue and conform to fracture critical requirements if the design has fracture critical components in it.

Fabricators of finger or sliding plate devices shall be pre-qualified 513 Level UF fabricators. Review Section 302.4.1.3 and contact the Office of Structural Engineering for recommendations.

306.3 EXPANSION DEVICE USES – BRIDGE OR ABUTMENT TYPE

306.3.1 INTEGRAL OR SEMI-INTEGRAL TYPE ABUTMENTS

No allowance for temperature need be made.

The vertical joint between abutment backwall and approach slab should be finished as per Standard Bridge Drawing AS-1-15, Detail B or C.

306.3.2 REINFORCED CONCRETE SLAB BRIDGES

The following table specifies joint requirements. Expansion length is defined as the total length if no fixed bearing exists, or length from fixed bearing to proposed expansion device location, if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required	Approach Slab Joint
0 - 40	0 - 12	None	AS-1-15 detail B or C
40 - 200	12 - 60	None (1) PM (2)	AS-1-15 detail B or C (1) AS-1-15 detail D or F (2)
200 +	60 +	Non-standard Strip Seal	AS-1-15 detail B or C

(1) = flexible abutments and piers (CPP-1-08 and CPA-1-08)

(2) = abutments and/or piers fixed or rigid

PM = Polymer Modified Asphalt Joint

306.3.3 STEEL STRINGER BRIDGES

The following table specifies joint requirements based on expansion length defined as the total length of structure, if no fixed bearing exists, or length from fixed bearing to proposed expansion device location if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required	Approach Slab Joint
0 - 30	0 - 10	None	AS-1-15 detail B or C
30 - 125	10 - 38	PM (1) or EXJ-4-87	AS-1-15 detail B or C
125 - 400	38 - 125	EXJ-4-87	AS-1-15 detail B or C
400 +	125 +	TTED or MED	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

TTED = Tooth Type expansion device

MED = Modular Expansion Device

(1) = Stringer bridges with sidewalks should not use polymer modified expansion joint systems.

306.3.4 PRESTRESSED CONCRETE I-BEAM BRIDGES

The following table specifies joint requirements based on expansion length defined as the total length of structure, if no fixed bearing exists, or length from fixed bearing to proposed expansion device location if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required	Approach Slab Joint
0 - 40	0 - 12	None	AS-1-15 detail B or C
40 - 225	12 - 65	PM (1) or EXJ-6-06	AS-1-15 detail B or C
225 - 500	65 - 150	EXJ-6-06	AS-1-15 detail B or C
500 +	150 +	TTED or MED	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

TTED = Tooth Type expansion device

MED = Modular Expansion Device

(1) = Stringer bridges with sidewalks should not use polymer modified expansion joint systems

306.3.5 NON-COMPOSITE PRESTRESSED BOX BEAM BRIDGES

The following table specifies joint requirements based on expansion length defined as the total length of structure, if no fixed bearing exists, or length from fixed bearing to proposed expansion device location if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required (2)	Approach Slab Joint
0 - 40	0 - 12		AS-1-15 detail A
40 - 225	12 - 65	PM (1) or EXJ-5-93	AS-1-15 detail E AS-1-15 detail B or C
225 - 500	65 - 150	EXJ-5-93	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

(1) = Bridges with sidewalks should not use polymer modified expansion joint systems

(2) = Joint requirements are for rigid or fixed abutments. For flexible abutments requiring no expansion movement a PM joint is recommended except for (1).

306.3.6 COMPOSITE PRESTRESSED CONCRETE BOX BEAM BRIDGES

The following table specifies joint requirements based on expansion length defined as the total length of structure, if no fixed bearing exists, or length from fixed bearing to proposed expansion device location if one exists.

Expansion Length (ft)	Expansion Length (m)	Joint Required (2)	Approach Slab Joint
0 - 40	0 - 12	PM	AS-1-15 detail D or F
40 - 225	12 - 65	PM (1) or EXJ-5-93	AS-1-15 detail D or F AS-1-15 detail B or C
225 - 500	65 - 150	EXJ-5-93	AS-1-15 detail B or C

PM = Polymer Modified Asphalt Joint

(1) = Bridges with sidewalks should not use polymer modified expansion joint systems

(2) = Joint requirements are for rigid or fixed abutments. For flexible abutments requiring no expansion movement a PM joint is recommended except for (1).

306.3.7 ALL TIMBER STRUCTURES

No allowance for temperature need be made.

307 BEARINGS

307.1 GENERAL

The Department's policy is, whenever possible, use laminated elastomeric bearings.

Justification, including design calculations showing elastomeric bearings will not be adequate for the structure, must be available.

When specialized bearings, such as pot, disc or spherical, are required, detail notes shall be included in the contract plans. A plan note for pot bearings is provided in the appendix and may require modification by the designer based on the specific structure. If a cost evaluation shows that either spherical or disc bearings could be competitive against pot bearings, those bearings should be included in the plans and special notes developed.

For specialized bearings, the designer's detail plan notes shall require the contractor to coordinate the required substructure bearing seat elevations or dimensions with the selected bearing manufacturer. A note is available in Section 700.

307.2 BEARING TYPES

307.2.1 ELASTOMERIC BEARINGS

Refer to S*14.7.5* for additional design requirements.

610.6 COFFERDAMS AND EXCAVATION BRACING

Use this note when the plans include detail designs for temporary shoring.

[610.6-1] ITEM 503, COFFERDAMS AND EXCAVATION BRACING, AS PER PLAN:
The design shown on the plans for temporary support of excavation is one representative design that may be used to construct the project. The Contractor may construct the design shown on the plans or prepare an alternate design to support the sides of excavations. If constructing an alternate design for temporary support of excavation, prepare and provide plans in accordance with C&MS 501.05. The Department will pay for the temporary support of excavation at the contract lump sum price for Cofferdams and Excavation Bracing. No additional payment will be made for providing an alternate design.

610.7 DECK PLACEMENT NOTES

610.7.1 FALSEWORK AND FORMS

Use the following note when web depths greater than 84 in. are specified.

[610.7.1-1] ITEM 511, CLASS QC2 CONCRETE, SUPERSTRUCTURE, AS PER PLAN *

Locate the lower contact point of the overhang falsework at least _**_ inches ± 2 in. above the top of the girder's bottom flange. The bracket contact point location requirements of C&MS 508 do not apply.

NOTE TO DESIGNER:

* Modify the pay item description to fit the specific project requirements.

** The minimum dimension for the location for the lower point of contact should be 76 in. below the bottom of the top flange. Designers should verify the acceptability of the design within the range of tolerance specified.

610.7.2 DECK PLACEMENT DESIGN ASSUMPTIONS

Use the following note on all projects requiring mechanized finishing machines to place deck concrete.

[610.7.2] DECK PLACEMENT DESIGN ASSUMPTIONS:

The following assumptions of construction means and methods were made for the analysis and design of the superstructure. The Contractor is responsible for the design of the falsework support system within these parameters and will assume

responsibility for superstructure analysis for deviation from these design assumptions.

An eight wheel finishing machine with a maximum wheel load of _____ kips.

A minimum out-to-out wheel spacing at each end of the machine of 103".

A maximum spacing of overhang falsework brackets of 48 in.

A maximum distance from the centerline of the fascia girder to the face of the safety handrail of 65".

NOTE TO DESIGNER:

Refer to BDM Section 302.2.7.2.c for design information regarding finishing machine loads.

Where:

ADTT = the number of trucks per day in one direction averaged over the design life

$ADTT_{20}$ = the number of trucks per day in one direction occurring in the design year (year 20)

S3.6.1.6 PEDESTRIAN LOADS

For bridges that can accommodate service vehicles, refer to BDM Section 301.4.1 for loading requirements.

S3.6.2.1 GENERAL

For deck joints at all limit states, the Dynamic Load Allowance, IM, shall be taken as 125% of the static effect of either the design truck or the design tandem.

S3.6.5.1 PROTECTION OF STRUCTURES

Use the flow chart provided in BDM Figure S3.6.5.1-1 to determine protection requirements for substructures against vehicle collisions. Roadway geometry and/or accident experience, either at the site or at a comparable site, may be used to override the flow chart to determine inclusion or omission of protection.

S3.10.4 SEISMIC PERFORMANCE ZONES

All bridges in the state of Ohio fall within Seismic Zone 1.

S3.10.9.2 SEISMIC ZONE 1

The entire State of Ohio shall be assumed to have an acceleration coefficient above 0.025 but less than 0.09.

Design the connection of the superstructure to the substructure to resist a horizontal seismic force in the restrained direction equal to 0.2 times the vertical reaction due to the tributary permanent load. The tributary area refers to the uninterrupted segment of a superstructure contributing to the load on the seismic restraint. The restrained direction for an expansion bearing is typically transverse to the structure. The tributary permanent load shall include an allowance for future wearing surface.

Assume the Extreme Event I load factor for live load (γ_{EQ}) is equal to 0.0.

Standard integral and semi-integral abutment types do not require the addition of seismic restraints. The horizontal restraint provided by these abutment types is sufficient to resist the seismic force generated by the tributary area contributing dead load to the abutment. For multiple span structures with integral or semi-integral abutments, additional seismic restraints located at one or more piers may be required to resist the remaining seismic force acting on the superstructure. Diaphragm Guides, as specified in BDM Section 303.2.2.7, are required for every semi-integral abutment.

If seismic restraints are provided, design the substructure units for an earthquake force (EQ) at the Extreme Event I limit state equal to 0.2 times the tributary dead loads applied in the restrained direction resulting in the maximum load effect.

Refer to *Article 4.7.4.4* for minimum seat width requirements.

S3.11.2 COMPACTION

The Department typically ignores the effect of additional earth pressure from mechanical compaction equipment on retaining walls. For situations requiring special compaction equipment by plan note, proposal note or special provision, contact the Office of Structural Engineering for additional guidance.

S3.11.6.5 REDUCTION OF SURCHARGE

Do not reduce the Live Load Surcharge regardless of the presence of an approach slab.

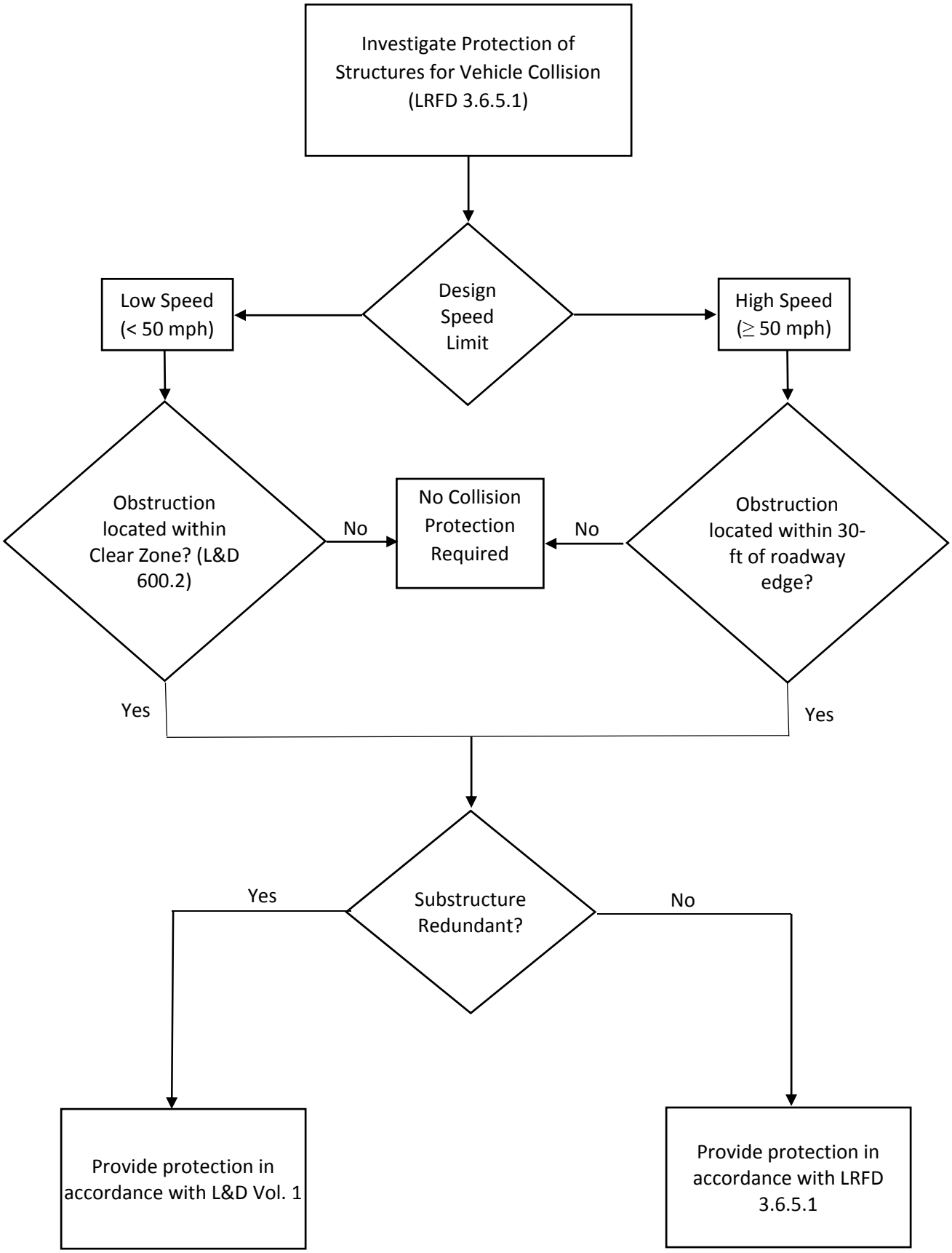

Figure *S3.6.5.1-1*

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