Oregon Department of Transportation

SECTION 1.2
Bridge Design, General

Revisions for the current edition are highlighted yellow. Deleted text is not marked.

Past editions of the Bridge Design Manual are available through our website.

1.2 Bridge Design, General

1.2.1 Bridge Design Standards

1.2.2 Bridge Design Deviations (DD) and Roadway Design Exceptions (DE)

1.2.3 Bridge Design Categories

1.2.4 Bridge Location and Environment

1.2.5 Structure Appearance and Aesthetics

1.2.6 Bridge Types & Selection Guidance

1.2.7 Bridge Layout

1.2.8 Bridge Security Design Considerations

1.2.9 Bridge Name Plates & Markers

1.2.10 Accessibility

1.2.1 Bridge Design Standards

1.2.1.1 Standard Specifications and Standard Drawing Manuals

- *LRFD Bridge Design Specifications (10th Edition, 2024)* published by the American Association of State Highway and Transportation Officials (AASHTO).
- *AASHTO Guide Specifications for LRFD Seismic Bridge Design 3rd Edition (2023)*.
- *AASHTO Guide Specifications for Seismic Isolation Design, 4th Edition (2014) with 2023 Interim revisions.*
- *Guide Specifications for Bridges Subject to Tsunami Effects (st Edition, January 2022)* published by *AASHTO*.
- *AASHTO Guide Design Specifications for Bridge Temporary Works, 2nd Edition, 2017.*
- *AASHTO LRFD Guide Specifications for Accelerated Bridge Construction (1st Edition, 2018)*.
- *LRFD Guide Specifications for the Design of Pedestrian Bridges (2nd Edition, December 2009 with 2015 interims)* published by *AASHTO*.
- *Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association (AREMA*) as modified by the individual requirements of each railroad company.
- *Oregon Standard Specifications for Construction*, published by ODOT and pertinent special provisions (for all construction except bridges carrying railways).
- *Oregon Standard Drawings*, published by ODOT, Standards Engineer.
- *AASHTO Guide for Design and Construction of Near-Surface Mounted Titanium Alloy Bars for Strengthening Concrete Structures*
- *AASHTO Guide Specifications for Design of Bonded FRP Systems for Repair and Strengthening of Concrete Bridge Elements, First Edition*

1.2.1.2 Use of Oregon Standard Drawing and Standard Details

The Standard drawings and standard details prepared by ODOT have been developed through a long history of collaboration with Oregon contractors and fabricators. Consider impacts to both when making modifications.

Use Oregon standard drawings without significant change, as determined by the drawing Engineer of Record. Where a significant change to a standard drawing is needed, submit a design deviation request to the State Bridge Engineer. Where a significant change to a bridge rail standard drawing is needed, submit a design exception request per *BDM 1.2.2.1*. Where an equivalent ODOT standard drawing or accompanying design detail exists, do not use standard drawings or design details from another state or agency without approval of a design deviation from the State Bridge Engineer.

The standard details do not include the seal of the technical owner. The designer or the Engineer of Record (EOR) is responsible for sealing the contract plans with the standard details, and the design calculations which is specific to the project where the standard details are used.

1.2.2 Bridge Design Deviations (DD) and Roadway Design Exceptions (DE)

The bridge design field is an art that is constantly changing. It is understood that designers will occasionally use innovative details or methods that differ from those contained in this manual and on the standard drawings. Designers having experience in other states may also want to introduce details and methods which have worked well in those states. In addition, context-sensitive design requires the exercise of engineering judgement and sometimes leads to details or methods that satisfy the intent of this manual or the standard drawings, but do not meet the **letter** of these documents.

Submit a request for a Design Deviation before replacing an established drawing or method from this manual. The two-column layout visually separates standards from guidance with established standards stated in the left column. Deviating from language in the left column of the *BDM* requires a Design Deviation unless stated otherwise. Replacing standards includes design methods or details established in other states, presented in research reports, or developed by designers. Engineers are encouraged to exercise good engineering judgment, which may result in innovative solutions, including new materials or techniques. Design Deviations allow the opportunity for these ideas to be documented and shared, potentially resulting in revisions to standard practice in the *BDM*. Prepare Design Exception and Design Deviation submittals to be consistent with *Guidelines for Drafting Liability Neutral Documents*.

In cases where a standard drawing or *BDM* design requirement is not applicable to the project circumstances and must be modified, a Design Deviation is necessary. This commonly occurs to meet a project goal, incorporate new technology or to meet a technical requirement e.g. significant modification to accommodate project geometry; ADA requirements; any modified attachments;

existing elements; local agency standards; or aesthetics. Modifications made in these instances cannot be based on preference or economy. They must be justified by structure geometry, configuration, constructability, and intended purpose. Use a standard drawing when it satisfies the need. When modifying a standard drawing, comply with appropriate design specifications (*LRFD*, *BDM*, etc.) to the fullest extent possible.

Modifications to standard drawings on repair and rehabilitation projects do not require Design Deviations, except on bridge rail drawings or when new design techniques or materials are used. This is due to the often unique needs and project specific circumstances on rehab and repair projects. These projects must still comply with *LRFD* and *BDM* design requirements or a Design Deviation is necessary. The Bridge Reviewer should devote extra attention to modified drawings and raise concerns to the standard drawing owner when appropriate.

Some elements of bridge work may require a Roadway Design Exception (refer to *ODOT Highway Design Manual, Part 1000* for more information about Roadway Design Exceptions). All Design Exceptions related to bridge rail must be signed by the State Bridge Engineer prior to approval by the State Roadway Engineer. In addition, when Design Exceptions involve structural work, such as sidewalk widening, the State Bridge Engineer is expected to concur. A Design Deviation is not required for project elements where a Design Exception is submitted. When it is unclear whether a Design Deviation or exception is required, contact the relevant bridge technical resource as early in the design process as possible.

1.2.2.1 Design Exceptions

For exceptions relating to a bridge structure, barrier protecting a bridge column, or bridge rail the State Bridge Engineer needs to provide concurrence on a Roadway Design Exception. On outsourced projects, include the ABR (agency bridge reviewer) in all discussions concerning structural related Design Exceptions. In these cases, modify the Roadway Design Exception process in *HDM 1004.2* as follows:

1. Complete the Roadway Design Exception Form. Get information from both Roadway and Traffic designers to complete the form. Request a design exception control number using the online form at https://www.oregon.gov/odot/Engineering/Pages/DENumber.aspx
2. Revise the first two concurred by signature lines to be for the **State Bridge Engineer** and the **ODOT Region Tech Center Roadway Manager**.
3. Send a link to the draft Design Exception to the relevant bridge technical resource and all necessary Region resources, for review prior to signing.
4. After addressing comments, save the Design Exception as a PDF, create the necessary signature fields, and sign the file.
5. Submit a link to the file for Region signatures according to appropriate Region process.

6. Submit a link to the file to the Bridge Design Manual Standards Engineer requesting the State Bridge Engineer's signature.
7. After Region and Bridge signatures are complete, submit the Design Exception or ProjectWise link to the ODOT Design Exception Mailbox at ODOTDesignExceptions@odot.oregon.gov for final processing. Depending on the Region, this step may be the responsibility of the designer.
8. The submitter will be notified once signing of the Design Exception is complete.

1.2.2.2 Design Deviations

Identify whether a Design Deviation is necessary in the DCSA per *BDM 2.9.2*. Contact the relevant bridge technical resource to notify them that a Design Deviation has been identified and to confirm a Design Deviation is necessary. An email inquiry about the proposed modification suffices for confirmation on whether a formal Design Deviation is necessary or not. On outsourced projects, include the ABR (agency bridge reviewer) in all discussions concerning structural related Design Deviations. The State Bridge Engineer makes the final decision to accept or reject a request for Design Deviation.

When a Design Deviation is needed, follow the Design Deviation process as follows:

1. EOR/designer completes the Design Deviation Form available on the ODOT Bridge Engineering website. In the request, include a brief description of the project, an explanation of the issues, what is being proposed, a justification for the proposed Design Deviation, and any supporting documents.
2. The relevant bridge technical resource reviews the submission and emails comments to the EOR/designer. On local agency projects include the Senior Local Agency Bridge Standards Engineer for review. The relevant bridge technical resource will notify the State Bridge Engineer of the design deviation.
3. After addressing comments, EOR saves the Design Deviation as a PDF in ProjectWise, signs the file and circulates the file for signatures to relevant parties.
4. EOR/designer submits a Project Wise link to the signed file to the relevant bridge technical resource for final signature by the State Bridge Engineer. The bridge technical resource will submit the ProjectWise link, along with their recommendation, to the State Bridge Engineer for signature. A response to each request will be returned by email within 10 business days.
5. The State Bridge Engineer will notify the EOR/designer and bridge technical resource once signing of the Design Deviation is complete.

1.2.2.3 Technical Bulletins

When technical issues arise between scheduled *BDM* updates which require urgent distribution of guidance to the design community, a Technical Bulletin is issued. Check the ODOT Technical Guidance web page for Technical Bulletins.

1.2.3 Bridge Design Categories

1.2.3.1 Bridge Design Categories, General

Bridge design categories determine the design criteria and requirements for projects on bridges. These categories include the following:

- Modernization.
- Retrofit.
- Preservation.
- Maintenance.
- Local Agency.

For projects involving multiple bridges, determine the category per bridge. Bridge Program will complete an initial categorization at desk scoping, when possible. Validate the categorization during field scoping. For projects initiating outside Bridge Program, establish the bridge design category at field scoping. Contact the Bridge Design Manual Standards Engineer with questions regarding the bridge design category. Document the identified category in the Bridge Design Criteria. When project need's change after scoping, contact the Program Manager according to *BDM 2.9.5* prior to changing the design category for any bridge.

These categories operate independently from the roadway design standards identified in the *Highway Design Manual Section 100*. A project involving bridges will have both a roadway design standard and at least one bridge design category. For projects initiating outside of Bridge Program, the bridge design category may be based on the work required by the roadway design standard; however the bridge design category must still be determined.

The design requirements governed by these categories include:

- The level of alternatives analysis required and type of documentation, i.e.:
  - Bridge TS&L Report.
  - Bridge Strategy Memo.
  - Bridge Design Criteria and Standards Assessment (DCSA).
- The extent of bridge rail work.
- The level of seismic retrofit.
- The amount of Bridge Section review required.

All projects, regardless of design category, require a minimum of one site visit to be performed. Identify and document existing conditions and defects that may exist, to tailor solutions to site conditions.

The EOR, or assigned designee, will perform the site visit. Collaborate with other

While site visits are required on all projects, they are more crucial on rehabilitation, preservation, or retrofitting of existing structures. These are projects where existing conditions often dictate design elements and solutions.

disciplines involved in the project at the site visit to discuss overlapping design elements. Coordinate site visits with the Region Bridge Inspector and Bridge Maintenance to facilitate access, where appropriate, and to assure all defects are identified.

Perform the site visit early enough in the project delivery process to allow time for incorporation of site visit findings into project DAP documents.

Roadway design standards and other agreements govern work outside of the bridge footprint, including approach slabs, drainage features and bridge rail transitions.

Consider performing an initial scoping site visit prior to TS&L, as well as a site visit near the end of project delivery to ensure site conditions have not changed.

1.2.3.2 Bridge Modernization

The bridge modernization design category applies to the following project types:

- New bridge construction.
- Bridge replacement.
- New bridge deck or superstructure.
- Phase 2 seismic retrofit projects.
- Bridge widening requiring the addition of one or more girder lines.

On bridge modernization work, use full current bridge design standards for the entire bridge, except where practical design opportunities or innovations are available. In these cases, document all variations from bridge standards in design deviations or exceptions, as described in *BDM 1.2.2*. Per *BDM 2.9.5*, submit a Bridge TS&L Report for all bridge modernization category work.

1.2.3.3 Bridge Retrofit

The bridge retrofit design category includes any work that upgrades the functional characteristics of a bridge, including load-carrying capacity, except that covered by modernization. A bridge retrofit project can include multiple work elements. Potential work elements include:

- Bridge strengthening.
- Structural concrete overlays, ACP overlay.
- Overhang or sidewalk widening.
- Bridge raising. See *BDM 1.16.1*.
- Bridge rail replacement.
- Bearing replacement.

When evaluating projects that include bridge retrofit work during the scoping and Project Initiation phases, consider the bridge holistically. Consider what other related elements of the bridge should also be updated. As an example, retrofitting a bridge rail may be appropriate during a structural concrete overlay, or a strengthening may also include phase 1 seismic retrofit. Clearly document modifications to scope from this process in the project documents (Scoping Notes, Project Charter, CMR or DCSA, depending on project phase) and solicit Program Manager approval prior to proceeding.

Identify required design deviations and Design Exceptions in the DCSA. Use a Bridge Strategy Memo, according to *BDM 2.9.6*, to communicate these decisions to the project team.

1.2.3.4 Bridge Preservation

The bridge preservation design category applies to work that does not change the functional characteristics of a bridge, including load-carrying capacity. Relevant work includes:

- Bridge coating.
- Joint repairs and replacements.
- Protective screening.
- Phase 1 seismic retrofit.
- Non-structural concrete overlays (that do not trigger updating the load rating per *ODOT LRFR 1.7*).
- Structural concrete inlays and ACP inlays (that do not trigger updating the load rating per *ODOT LRFR 1.7* and do not change deck grades).

The following qualify as bridge preservation, unless other work on the bridge requires another category:

- Bridge rail height modifications using *BR285* or similar.
- Strengthening required to carry temporary construction loads, i.e. containment.
- In-kind bearing replacement.

When evaluating projects that include bridge preservation work during the scoping and Project Initiation phases, consider the bridge holistically. While this category may not require updates to bridge elements, consider if it makes sense to update other related elements of the bridge. As an example, retrofitting a bridge rail may be appropriate during a structural concrete inlay while existing rebar is exposed.

This category of work does not require design deviations. Instead, use the DCSA to document project decisions, such as overlay type, and as documentation of communication with the relevant technical specialist. Use the DAP Narrative to communicate all bridge work with the project team, without requiring a Bridge TS&L Report or Bridge Strategy Memo.

When using innovative methods on bridge preservation projects, submit a BDM Revision Request form so the method can be evaluated and possibly adopted into the *BDM*. Thoroughly describe the method and how it applied to the project(s) on which the innovation was used.

1.2.3.5 Bridge Maintenance

The bridge maintenance category includes those projects, of any scale, that are funded exclusively with Major Bridge Maintenance (MBM) funds or other similar sources of state funding. Design these projects according to the *Bridge Maintenance Design Manual* and coordinate with the Bridge Maintenance Engineer and the District Bridge Supervisor. Refer to TSB22-01(B) for MBM work related to roadside safety feature design (i.e. bridge rails).

1.2.3.6 Local Agency

The local agency category includes projects with work on local agency structures. *BDM* standards apply to all local agency projects, both certified and non-certified, except as modified for local agency projects in the following *BDM* sections:

- *BDM 1.2.9.1 Bridge and Structure ID Markers.*
- *BDM 1.3.2.1 Wearing Surface.*
- *BDM 1.5.6.1 Design of Precast Prestressed Elements*
- *BDM 1.9.2.1 Deck Slabs.*
- *BDM 1.9.2.3 Precast Deck Panels.*
- *BDM 1.9.3.1.6 Asphaltic Concrete Overlays.*
- *BDM 1.9.3.1.6.1 Waterproofing Membranes.*
- *BDM 1.9.4.2 Deck Closure Pours.*
- *BDM 1.13.1 Bridge Rail*.
- *BDM 1.17.2.1 General Considerations, Seismic*.

Refer to *Local Agency Guidelines (LAG)* and *ODOT Delivery of Local Agency Projects (ODLAP)* for additional guidance on non-technical design content.

1.2.3.7 Additional Requirements for Major Bridges

Evaluate major bridges in the Modernization, Retrofit and Preservation design categories for additional requirements. For the purposes of this section, major bridges have one or more of the following elements:

- Delivered by Major Projects Division (or its successor).
- Use of major innovative structural design elements or construction technologies used three times or less previously in Oregon.
- Bridge components with unique structural members or operational characteristics, construction methods or requiring specific inspection procedures (including but not limited to suspension bridges, cable-stayed bridges, movable bridges, arch bridges, truss bridges, segmental bridges, extradosed bridges, bridges with in-span hinges).
- Construction estimates over $150 million.
- Tunnel carrying traffic, not including pedestrian tunnels.
- Border bridge.
- Bridge longer than 1,100 feet.

- Main span longer than 370 feet.
- River crossings with a deck greater than 10,000 square feet. Does not include forks of the rivers.
- Ancillary structures of any of the bridges that fit the above requirement.
- Bridge having a Bridge Operational Categorization of Critical Bridge per *BDM 1.17.2.1*.

Evaluate the use of the following additional requirements on major bridges. Document decisions regarding these requirements in the TS&L Report.

- Alternative Delivery (Design-Build, CMGC, etc.).
- Advanced investigation (geotechnical, seismic, hydraulics, wind, materials, etc.).
- Quality Control & Assurance Procedure (see *BDM 2.5*).
- 3D modeling (see *BDM 1.4.2*).
- Advanced ABC methods (SPMT, lateral slide, jack-up/Roll-In systems, etc.).
- Work containment, temporary structure additional cost breakdown.
- Stamped demolition plans (*00501*).
- Stamped shop drawings for complex or unique structural element.
- Maintenance Plan (e.g. details for bearing replacement, jacking, etc.).
- Inspection Access.
- Design Life (e.g. 100 year and material evaluation).
- Placement of accelerometers for seismic monitoring and post-event inspection (*BDM 1.17.6*).

1.2.4 Bridge Location and Environment

The level of effort to prevent corrosion depends mainly on the potential for exposure to a corrosive environment. Refer to the appropriate *BDM* sections for the appropriate material selection and element treatment based on the bridge location and environment as defined in the following sections.

1.2.4.1 Marine Areas

Marine areas are typically the most highly corrosive conditions and require the highest level of protection against deterioration and corrosion. For the purposes of determining when the specified corrosion protection is required a marine area is defined as any of the following:

- A location in direct contact with ocean water, salt water in a bay, or salt water in a river or stream at high tide (substructure).
- A location within ½ mile of the ocean or salt water bay where there are no barriers such as hills and forests that prevent storm winds from carrying salt spray generated by breaking waves.
- A location crossing salt water in a river or stream where there are no barriers such as hill and forests that prevent storm winds from generating breaking waves.

1.2.4.2 Coastal Areas

Coastal areas are defined as locations within 25 air miles of the Pacific Ocean, and not otherwise classified as Marine area.

1.2.4.3 Snow and Ice Areas

Snow and ice areas are defined as all areas of central and eastern Oregon, the Columbia River Gorge, Jackson County, and any other areas above 1500 feet elevation or otherwise identified by the associated maintenance district. These areas are intended to include all areas with the potential to receive periodic application of deicing chemicals.

1.2.4.4 Mild Areas

Mild areas are defined as all areas not in a marine area, coastal area, or snow and ice area. This includes all western Oregon below 1500 feet elevation that is not within 25 miles of the Pacific Ocean.

1.2.5 Structure Appearance and Aesthetics

1.2.5.1 General

Consider the structure appearance with respect to its surroundings and the context of the site.

ODOT has no general directive or mandate on aesthetics or aesthetic design.

For bridges, appearance is best when elements are few and simple.

Bridge elements are pleasing when the structural intent is clear with respect to the size and shape of the element. Elements forced into a non-structurally responsive shape for decoration are not considered aesthetically pleasing and may be a significant distraction and a safety hazard. Decorations on bridges that are not part of the structural support system may not be maintained to the same level as the structural portions of the bridge. A separate IGA can be executed for maintenance of non-structural features.

Aesthetics and environmental considerations may have apparent conflicts. Historic, ADA and environmental issues may impact the bridge rail type, structure configuration, type of foundation or bent placement. Start the permit application and coordination process for historic structures as early as possible in the design stage. Aesthetics concerns, especially within an existing documented site context, are valid issues that can and should impact resource agencies permitting considerations. Balancing historic needs and ADA requirements requires early coordination and requirements are adhered to the maximum extent feasible.

There is a misconception that improving appearance always costs more. The challenge to the engineer is to use creativity and ingenuity to improve the appearance without increasing cost. When people think that improved appearance is going to add costs, they are generally thinking in terms of add-ons, special ornamental features or special colors. The greatest aesthetic impact

can be made by the structural elements themselves. These are seen first, and at the greatest distance. The bridge can be made attractive if these major elements are well shaped, and if they fit in well with the surroundings.

The following topics are commonly known to assist in producing visually pleasing structures. They are discussed in more detail in the following sub-sections.

- Location
- and surroundings.
- Horizontal and Vertical Geometry.
- Superstructure Type and Shape.
- Bent Shape and Placement.
- End bent Shape and Placement.
- Parapet and Railing Details.
- Colors.
- Textures.
- Ornamentation.

1.2.5.2 Location and Surroundings

When determining the appearance of a bridge, the bridge must be considered in context with its surroundings. Decisions need to be made regarding what color, shape and type of bridge will look best at a given location. The surrounding area may be industrial, urban, or rural. A bridge that looks pleasing in a rural setting may look totally out of place in an urban area.

Individual bridges that span a major land area or body of water, because of their large size, dramatic location, and carrying capacity, will tend to dominate their surroundings. While these structures must harmonize with the surroundings, their importance and size requires that the aesthetic qualities of the structure stand on their own. Multiple bridges seen in succession create a cumulative aesthetic impact on the landscape that must be considered. In these situations, there is more reason for uniformity, and there should be no noticeable differences between structures, without an obvious reason. A specific theme for a particular route, such as a parkway, is often appropriate.

Routine bridges, such as highway overpasses and stream crossings, should be simple, with minimal changes, and with all the elements in clear relationship with one another. Since many of these bridges are viewed in elevation by those traveling on a roadway below, the structure type, span lengths, and proportions, as viewed in elevation, should be carefully considered.

Bridges that are infrequently viewed, such as those on lightly traveled roadways, are rarely seen by anyone. In these cases, attention to the elements that can be seen from the roadway surface such as parapets, railings, transitions, and road surface, are important.

1.2.5.3 Horizontal and Vertical Geometry

Geometric design standards often dictate the orientation of a bridge. The emphasis is on the need for safe, convenient driving and providing a more attractive highway system. Bridges must adapt to the highway alignment. Thus, they often lie within the curvature of the road and follow the slopes or curvature in elevation. Large curvature is not only desirable from a safety standpoint, but also for aesthetics.

With skewed structures, when it is necessary to orient the substructure parallel to the feature crossed, a wide bridge presents a greater visual impact. The use of natural surfaces that blend in with the surrounding environment may lessen the visual impact. Bents and end bents in waterways that lie parallel to the river's banks look better than those placed perpendicular to the crossing road.

If an alignment requires a curved bridge, then the external longitudinal lines, traffic barriers, and fascia lines of the structure should follow the curved centerline to provide a smooth visual flow. A smooth transition helps the structure fit in with the local topography. Parallel lines should be maintained by matching barrier, sidewalk, curb and fascia depth across the structure.

1.2.5.4 Superstructure Type and Shape

The appearance of a bridge is greatly influenced by different aspects of the superstructure. These include the superstructure type, depth, overhang width, number of spans, and span lengths. One way to make the structure light and slender, without making it appear weak and unsafe, is to use a favorable visible slenderness ratio (the ratio of span length to the visible structure depth, including the decking and any concrete traffic barrier or steel railing). The typical visible slenderness ratio will vary from approximately 10 to 40 depending on the type of superstructure chosen.

A girder depth that is too shallow gives the appearance that the bridge is not structurally safe. A girder that is too deep makes the bridge look bulky and overpowering. Bridges with a well-proportioned slenderness ratio denote strength without excessive materials.

An additional guideline that enhances the appearance of multiple spans is to avoid changing girder depths from one span to another. This would give a very awkward appearance and would not allow the structure to flow evenly across the bridge. From an aesthetic standpoint, deck overhang should be proportional to the girder depth; a desirable overhang would be about 2/3 the girder depth. Vertical stiffeners make steel girders seem heavier, and should be avoided on the fascia side of fascia girders. Haunched girders can make a bridge look more slender, and help demonstrate the flow of forces in the bridge. Fishbelly girders create a heavy look, and could tend to look awkward. Some structure types are more visually elegant than others, such as trapezoidal box girders and concrete segmental bridges. An arch bridge is one of the most natural bridge types, and generally considered one of the most pleasing. Both thru and deck arches can be considered.

1.2.5.5 Bent Shape and Placement

The visual impression that a person gets from a bent is primarily influenced by the proportions, the relative width and height, and the configuration of the bent cap with respect to the bent columns. Bent proportion, in turn, is determined by the bridge geometry and superstructure type and shape. Bents can broadly be classified as either short or tall. Short bents are typically more difficult to design with aesthetic proportions. Care should be taken in proportioning a bent to make sure that horizontal lines of the superstructure are not interrupted. Large bents may direct attention away from the superstructure. Bents that are too slender may convey a feeling of instability.

However, there are aesthetic issues that are common to all bent types involving the shape of the columns and the bent caps. The selection of the proper bent type can be dictated by the site, bridge geometry and design considerations.

The shape and location of the columns affect the appearance of the bents. The light reflecting from the surface often controls how the viewer perceives it. A square or rectangular column with beveled corners will appear more slender due to the edge lines and varying shades of reflected light. The designer needs to assure that the treatments used are in harmony with the rest of the structure. Bent caps, cantilevered ends, and column spacing can be designed to make the bent appear more graceful. For hammerhead bents, the stem width and height, and the cantilever length and depth should be carefully balanced, and in pleasing proportion. Solid bents can be battered to improve their appearance. The batter should be determined by the bent height and the relative dimensions at the top and bottom of the bent. Gradual lines are important. While tall bents are less common than short bents, they allow a greater opportunity for aesthetic treatment.

1.2.5.6 End Bent Shape and Placement

For most simple span bridges and some multi-span bridges, the end bents are the most visible elements. While the end bent's function is to support the superstructure and transfer loads to the ground, it is important to maintain proper proportion in order to create a good appearance. Good proportions between various elements of the bridge give character to the bridge. For the end bents it is important to consider the relationships between the exposed end bent height and length, the size and type of wingwalls, and the superstructure depth. An attempt should be made to achieve a balance between these elements.

The designer must maintain order between the lines and edges of the structure. Too many lines, or lines that are close to but not parallel to each other, can disrupt the eye and diminish the appearance of the bridge. The monotony of a large flat wingwall can be broken up using textures such as scoring, recessing, or grooving. Surface textures, either by using or simulating natural stone around the area of the bridge, can be used to integrate the structure with its surroundings.

The orientation of the end bents to the feature crossed will create different visual appearances. End bents on severe skews can have very long stems and wingwalls. Consideration should be given to the aesthetic impact of those concrete surfaces. Wingwalls are often very predominating

features. The orientation of the wingwalls allows for more or less visual impact. On divided roadways, consider the view presented from the opposite direction of travel.

1.2.5.7 Parapet and Railing Details

The railings or barriers, along with the deck fascia and fascia girders, are sometimes the most dominant visual aspect of the bridge. The railings are viewed by people traveling under the structure who see them in elevation and by people in vehicles on the bridge traveling parallel to them. When vehicle speeds are high, the railing or barrier should have simple and pronounced details because passengers cannot notice fine details. The shape of the railing or barrier system should relate to its function and the overall aesthetic design of the bridge.

The design and appearance of any fencing to be placed on the bridge should be consistent with the railing or barrier system. The vertical supports of the screening should align with the railing post spacing. Fencing on concrete barriers should be detailed to match the construction joints and the ends of the barriers.

See *BDM 1.13.3* for additional information.

1.2.5.8 Colors

When there is a reason to color the concrete, steel, or railings, a decision should be made whether the color should complement or contrast with the surrounding environment. Strong consideration should be made to the fact that colored concrete or steel will require a high level of maintenance. The designer should also consider the appearance if regular maintenance is not performed (e.g., peeling paint, rust spots, etc.).

Coloring agents are not allowed in concrete because of complicated quality control, difficulty in matching colors in each batch, and the high cost of materials. It is nearly impossible to get an identical color of concrete from one pour to the next, or over a period of time between placements. Staining concrete can create a mottled appearance when appropriate to match natural stone, and can be effective if a trial section is used to qualify the process. External coatings are allowed, and when applied correctly can achieve the desired appearance. However, they have durability limitations, and must be used with caution due to concern regarding the owner's ability to maintain the coating.

1.2.5.9 Textures

Texturing concrete can be achieved through form liners, panels, stone or brick veneer, or acid washing. Any texturing should fit in within the overall design and proportions of the structure.

Several types of commercial form liners are available. Natural stone or brick facades can also be used. Stone is most often used for parkway bridges and those in rural settings. The cost of stone covering can be quite high; and should therefore be limited to areas of high visibility and established contextual settings. When a concrete cap is used on the top of a wingwall or retaining wall, it should be visually proportioned to the wall itself.

1.2.5.10 Ornamentation

Ornamentation can be added to a bridge in special circumstances. The additional cost of add-ons is rarely justified except in cases of importance to the community (such as a gateway to a city) or of historical significance. Details such as ornamental light posts, columns or pylons, real or simulated gatehouses, commemorative plaques or reliefs may be added. The designer should consider these details carefully since it is just as easy to detract from the overall appearance of the bridge, as it is to improve it.

Such details are secondary to the primary purpose of the structure, which is to provide a safe and efficient crossing to the public. Ornamental and non-structural details require additional coordination, sketches and drawings to ensure that the details will add to the aesthetic characteristics of the structure in a way acceptable to all concerned. ADA requirements need to be reviewed carefully to ensure these items do not create protruding objects or restrictions in the clear width available to pedestrians.

Local stakeholders sometimes request ornamental screening and features on overpass structures to showcase local attractions as a gateway to their community. Ornamental protective screening should not be a distraction to drivers, and must not cause sight distance or clearance problems. Treatments must not reflect a commercial interest. See *BDM 1.13.12* for additional screening requirements.

1.2.6 Bridge Types & Selection Guidance

1.2.6.1 Bridge Types and Economics

Bridge superstructure type is generally the most important factor influencing bridge costs. Substructure cost is normally included in bridge deck area unit cost. In some situations, the substructure cost can be greater than 50 percent of the unit cost, when significant seismic design and details are required for the bridge. Each project site is unique and should be evaluated for conditions that alter the usual cost expectations. For usual cost expectation of bridge deck area unit cost, refer to Bridge Section's annual Bridge Cost Data for bridges constructed in Oregon and the FHWA website (https://www.fhwa.dot.gov/bridge/nbi/sd.cfm) for structures in other states in the national bridge inventory. Use the last three years average unit cost as a basis for comparison.

If an estimated deck area unit cost for a bridge with a typical substructure is more than 15 percent higher than the average unit cost shown in both the *Bridge Section's Cost Data* and the FHWA bridge replacement unit cost, inform the design lead and design team as soon as possible including the reasons for the higher unit cost. Re-evaluate the alternatives with the design team for their effectiveness at meeting the project's basic goals and look for innovative solutions to address the high cost.

Various types of bridge superstructure provide efficient solutions for different span arrangements. There are many reasons for choosing particular span length(s) for a bridge, some of which are discussed below. There is generally significant overlap for common span ranges, so

multiple bridge types are viable. *Table 1.2.6.1-1* shows various bridge types categorized by construction material and method of construction with the design span ranges.

Table 1.2.6.1-1 Bridge Type Span Range

Bridge Type	Span Range (feet)
Precast concrete slabs	up to 83
Precast concrete box beams	up to 120
Cast-in-place concrete slabs	up to 66
Precast integral deck concrete girder	up to 130
Precast concrete girder, BT72	up to 140
Precast concrete girder, BT84	up to 160
Precast concrete girder, BT90 & BT96	up to 183 *
Cast-in-place box girder	up to 160 **
Cast-in-place post-tensioned box girder	up to 300 **
Steel girder	40 to 400
Steel box	200 to 400**
Steel truss	greater than 300

* Length for BT90 & 96 is limited by prestressing bed capacity for Oregon precasters.

** Normally used for longer, multi-span continuous bridges

When using precast or prefabricated girders, verify that there is an acceptable route for shipping. As girder lengths increase, shipping becomes more difficult on roadways with sharp curves, high superelevation or load-restricted bridges.

Timber bridges up to 30 feet of length may be considered for special situations (See *BDM 1.8.1*). The cost of a timber bridge may be more than concrete and steel bridges of the same length.

Do not use cast-in-place concrete slabs with any span greater than 66 feet. Cast-in-place concrete slab superstructures have significant dead load deflections. Even if actual deflections match estimated deflections, it will likely take 10 to 15 years for creep deflection to diminish. For longer span lengths, the ride quality would be unacceptable while waiting for the creep deflection to occur.

Do not use voids in cast-in-place concrete slab superstructures. Although such designs are effective at reducing the structure weight and dead load deflections, it is very difficult to secure the voids in the field. The potential for failure is unacceptably high.

When cast-in-place slabs are used, ensure the edge beam requirements in *LRFD 4.6.2.1.4, 5.14.4.1* and *9.7.1.4* are met.

Where a design deviation is approved by the State Bridge Engineer for use of voids in a cast-in-place concrete slab superstructure, apply the edge beam requirements listed above to this type of bridge.

Use HPC concrete in cast-in-place concrete slab superstructures. Place concrete full-depth of the slab (i.e., no horizontal construction joints). For cast-in-place slab superstructures having any span greater than 40 feet, apply a deck sealer product (from the QPL) at least 60 days after placement of the slab.

1.2.6.1.1 Precast Concrete versus Cast-in-Place Concrete

Formwork is the key to concrete structure costs. Use of standard forms or repeated use of specially built forms means lower costs. For smaller bridges in remote areas, precast or shop-fabricated elements usually lead to the most economical solution. Also see *BDM 1.16.2, Accelerated Bridge Construction*, for more guidance in the use of precast elements.

Precast concrete slabs have the following advantages:

- Good for shorter stream crossings, low-volume roads, and remote locations.
- No falsework required in roadway or stream.
- Fast, simple installation, saving construction time.
- Shallow depth providing greater clearance to stream or roadway surfaces below.

However, they have problems with:

- Providing smooth riding surfaces. (Wearing surface is required to level up except for low-volume roads.)
- Accommodating horizontal curves, gradelines, or superelevations. (Thickness of wearing surface to accommodate superelevation can become excessive.)

Precast concrete box girders, and deck Bulb-T girders have most of the same positive and negative points as precast concrete slabs. They can accommodate longer spans, but they do have deeper depths resulting in less clearance to stream or roadway surfaces below.

In general, cast-in-place concrete spans are a good choice for:

- Accommodating horizontal curves, gradelines, or superelevations.
- Longer spans.

However, three drawbacks are:

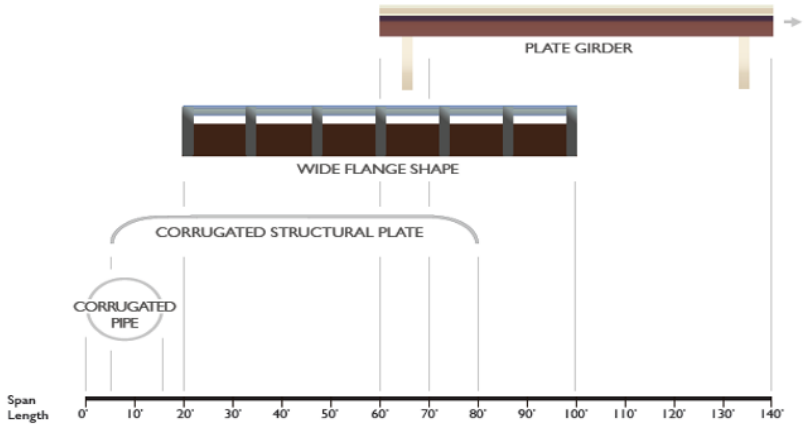
- Falsework is required.
- Falsework in the roadway below a grade crossing creates traffic hazards.
- Settlement of falsework before post-tensioning begins is a potential problem.

1.2.6.1.2 Short Span Steel Bridges

Steel provides an excellent solution for short span bridges because steel is often lighter than other materials, resulting in smaller or fewer erection cranes and smaller substructures. In addition, short span steel bridges can be fabricated off-site in a controlled environment and be ready to

erect when it reaches the bridge site. Several section options are available depending on the length of the bridge, including buried plate structures, wide flange shape/rolled beams and plate girders for span length from 20 feet to 140 feet as shown *Figure 1.2.6.1.2-1*.

Figure 1.2.6.1.2-1 Short Span Steel Bridge Alternatives



1.2.6.1.3 Composite Steel Girder Bridges

Steel construction extends the span length range and usually does not require falsework in the roadway or stream. Used for simple spans up to 260 feet and for continuous spans from 120 feet to 400 feet. This bridge type has relatively low dead load when compared to a concrete superstructure which makes it an asset in areas where foundation materials are poor. Shipping and erecting of large sections must be reviewed.

1.2.6.1.4 Bridge Widening

Generally, a type of construction that matches the existing bridge should be considered for the widened portion. It is desirable to design the widened portion to have a similar appearance to the existing. With these considerations, similar stiffness between the existing and widened structures can be achieved.

See *BDM 1.3.3.3* for structure widening loading.
See *BDM 1.5.6.2.6* and *1.5.7.11* for concrete structure widening.
See *BDM 1.6.2.18* for steel structure widening.
See *BDM 1.11.3.3* for substructure widening.
See *BDM 1.17.2.7* for seismic design requirements for bridge widening.

1.2.6.1.5 Design Criteria for Major or Unusual Bridges

Some elements of design criteria for major and unusual bridges may not be appropriate for normal bridges and may be dependent on the location and expected service level. For those bridges the design criteria will be established specifically for each bridge in a collaborative effort between ODOT Bridge Engineering Section and the Region. Early coordination is required to

allow time to establish the design criteria. See *BDM 1.2.6.3.2* for further guidance regarding unusual bridges.

1.2.6.1.6 Maintenance and Provisions for Inspection of Bridges

- Formal constructability and maintainability reviews by representatives of the Construction and Maintenance Sections are required for most bridges to determine the practicality and feasibility of erection/construction of the bridge as assumed in the design as well as adequacy for future maintenance.
- Preparation of an Inspection and Maintenance Guide for the future operation of each major or unusual bridge (see *BDM 2.10.8*).
- Consider designing for the possibility of future bearing replacement. Bearing replacement requires the use of jacks to lift the superstructure off the bearings to be replaced. Indicate the position of these jacks, and allowable jacking loads, on the drawings (per *BDM 1.3.4*). Provide distribution reinforcement to accommodate the jack loads in the top of the piers and the soffit of the superstructure. Further, consider the relocation of the reactions in the transverse analysis of the superstructure when the jacks are engaged to replace the existing bearings.
- Bridges fabricated from coated structural steel should be designed for future recoating according to *BDM 1.6.4.4.1*.

1.2.6.2 Substructure Guidance

See *Section 1.11* for information and design guidelines for end and interior bents and wingwall layout.

1.2.6.3 Special Considerations for Federal-Aid Projects

1.2.6.3.1 Alternate Designs

According to the Federal Highway Administration (FHWA), the practice of providing alternate designs for major bridges results in substantial savings in bridge construction costs. Current FHWA policy states that use of alternate designs is optional and at the discretion of State highway agencies. If alternate designs are appropriate, consider the following:

- Utilize competitive materials and structural types. Prepare each alternate design using the same design philosophy. (That is, LRFD design, finite element analysis, etc.) Ensure the design/construction requirements for the entire bridge (foundation, substructure, deck) are compatible.
- Prepare estimates for all Alternate Designs during the TS&L design phase.

Note: Do not confuse this **Alternate Designs** with the TS&L **Alternatives Study**. This Alternate Designs is the actual preparation of two or more designs, and plan sheets, to be included in the bid documents.

1.2.6.3.2 Unusual Structures

FHWA policy requires **unusual bridges** to be approved by FHWA before being designed. An u**nusual bridge** may have:

- Difficult, new or unique foundation elements or problems.
- A new or complex design concept involving unique operational or design features.
- Design procedures which depart from current acceptable practice.

Examples of unusual bridges include:

- Cable-stayed, suspension, arch, segmental concrete, moveable, or truss bridges, and other bridge types which deviate from *AASHTO Design Specifications or Guide Specifications.*
- Bridges requiring abnormal dynamic analysis for seismic design.
- Bridges designed using a three-dimensional computer analysis.
- Bridges with span lengths exceeding 500 feet.
- Bridges with major supporting elements of ultra-high strength concrete or steel.

Other unusual structures include:

- Tunnels.
- Geotechnical structures featuring new or complex wall systems or ground improvement systems.
- Hydraulic structures that involve complex stream stability countermeasures.
- Designs or design techniques that are atypical or unique.

Where unusual bridges are identified, seek FHWA involvement at Project Initiation. Do not advance the design beyond TS&L without FHWA approval.

1.2.6.3.3 Experimental Features Program

An experimental feature is a material, process, method, or equipment item that:

- Has not been sufficiently tested under actual service conditions to be accepted without reservation in normal highway construction, or
- Has been accepted, but needs to be compared with acceptable alternatives for determining relative merits and cost effectiveness.

Although the Experimental Features Program is normally used in conjunction with Federal-Aid projects, the program format has occasionally been followed for projects funded entirely with State funds. In some cases, FHWA has paid part of the research cost for basically a State-funded experimental program.

The intent of the Federal-Aid Experimental Features Program is to allow ODOT time to develop, test, and evaluate specifications for new, innovative, or untried products or processes.

1.2.6.3.4 Specifying Proprietary Items

To encourage competitive prices from manufacturers and suppliers, FHWA has established a policy for specifying proprietary products or processes for Federal-Aid projects. Generally, **proprietary** means:

- Calling out a product on plans or in specifications by brand name.
- Using specifications written around a specific product in such a way as to exclude similar products.

The policy basically says:

- You must use two, preferably three, products when specifying by name brand.
- You can use generic specifications patterned after a specific item if at least two manufacturers can supply the item.

On the other hand, specifying one proprietary item is allowed only:

- If it qualifies for the experimental features program.
- If, with written justification from ODOT, FHWA specifically approves in advance a single product, which is essential because of compatibility with an existing system, or the only suitable product that exists.

1.2.6.3.5 Use of Debris from Demolished Bridges and Overpasses

Public Law 109-59 Section 1805, dated August 10, 2005, mandates that for Federal-Aid bridge replacement and rehabilitation projects, States are **directed to first make the debris from the bridge demolition available for beneficial use by the Federal, State or local government, unless such use obstructs navigation.** Links are provided for more information:

- Public Law 109-59 August 10, 2005.
- FHWA Memorandum of March 7, 2006.

Environmental regulations may prohibit the use of debris in waterways.

1.2.6.4 Use of Salvage Materials

ODOT Bridge Engineering Section does not prefer the use of used bridge items. Use new materials for new bridges, replacement bridges, and for added portions of widened bridges. Incorporation of used materials requires an approved design deviation (see *BDM 1.2.2*). Include the following issues in a design deviation request:

- Locate and include in the project records for the new bridge all original material certifications and documentation of material properties.
- Document the condition of the used materials.
- Locate and include a copy of applicable portions of the original calculation book in the project records for the new bridge. The copied portions may be scanned and transmitted electronically to the design engineer. Hard copies should be made and included in the calculation book for the new bridge.

- Prepare a new calculation book for the new bridge.
- Document agreement from FHWA (on Federal projects) with a Public Interest Finding processed through Roadway Section.
- Designate on the new plans the portions of the new bridge that are built with salvaged materials.

1.2.7 Bridge Layout

At the start of the Preliminary Design Phase, after collecting and reviewing available project data, start identifying site constraints that will impact or affect the bridge layout. Suggested items to discuss with respective project team members (list may not include all applicable items):

- Right of way.
- Geology; poor soils.
- Known buried hazardous materials.
- Waterway; thalwag, potential scour areas.
- Floodplains.
- Riparian zones.
- Wetlands.
- Historic resources.
- Archeological sites.
- Buildings.
- Parks.
- Air space envelope.
- Fluvial envelope.
- Railroad envelope.
- ADA improvements.

Consider these items early in the bridge layout process. Learning of these constraints later may cause rework that can affect both schedule and budget.

1.2.7.1 Spans and Proportions

1.2.7.1.1 Column Locations

Column locations, which of course affect span lengths, are subject to clearance requirements of *BDM 2.14.4.2, AASHTO* standard clearances, and hydraulic considerations. After these conditions are met, spans lengths may also be governed by environmental issues, economics and aesthetics. Consider alternate structure types to best fit the needs of the site.

Consider the effects of columns in waterways when locating columns and setting span configurations. Consider the possibility for scour or difficulty in inspecting a column that is in the highest flow area of a river. Avoid placing the column directly in the middle of the river.

Protect columns located in the median of a divided highway and within the clear zone (as determined by the roadway designer), from traffic by a guardrail or concrete barrier. Check with

the roadway designer regarding which barrier will be used. It will affect the bridge's appearance and may influence the type of column selected. Design according to *BDM 1.3.5*.

1.2.7.1.2 Structure Depth

Structure depth including deck (also referred to as superstructure depth) is generally controlled by span length and clearance limitations. Although a minimum depth structure may be aesthetically appealing, it may not be the optimal solution for the site.

For steel superstructures, use the minimum depth recommended in *LRFD Table 2.5.2.6.3-1* for estimating purposes. Girder depths for haunched girders made continuous may be reduced up to 20 percent. For haunched girder, use minimum depth of L/40 at center of span and L/20 at intermediate bent.

For concrete superstructures with continuous spans, use the minimum depths given in *Table 1.2.7.1.2-1*.

Table 1.2.7.1.2-1 Minimum Superstructure Depth for Concrete Superstructures with Continuous Spans

Reinforced Concrete Superstructures:	**Minimum Depth:**
Balanced 3-span cast-in-place slabs with main reinforcement parallel to traffic	d = 0.542 + L/48
T-Beams	d = L/19
Box Girders, constant depth	d = L/21
Post Tensioned Box Girders:	**Minimum Depth:**
Continuous, uniform depth	d = L/29
Precast Prestressed Concrete Superstructures:	**Minimum Depth:**
Slabs and Boxes	d = L/40
Deck Bulb-T Girders	d = L/33
Bulb-I and Bulb-T girders	d = L/25

Table notes:

d = depth of constant depth members or depth at midspan of haunched member

L = span length between centerlines of bearings for a simple span bridge or longest span between centerlines of bents for a continuous span bridge

Increase depths given in *Table 1.2.7.1.2-1* for simple span bridges by 10 percent.

Depths shown are for constant-depth sections. Depth at midspan of haunched members may be reduced 15 percent for beams with continuous parabolic haunches or with straight haunches equal to ¼ the span where the total depth at the haunch is 1.5d.

Where minimum depth requirements, given above, are satisfied, the optional live load deflection criteria in *LRFD 2.5.2.6.2* will not be required. When minimum depth requirements are not satisfied, verify that the live load deflection does not exceed the limits recommended in *LRFD 2.5.2.6.2*.

When both minimum depth and live load deflection requirements are not satisfied, submit a request for a design deviation (see *BDM 1.2.2*). As justification for the request, document girder and deck service stress levels, live load deflection, and provide evidence of similar structures already in service with satisfactory performance.

1.2.7.1.3 Girder Spacing

Girder spacing is normally dependent on girder capacity. As span length increases, girder spacing should decrease. Limit deck overhangs to no more than one-half the girder spacing. Long deck overhangs tend to sag over time (even decks post-tensioned transversely).

1.2.7.2 Bridge Length

Determine the bridge length by referring to the following, as applicable:

- *BDM 1.11.2.1*, *Determining Bridge Length.*
- Bridge Standard Drawing *BR115*, *Standard Slope Paving.*
- *BDM 2.14.7.2*, *Hydraulic Requirements for Stream Crossings.*
- *BDM 2.14.11.3*, *Railroad Clearances.*
- *BDM 2.14.8*, (Wildlife passage requirements that may add structure length).
- The remainder of *BDM 1.2.7.2*.

1.2.7.2.1 Width and Cross Section of Lower Roadway

For horizontal clearances, see *BDM 2.14.4.2*. Choose the back-slopes as follows:

- Use 2:1 end fill slopes for all bridges unless the geotechnical designer recommends otherwise.
- 1.5:1 end fill slopes are common for county roads and less-traveled highways. Review the *ODOT Highway Design Manual Figure 300-22, Standard Sections for Highways Other Than Freeways*, but do not use a slope steeper than 2:1 unless a steeper slope is recommended in the *Geotechnical Report*.

1.2.7.2.2 Stock Paths at Stream Crossings

Provisions for stock to cross the roadway should be located away from the bridge crossing to reduce concentration of pollutants in the stream. However, if a stock path running under the bridge parallel to the stream is required, additional bridge length will be needed to accommodate:

- Sufficient horizontal space and vertical clearance to construct a benched section for a path above ordinary high water.
- A fence to keep stock out of the stream.

Stock passes are also discussed in the *ODOT Highway Design Manual*.

1.2.7.3 Substructure Guidance

Read the *Geotechnical Report* for information and recommendations about type of foundation required, or talk to the geotechnical designer when the *Geotechnical Report* is not yet available. For stream crossings, recommendations for scour and riprap protection are contained in the *Hydraulics Report*.

1.2.8 Bridge Security Design Considerations

1.2.8.1 Bridge Security Design Considerations

Consider project-specific countermeasures during the Scoping Phase for those structures which ODOT management determines need specific attention.

Potential bridge security threats include: **carried and placed** bombs, vehicle bombs, intentional vehicle or ship collisions, intentional fires, and other intentional and unintentional threatening activities. This section tells when and how to consider potential bridge security threats during the design of:

- New bridges.
- Bridge widenings.
- Bridge rehabilitation projects.

1.2.8.1.1 Countermeasures

Four countermeasures can help protect structures against potential security threats:

- Deter: Prevent an aggressor from attacking the structure by making the security presence known such as police or other authorized personnel.
- Deny: Prevent an aggressor from entering an unauthorized zone by a physical barrier such as security fencing, secure hatches or locked doors.
- Detect: Observe unauthorized personnel in a restricted area by means such as cameras or sensors.
- Defend: Provide **hardening** measures to protect a component from attack.

1.2.8.1.2 Process

Assess the probable structure specific security risks:

- Remote.
- Possible.
- High.
- Critical.

Remote: Only applies to structures on remote, low volume AADT facilities. Implementation of security countermeasures normally not warranted.

Possible: Applies to structures on the non-freeway State Highway System. Consider implementing security countermeasures associated with Deterring and Denying access to the structure. Ideas to consider include:

- Locate box girder soffit access openings away from abutments, requiring a ladder or other mechanical means to gain access.
- Provide shielded locking mechanisms on all access openings.
- Place secure screens at soffit vents near abutments.

- Prevent access to maintenance walkways and girder flanges at abutments.
- Post warning signs on the bridge approaches and below the structure.
- Deny access to critical structural components.
- Prevent vandalism, graffiti artists, or camping.

High: Applies to structures on the Interstate Highway System. Consider implementing security countermeasures associated with Deterring, Denying, Detecting, and Defending the structure. In addition to the items listed under **Possible**, include the following:

- Establish guidelines for standoff distance
- Eliminate access to small confined spaces

Critical Structures: These are structures that have been determined to be the most vulnerable structures in the State of Oregon.

Some bridges, due to their complex and unique nature, will require project-specific countermeasures along with those countermeasures that apply to all structures. These are bridges considered **critical** to the transportation network. The most critical bridges will also require site-specific operational security plans. The ODOT Emergency Preparedness Committee identified critical bridges and their potential vulnerabilities. To find out more, contact the Statewide Emergency Operations Manager in the ODOT Office of Maintenance and Operations.

Consider the need for security countermeasures during the Scoping Phase to ensure that added costs are included in the project budget. Define countermeasures and security plans and include in the TS&L Report. The bridge designer is to consult with the Bridge Operations Engineer for security guidance and to maintain consistency statewide.

If the Bridge Operations Engineer decides a critical bridge needs specific mitigation measures, consider these strategies first:

- Locate piers and towers so vehicular access is prevented.
- Design redundancy with critical elements.
- Place barriers to provide standoff distance when critical structural elements cannot be located away from vehicular traffic. If this cannot be achieved, the critical structural member or mechanical system should be analyzed and hardened against the design threat.
- Install locks, caging, and fencing to deny access to key points of vulnerable structural and mechanical systems.
- Install motion detectors or security cameras, and plan for communications to security response entities, to minimize **time-on-target**.

When cost-effective, consider selective protection of the structural integrity of key members against collapse. Ways to do this include strengthening key substructure members, adding redundancy, and use of blast hardening.

Again, consider project-specific countermeasures during the Scoping Phase for those structures which ODOT management determines need specific attention.

1.2.8.2 Placing Buildings Beneath ODOT Bridges

The placement of buildings beneath ODOT bridges is strongly discouraged. However, if local public agencies request and are given approval to place buildings below ODOT bridges, satisfy the following requirements:

- Maintain the structural integrity of the bridge:
  - Shore excavations that extend below the bottom of bridge footings adjacent to the proposed building according to Standard Specifications *SP 00510.44*.
  - Replace any soil removed within the vicinity of a bridge footing and compact according to Standard Specifications *SP 00510.46(a)*.
- Bridge maintenance provisions:
  - Provide 10 feet of vertical clearance between roof and superstructure for operation of snooper cranes, or for hanging scaffolds; or
  - Design the building's roof system to act as a work platform for maintenance or construction activities. Provide 3 feet minimum vertical clearance between roof and superstructure. Design the roof sheathing and purlins for a working load of 250 pound point load or 100 psf, whichever controls. Extend the design area 10 feet beyond the shadow of the structure. Design members below the purlin level for a working load of 50 psf over an area of 10' x 20'.
- Future seismic retrofit provisions:
  - Place the building to allow for increasing the size of the existing footing or footings by 50 percent plus an allowance of 5 feet for work area.
  - Make the building owners aware that future footing excavations or pile driving could cause vibrations in the building with a potential for damage to the building or contents. And that the State will not be responsible for any damage to the building or contents caused by such construction.
- Future bridge replacement or widening provisions:
  - Evaluate the need for a new bridge or future widening of the bridge. If the potential exists, allow for increasing the bridge width and construction of new footings. Allow 5 feet around the future footings for work area.
  - Make the building owners aware that future footing excavations or pile driving could cause vibrations in their building with a potential for damage to the building or contents. And that the State will not be responsible for any damage to the building or contents caused by such construction.
- Falling object protection:
  - Place protective fencing on the bridge above the building to cover the limits of any ground activity below the bridge.
  - Make the building owners aware that the State will not be responsible for any damage to the building or content caused by falling objects.
- Bridge fire protection:

    - The building shall be constructed of non-flammable materials and be equipped with an automatic sprinkler system.
    - The building shall not be used to store large quantities of flammable materials.
- Right of Access:
    - ODOT and or contractor employees shall be given access to the property and building as needed to perform any construction or maintenance activities.

Submit proposals to the District Manager and the Bridge Operations Engineer for review and approval. Include a drawing or drawings showing the existing bridge with all pertinent members dimensioned, and showing the proposed building with all pertinent dimensions, clearances, materials and roof design loads. The drawing or drawings shall be prepared, signed, and stamped with a seal of an engineer registered to practice in the State of Oregon.

1.2.9 Bridge Name Plates & Markers

1.2.9.1 Bridge and Structure ID Markers

C1.2.9.1

Specify bridge identification (ID) markers according to *BR195* on all bridges, and culverts defined as a bridge per *BDM 1.12.1*.

Bridge ID markers are optional for local agency projects.

Coordinate with the Hydraulics Engineer to determine if a culvert field mark is appropriate in lieu of a bridge ID marker.

Specify bridge ID markers on all new bridges, widening projects and when existing markers will be impacted by the project. Replace existing bridge ID markers in poor condition or when the phone number on the bridge ID marker is out of date.

All bridges should have current bridge ID markers as part of a project.

Include bridge identification markers in the bid schedule of items for contractor installation.

When the Region has an arrangement with District Maintenance, installation by Agency staff is acceptable.

Show bridge ID marker placement locations in the contract plans, typically on the Deck Plan using *Detail Reference Number 80.* See *SP 00842* for mounting instructions.

Bridge ID markers are not part of the project signing and should not be shown in the sign plans.

Place bridge ID markers in the bridge rail transition at both ends of the bridge regardless of the direction of traffic. Place ID markers facing on-coming traffic, per *SP 00842*. When the structure is located over another public roadway, place additional bridge identification markers on the face of the bridge bent, immediately adjacent to and on both sides of the under-crossing roadway, facing on-coming traffic. When the structure is located over another public roadway and the bridge bents are not accessible or visible, place additional bridge ID markers on a delineator immediately adjacent to and on both sides of the under-crossing roadway, facing on-coming traffic.

Configure each bridge ID marker in accordance with *Table 1.2.9.1*. Show this information in a table, or on a sign image, in the bridge plans. Add the structure alias to the "alias" tab in BDS.

BR195 shows dimensions, text, colors and other requirements of the marker for inclusion in the contract plans.

Table 1.2.9.1-1 Bridge ID Marker Legend

Bridge ID Marker Element	**Explanation**
Telephone number of the appropriate agency Dispatch Center:	For state owned bridges, find telephone numbers for the appropriate TOC dispatch here. Dispatch center boundaries may not correspond to Region boundaries. Consultants contact the Agency Bridge Reviewer (ABR) for the correct contact number.
US or OR Route Number:	e.g. I-5, US97, OR42
State Highway Number:	e.g. 001, 004, 0025
Milepoint Number:	
Bridge Number:	
Structure Alias:	Provide one of the following, listed in order of preference: • The commemorative, historic, local, or interchange name as noted in parentheses of the structure name (e.g. Wilson R_Hwy 37_MP 5.78 (Mills) alias for the ID marker would be Wilson River (Mills)). • The alias on the existing Bridge ID marker. • Consult with District Bridge Crew to generate a common local structure alias. Do not restate information in the Structure Alias that is already on the ID marker (e.g. MP #, Hwy #). Limit Structure Alias to three rows and 10 characters per row. Use the maximum letter height unless the length of the alias does not fit. Do not reduce letters below ¾ inch in height.

1.2.10 Accessibility

1.2.10.1 Accessibility Standards

Use the *2010 ADA Standards for Accessible Design* for the design of all Federal-Aid projects.

Design pedestrian overpass and underpass ramps according to *HDM 810.9.22*. Design pedestrian railings per *AASHTO 13.8.1*. Design other features, such as handrails and stairs, to comply with the *Oregon Structural Specialty Code.* Review the roadway series standard drawings for handrailing and stair requirements.

C1.2.10.1

Refer to *BDM 1.15.5* for inspection and maintenance accessibility requirements.

1.2.10.2 ADA Compliance for Bridge Work

The *Americans with Disabilities Act of 1990 (ADA)* prohibits discrimination and ensures equal opportunity for persons with disabilities in employment, state and local government services, public accommodations, commercial facilities, and transportation. Government entities must make services accessible and usable to all people, including people with disabilities. Implementation guidelines, standards, and court decisions provide guidance on how to comply with the law.

C1.2.10.2

Guidance documents are applied to transportation construction and maintenance decisions, but there is limited guidance about specific work activities on bridges. This document provides guidance on the ADA application to the unique situations created by bridge retrofit, preservation and maintenance projects.

There is also information provided in *HDM 110.2.2* and *800*.

1.2.10.2.1 General Guidance

Ensure that a bridge infrastructure is accessible and usable, including bridge sidewalk facilities when provided. Address ADA requirements on bridge projects that alter access or usability of a pedestrian route.

C1.2.10.2.1

ADA requirements are addressed in several ways:

- Through the ODOT ADA Title II Transition Plan, all pedestrian facilities are brought into compliance over time.

- Specific work triggers a requirement to bring certain facilities into compliance at the same time as the work is performed. Examples of specific work that triggers accessibility improvements include when a new bridge is constructed, when a new sidewalk is added to a bridge, or when the level of work on a bridge is considered to be an alteration, see *BDM 1.2.10.2.2*.

Review the ODOT CQCR asset layer for ADA upgrades to be incorporated into the project as a result of a citizen complaint.

For more information about the CQCR process refer the *Highway Design Manual, Part 800*.

DETERMINING PEDESTRIAN ROUTES

An existing bridge is considered to have a sidewalk for pedestrian passage when the clear width is at least 32 inches and is intended for pedestrian use. For purposes of this section, clear width includes the curb width where sidewalk is constructed monolithically with the curb (common practice on bridges). When there is a joint to cast the curb separately from the sidewalk, the curb width is not included in sidewalk width.

C DETERMINING PED. ROUTES

Below is guidance on the implications of ADA based on sidewalk width. For additional information see *HDM 815.3.8*.

Clear width < 32 inches:

- Designation: Bridge safety curb.
- Implications: ADA requirements do not apply.

Measured clear width ≥ 32 inches:

- Designation: Sidewalk
- Implications: Triggers ADA upgrades per *BDM 1.2.10.2.1*

32 in. ≤ Measured clear width ≤ 48 in.:

- Designation: Sidewalk
- Implications: Roadway Design exception is required for clear width if no curb ramp work is required.

48 in. < Design clear width ≤ 54 in.:

- Designation: Sidewalk
- Implications: Roadway Design exception is required for clear width if curb ramp work is required.

ALTERING ACCESS OR USABILITY OF A PEDESTRIAN ACCESS ROUTE

Upgrade all affected facilities when altering access or usability of a pedestrian route. Address accessibility requirements.

Alterations that result in below standard pedestrian facilities (including existing conditions) require an ADA design exception.

It is the responsibility of the roadway designer to prepare the ADA design exception.

Do not modify a project's scope of work or activities for the purpose of avoiding triggering accessibility upgrades. Likewise, a project is not required to expand the original project limits to meet ADA requirements.

Below are specific requirements for upgrading facilities when alterations are made. See the next section for what qualifies as "alterations."

- When alterations (see *BDM 1.2.10.2.2*) affect access to a bridge sidewalk, ensure that the sidewalk can be accessed from the approaching shoulder or sidewalk utilizing a curb ramp design. Construct ADA ramps to provide access to the walkway when they are in "poor" or "missing" condition in the *FACS-STIP* asset layer.
- When alterations (see *BDM 1.2.10.2.2*) affect the usability of the bridge sidewalk, ensure that the sidewalk is

C ALTERING ACCESS OR USABILITY OF A PEDESTRIAN ACCESS ROUTE

Alterations are common as part of a deck overhang or sidewalk widening project. Refer to the *HDM 110.2.2* for more information on requirements and examples of commonly encountered ADA curb ramp triggers at bridges.

Review *HDM 110.2.*, for determining curb ramps triggered with paving overlays and *BDM 1.2.10.2* for ADA compliance. Refer to ODOT operational notice *MG100-107 (Appendix H of HDM)* for what is determined to be maintenance activities versus an alteration that would require curb ramps to be reconstructed.

Refer to the *HDM 810.7.2* and *815815.3.8* for geometric guidance on walkways at bridge approaches and curb ramp design.

readily accessible to people with disabilities to the maximum extent feasible.	Explore alternatives to improve the level of accessibility of an existing sidewalk when it is below ODOT standards. See *HDM 810.5* for additional information.
• When alterations (see *BDM 1.2.10.2.2*) affect the usability of the bridge sidewalk, and the sidewalk width is below 5 feet, provide a 5 foot by 5 foot passing space every 200 feet along the sidewalk. • When alterations (see *BDM 1.2.10.2.2*) affect the usability of the bridge sidewalk, address accessibility barriers which include narrow passages, obstructions or routes lacking sufficient passing space to the maximum extent feasible. • When a sidewalk is not present, treat the existing shoulder as a pedestrian route when determining the impact of alterations. Ensure passage along shoulder is not degraded.	
In addition, below are specific requirements for upgrading facilities when alterations are made by a Bridge Maintenance category project:	These requirements are to align with the objectives of the MBM program: to keep structures in service by addressing localized deterioration. See TSB22-01(B).
• ADA improvements beyond 25 percent of the original MBM project budget must receive funding outside of MBM to be addressed.	This relieves the undue financial burden and allows MBM to continue to meet the obligation to perform the program duties. See *HDM 1004.4.2* and Statewide Code Interpretations of the Disproportionate Cost Limitation.
• Avoid degrading the effectiveness of existing roadside safety devices, bicycle or pedestrian facilities. Design deviations are not required to document substandard devices if they are not negatively altered during the project.	Documented in *TSB22-01(B) 1* under the Do No Harm premise.

- When the resulting algebraic difference is not greater than 11 percent at ADA ramps, an upgrade is not required.

In these cases, the curb ramp is considered usable.

1.2.10.2.2 Work Activity Triggers

The work types listed below are not considered **alterations** and are considered maintenance activities. These work types do not result in changes to usability of the pedestrian facility. The list is not exhaustive.

- Any of the following that do not overlap the pedestrian facility (sidewalk, shoulder, and crosswalk): structural deck overlays, thin bonded polymer system overlays, ACP overlays, deck seals, expansion joint repair or replacement.
- Deck repair patching, repair of deck soffit, full depth deck repair when these activities do not span the length of the bridge.
- Under deck superstructure repair.
- Repair of sidewalk soffit, repair of longitudinal sidewalk beams, repair of cantilevered sidewalk supports.
- Bridge painting.
- Cathodic protection.
- Repair in-kind of existing bridge rails.
- Concrete patching of superstructure elements, prestressed components, concrete surface finishing.
- Bonded structural strengthening (FRP, titanium, other metals, surface or near-surface), resin injection of concrete cracks.
- Seismic retrofits.
- Expansion joint repair or replacement (that do not affect a pedestrian facility).
- Bearing device cleaning and lubrication.
- Substructure or foundation repair.

C1.2.10.2.2

The US DOJ/FHWA memorandum defines an **alteration** as: A change that affects or could affect the usability of all or part of a building or facility. Alterations of streets, roads, or highways include activities such as reconstruction, rehabilitation, resurfacing, widening, and projects of similar scale and effect. Activities defined as maintenance by the US DOJ/FHWA on streets, roads, or highways, such as filling potholes, are not alterations.

Examples of alterations of bridges include rail retrofit, widening, bridge deck concrete overlays, and asphalt concrete overlays when part of a full width paving project that extends beyond the bridge.

Evaluate activities not listed above based on their impact to the usability of the pedestrian facility; activities that affect the usability are considered **alterations**.

Consult the Senior ADA Standard Engineer for assistance in determining alteration activities.

The following are also maintenance activities, but the pedestrian facility is being altered with a limited scope or incremental improvement. The repair work needs to meet ADA requirements to the maximum extent feasible.
This includes but is not limited to:

- Spot sidewalk repair.
- Expansion joint repair or replacement that affect a pedestrian facility.
- Deck drainage improvements.

Review *HDM 110.2.2* for surface alterations that trigger curb ramp reconstruction.

(1) EXISTING BRIDGES & SAFETY CURBS

Do not reduce existing pedestrian facilities width below current standards. Existing bridges may support pedestrian passage, either by providing a sidewalk or by providing adequate shoulder width.

C (1) EXISTING BRIDGES & SAFETY CURBS

Existing bridges that have **safety curbs** do not have sidewalks. The clear width of the horizontal surface of a **safety curb** is less than 32 inches.

Provide an ADA ramp for accessing a safety curb only when an existing pedestrian facility is connected to the bridge.

Safety curbs are features with similar appearance as sidewalks but are provided as part of a bridge rail system and are not intended to provide passage for pedestrians. Some pedestrians may still be able to traverse them.

A safety curb was previously called a brush curb.

Figure 1.2.10.2.2-1 Existing Bridge Rail, Section with Safety Curb

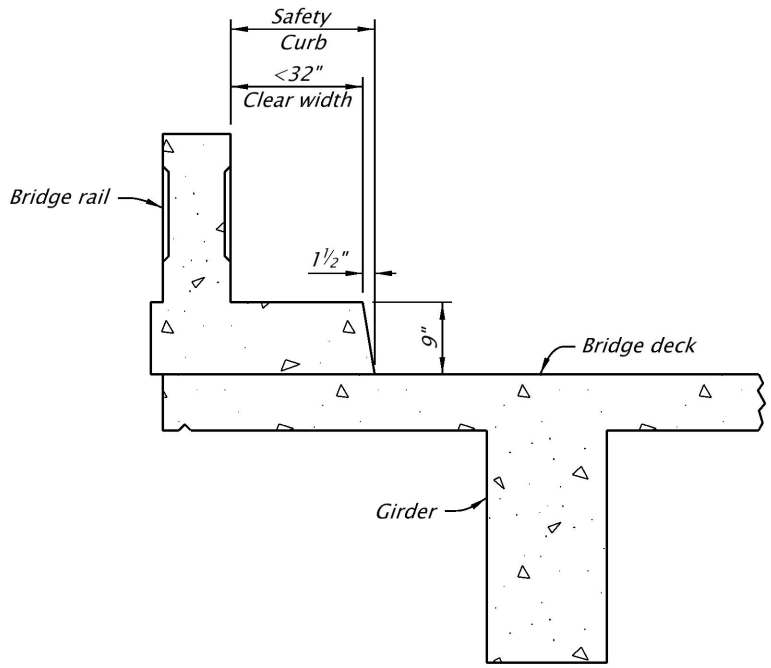


Figure 1.2.10.2.2-2 Existing Bridge, Section with Sidewalk

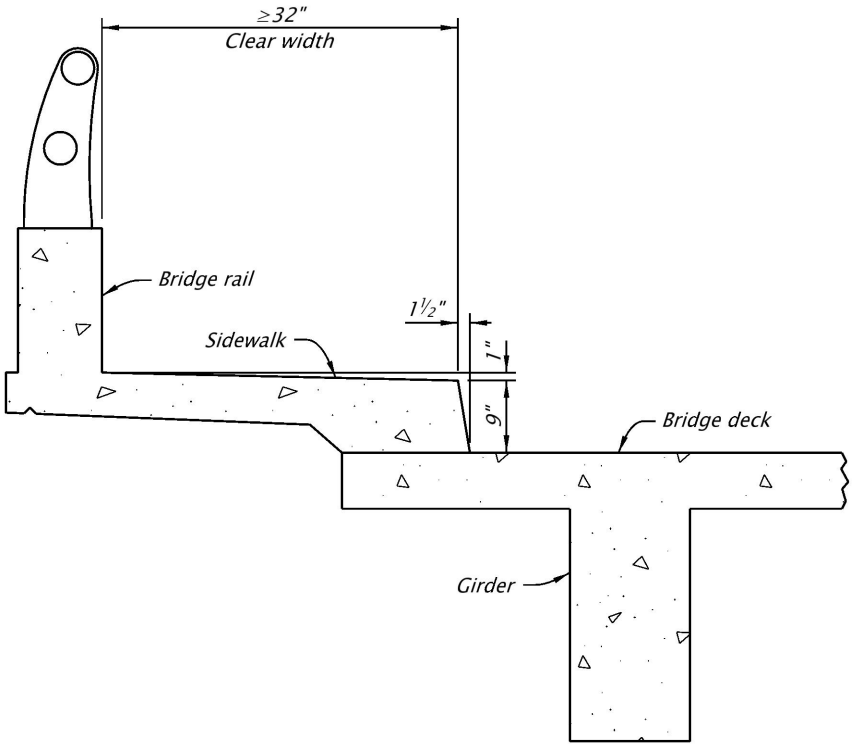
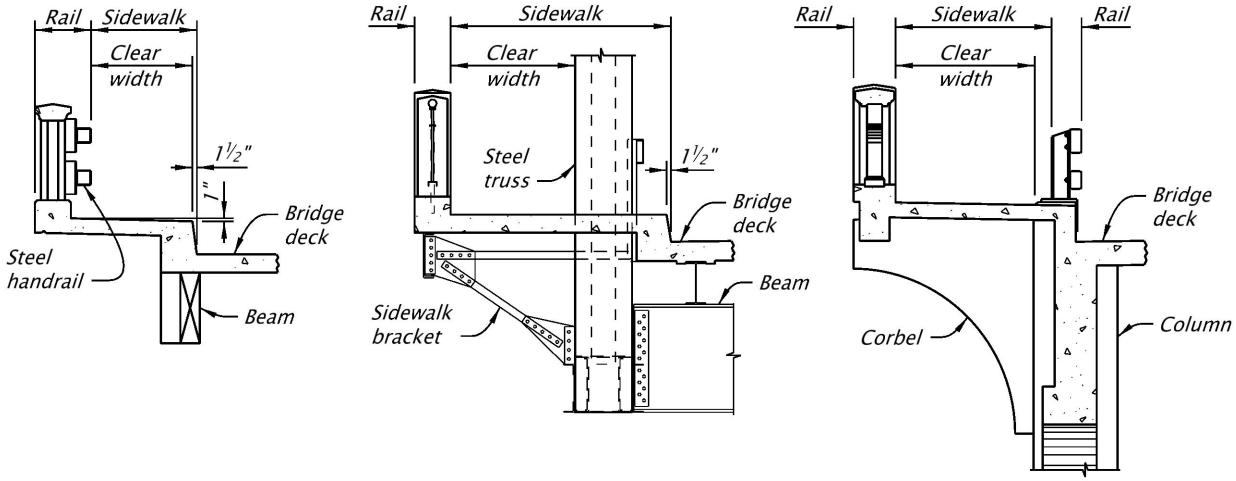


Figure 1.2.10.2.2-3 Existing Bridge, Clear Width Examples



Document the feasibility of upgrades or reasonable upgrades/options considered. Document the rationale (i.e., the justification) for why the upgrade(s) or option(s) was (were) not feasible.

When upgrades are required due to alterations, the feasibility of upgrades depends on numerous factors including but not limited to the following:

- Structural capacity of the bridge to accept additional dead load and pedestrian load. Perform load rating to determine when the main structural system has additional capacity to support the upgrade.
- Additional strengthening required to support the proposed upgrade. Determine when the project may include girder strengthening.
- Structural system.
    - Thickness and reinforcement of existing concrete cantilevered sidewalks (when the existing sidewalk is thin and lightly reinforced, strengthening of the existing sidewalk might not be feasible, for example).
    - Spacing and configuration of sidewalk brackets and edge beams supporting a sidewalk.
    - Bridge deck thickness.
    - Girder spacing (may limit reasonable widening).
    - Presence of truss or arch members above deck.
- Interaction of the proposed upgrade with future program work such as rail retrofit or bridge deck widening (when a major rail or widening project is planned or needed, it may be most reasonable to improve accessibility at the same time).
- Historic preservation needs (some accessibility modifications may impact the significance of historic

features of the bridge, while others may be acceptable due to limited scope of impacts or reversibility). See *BDM 1.2.10.2.3* for historic bridges.

- Roadway geometrics or roadway cross section. Roadway geometrics and cross section elements that can be reconfigured to increase accessibility of the pedestrian access route or sidewalk on one or both sides of the bridge need to be evaluated.

(2) RAIL RETROFIT OR REPLACEMENT

Upgrade existing pedestrian facilities when replacing existing bridge rail. Upgrade existing pedestrian facilities when access or usability is affected when retrofitting an existing bridge rail. Do not decrease the width of an existing sidewalk for installation of bridge rail retrofit or bridge rail transitions at bridge ends.

C RAIL RETROFIT OR REPLACEMENT

Review the *Highway Design Manual* for applicable standards. Coordinate with Traffic and Roadway.

(3) INTERSECTIONS ON BRIDGE STRUCTURES

When a bridge alteration project includes an intersection, provide or upgrade curb ramps at the affected intersection. Coordinate with the roadway designer in preparing curb ramp details for construction. Review for constructability by both disciplines.

C INTERSECTIONS ON BRIDGE STRUCTURES

Without cross discipline review and coordination, the curb ramp is at high risk for construction failure and non-acceptance. Refer to *HDM 815.3.8* or *HDM 110.2.2* for general guidance. ReviewReview the *Highway Design Manual* for applicable standards for curb ramp design.

(4) TEMPORARY TRAFFIC CONTROL AND WORK ZONES

For construction or maintenance work, provide a temporary accessible route with a level of accessibility equal to or better than the existing pedestrian facility. Do not create new barriers to pedestrian accessibility with a Temporary Pedestrian Accessible Route (TPAR).

C TEMPORARY TRAFFIC CONTROL AND WORK ZONES

For TPAR guidance see TPAR Overview and TCP Design Manual Chapter 3.4.5 or consult the State Traffic Work Zone Engineer.

For example, when an existing shoulder across a structure is four feet wide, provide a four foot temporary pedestrian access route for pedestrian traffic.

1.2.10.2.3 Design Considerations

HISTORIC BRIDGES

For bridges that are considered a historic resource, where accessibility modifications impact the significance of historic features of the bridge, consult with the Region Environmental Coordinator and the Historic Resource Coordinator to ensure the State Historic Preservation Office (SHPO) comments are addressed.

When there is a conflict between federal historic preservation requirements and accessibility requirements, a Design Exception is required to validate and justify any deviation from meeting the accessibility standards. Include in the Design Exceptiona letter from SHPO declaring that an adverse effect would be caused by meeting the full requirements of the ADA. Ensure the letter describes whether alternative designs or incremental ADA improvements would create adverse effects. Consider and document mitigations that will be used to minimize the impact to pedestrians with disabilities. Mitigating options might be posted minimum widths or possible accessible detours.

C 1.2.10.2.3

C HISTORIC BRIDGES

Where upgrading accessibility would conflict with federal law regarding historic preservation, neither law supersedes the other.