Chapter Thirty-six

BRIDGE/STRUCTURE DESIGN

BUREAU OF LOCAL ROADS AND STREETS MANUAL

Chapter Thirty-six
BRIDGE/STRUCTURE DESIGN

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36-1 GENERAL

36-1.01 Scope of Work Definitions

The scope of work for a bridge project may be any of the following:

1. Bridge Replacement. Replacement of the entire existing bridge (i.e., superstructure, substructure, and foundation).

2. Bridge Reconstruction. Replacement of all or most of an existing bridge with the same type, size, and location (i.e., same substructure locations, span lengths, and bridge width). The foundation may or may not be reused.

3. Existing Bridge to Remain in Place. If an existing bridge is structurally sound, meets the design loading capacity and the minimum width criteria for a structure to remain in place, and it is not a high-accident location, it is likely not cost effective to improve the geometrics of the bridge. When these conditions are met, an existing bridge can remain in place. In some cases, only the bridge substructure (e.g., abutments, piers) and/or foundation (e.g., footings, piles) may require rehabilitative work. These may also be considered existing bridges to remain in place for the application of geometric design criteria.

4. Bridge Rehabilitation. Major work on one or more of the components of an existing bridge (i.e., superstructure, substructure, and/or foundation).

5. Bridge Deck Rehabilitation. If the existing bridge deck is structurally deficient, it may be rehabilitated as part of a project. In addition, where the bridge deck is structurally sound but the width is inadequate (i.e., the bridge is functionally obsolete), the bridge deck may be rehabilitated solely to widen the bridge deck. Bridge deck widening may then require work to the superstructure and/or substructure.

6. Bridge Deck Repair. The existing bridge deck is structurally adequate and the width is adequate to remain in place, but partial and full-depth repairs are required and an overlay may be necessary to improve rideability and to maintain the integrity of the deck.

7. Bridge Rails/Transitions. For reconstructed bridges or rehabilitated bridge decks, the existing bridge rails and/or approaching guardrail-to-bridge-rail transitions may need upgrading to meet current IDOT criteria. For existing bridges to remain in place within the project limits, the local agency, Central BLRS, district, and/or Bureau of Bridges and Structures will evaluate the adequacy of the existing bridge rail to determine if it should

be upgraded. The roadway designer will evaluate the adequacy of the existing approaching bridge rail transition for needed upgrading.

36-1.02 Bridge Condition Report

A Bridge Condition Report (BCR) is used to identify deficiencies and establish scope of work necessary to rehabilitate an existing structure for all funding types, and to justify replacement of existing structures (including bridges, culverts, tunnels, viaducts, etc.) for Federal-Aid projects. A BCR is also required as justification for those structures that are to remain. When required by these criteria, submit a BCR to IDOT for review and approval prior to or with submittal of the Preliminary Bridge Design and Hydraulic Report (PBDHR). The BCR must be approved for approval of the PBDHR. For guidance on the content and preparation of the Bridge Condition Report, see Sections 10-2.03 and 22-2.06.

36-1.03 Preliminary Bridge Design and Hydraulic Report

The Preliminary Bridge Design and Hydraulic Report contain the necessary information for use by IDOT personnel to review the preliminary bridge design and to process the hydraulic reports for local agency bridge and culvert construction projects. For guidance on the content and preparation of the PBDHR, see Section 10-2.03 and 22-2.06.

36-2 STRUCTURAL DESIGN

Structures include such items as bridges, single and multiple cell culverts, retaining walls, and sign structures. Structural designs shall have the dated seal, signature, and applicable certification affixed to the first sheet of the structural plans, usually the General Plan and Elevation sheet. Exceptions to this requirement include pre-approved designs such as pipe culverts, retaining walls or other structures contained in the Standard Specifications or IDOT manuals.

36-2.01 <u>IDOT Criteria</u>

The Bureau of Bridges and Structures has adopted the current edition of the AASHTO *Standard Specifications for Highway Bridges* for structural design. Exceptions, clarifications, exclusions, and supplements to the AASHTO *Standard Specifications* are published in the *IDOT Bridge Manual* and its supplemental *Manuals*. The *IDOT Standard Bridge Plans* presents standardized plan sheets and designs that are commonly used for the preparation of precast concrete deck beam bridge projects. These documents and the *IDOT Standard Specifications for Road and Bridge Construction* collectively form the design controls for all structures in the State of Illinois.

36-2.02 <u>Bridge Design for Local Agencies</u>

It is highly recommended that the structural design of all local agency bridge projects follow the same criteria as that used for IDOT bridges. The following Sections present additional criteria applicable to local agency bridge projects.

36-2.02(a) Foundations/Substructures

The following will apply to the design of foundations and substructures for bridges on local agency projects:

1. <u>Type</u>. The foundation for a bridge normally consists of concrete or steel piling. Substructure piers and abutments should be steel and/or concrete. Other materials (e.g., treated timber) may be used. However, because of inferior past performance, the use of timber piles is not recommended.

2. <u>Pile/Abutment Lengths</u>. For information on pile and abutment lengths, see the *IDOT Geotechnical Manual*.

36-2.02(b) Bridge Deck Protection

To reduce the deterioration of bridge decks and to provide additional protection for bridge decks that are subjected to deicing agents, Figure 36-2A presents those protective measures that should be provided.

Type of Bridge Deck	Type of Protection	Without Deicing Agents	With Deicing Agents
Slab Floors (Poured-in-Place)	2 1/4 in ± 1/4 in (55 mm ± 5 mm) concrete cover over deck reinforcement	Required	Required
	Use of high-quality concrete	Required	Required
	Epoxy coated reinforcement bars in top mat of deck reinforcement	Required	Required
	Protective coat (linseed oil) on bare concrete areas	Recommended	Required
Precast Prestressed Concrete Deck Beams	Flowable, non-shrink, non-metallic grout in longitudinal keyways	Recommended	Required
	Placement of mortar fairing course and waterproofing membrane system prior to surfacing with bituminous overlay	Recommended	Required
	Bituminous Overlay	Recommended	Required
	Corrosion Inhibitor	Optional	Recommended

Note: Include a statement indicating whether or not the structure will be subjected to deicing agents in the project correspondence (see Form BLR 10210).

PROTECTIVE MEASURES FOR BRIDGE DECKS

Figure 36-2A

36-2.02(c) Seismic Design

Local agencies must use Division IA of the AASHTO *Standard Specifications for Highway Bridges*, latest edition, to evaluate the seismic design of all new and reconstructed bridges.

Preliminary earthquake analyses provide that single-span bridges included in the *Standard Plans, Precast Prestressed Concrete Deck Beam Bridges*, Illinois Department of Transportation, adopted April 4, 2005, meet the minimum requirements of the AASHTO *Standard Specifications* statewide. Multiple-span precast prestressed concrete deck beam bridges (PPCDB) utilizing the “Standard Plan” design may be used without additional analysis only in the parts of the State that fall in the SPC A. For multiple-span PPCDB located in SPC B and C, adequacy for seismic design should be evaluated on a project-by-project basis.

For more information on seismic design, see the *IDOT Bridge Manual*.

36-2.02(d) Scour Evaluation Criteria

The National Bridge Inspection Standards (NBIS) requires that bridges, exclusive of culverts, be evaluated for their potential for failure due to streambed scour. Culverts are exempted from scour evaluation requirements but should be carefully monitored if scour appears to be a problem. This scour critical evaluation must be performed in accordance with FHWA Technical Advisory 5140.23 and FHWA Hydraulic Engineering Circular No. 18 (HEC 18), both titled *Evaluating Scour at Bridges*.

The scour evaluation should include all effects of long-term stream stability, constriction of the channel by the structure, and local scour. Calculations to estimate potential scour depths will be limited to contraction and local pier scour only. The HEC 18 equations are unreliable for calculating local scour at abutments and should not be used for that purpose. The following applies:

1. <u>Scour Design for New/Rehabilitated Bridges</u>. New and rehabilitated bridges must be designed for scour estimated for a flood with a 100 year recurrence interval. The substructure and foundations design must ensure stability for scour as previously stated. New bridges will be designed so that coding for Item 113, Scour Critical Appraisal Rating, in the ISIS is “5”, “8” or “9”. Rehabilitation projects also allow a rating of “7”. The bridge designer’s name should be submitted to the district as the scour analyst to be recorded in the ISIS.

2. <u>Scour Evaluation of Existing Bridges</u>. Existing bridges must be evaluated or assessed for estimated scour from a superflood with an approximate 500 year recurrence interval. Scour estimated by the Rational Method or calculated using the equations from HEC 18 for existing bridges will be considered acceptable up to the limit of substructure failure (factor of safey equal to 1). Bridges with unknown foundations should be assessed according to existing conditions and sound engineering judgment.

   Scour evaluations performed for existing bridges that are open to traffic and require an NBIS maintenance inspection will provide the basis for the coding of Item 113 in ISIS; see Section 6-4. This evaluation may be performed utilizing the “Bridge Scour Assessment Procedure (BSAP)” or the “Simplified Scour Evaluation Method (SSAM).” Information on these methods can be obtained from the Bureau of Bridges and Structures.

36-2.03 <u>Bridge Rails</u>

36-2.03(a) Projects on the National Highway System

With two exceptions, bridge rails on new projects on the National Highway System (NHS) must be crash-tested and meet the performance criteria of NCHRP 350 *Recommended Procedures for the Safety Performance Evaluation of Highway Features*. The designer should note that the use of any curb or brush block in combination with a bridge rail must also meet NCHRP 350 criteria; i.e., the crash test must have been conducted on the combination curb/bridge rail configuration. Existing bridge rail shall at a minimum meet NCHRP 230 standards; however, it is still desirable to meet NCHRP 350 standards.

The following two exceptions apply to the use of NCHRP 350-approved bridge rails on NHS projects:

- bridges with a current ADT less than 1000 vehicles per day, or
- bridges in urban areas where the regulatory speed limit is less than 40 mph (60 km/h) and the bridge and roadway cross section is a parapet/curb-and-gutter design.

For these two exceptions and with approval from IDOT, local agencies may use bridge rails that have not been crash tested to NCHRP 350 criteria on a case-by-case basis. All bridge designs must meet AASHTO criteria for loading and configuration. In areas where records indicate a number of crashes have previously occurred or where unique geometric conditions create a significant potential for crashes, the designer should evaluate the need for a crash-tested rail at these sites.

36-2.03(b) Non-NHS Projects

For bridge projects on other than NHS routes, reference is made to the NCHRP 350 criteria for the designer’s use. All bridge designs must meet AASHTO criteria for loading and configuration. In areas where records indicate a number of crashes have previously occurred or where unique geometric conditions create a significant potential for crashes, the designer should evaluate the need for a crash-tested rail at these sites.

36-2.04 Utility Attachments

36-2.04(a) General

Utility facilities attached to highway structures present varying degrees of hazard to the road user and to the structure. Utility attachments are not recommended if there are other practical methods to provide utility accommodation; however, the local agency may grant approval for the accommodation of utilities on bridges based on an engineering study.

Section 36-2.04 addresses the requirements, limitations, procedures, and assessment of charges for the permitted attachment of utility facilities to bridges or traffic structures on or over public highways in Illinois. The provisions of this Section are applicable to both existing and proposed bridges for the attachment of a new utility, the expanding of an existing utility attachment, or the voiding of an existing permit for a utility attachment.

The approval of an application for a utility attachment to a highway structure should be based on:

- the type, volume, pressure, or voltage of the commodity to be transmitted and the associated risk to the road user and the structure;
- the type, length, and value of the structure and its relative importance to the transportation system;
- the alternative routings available to the utility and their relative practicality;
- the proposed method of attachment;
- the degree of interference with bridge maintenance work;
- the aesthetic impact to the structure of the utility attachment; and
- the public benefit expected from the utility service compared to the risk of structural attachment.

Utilities should not be attached to structures when alternative locations are available. Alternative locations, separate from the bridge, include:

- underground,
- under stream,
- independent poles,
- cable supports, and
- tower supports.

The utility company must include the supporting data in its request to demonstrate the impracticality of alternative routing.

When the local agency requires the removal or adjustment of any existing utility attachment due to the renovation or removal of an existing bridge, the existing permit should be automatically voided. The issuance of a new Bridge Attachment Permit will acknowledge receipt of any assessment charge and will give the necessary permission to attach, operate, and maintain the facility. For a new structure, the permit should include an agreement for the period of construction, as well as a provision to attach, operate, and maintain the facility upon completion of the construction.

Approved cut-off facilities should be required at each end of the highway structure so that service through the facilities attached to the structure can be cut off in case of a crash or other occurrence requiring such interruption.

The local agency should require plans and specifications showing the size, weight per foot (meter), and proposed method of attachment of the utility elements and stating the type of commodity to be transmitted, the proposed pressure or voltage, and the proposed location of cutoffs adjacent to the structure.

Any anticipated expansion should be included in the permit.

36-2.04(b) Acceptable Attachment Methods

If it is determined that there is no reasonable alternative location separate from the bridge, the following attachment locations will be considered in the following order of preference: 1) diaphragms, 2) beams, and 3) deck. However, in any case, attachment to main structural members or to the deck will only be allowed when the structural integrity of the structure is not impaired.

Where utility attachment is necessary, the following general practices should be followed:

1. For existing structures, locate the attachment below the floor of the structure between beams or girders and above the lowest structural member.

2. For new structures, consider the utility conduits in the structure design.

3. Design supports and hangers to clamp or bolt without drilling to steel and prestressed or post-tensioned concrete structural elements.

4. Design inserts for hangers to be drilled into existing structures or cast into new structures in non-critical concrete areas (e.g., the floor slab). Inserts for new construction should be shown on the construction plans.

36-2.04(c) Attachment Methods Not Recommended

Utility installations transmitting volatile, flammable, corrosive, energized, or pressurized products (especially those under significant pressure) are the highest risk facilities, and attachments to bridges generally should not be permitted. In addition, the following practices or attachment methods are not allowed:

- burying conduit or cable in bridge deck slabs or sidewalks, except bridge lighting conduit may be allowed in the lower part of the parapet curb.
- drilling holes outside the middle third of the web of load-carrying structural steel elements,
- welding onto structural steel elements,
- drilling into prestressed or post-tensioned concrete supporting beams,
- casting inserts into the bottom of prestressed concrete members,
- attachments that will reduce critical clearances or freeboard,
- attachments outside the fascia of the bridge,
- gas pipelines over 4 in (100 mm) in diameter or having internal pressure exceeding 75 psig (520 kPa),
- more than one gas pipeline per structure, and

- pipelines carrying liquids or gases that are considered extraordinarily hazardous.

36-2.04(d) Additional Considerations

The following lists additional factors that should be considered for proposed utility attachments to bridges:

1. No attachment will be permitted that impairs inspection and maintenance procedures.

2. To preserve aesthetics, if a bridge is in a visible area, the utility should be attached underneath the structure, tucked in among the beams, rather than hooked to the outside.

3. To ensure a safe installation, the utility attachment should be on the downstream side of the bridge because, during floods, trees and other drift will occasionally strike the beams.

4. Because of maintenance work on bridge rails, do not allow attachments to bridge rails or the bolts used to fasten bridge rails to bridges.

5. Trenching operations that are so close to the bridge footings that there may be undercutting or sloughing must not be allowed.

6. Attachments to historic bridges should be coordinated with the applicable historic agencies (e.g., Illinois Historic Preservation Agency).

7. Seismic factors must be considered for proposed utility attachments.

8. Utility facilities may pass through free-standing abutments, but not those that move with temperature changes.

9. Installation of the utility must not interfere with the contractor constructing the bridge.

10. The following specifically applies to proposed pipelines on bridges:

    - For a pipeline installation to be approved, it must either be encased or extra strong. If the utility company proposes to meet this requirement by using higher strength pipe, the local agency should require certificates on the high-strength pipe.
    - Design the attachment to prevent discharge of the pipe product into the stream or river in case of pipe failure.
    - Using bridge members to resist forces caused by moving fluids will not be permitted.

36-2.05 <u>Culverts</u>

Section 38-3 discusses the structural design of culverts.

36-2.06 Retaining Walls

36-2.06(a) Preliminary Design

There are many different types of retaining wall systems (e.g., conventionally reinforced concrete, MSE, soldier pile, sheet pile) that can be used on transportation projects. The review of the preliminary design (TS&L review) is required for all walls that are a minimum of 10 ft (3 m) high, as measured from the top of the wall to the bottom of the footing or cast-in-place fascia. This submittal for review should include the configuration of the wall, type of construction, and soils borings. The number of borings and the detailed information required is described in the *IDOT Bridge Manual* and the *Geotechnical Manual*. This review submittal should be sent to the district for transmittal to the Local Bridge Unit and will be reviewed by the Foundation Unit of the Bureau of Bridges and Structures.

36-2.06(b) Final Design Plans

An Illinois licensed structural engineer shall design all retaining walls that are at least 10 ft (3 m) high, as described in Section 36-2.06(a). Pile-supported retaining walls on spread footing foundations will not require a review of the final plans because the pile type and loads have been reviewed during the initial review. Spread footing walls normally will not require a final plan review because the allowable bearing pressure is determined and shown on the TS&L during the initial design, with the understanding that the designer will later size the footing using this value. The district can generally accept these plans based on the licensed structural engineer's seal and certification.

Retaining walls other than conventionally reinforced concrete (e.g., soldier pile, sheet pile, MSE, soil nailed, gabion, bin, crib block double wall) that are 10 ft (3 m) or greater in height are less common and require the submittal of preliminary plans, and possibly final plans for review and approval for structural adequacy.

36-3 BRIDGE SIZING/GEOMETRICS

A variety of factors determine the appropriate size and cross section of a bridge under design. Section 36-3 discusses the geometric design elements pertaining to bridge design (e.g., bridges on horizontal curves, cross slopes). Section 36-4 presents typical sections for bridge overpasses and underpasses. Section 36-5 presents tables of geometric design criteria for bridges on local facilities.

The design criteria provided in Section 36-3 are applicable to all bridges on the local system located within the limits of a proposed improvement, except those bridges located within a 3R type improvement or where specific policy items are governed by other IDOT directions. Bridge widths for 3R type improvements are included in Chapter 33.

36-3.01 Bridge Width

See Sections 36-4 and 36-5 for bridge width criteria and application.

36-3.02 Bridge Length

36-3.02(a) Bridges Over Roadways

The roadway section passing beneath a bridge will determine the bridge length in combination with structural design elements (e.g., abutment type). The underpass opening will be based on the following roadway design elements:

- the underpass roadway width;
- the presence of sidewalks and/or bikeways;
- the presence of auxiliary lanes; and
- the horizontal clearance to obstructions (i.e., the roadside clear zone).

See Section 36-4 for typical underpass sections. For high unit cost bridges, the designer may consider locating abutments or piers on the right side of the roadway adjacent to the shoulder where the savings in structure cost could make the required barrier protection cost effective.

36-3.02(b) Bridges Over Waterways

Among other factors, bridge length over waterways is determined by considering local topography, hydraulic recommendations, geometric recommendations, geotechnical considerations, and structural factors. The locations and elevations of the bridge abutments are dependent on the method used to terminate the approach embankment and transition to the structure. Where a stable end slope terminates the embankment, an open abutment should be located at or near the top of the end slope. End slopes should be 1V:2H or as otherwise established by a geotechnical stability analysis. Where the embankment is terminated at a vertical plane, a closed or earth-retaining abutment should be located at that plane. The use of an end slope to terminate the embankment results in a longer bridge than one using a closed abutment; however, overall bridge costs are generally lower with the open abutment design because of the high cost of closed abutments. Closed abutments are seldom economical where their height exceeds 10 ft (3 m) and should not be used without a detailed cost investigation.

36-3.03 Vertical Clearances

See Sections 36-4 and 36-5 for vertical clearance criteria and application.

36-3.04 Sidewalks and Bikeways

If pedestrian activity is anticipated, provide sidewalks on both sides of urban and suburban structures. The standard sidewalk width on structures is 5 ft (1.5 m). Where wider sidewalks exist on approaching roadways, sidewalk widths greater than 5 ft (1.5 m) may be considered.

If an approach roadway with a shoulder has a sidewalk that is to be carried across the bridge, a traffic barrier should be provided between the roadway and the sidewalk. For design speeds of 45 mph (70 km/h) or less, a curb may be placed at the edge of the bridge roadway and continued along the edge of the shoulder of the approach roadway. See Section 36-4 for a typical section.

Bikeways should be accommodated on the structure as described in Chapter 42.

36-3.05 Horizontal Curves

Superelevation transitions should be avoided on bridges and their approaches. Where a curve is necessary on a bridge, the desirable treatment is to place the entire bridge and its approaches on a flat horizontal curve with minimum or no superelevation. In this case, a uniform superelevation rate is provided throughout (i.e., the superelevation transition is neither on the bridge nor its approaches) or the normal crown section is maintained throughout the curve.

Where a bridge is located within a superelevated horizontal curve, the entire bridge roadway is sloped in the same direction and at the same rate across the deck (i.e., the shoulders or gutters and traveled way will be in a planar section). This also applies to the approach traveled way and the approach shoulder pavements. The approach traveled way and approach shoulders are illustrated in the *IDOT Highway Standards*. However, the high-side shoulder on a roadway section off the bridge should slope away from the traveled way at a rate such that the maximum shoulder rollover factor for the roadway classification and design traffic. To accomplish the longitudinal shoulder slope transition away from the bridge, the designer should refer to the applicable figure in Section 36-4. See Chapter 29 for more information on horizontal alignment.

If the bridge is built on tangent but the roadway is built on curve, an additional width may be necessary to provide the minimum horizontal clearance to the bridge rail.

36-3.06 Cross Slopes

The typical sections in Section 36-4 illustrate the cross slope criteria for bridges, which is typically 1.5% to 2.0% for the traveled way and 2.0% for the shoulders. This means that the shoulder cross slope (which varies from 4.0% to 8.0%) on the approaching roadway must be transitioned to meet the cross slope on the bridge. The rate of transition for the shoulder slope should be equal to a maximum relative longitudinal gradient of 0.4% between the edge of traveled way and the outside edge of shoulder.

For more information, see the *IDOT Bridge Manual*.

36-3.07 Grades

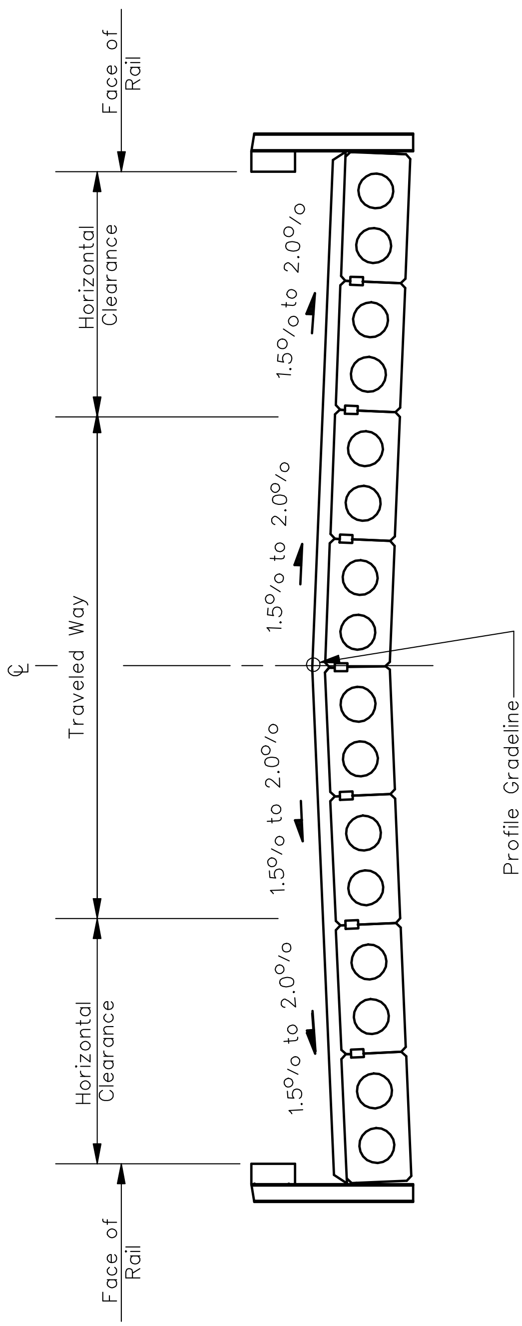
Where a bridge is not within the limits of a vertical curve and has a curb, the designer should provide a minimum longitudinal gradient of 0.5% across the bridge. Otherwise, a 0.0% gradient is acceptable for structures without curbs or those with curbs that have a superelevation.

36-4 TYPICAL SECTIONS

This Section presents typical sections for bridges on tangent or with superelevation; for roadways beneath bridges; and for highways passing over railroads. With the exception of cross slopes on bridges, the typical sections do not provide the numerical dimensions for the various cross section elements; i.e., these are nomenclature presentations. See Section 36-5 and Chapter 32 for the applicable numerical criteria.

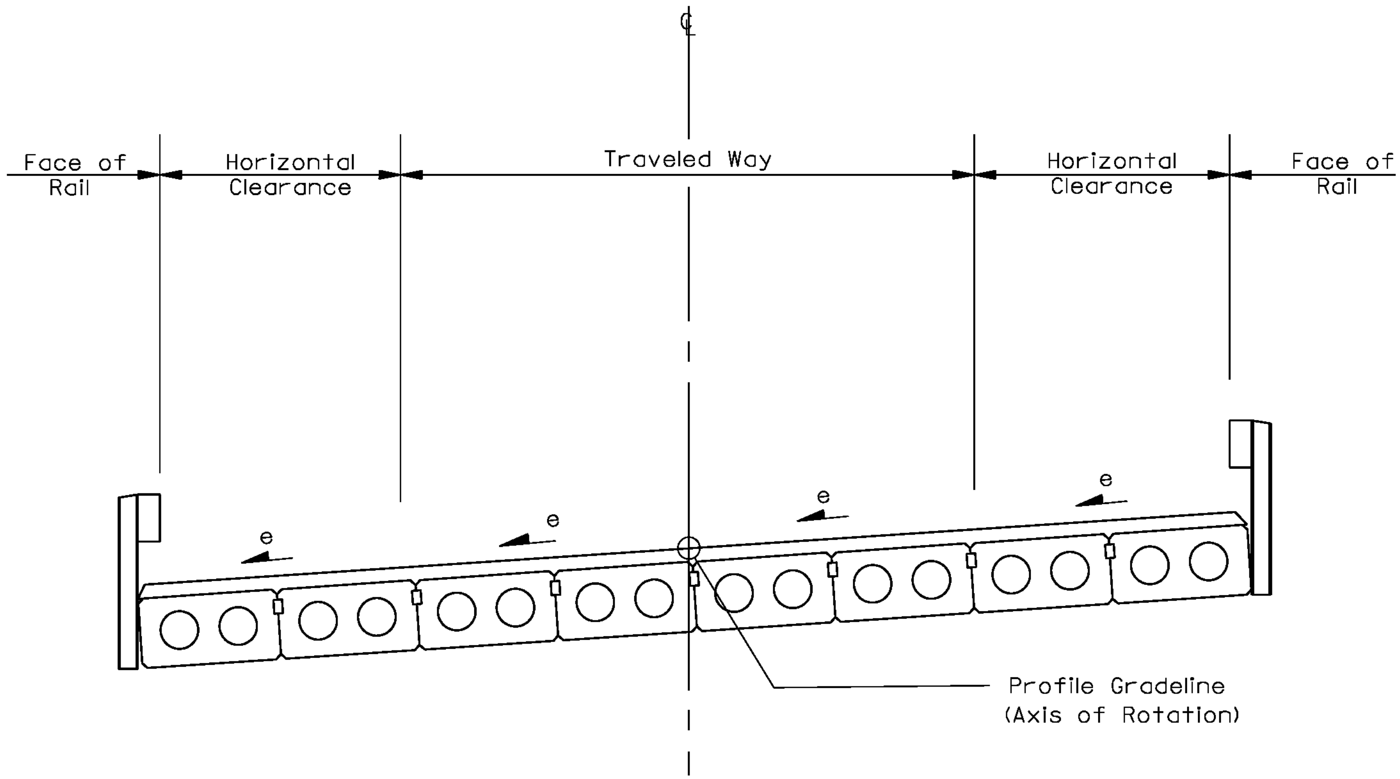
The following typical section figures are included in this Section:

- Clear Roadway Width of Bridges for New and Reconstructed Rural Two-Lane Roads (Figure 36-4A).
- Clear Roadway Width of Superelevated Bridges on Rural Two-Lane Roads (Figure 36-4B).
- Clear Roadway Width of Bridges for New and Reconstructed Urban Streets with Raised-Curb Median (Figure 36-4C).
- Clear Roadway Width of Bridges for New and Reconstructed Roads and Streets with Bikeways (Figure 36-4D).
- Clear Roadway Width of Bridges for New and Reconstructed Two-Lane Urban Streets (Flush/Traversable Median) (Figure 36-4E).
- Clear Roadway Width of Superelevated Bridges on Urban Streets with Raised-Curb Median (Figure 36-4F).
- Clear Roadway Width of Superelevated Bridges on Urban Streets with Flush/Traversable Median (Figure 36-4G).
- Clear Roadway Width of Superelevated Bridges on Two-Lane Urban Streets (Figure 36-4H).
- Clearances for Bridges over Two-Lane Roads (Figure 36-4I).
- Highway Grade Separation over Railroad (Natural Ground Less Than 4 ft (1.2 m) Below Rail) (Figure 36-4J).
- Highway Grade Separation over Railroad (Natural Ground 4 ft (1.2 m) or More Below Rail) (Figure 36-4K).



CLEAR ROADWAY WIDTH OF BRIDGES FOR NEW AND RECONSTRUCTED RURAL TWO-LANE ROADS

Figure 36-4A

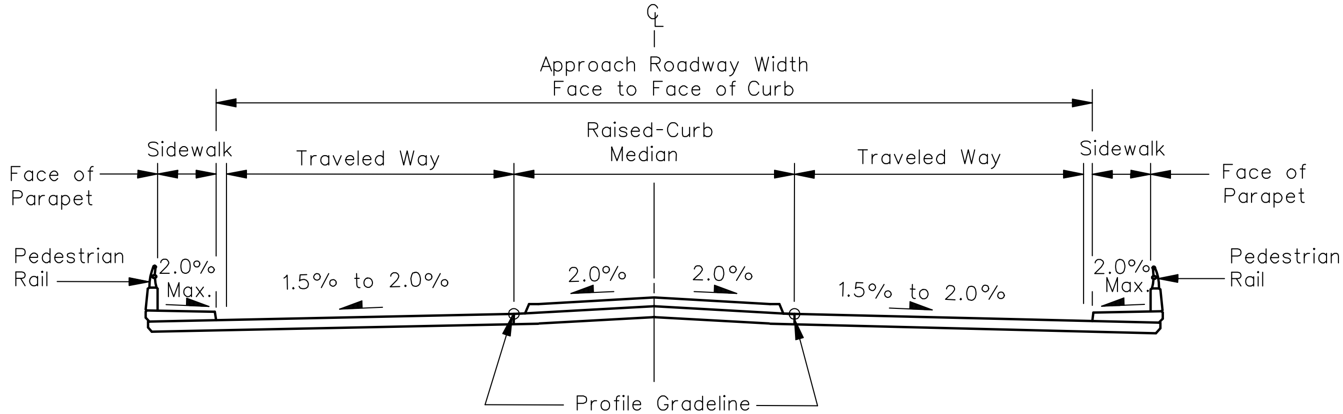


Note:

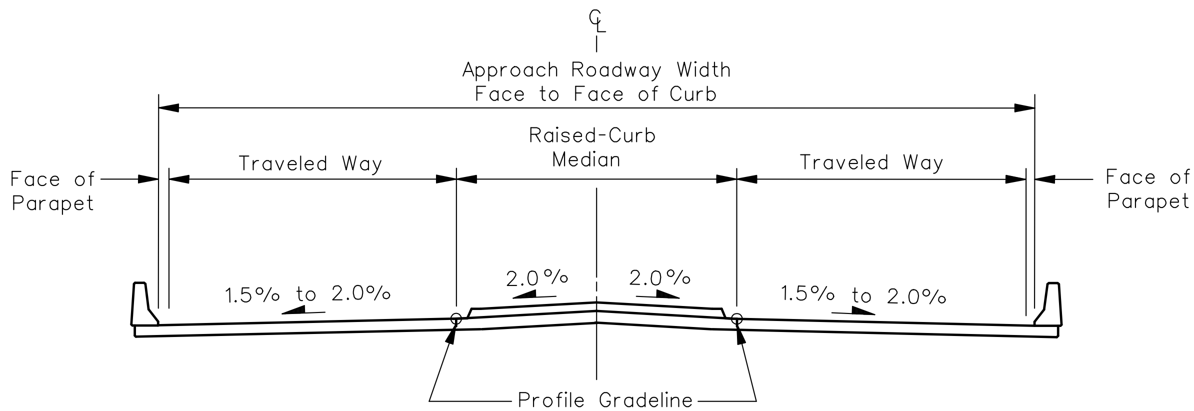
Where a bridge lies within a horizontal curve with superelevation, the shoulder on the high side of the bridge (starting just off the end of the bridge approach shoulder pavement) will be gradually transitioned into the design slope of the shoulder on the approaching roadway. Also see the IDOT Highway Standards*. This transition should be accomplished by providing a maximum relative longitudinal difference in gradient of 0.4% between the edge of the traveled way and the outside edge of the shoulder.*

CLEAR ROADWAY WIDTH OF SUPERELEVATED BRIDGES ON RURAL TWO-LANE ROADS

Figure 36-4B



Sidewalk — Both Sides



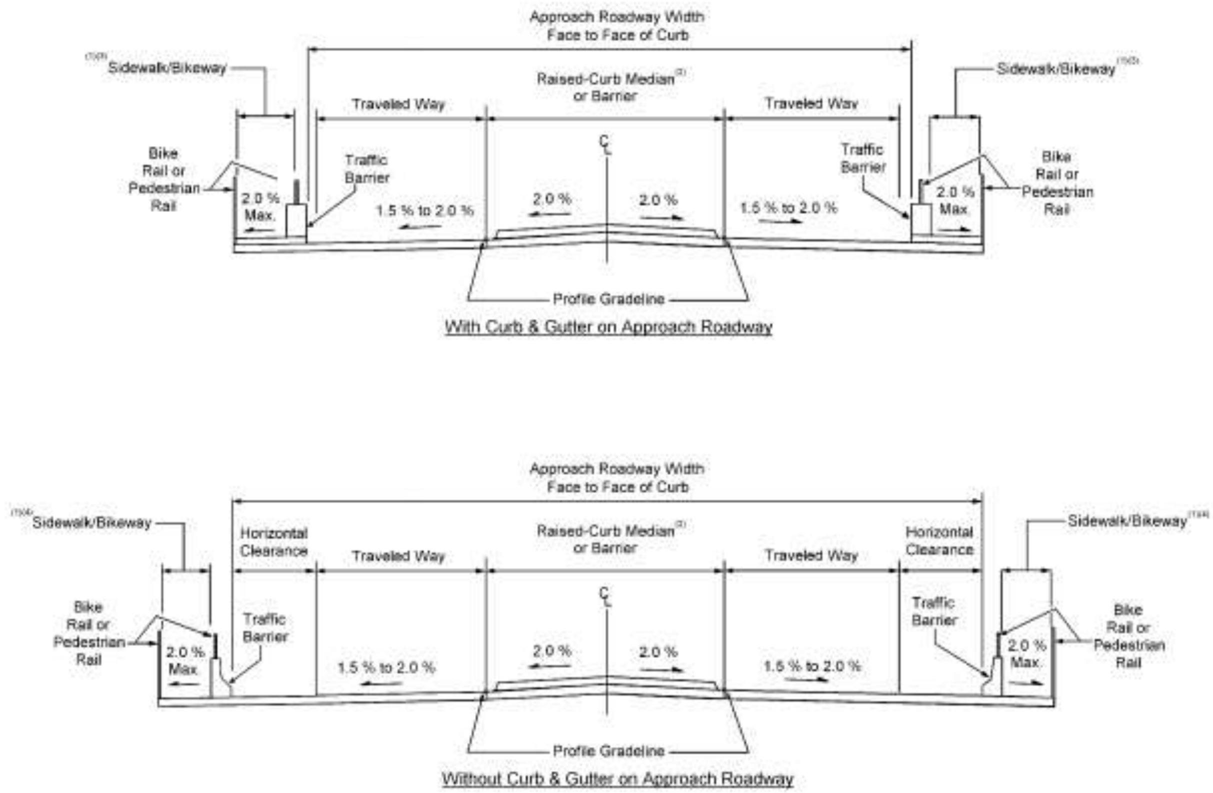
Sidewalks Not Provided

Note:

Where a flush/traversable median is used on the approach, a raised-curb median may be used across the structure where bridge decks are subject to frequent icing conditions.

CLEAR ROADWAY WIDTH OF BRIDGES FOR NEW AND RECONSTRUCTED URBAN STREETS WITH RAISED-CURB MEDIAN

Figure 36-4C

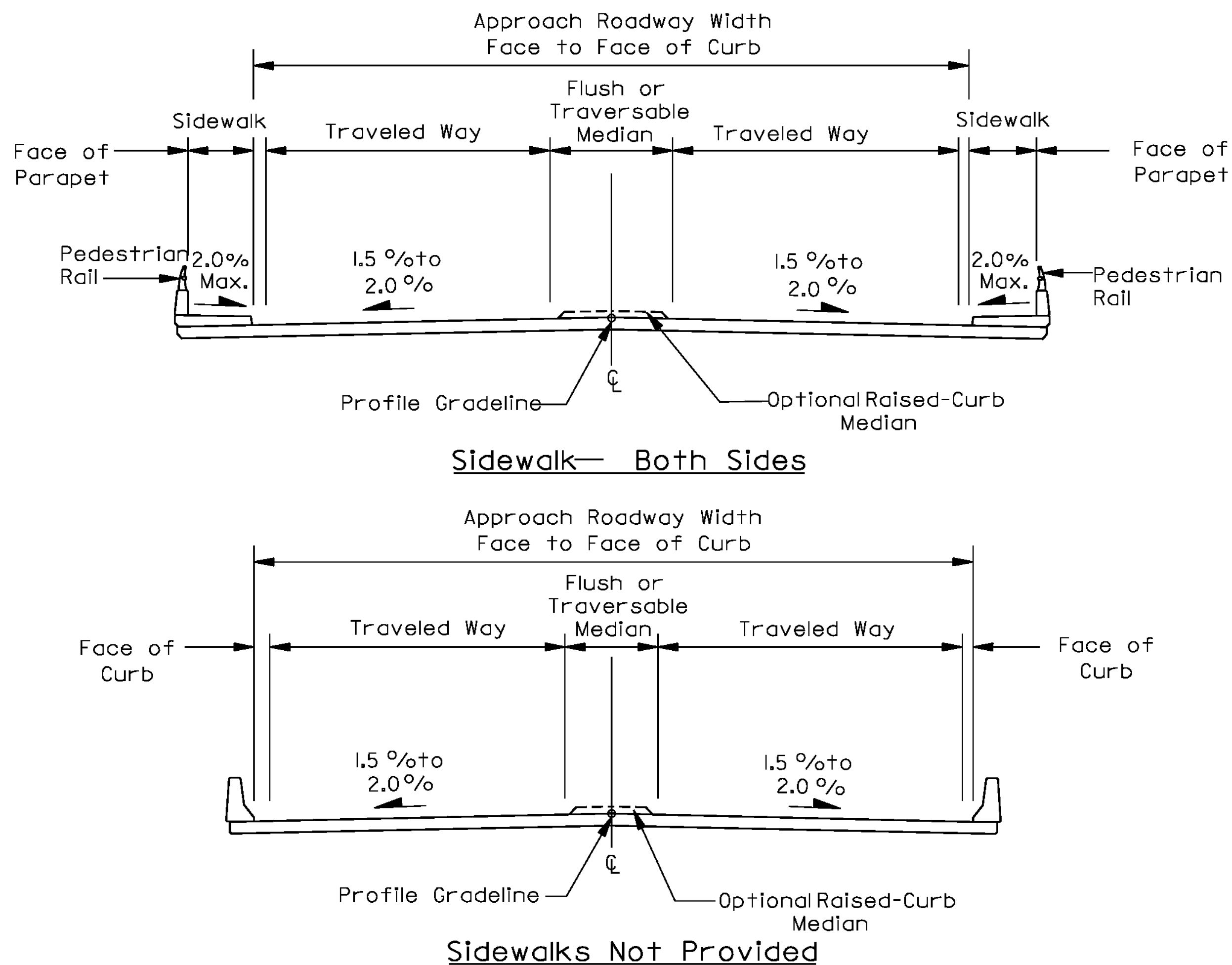


Notes:

1. *If bikeways are required on one side only, design the parapet, handrail , and bike rail as appropriate.*
2. *Where a flush/traversable median is used on the approach, a raised-curb median may be used across the structure where bridge decks are subject to frequent icing conditions.*
3. *Only consider this template under special warrant or conditions (e.g., vehicular posted speed limits of 45 mph or greater with high pedestrian volumes, concentration of elementary school children, designated off-road bikeways, or other demonstrated hazardous conditions).*
4. *Only consider this template with no curb and gutter on the approaches under special warrant or conditions (e.g., vehicular posted speed limits of 45 mph or greater with high pedestrian volumes, concentration of elementary school children, designated off-road bikeways, or other demonstrated hazardous conditions).*

CLEAR ROADWAY WIDTH OF BRIDGES FOR NEW AND RECONSTRUCTED ROADS AND STREETS WITH BIKEWAYS

Figure 36-4D

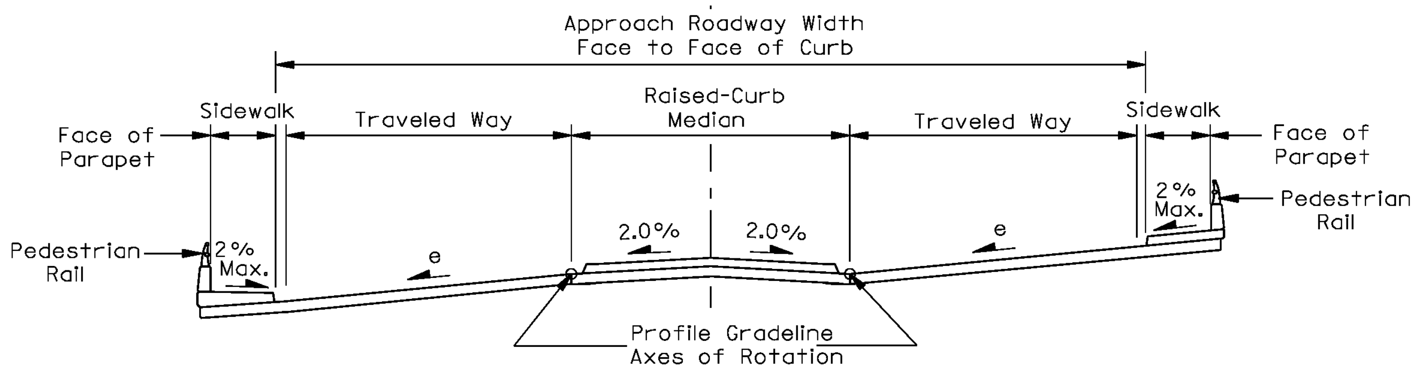


Note:

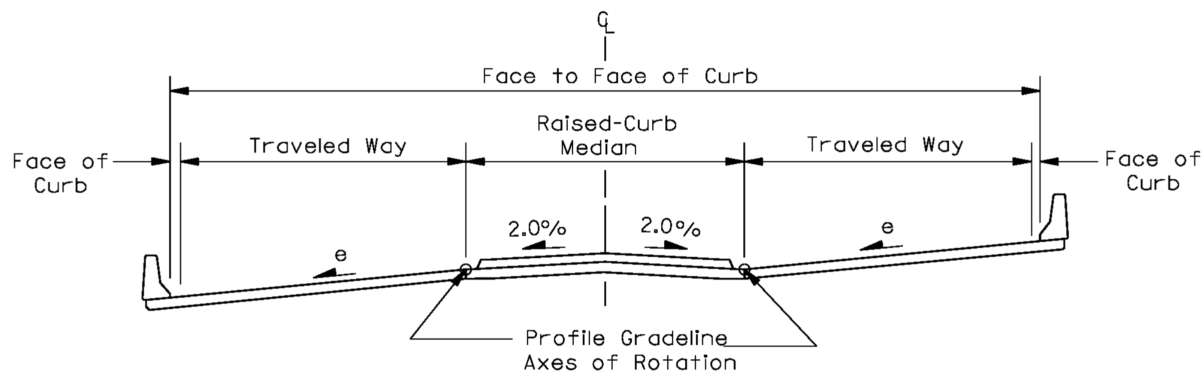
Where a flush/traversable median is used on the approach, a raised-curb median may be used across the structure where bridge decks are subject to frequent icing conditions.

CLEAR ROADWAY WIDTH OF BRIDGES FOR NEW AND RECONSTRUCTED TWO-LANE URBAN STREETS (Flush/Traversable Median)

Figure 36-4E



Sidewalk— Both Sides



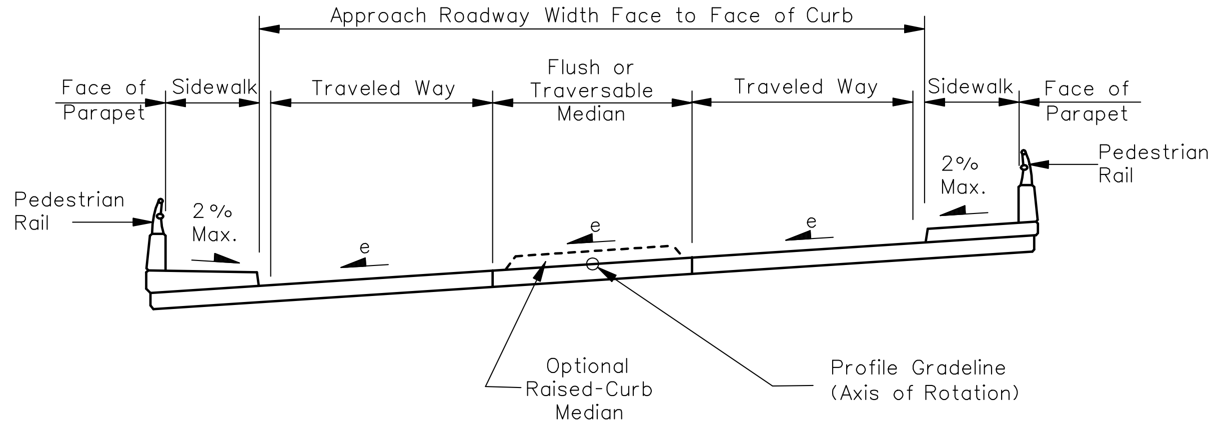
Sidewalks Not Provided

Note:

Where an urban bridge lies within a horizontal curve with superelevation, the gutter on the high side of the bridge (starting just off the end of the bridge approach pavement) is gradually transitioned into the design slope of the gutter on the approaching roadway. See the IDOT Highway Standards*. This transition should be accomplished by providing a maximum relative longitudinal difference in gradient of 0.40% between the edge of the traveled way and the flow line of the gutter.*

CLEAR ROADWAY WIDTH OF SUPERELEVATED BRIDGES ON URBAN STREETS WITH RAISED-CURB MEDIAN

Figure 36-4F

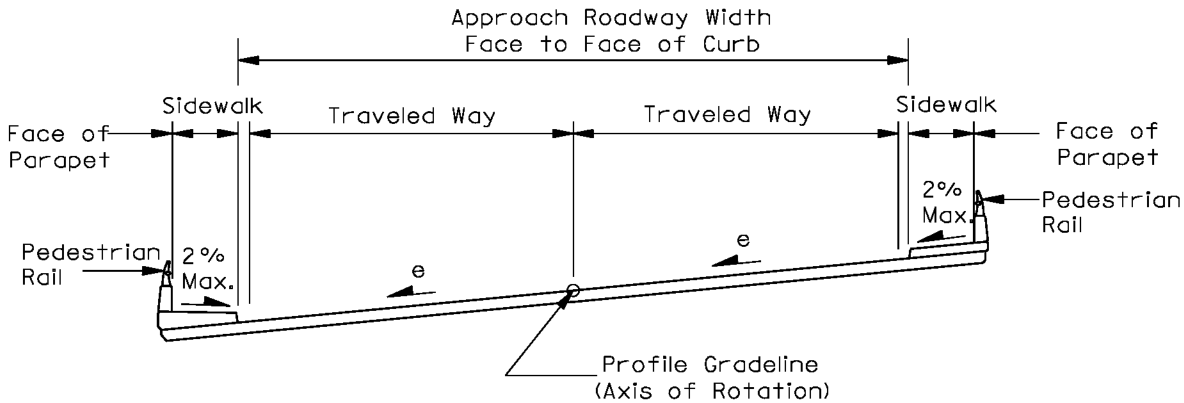


Note:

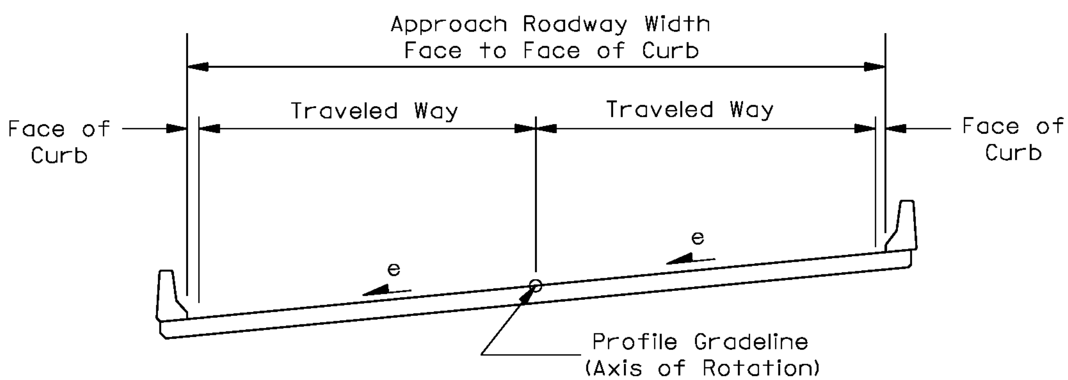
Where an urban bridge lies within a horizontal curve with superelevation, the gutter on the high side of the bridge (starting just off the end of the bridge approach pavement) is gradually transitioned into the design slope of the gutter on the approaching roadway. See the IDOT Highway Standards*. This transition should be accomplished by providing a maximum relative longitudinal difference in gradient of 0.40% between the edge of the traveled way and the flow line of the gutter.*

CLEAR ROADWAY WIDTH OF SUPERELEVATED BRIDGES ON URBAN STREETS WITH FLUSH/TRAVERSABLE MEDIAN

Figure 36-4G



Sidewalk— Both Sides



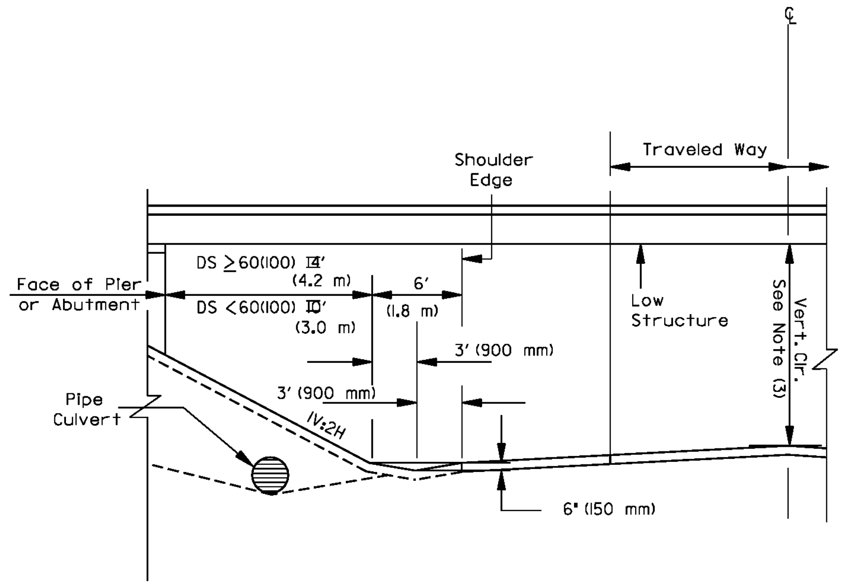
Sidewalks Not Provided

Note:

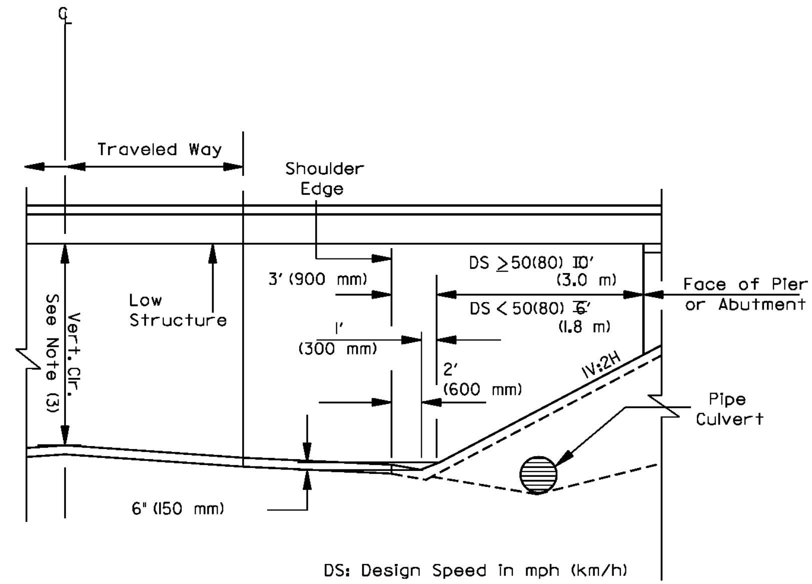
Where an urban bridge lies within a horizontal curve with superelevation, the gutter on the high side of the bridge (starting just off the end of the bridge approach pavement) is gradually transitioned into the design slope of the gutter on the approaching roadway. See the IDOT Highway Standards*. This transition should be accomplished by providing a maximum relative longitudinal difference in gradient of 0.40% between the edge of the traveled way and the flow line of the gutter.*

CLEAR ROADWAY WIDTH OF SUPERELEVATED BRIDGES ON TWO-LANE URBAN STREETS

Figure 36-4H



CONFIGURATION A



CONFIGURATION B

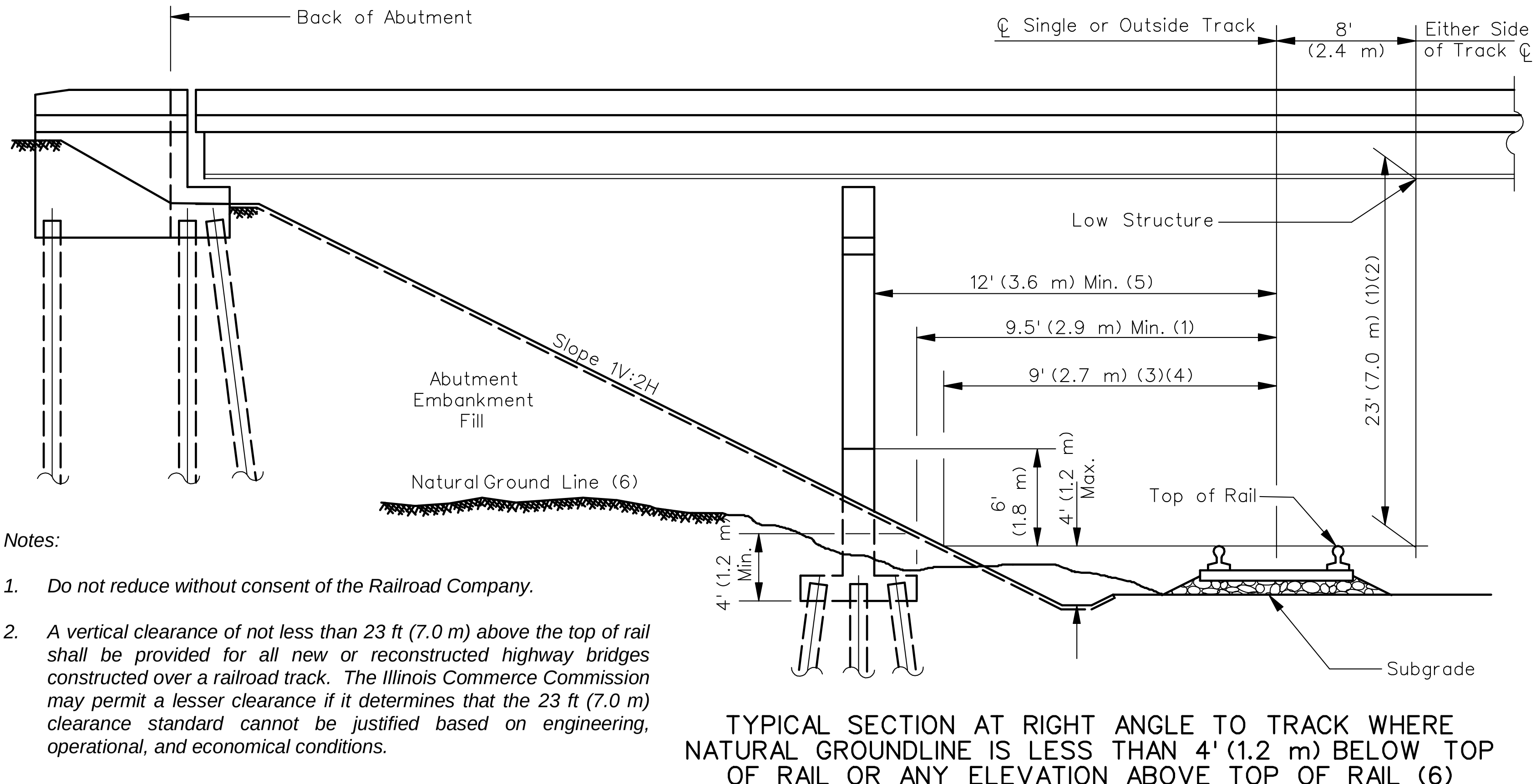
Functional Classification of Underpassing Highway	Current ADT or 20-Year DHV	Configuration	Minimum Vertical Clearance
Rural Arterial (New)	All ADTs	A	16'-6" (5.0 m)
Rural Arterial (Reconstruction)	All ADTs	A	16'-3" (4.9 m)
Urban Arterial	All ADTs	A	14'-9" (4.5 m)
Local Road or Collector	DHV > 200	A	14'-9" (4.5 m)
Local Road or Collector	DHV ≤ 200	B	14'-9" (4.5 m)
Local Road or Collector	ADT ≤ 400	B	14'-9" (4.5 m)

Notes:

1. *Locate the upstream traffic end of a through pipe culvert outside the clear zone of the near edge of traveled way.*
2. *All horizontal dimensions are right-angle dimensions.*
3. *Locate the minimum clearance point at the least clearance point above the usable roadway under, including stabilized shoulders.*

CLEARANCES FOR BRIDGES OVER TWO-LANE ROADS

Figure 36-4I



Notes:

1. *Do not reduce without consent of the Railroad Company.*

2. *A vertical clearance of not less than 23 ft (7.0 m) above the top of rail shall be provided for all new or reconstructed highway bridges constructed over a railroad track. The Illinois Commerce Commission may permit a lesser clearance if it determines that the 23 ft (7.0 m) clearance standard cannot be justified based on engineering, operational, and economical conditions.*

3. *This dimension may be increased by up to 8 ft (2.4 m) on one side only, as may be necessary for off-track maintenance equipment when justified by the Railroad Company.*

4. *This dimension may be increased by up to 3 ft (1.0 m) where special conditions, such as heavy and drifting snow, are a problem.*

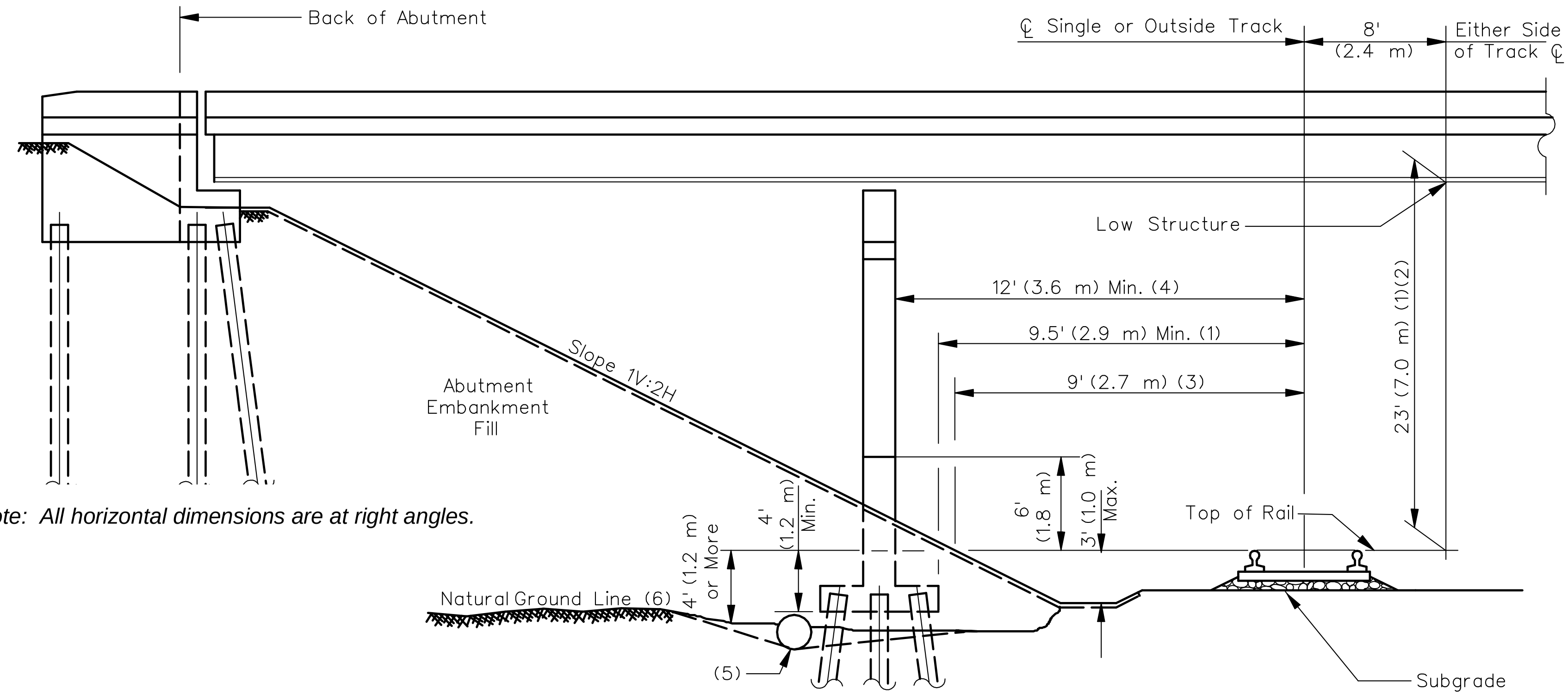
5. *Locate piers or columns so as not to encroach on drainage ditches.*

6. *Where natural ground is 4 ft (1.2 m) or more below top of rail, see Figure 36-4K.*

Note: All horizontal dimensions are at right angles.

HIGHWAY GRADE SEPARATION OVER RAILROAD
(Natural Ground Less Than 4 ft (1.2 m) Below Rail)

Figure 36-4J



Note: *All horizontal dimensions are at right angles.*

TYPICAL SECTION AT RIGHT ANGLE TO TRACK WHERE NATURAL GROUNDLINE IS 4' (1.2 m) OR MORE BELOW TOP OF RAIL (6)

Notes:

1. *Do not reduce without consent of the Railroad Company.*
2. *A vertical clearance of not less than 23 ft (7.0 m) above the top of rail shall be provided for all new or reconstructed highway bridges constructed over a railroad track. The Illinois Commerce Commission may permit a lesser clearance if it determines that the 23 ft (7.0 m) clearance standard cannot be justified based on engineering, operational, and economical conditions.*
3. *This dimension may be increased by up to 8 ft (2.4 m) on one side only, as may be necessary for off-track maintenance equipment when justified by the Railroad Company.*
4. *Locate piers or columns so as not to encroach on drainage ditches.*
5. *Intercepted drainage along railroad embankment shall be accommodated with a minimum 3 ft (900 mm) diameter culvert or carried along highway embankment.*
6. *Where natural ground is less than 4 ft (1.2 m) below top of rail, see Figure 36-4J.*

HIGHWAY GRADE SEPARATION OVER RAILROAD
(Natural Ground 4 ft (1.2 m) or More Below Rail)

Figure 36-4K

36-5 TABLES OF DESIGN CRITERIA

Figure 36-5A presents the design criteria for new or reconstructed bridges on rural collectors/local roads. Figure 36-5B presents the criteria for new or reconstructed bridges on suburban/urban arterials. Figure 36-5C presents the criteria for new or reconstructed bridges on urban collectors/local streets.

Classification		Collector				Local				
Approach Roadway Criteria		See Figure 32-2A				See Figure 32-2B				
Design Traffic Volumes (ADT)		≤ 400	401-2000	2001-4000	> 4000	≤ 250	251-400	401-2000	2001-4000	> 4000
Clear Roadway Bridge Widths (Face-to-Face of Traffic Barriers)(2)(3)(4)		24′ (Traveled Way + 2′ each side)	28′ (Traveled Way + 3′ each side)	32′ (Traveled Way + 5′ each side)	40′ (6) (Approach Roadway Width)	22′ (7) (Traveled Way + 2′ each side)	24′ (Traveled Way + 2′ each side)	28′ (Traveled Way + 3′ each side)	30′ (Traveled Way + 4′ each side)	40′ (6) (Approach Roadway Width)
Minimum Width of Bridges (Face-to-Face of Traffic Barriers) Allowed to Remain in Place(5)		22′	22′	24′	28′	20′	20′	22′	24′	28′
Minimum Design Flood Frequency		20 year(10)	20 year	30 year		15 year(7)	20 year		30 year	
Minimum Clearance Above Design High-Water Elevation(8)		1′								
Design Live Load	New	HS-20								
	Remain in Place(11)	HS-15				H-15 (H-10 where ADT < 50)				
Vertical Clearance for Structures Over Highways(9)	New	See Figure 36-4I								
	Remain in Place	14′								
Horizontal Clearance for Structures Over Highways		See Figure 36-4I								
Horizontal Clearance Over Railroads		See Figures 36-4J and 36-4K								
Vertical Clearance for Pedestrian or Bicycle Structures Over Highways		17’-3”								
Vertical Clearance Over Railroads		23’-0”								

DESIGN CRITERIA FOR NEW OR RECONSTRUCTED(1) RURAL BRIDGES

Figure 36-5A (US Customary)

Classification		Collector				Local				
Approach Roadway Criteria		Figure 32-2A				Figure 32-2B				
Design Traffic Volumes (ADT)		≤ 400	401-2000	2001-4000	> 4000	≤ 250	251-400	401-2000	2001-4000	> 4000
Clear Roadway Bridge Widths (Face-to-Face of Parapets)[2][3][4]		7.2 m (Traveled way + 0.6 m each side)	8.6 m (Traveled way + 1 m each side)	9.6 m (Traveled way + 1.5 m each side)	12.0 m (6) (Approach Roadway Width)	6.6 m (7) (Traveled way + 0.6 m each side)	7.2 m (Traveled way + 0.6 m each side)	8.6 m (Traveled way + 1 m each side)	9.0 m (Traveled way + 1.2 m each side)	12.0 m (Approach Roadway Width) (6)
Minimum Width of Bridges (Face-to-Face of Parapets) Allowed to Remain in Place[5]		6.6 m	6.6 m	7.2 m	8.4 m	6.0 m	6.0 m	6.6 m	7.2 m	8.4 m
Minimum Design Flood Frequency		20 year[10]	20 year	30 year		15 year[7]	20 year		30 year	
Minimum Clearance Above Design High-Water Elevation[8]		300 mm								
Design Live Load	New	MS-18								
	Remain in Place[11]	MS-13.5				M-13.5 (M-9 where ADT < 50)				
Vertical Clearance for Structures Over Highways[9]	New	See Figure 36-4I								
	Remain in Place	4.3 m								
Horizontal Clearance for Structures Over Highways		See Figure 36-4I								
Horizontal Clearance for Structures Over Railroads		See Figures 36-4J and 36-4K								
Vertical Clearance for Pedestrian or Bicycle Structures Over Highways		5.3 m								
Vertical Clearance for Structures Over Railroads		7.0 m								

DESIGN CRITERIA FOR NEW OR RECONSTRUCTED[1] RURAL BRIDGES
Figure 36-5A (Metric)

Footnotes for Figure 36-5A

(1) *Implies reconstruction of a significant length of existing highway either on new location or within existing right-of-way. For reconstruction of relatively short intermittent highway segments within a project, the design criteria used, where cost-safety effective, should be consistent with the adjacent highway design but not less than that allowed to remain in place.*

(2) *The minimum bridge width shall not be less than the width of the approaching traveled way plus the paved portions of the shoulders.*

(3) *Bridge widths for bridge rehabilitation projects are discussed in Chapter 33.*

(4) *For reconstruction projects, where the minimum required shoulder widths on a structure can only be obtained with the addition of new beams and substructure, a cost-safety evaluation should be made to determine the appropriateness of providing the required width. Significant decreases of the required widths should not be considered.*

(5) *Bridges remaining in place without a design exception approval when a safety record is satisfactory if the bridge is being gapped within a roadway section. Clear width between curbs or rails, whichever is less, should be equal to or greater than the approach traveled way width.*

(6) *For bridges in excess of 100 ft (30 m) in length, a minimum bridge width of 30 ft (9.0 m) will be permitted.*

(7) *For road district projects only, the bridge width may be 20 ft (6.0 m), and the design flood frequency may be 10 years for ADTs less than or equal to 150.*

(8) *For reconstruction projects, the proposed low superstructure should not be below the existing superstructure unless 1 ft (300 mm) of clearance is achieved. Any proposed clearance less than 1 ft (300 mm) above design high-water elevation must be accompanied by a request for a design exception.*

(9) *The minimum required vertical clearance must be available over the traveled way and any paved shoulders.*

(10) *The design flood frequency may be 15 years for ADT under 250.*

(11) *The design live load for bridges to remain in place only applies to minor rehabilitation and in-kind replacements (e.g. rail or joint repair, partial deck repair, individual stringer replacement, etc.). Other work, including deck replacement shall be considered new.*

Note: Traveled way width is the sum of the widths of all travel lanes. It is the larger of the value from Chapter 32 or, for existing bridges, the existing (or proposed) width of the approach traveled way.

Classification		Suburban Arterial			Urban Two-Way Arterial			Urban One-Way Arterial		
Highway Type		TWS-2	TWS-4	TWS-6	TWS-2	TWS-4	TWS-6	OWS-2	OWS-3	OWS-4
Approach Roadway Criteria		See Figure 32-2C			See Figure 32-2D			See Figure 32-2E		
Design Traffic Volumes		Two-Way DHV(2)						One-Way DHV(2)		
		< 1250	1250-2050	2050-2900	< 1250	1250-2050	2050-2900	< 1300	1300-1850	> 1850
Clear Roadway Bridge Widths (Face-to-face of Parapets or Curbs)(3)(4)		Approach Surface Width			Approach Roadway Width (but not less than existing roadway width) or Face-to-Face of Curb as Specified in Chapter 32					
Minimum Width of Bridges (Face-to-Face of Parapets or Curbs) Allowed to Remain in Place(5)		Traveled Way + 2′ Each Side for Rural Approach Cross Sections Width of Approach Roadway (face-to-face of curb) for Urban Approach Cross Sections								
Minimum Design Flood Frequency		30 year								
Minimum Clearance Above Design High-Water Elevation(6)		1′								
Design Live Load	New	HS-20								
	Remain in Place(8)	HS-15								
Vertical Clearance for Structures Over Highways(7)	New	See Figure 36-4I								
	Remain in Place	14′								
Horizontal Clearance for Structures Over Highways		See Figure 36-4I or 1.5′ Behind Face of Curb								
Vertical Clearance for Pedestrian or Bicycle Structures Over Highways		17’-3”								
Vertical and Horizontal Clearance for StructuresOver Railroads		See Figures 36-4J and 36-4K								

TWS = Two-Way Street OWS = One-Way Street

DESIGN CRITERIA FOR NEW OR RECONSTRUCTED(1) SUBURBAN/URBAN ARTERIAL BRIDGES

Figure 36-5B (US Customary)

Classification		Suburban Arterial			Urban Two-Way Arterial			Urban One-Way Arterial		
Highway Type		TWS-2	TWS-4	TWS-6	TWS-2	TWS-4	TWS-6	OWS-2	OWS-3	OWS-4
Approach Roadway Criteria		See Figure 32-2C			See Figure 32-2D			See Figure 32-2E		
Design Traffic Volumes		Two-Way DHV(2)						One-Way DHV(2)		
		< 1250	1250-2050	2050-2900	< 1250	1250-2050	2050-2900	< 1300	1300-1850	> 1850
Clear Roadway Bridge Widths (Face-to-face of Parapets or Curbs)(3)(4)		Approach Surface Width			Approach Roadway Width (but not less than existing roadway width) or Face-to-Face of Curb as Specified in Chapter 32					
Minimum Width of Bridges (Face-to-Face of Parapets or Curbs) Allowed to Remain in Place(5)		Traveled Way + 600 mm Each Side for Rural Approach Cross Sections Width of Approach Roadway (face-to-face of curb) for Urban Approach Cross Sections								
Minimum Design Flood Frequency		30 year								
Minimum Clearance Above Design High-Water Elevation(6)		300 mm								
Design Live Load	New	MS-18								
	Remain in Place(8)	MS-13.5								
Vertical Clearance for Structures Over Highways(7)	New	See Figure 36-4I								
	Remain in Place	4.3 m								
Horizontal Clearance for Structures Over Highways		See Figure 36-4I or 450 mm Behind Face of Curb								
Vertical Clearance for Pedestrian or Bicycle Structures Over Highways		5.3 m								
Vertical and Horizontal Clearance for StructuresOver Railroads		See Figures 36-4J and 36-4K								

TWS = Two-Way Street OWS = One-Way Street

DESIGN CRITERIA FOR NEW OR RECONSTRUCTED(1) SUBURBAN/URBAN ARTERIAL BRIDGES

Figure 36-5B (Metric)

Footnotes for Figure 36-5B

(1) *Implies reconstruction of a significant length of existing highway either on new location or within existing right-of-way. For reconstruction of relatively short intermittent highway segments within a project, the design criteria used, where cost-safety effective, should be consistent with the adjacent highway design but not less than that allowed to remain in place.*

(2) *The design hourly volumes (DHV) are calculated using a peak hour factor (PHF) = 1.0; adjust these values using local peak-hour factors.*

(3) *Bridge widths for bridge rehabilitation projects are discussed in Chapter 33.*

(4) *For urban bridges requiring sidewalks, the width of the sidewalks is 5 ft (1.5 m) unless a wider width is specified by the local agency.*

(5) *Bridges remaining in place without a design exception approval when a safety record is satisfactory if the bridge is being gapped within a roadway section. Clear width between curbs or rails, whichever is less, should be equal to or greater than the approach traveled way width.*

(6) *For reconstruction projects, the proposed low superstructure should not be below the existing superstructure unless 1 ft (300 mm) of clearance above design high water is achieved. Any proposed clearance less than 1 ft (300 mm) above design high water elevation must be accompanied by a request for a design exception.*

(7) *The minimum required vertical clearance must be available over the traveled way and any paved shoulders.*

(8) *The design live load for bridges to remain in place only applies to minor rehabilitation and in-kind replacements (e.g. rail or joint repair, partial deck repair, individual stringer replacement, etc.). Other work, including deck replacement shall be considered new.*

Note: Traveled way width is the sum of the widths of all travel lanes. It is the larger of the value from Chapter 32 <u>or</u>, for existing bridges, the existing (or proposed) width of the approach traveled way.

Classification		Urban Two-Way Collector		Urban One-Way Collector		Urban Local	
Highway Type		TWS-2	TWS-2	OWS-2	OWS-2	TWS-2	TWS-2
Approach Roadway Criteria		See Figure 32-2F		See Figure 32-2G		See Figure 32-2H	
Design Traffic Volumes		Two-Way ADT		One-Way ADT		Two-Way ADT	
		<5000	≥5000	<5000	≥5000	<1000	1000-5000
Clear Roadway Bridge Widths (Face-to-face of Parapets or Curbs)[(2)(3)]		Approach Roadway Width (but not less than existing roadway width) or Face-to-Face of Curb as Specified in Chapter 32					
Minimum Width of Bridges (Face-to-Face of Parapets or Curbs) Allowed to Remain in Place[(4)]		Approach Roadway Width or Face-to-Face of Curb					
Minimum Design Flood Frequency		30 year					
Minimum Clearance Above Design High-Water Elevation[(5)]		1′					
Design Live Load	New	HS-20					
	Remain in Place[(7)]	HS-15					
Vertical Clearance for Structures Over Highways[(6)]	New	See Figure 36-4I					
	Remain in Place	14′					
Horizontal Clearance for Structures Over Highways		See Figure 36-4I					
Vertical Clearance for Pedestrian or Bicycle Structures Over Highways		17’-3”					
Vertical and Horizontal Clearance for Structures Over Railroads		See Figures 36-4J and 36-4K					

TWS = Two-Way Street OWS = One-Way Street

DESIGN CRITERIA FOR NEW OR RECONSTRUCTED[(1)] URBAN COLLECTOR/LOCAL STREETS BRIDGES

Figure 36-5C (US Customary)

Classification		Urban Two-Way Collector		Urban One-Way Collector		Urban Local	
Highway Type		TWS-2	TWS-2	OWS-2	OWS-2	TWS-2	TWS-2
Approach Roadway Criteria		See Figure 32-2F		See Figure 32-2G		See Figure 32-2H	
Design Traffic Volumes		Two-Way ADT		One-Way ADT		Two-Way ADT	
		<5000	≥5000	<5000	≥5000	<1000	1000-5000
Clear Roadway Bridge Widths (Face-to-face of Parapets or Curbs)[2][3]		Approach Roadway Width (but not less than existing roadway width) or Face-to-Face of Curb as Specified in Chapter 32					
Minimum Width of Bridges (Face-to-Face of Parapets or Curbs) Allowed to Remain in Place[4]		Approach Roadway Width or Face-to-Face of Curb					
Minimum Design Flood Frequency		30 year					
Minimum Clearance Above Design High-Water Elevation[5]		300 mm					
Design Live Load	New	MS-18					
	Remain in Place[7]	MS-13.5					
Vertical Clearance for Structures Over Highways[6]	New	See Figure 36-4I					
	Remain in Place	4.3 m					
Horizontal Clearance for Structures Over Highways		See Figure 36-4I					
Vertical Clearance for Pedestrian or Bicycle Structures Over Highways		5.3 m					
Vertical and Horizontal Clearance for Structures Over Railroads		See Figures 36-4J and 36-4K					

TWS = Two-Way Street OWS = One-Way Street

DESIGN CRITERIA FOR NEW OR RECONSTRUCTED[1] URBAN COLLECTOR/LOCAL STREETS BRIDGES

Figure 36-5C (Metric)

<u>Footnotes for Figure 36-5C</u>

(1) *Implies reconstruction of a significant length of existing highway either on new location or within existing ROW. For reconstruction of relatively short intermittent highway segments within a project, the design criteria used, where cost-safety effective, should be consistent with the adjacent highway design but not less than that allowed to remain in place.*

(2) *Bridge widths for bridge rehabilitation projects are discussed in Chapter 33.*

(3) *For urban bridges requiring sidewalks, the width of the sidewalks is 5 ft (1.5 m) unless a wider width is specified by the local agency.*

(4) *Bridges remaining in place without a design exception approval when a safety record is satisfactory if the bridge is being gapped within a roadway section. Clear width between curbs or rails, whichever is less, should be equal to or greater than the approach traveled way width.*

(5) *For reconstruction projects, the proposed low superstructure should not be below the existing superstructure unless 1 ft (300 mm) of clearance above design high water is achieved. Any proposed clearance less than 1 ft (300 mm) above design high water elevation must be accompanied by a request for a design exception.*

(6) *The minimum required vertical clearance must be available over the traveled way and any paved shoulders.*

(7) *The design live load for bridges to remain in place only applies to minor rehabilitation and in-kind replacements (e.g. rail or joint repair, partial deck repair, individual stringer replacement, etc.). Other work, including deck replacement shall be considered new.*

Note: Traveled way width is the sum of the widths of all travel lanes. It is the larger of the value from Chapter 32 <u>or</u>, for existing bridges, the existing (or proposed) width of the approach traveled way.