# TABLE OF CONTENTS ~ GENERAL DESIGN

# 1 General Design

## 1.1 Overview

The Bridges and Structures Bureau (BSB) follows established Iowa Department of Transportation (Iowa DOT) practices, and on design and repair projects the Bureau works closely with the Design Bureau and Contracts and Specifications Bureau, as well as other bureaus. Bridges, culverts, sign structures, and other transportation structures are designed either by the Bureau or by engineering consultants, which are reviewed by the Bureau. To accommodate both groups of designers, many of the Bureau practices and resources have been placed on the Bureau web site (https://iowadot.gov/bridge/). Other resources for designers in the Bureau are available on the Iowa DOT W-drive. Complete details of the resources will not be repeated in this manual section.

Bridge and culvert designs generally progress from concept to preliminary design to final (or detail) design to contract. Generally, projects are packaged for contract letting as road, bridge, or separate. For a road project the Design Bureau has the lead and incorporates plan sheets from the Bridges and Structures Bureau and other bureaus into its plans. For a bridge project the reverse is true. For a separate project both the Design Bureau and the Bridges and Structures Bureau develop separate design plans. Even when projects are developed separately, however, the Contracts and Specifications Bureau may tie them together in a single contract.

Project plans at the Iowa DOT are produced in MicroStation software by design technicians as well as engineers. Plan production is aided by seed files for typical plan sheets, working standard drawings, and

signed standard plans for several bridge, culvert, and sign support structure types, all of which are available on the Bureau's web site. Both preliminary and final design software developed by the Bureau also is available on the web site and on the W-drive. Specific design and detail policies are covered either in this Bridge Design Manual or in Culvert and Bridge Checklists on the web site.

The Bureau has had a long-standing policy of checking in-house new bridge designs, and that policy now has been broadened and formalized in the Quality Control/Quality Assurance Plan [BDM 1.11]. A similar plan for bridge engineering consultants has been written into "Conducting Business with the Iowa DOT Bridges and Structures Bureau" [BDM 1.4].

It is expected that most projects will be completed without need for revision. However, necessary revisions can be accommodated during the contract letting process.

## 1.2 Definitions

**Article** refers to any numbered subdivision within a section of a direct reference such as *AASHTO LRFD Bridge Design Specifications, Bridge Design Manual,* or *Standard Specifications for Highway and Bridge Construction*. All of the following are articles: 1.1, 1.1.1, 1.1.1.1, and 1.1.1.1.1.

**Average span length (ASL)** is the average length of the two spans adjacent to a pier. See Figure 1.2-1.

**Bridge length (BL)** for structural design is the length from centerline of abutment bearing to centerline of abutment bearing. See Figure 1.2-1. In some situations bridge length may be taken as the length from expansion joint to expansion joint.

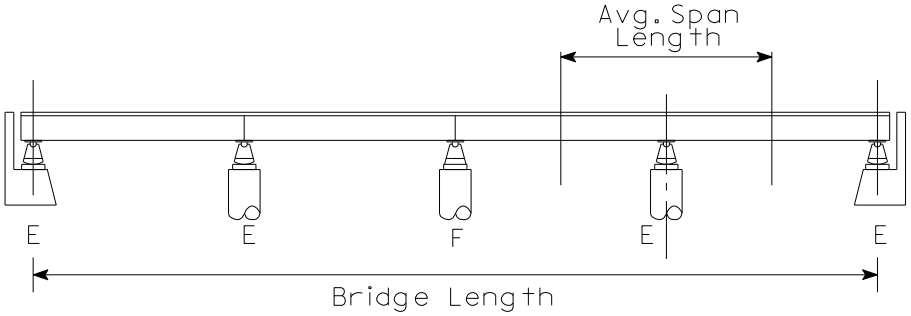



Figure notes:

- E indicates an expansion support.
- F indicates a fixed support.

**Figure 1.2-1. Length definitions**

**Built-in (sacrificial) wearing surface (BWS)** is taken as the top 0.75 inches of the original bridge deck. Weight of the built-in wearing surface is considered part of DC1, non-composite dead load of structural components and nonstructural attachments, [AASHTO-LRFD 3.3.2], but the wearing surface is not considered to contribute to the strength or stiffness of any part of the superstructure.

**Bureau** refers to the Bridges and Structures Bureau, Iowa Department of Transportation.

**File** includes electronic information in the project directory. Up to about the year 2022 the term file referred primarily to hard copy information placed in a physical yellow manila paper file envelope. References to file in this section of the Bridge Design Manual will be refined in the future.

**Future wearing surface (FWS)** is a concrete or hot mix asphalt overlay applied to the original bridge deck. Bureau practice is to consider the future wearing surface part of DW under the AASHTO LRFD

Specifications at 0.020 ksf but to neglect any potential contribution of the overlay to strength or stiffness of the superstructure.

**H-series** is a set of standard plans for pretensioned prestressed concrete beam (PPCB) bridges of specified roadway width.

**J-series** is a set of standard plans for continuous concrete slab (CCS) bridges of specified roadway width.

**Longitudinal** is the direction associated with the roadway centerline of construction and main girders. See Figure 1.2-2.

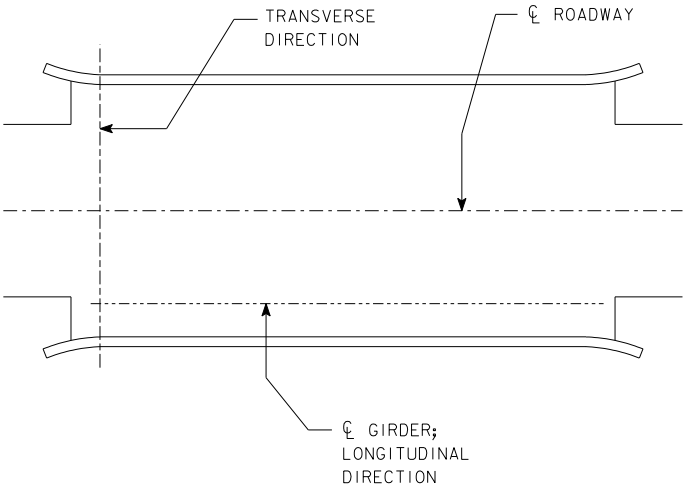



**Figure 1.2-2. Longitudinal and transverse direction definitions**

**National Highway System (NHS)** is composed of the following subsystems:

- Interstate,
- Other Principal Arterials,
- Strategic Highway Network (STRAHNET),
- Major Strategic Highway Network Connectors, and
- Intermodal Connectors.

Iowa state and city NHS maps are available from the NHS web site at the following URL.

https://www.fhwa.dot.gov/planning/national_highway_system/

**Natural ground elevation** is the average natural ground elevation along the longitudinal centerline of the foundation.

**Primary Highway System:** "Primary roads" or "primary road system" means those roads and streets both inside and outside the boundaries of municipalities which are under department (defined as state department of transportation) jurisdiction [Iowa Code 306.3.6].

**Quality Assurance** is an overall review performed and documented by the Transportation Engineer Manager (typically the supervising Unit Leader) during a bridge design.

**Quality Control** is the process of checking accuracy of computations, plans, and other design documents to ensure that a bridge design is free of errors and omissions. Quality control is the responsibility of the designer, design technician, and checker.

**RS-series** is a set of standard plans for rolled steel beam (RSB) bridges of specified roadway width.

**Section** refers to a chapter or division of a direct reference such as *AASHTO LRFD Bridge Design Specifications, Bridge Design Manual,* or *AASHTO Standard Specifications for Highway and Bridge Construction*. The following are examples of sections: 1. 2. and 3.

**Substructure** is any construction below the bearing seats or, in the absence of bearings, below the soffit of the superstructure.

**Transverse** is the direction normal to the roadway centerline of construction and main girders. See Figure 1.2-2.

**Unit Leader** is the supervisor of the Bridges and Structures Bureau Preliminary Design Unit, Final Design Unit, or Consultant Coordination Unit.

## 1.3 Abbreviations and notation

**A&A,** authentication and authorization
**ASL**, average span length
**BARS,** Bridge Analysis and Rating System
**BL**, bridge length
**BRIS,** Bridge Information System
**BSB,** Bridges and Structures Bureau (formerly OBS, Office of Bridges and Structures)
**BWS,** built-in wearing surface
**CCS,** continuous concrete slab
**CWPG**, continuous welded plate girder
**D**, dead load, including DC1, DC2, and DW
**DC1,** non-composite dead load of structural components and nonstructural attachments such as beams, deck, haunches, and diaphragms [AASHTO-LRFD 3.3.2].
**DC2,** composite dead load of structural components and nonstructural attachments such as barrier rails, sidewalks, curbs, and medians that are not part of the initial deck pour [AASHTO-LRFD 3.3.2].
**DGN** or **dgn,** file type for MicroStation files
**DW,** dead load of wearing surfaces and utilities [AASHTO-LRFD 3.3.2].
**EOR,** engineer of record
**ERMS**, Electronic Records Management System
**FHWA,** Federal Highway Administration
**Form 220008,** Bridge Inventory Report Form (formerly Form 107)
**FWS**, future wearing surface
**I**, live load impact [AASHTO-I 3.8]
**IM,** dynamic load allowance [AASHTO-LRFD 3.6.2]
**L**, live load, HS20 truck load or lane load, whichever has greater effect; military load, if applicable [AASHTO-I 3.7]
**LARS,** Load Analysis and Rating System
**LL,** live load, HL-93 [AASHTO-LRFD 3.6.1]
**LRFD**, load and resistance factor design
**MB**, Maintenance Bridge. MB projects include bridge deck patching, bridge approach work, and miscellaneous bridge repairs.
**N or N-value**, standard penetration test number of blows per foot. N also may be given as **SPT NO**, the Standard Penetration Number, in the soils information chart reference.
**NHS,** National Highway System
**PIN,** program improvement number
**POI,** point of intersection of pavement surface cross slopes that defines the profile grade location
**PPCB,** pretensioned prestressed concrete beam
**PPMS**, Program and Project Management System (Masterworks)
**PSS,** Project Scheduling System
**QA,** quality assurance

**QC,** quality control
**QM-A,** Quality Management - Asphalt
**RAMS**, Road Asset Management System
**RCBC,** reinforced concrete box culvert
**RSB,** rolled steel beam
**SIIMS,** Structure Inventory and Inspection Management System
**TEM,** Transportation Engineer Manager (usually the supervising Unit Leader)
**TS&L,** type, size, and location
**URL,** Uniform Resource Locator

## 1.4 References

### 1.4.1 Direct

Throughout the *Bridge Design Manual* there are frequent, direct references to specific portions of standards and publications. Direct references are included in brackets [ ] using the abbreviations given below. Applicable references to the AASHTO LRFD Specifications and, in a few cases, to the Standard Specifications are given with each article heading.

Although the latest editions are listed below there are some circumstances in which documents referenced in this manual have been prepared on the basis of previous editions.

[AASHTO-division article, table, or figure] refers to *AASHTO Standard Specifications for Highway Bridges, 17th Edition (2002)* with current errata changes - design, seismic design, or construction division with article, table, or figure number.

[AASHTO-LRFD article, table, or figure] refers to *AASHTO LRFD Bridge Design Specifications, 8th Edition (2017)* with article, table, or figure number.

[AASHTO-LRFD-2020 article, table, or figure] refers to *AASHTO LRFD Bridge Design Specifications, 9th Edition (2020)* with article, table, or figure number.

[AASHTO-Temp article, table, or figure] refers to *AASHTO Guide Design Specification for Bridge Temporary Works, 1st Edition (1995) with 2008 Interim Revisions* with article, table, or figure number. [See also 2nd Edition (2017).]

[AASHTO-LTS-6 article, table, or figure] refers to AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition (2013)* with article, table, or figure number.

[AASHTO-LRFDLTS-1 article, table, or figure] refers to *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 1st Edition (2015)* with article, table, or figure number.

[BDM article, table, figure, or note] refers to the Iowa DOT Bridges and Structures Bureau *LRFD Bridge Design Manual* with article, table, figure, or plan note number. (Available on the Internet at:https://iowadot.gov/bridge/Design-Policies/LRFDdesignmanual )

[IDOT DS-number] refers to an Iowa DOT developmental specification, which is a hybrid of a supplemental specification and special provision.

[IDOT PPM policy number] refers to a policy in the Iowa DOT *Policies and Procedures Manual.*

[IDOT SS article] refers to Iowa DOT *Standard Specifications for Highway and Bridge Construction, Series 2009* with article number. (Available on the Internet at: https://iowadot.gov/erl/current/GS/Navigation/nav.htm)

[BSB SS sheet number] refers to a Bridges and Structures Bureau, Highway Administration "Standard Sheet" with sheet number. (Available on the Internet at: https://iowadot.gov/bridge/Bridge-and-Culvert-Standards/Bridge-Standards)

[DB DM article, table, or figure] refers to the Design Bureau, Highway Administration *Design Manual* with article, table, or figure number. (Available on the Internet at: https://iowadot.gov/design/Design-manual)

[DB RDD sheet number] refers to the Design Bureau, Highway Administration "Road Design Details" with sheet number. Formerly the detail manual was referred to as the "green book." (Available on the Internet at: https://iowadot.gov/design/Road-design-details)

[DB SRP sheet number] refers to a Design Bureau, Highway Administration "Standard Road Plan" with sheet number. Formerly the plan manual was referred to as the "red book." (Available on the Internet at: https://iowadot.gov/design/Standard-road-plans)

[CMB IM number] refers to Construction and Materials Bureau, Iowa DOT Instructional Memorandum number. (Available on the Internet at: https://iowadot.gov/erl/current/IM/navigation/nav.htm)

### 1.4.2 Indirect

Indirect references are general and infrequent sources of information for *Bridge Design Manual* that usually are not linked with specific article or section numbers. The list below is not complete; see major articles for applicable complete lists.

American Association of State Highway and Transportation Officials (AASHTO). *Manual for Bridge Evaluation, 3rd Edition.* Washington: AASHTO, 2018.

American Concrete Institute (ACI). *Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19).* Farmington Hills: ACI, 2019.

American Institute of Steel Construction (AISC). *Steel Construction Manual, 15th Edition.* Chicago: AISC, 2017.

American Railway Engineering and Maintenance-of-Way Association (AREMA). *Manual for Railway Engineering, 2019 Edition*. Landover: AREMA, 2019.

American Society for Testing and Materials (ASTM). *2022 Annual Book of ASTM Standards*. West Conshohocken: ASTM, 2022.

American Welding Society (AWS). *Bridge Welding Code, AWS D1.5-2020.* Miami: AWS, 2020.

Dirks, Kermit and Patrick Kam. *Foundation Soils Information Chart, Pile Foundation*. Ames: Iowa Department of Transportation, Office of Road Design, January 1989/September 1994.

Greimann, L.F., R.E. Abendroth, D.E. Johnson, and P.B. Ebner. *Final Report, Pile Design and Tests for Integral Abutment Bridges, HR-273, and Addendum.* Ames: Iowa Department of Transportation and College of Engineering, Iowa State University, 1987.

Lundquist, William A. *Iowa DOT Bridge Design Office Metric Handbook.* Ames: Office of Bridges and Structures, 1994 updated through 1996.

Federal Highway Administration (FHWA). *Steel Bridge Design Handbook*. FHWA-HIF-16-002. Washington, DC: FHWA, 2015.

Bridges and Structures Bureau. *Conducting Business with the Iowa DOT Bridges and Structures Bureau.* Ames: Bridges and Structures Bureau, April 2021. (Available on the Internet at: https://iowadot.gov/bridge/policy/ConductingBusinessWithIADOT.pdf)

Bridges and Structures Bureau, *Bridge and Culvert Plan Checklists*. (Available on the Internet at: https:/iowadot.gov/bridge//design-policies/Bridge-and-Culvert-Plan-Checklist)

Construction and Materials Bureau. *Construction Manual.* Ames: Construction and Materials Bureau, Iowa Department of Transportation, 2006. (Available on the Internet at: https://iowadot.gov/erl/current/CM/Navigation/nav.htm)

Precast/Prestressed Concrete Institute (PCI). *Bridge Design Manual.* 3rd Edition, 2nd Release. Chicago: PCI, 2014. (Available on the Internet at: https://www.pci.org/ItemDetail?iProductCode=MNL-133-11)

Sunday, Wayne and Kyle Frame. *New Bridge Construction Handbook.* Ames: Construction and Materials Bureau, Iowa Department of Transportation, 2000. (Available on the Internet at: https://iowadot.gov/construction_materials/structures_foundations/bridge_construction_handbook.pdf )

## 1.5 Americans with Disabilities Act

The Iowa Department of Transportation (Iowa DOT) intends to comply with the Americans with Disabilities Act (ADA), and the Design Bureau has developed specific guidelines based on “Proposed Guidelines for Public Rights of Way” (PROWAG) of 2011 and “Americans with Disabilities Act Accessibility Guidelines” (ADAAG) of 2010. The Design Bureau guidelines are in Chapter 12 of the Design Manual [DB DM 12A, 12B, and 12C], and more may be added in the future. The guidelines affect all new transportation facilities, and the Iowa DOT is developing a transition plan for existing facilities on state rights-of-way.

Because of the law and enforcement, the guidelines are absolute and not subject to engineering judgment. Construction tolerances must be accommodated on the high side of a minimum and on the low side of a maximum. For example, the Design Bureau has chosen to specify a target sidewalk cross slope of 1.5 percent to accommodate construction tolerances on the low side of the PROWAG 2 percent maximum.

For alteration of existing facilities there may be allowance for practicality when it is impossible to meet all guidelines. The designer shall discuss all exceptions with the Methods Unit of the Design Bureau.

Currently the Design Bureau requires bridges with “pedestrian access” to have ADA compliant facilities [DB DM 12C-1]. “Pedestrian access” includes sidewalks, trails, and shared use paths. Although ADA affects the design of new bridges, the Design Bureau also recommends ADA upgrades outside project limits [DB DM 12C-1]. In some cases, this could involve a bridge near road repairs when the bridge otherwise would not be included in the project.

Generally, it appears that complying with ADA in design of bridges with pedestrian facilities will involve maintaining minimum width, providing a slip-resistant walking surface, providing a surface with a maximum cross slope of 2 percent, bridging all joints that may be wider than 1/2 inch, beveling all vertical surface discontinuities more than 1/4 inch, and limiting all vertical surface discontinuities to 1/2 inch. For unusual situations on or under bridges requiring curb ramps, detectable warning surfaces, and other special accommodations the designer shall consult with the Methods Unit of the Design Bureau.

### 1.5.1 Sidewalks, trails, and shared use paths

Currently the Design Bureau has prepared guidelines for sidewalks and shared use paths [DB DM 12A-2, 12B-2]. Trails generally are defined as recreational facilities rather than transportation facilities, and the usual standards for trails may not meet the ADA [DB DM 12B-1]. The bridge designer shall consult with the Methods Unit in the Design Bureau for the latest standards for trails.

The following guidelines apply to a sidewalk on a bridge and, in a few cases, are slightly different from the Design Bureau's guidelines for a sidewalk beyond a bridge deck.

- Minimum width for a sidewalk shall be 5 feet. This width shall be clear of all obstructions at all elevations less than 6.7 feet above the sidewalk surface. Although the PROWAG guidelines state a minimum width of 4 feet, at a width of less than 5 feet passing zones are required, which would require a wider bridge deck at the zones. It is simpler for bridge design to provide a constant 5-foot width. Exceptions need to be discussed with the Methods Unit in the Design Bureau.

- Maximum cross slope shall be 2 percent. The Design Bureau uses a target 1.5 percent slope. The BSB will also typically target 1.5 percent slope on the bridge. Bridge sidewalks generally are constructed more accurately than sidewalks on grade so if drainage and ponding are a concern, consideration can be given to using a 2 percent cross slope on the bridge. The plan note needs to be worded carefully so that the contractor provides adequate drainage slope but does not exceed a 2 percent cross slope.

- Because a bridge sidewalk will be contained within the highway right-of-way, sidewalk grade in the direction of travel may follow but not exceed the roadway grade.

- The sidewalk surface shall be firm, stable, and slip resistant. Generally, the Iowa DOT standard specifications for a burlap drag or broom texture on concrete sidewalks should meet this requirement [IDOT SS 2511.03, C, 3]. In cases where steel plates are used to bridge deck joints the designer shall specify galvanized floor plate with raised figures (ASTM A786/A786M), also known as checker or diamond plate.

- Galvanized steel floor plate shall be used to bridge all joints greater than 1/2 inch wide in the direction of travel. For movable joints the plate shall be attached to one side with recessed anchor screws flush with the riding surface of the plate.

- Elevation discontinuities, such as floor plate, shall be limited to 1/2 inch. Elevation discontinuities between 1/4 inch and 1/2 inch shall be beveled with a slope not steeper than 1:2, vertical to horizontal, and the bevel shall be applied to the entire vertical discontinuity.

- If a sidewalk is provided at the elevation of the bridge deck, the sidewalk shall be separated from the roadway with a separation barrier [BDM 5.8.1.2.4]. If a sidewalk is elevated from the bridge deck with a curb no sidewalk edge protection at the curb is required.

### 1.5.2 Pedestrian overpasses

A bridge designed for pedestrian access only shall meet the guidelines stated above [BDM 1.5.1] and, in addition, shall have a maximum grade of 5 percent. See also the Preliminary section in this manual for guidelines specific to pedestrian overpasses [BDM 3.2.5]. Because the connecting facilities need to fit the overpass, the designer shall consult with the Methods Unit of the Design Bureau.

### 1.5.3 Other bridge-related facilities

Pedestrian underpasses and other bridge-related facilities shall meet the guidelines stated above [BDM 1.5.1] and, in addition, shall have a maximum grade of 5%. See also the Preliminary section in this manual for guidelines specific to pedestrian underpasses [BDM 3.5]. Because the connecting facilities need to fit the underpass or other facility, the designer shall consult with the Methods Unit of the Design Bureau.

The elevation guidelines for sidewalks listed above, when applied to box culvert underpasses, will require that the culvert floor be flat, without frost trough [7.2.4.11.4]. Because floor joints between precast box culvert sections are likely to exceed 1/2 inch in the direction of travel, precast culvert floors shall include a PC overlay [7.3.4.2.4]

## 1.6 Buy America Provisions

In general all manufactured products of iron, steel, or which have a coating of steel must be of domestic origin and shall be melted and manufactured in the U.S. For the specific requirements of the Buy America Provisions, see IDOT SS 1107.06, B and CMB IM 107.

Two of projects in 2014 included components manufactured from channel sizes of up to 10 inches. Smaller size channels are not always readily available in the U.S. For these smaller size channels, the designer should specify equivalent bent plates.

## 1.7 Bridge layout

### 1.7.1 Profile grade line

When the profile grade line is defined at the centerline of approach roadway it is necessary to consider the transition between the template of the approach roadway and the crown template of the bridge deck. The Design Bureau defines the profile grade to be the point of intersection (POI) between the pavement surface cross slopes as shown in Figure 1.7.1. The deck elevation at the bridge deck crown will be below the POI to account for the rounding of the bridge deck with a parabolic template.

The rounding of the approach roadway surface is not as well defined as the parabolic template established for the bridge deck crown, however some rounding of the roadway surface at the cross slope intercepts is typical during pavement placement and will match reasonably close to the template shown for the bridge deck crown.

The designer shall establish bridge deck elevations using Figure 1.7.1 and the appropriate ‘X’ value from Table 1.7.1. Typically, the crown template with the appropriate inserted ‘X’ and slope values should be shown on the Top of Slab Elevations sheet.

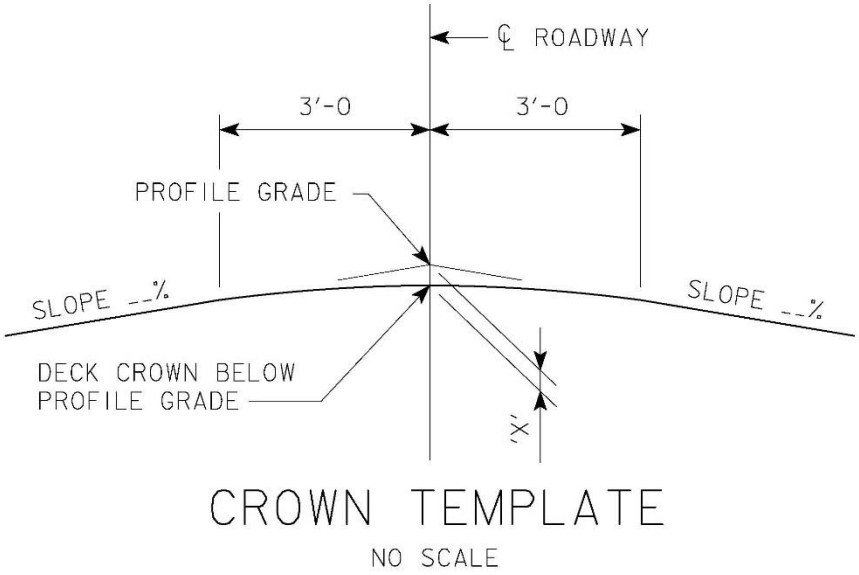



**Figure 1.7.1. Crown template with profile grade**

**Table 1.7.1. Recommended values for ‘X’ in Figure 1.7.1**

| Slope, % | ‘X’, feet |
|---|---|
| 2.0 | 0.03 |
| 2.5 | 0.04 |

| | |
|---|---|
| 3.0 | 0.05 |

Using this method will ensure the approach roadway surface in the travelled lanes and the outside edge of pavement will match the bridge deck elevations. Elevations shown on the longitudinal section of the situation plan sheet (or TS&L) will reflect the top of bridge deck crown elevations along the centerline of approach roadway to the nearest hundredth of a foot. These elevations shall be noted on the situation plan sheet with the correct 'X' value inserted as follows:

TOP OF BRIDGE DECK CROWN 'X' FEET BELOW PROFILE GRADE.

## 1.7.2 Slope

Bridges on steeper grades require additional consideration from designers:

- Horizontal versus along grade dimensioning with respect to span and beam lengths.
- The effect of deck and end beam slope on the detailing of expansion joints.
- Clearance between the bottom flange of beams and the edge of abutment footings or pier caps.
- Bearing details for tapered and curved sole plates.

Designers also need to consider the tendency of bridges with steeper downward slope over the entire length of the bridge to creep downhill over time. In order to prevent this movement, consideration should be given to fixing multiple piers and using integral or semi-integral abutments at least on the low end of the bridge.

When the difference between the horizontal length and the profile grade length for any span within a PPCB bridge is greater than 1/2 inch follow the guidelines below.

Bridge stationing shall be measured along the horizontal from centerline to centerline of bearings (vertical), but individual spans and bridge length are to be measured along the grade from the centerline to centerline of bearings (normal to grade) based on standard beam lengths as indicated in Figure 1.7.2-1.

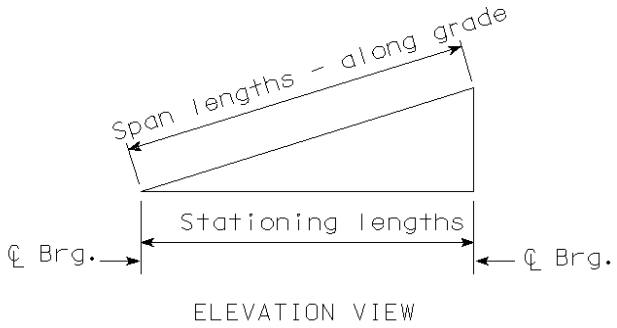



**Figure 1.7.2-1. Dimensioning of stationing and span lengths**

The situation plan should dimension the horizontal lengths of the bridge, centerline to centerline of abutment bearings and centerline to centerline of spans, and the corresponding stations. The plan should also include the dimension lengths from centerline to centerline of abutment bearings and face to face of paving notches for the lengths along the profile grade. Label these lengths "Horizontal" and "Along Grade". All other applicable plan lengths should be labeled accordingly. Although the span lengths based on profile grade chords will be known approximately during preliminary design, the final designer may need to adjust the lengths slightly depending on camber.

Include in the plans a partial longitudinal section showing centerline of abutment bearing vertical and centerline of bearing normal to grade as shown in Figure 1.7.2-2.

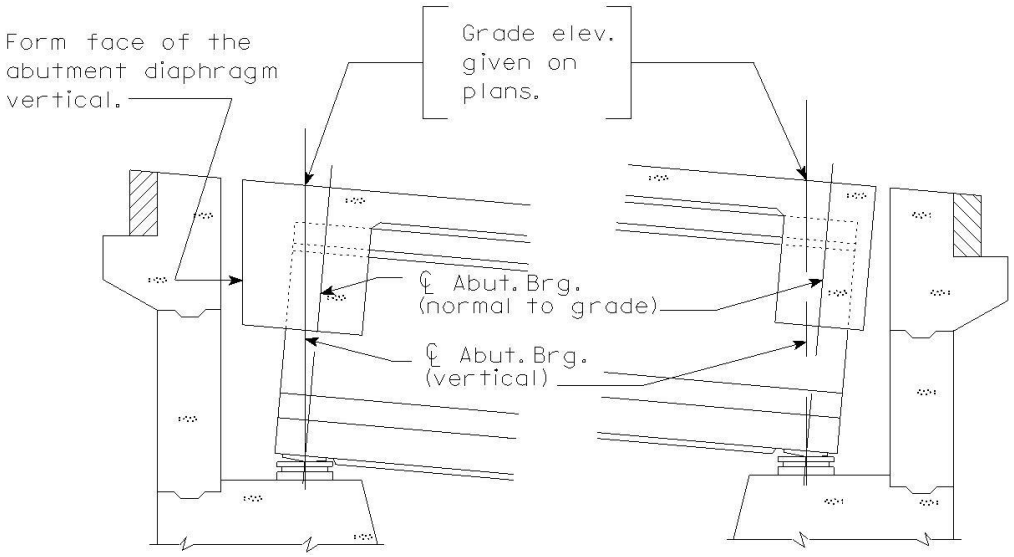



**Figure 1.7.2-2. Partial longitudinal section along centerline of roadway at abutments, with grade variations**

If there is an expansion joint at a pier, include a partial longitudinal section at the pier, showing centerline of beam bearings vertical and normal to grade as in Figure 1.7.2-3.

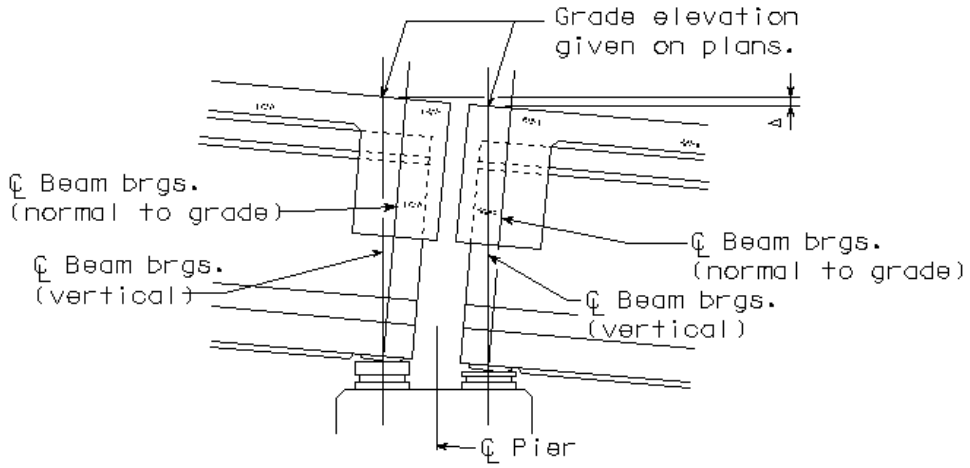



**Figure 1.7.2-3. Partial longitudinal section along centerline of roadway at pier, with grade variations**

If the change in elevation from the front of the backwall to the centerline of abutment bearing (vertical) or front to back of backwall is greater than 1/8 inch show the dimension as in Figure 1.7.2-4.

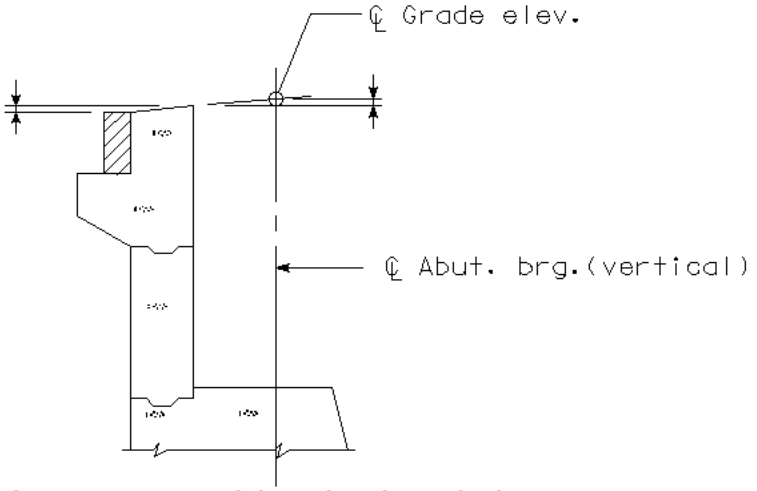



**Figure 1.7.2-4. Partial section through abutment**

## 1.7.3 Spiral curve

In order to minimize complicated bridge geometry, the Design Bureau will avoid using spiral curves on bridges [BDM 3.2.6.3.1]. For the unusual case in which the designer needs spiral curve information, it is given in Figure 1.7.3.

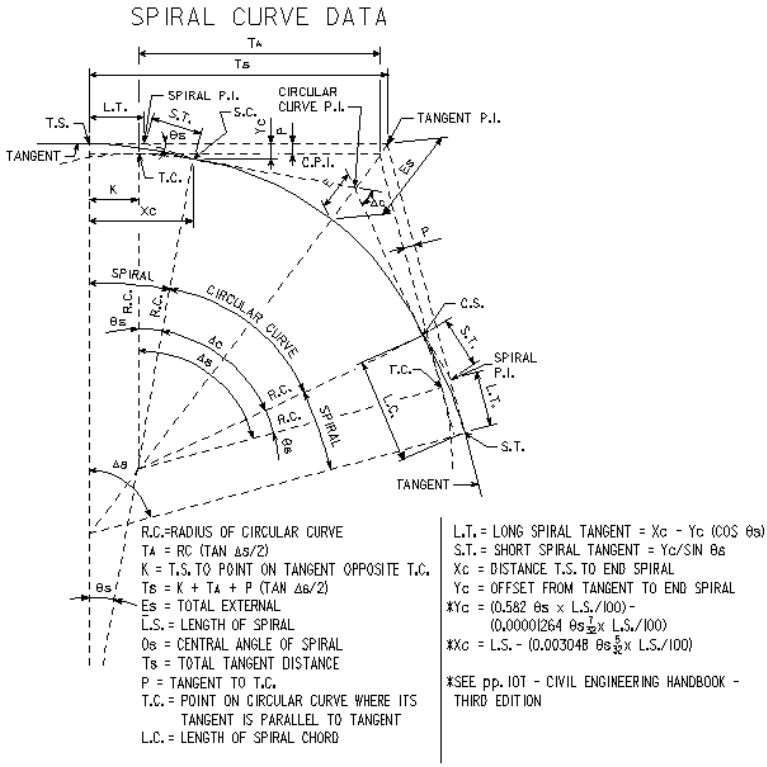



**Figure 1.7.3. Spiral curve information**

## 1.8 Bridge plan preparation

Although plans for a bridge are prepared by the Bridges and Structures Bureau or consultants to the Bureau, the plans must be coordinated with other bureaus associated with the project. The bridge will be part of a highway project and thus the bridge plans must fit with plans prepared by the Design Bureau or consultants to that bureau. The flow chart from concept to contract letting for a typical bridge replacement project is given in Section 1D-1 of the Design Bureau's Design Manual (https://iowadot.gov/design/dmanual/01D-01.pdf). When complete, the bridge plans are turned-in to the Contracts and Specifications Bureau and must meet its requirements.

Bridge plans follow standard formats established with the usage of the Bureau's CADD seed files. Guidance for using the seed files is available at: https://iowadot.gov/bridge/tools/CONNECT%20Seed%20Files.pdf Additional resources covering topics such as models, fonts, levels, and features are also available on the CONNECT Applications webpage.

Also, the CONNECT Applications webpage **Error! Hyperlink reference not valid.** includes instructions for various workflow topics such as:

- Project folder structure in ProjectWise document management software,
- Consultant project folder structure in ProjectWise,
- Using V8i Standards in CONNECT,
- OpenBridge Designer Version Maintenance,
- OpenBridge Designer Analysis Workflow, and
- OpenBridge Designer Starting Model,

Many of the detailed items on bridge plans, such as title block and location map, are covered in documents on the Bridge and Culvert Plan Checklist page (https://iowadot.gov/bridge/Design-Policies/Bridge-and-Culvert-Plan-Checklist).

Generally bridge plans are organized in the sequence indicated in the sub-articles that follow.

### 1.8.1 Title sheet

See also Plan Review Checklist: 2. Title Sheet – All Projects.

#### 1.8.1.1 Engineers seals

An index of seals is required on the title sheet for each project plan set. For each design type included in the project, such as structural, hydraulic, geotechnical, and roadway, the sheet number containing the seal and designer are listed in the index. When the project is prepared by the Bridges and Structures Bureau, the title sheet shall contain the seal-certification-signature blocks for the responsible structural and hydraulic designers. The responsible designers are defined in Table 1.8.1.1.

**Table 1.8.1.1. Designers responsible for sealing structural and hydraulic designs**

| **Design type** | **Seals to be placed on title sheet** | |
|---|---|---|
| | **Designer licensed as Professional Engineer** | **Designer not licensed** |
| Structural | Designer's seal | Supervising Final Design Unit Leader's seal |
| Hydraulic | Designer's seal | Preliminary Design Unit Leader's seal |

For projects that include signed standard plans (J-series, H-series, RS series, single RCBC, twin RCBC, triple RCBC, flume box culvert, overhead sign truss, and roadside dynamic message sign support standards), the index of seals additionally shall include the Bridge Engineer's name for structural design of the standards. The index line should read "Bridge (or Culvert or Sign Support) Standards, James S. Nelson or Norman L. McDonald (as appropriate), and Structural Design." The line is included in the index

of seals on the seed file for a bridge title sheet, and the designer will need to delete the line if it is inappropriate.

#### 1.8.1.2 Traffic data

Traffic data shall be given on a situation plan sheet, and the data or a note regarding the data shall be given on the title sheet. If there is a single bridge design in a project, the traffic data is to be given on the title sheet but, if there are multiple designs, a note is to be given that refers to the individual situation plan sheets for the traffic information.

The traffic information on the bridge title sheet is labeled as “Design Data Rural” or “Design Data Urban”, which matches the way the Design Bureau labels its traffic information. On the situation plan sheet the traffic information is labeled as “Traffic Estimate” and contains the same traffic information as shown on the title sheet.

Both the traffic information blocks and the traffic note referring to individual situation plan sheets are given on the seed title sheet, and the designer should delete the inappropriate items.

### 1.8.2 First sheet

See also Bridge Plan Review Checklist: 3. First Sheet of Design – All Projects.

#### 1.8.2.1 Bid items and quantities

Bid items and quantities in the table of Estimated Bridge Quantities are determined by the designer, with consideration of the guidelines below, and entered into PPMS when designed by the Bridges and Structures Bureau. The bid items are added to the first sheet with the BidItems application available in MicroStation. The Contracts and Specifications Bureau automatically receives the bid items to prepare the proposal.

The non-structural bid items listed below are added to the Estimate of Quantities in accordance with the following guidelines, which may involve the Bureaus of Design, Contracts, Local Systems, and Construction.

- Flaggers: The Design Bureau will add this item when a Standard Road Plan or a Design Bureau detail is referenced requiring it. Design Bureau will input a quantity of one. The Contracts and Specifications Bureau will then determine the contract period and change the quantity accordingly.

- Pilot Cars: The Design Bureau will add this item when a Standard Road Plan or a Design Bureau detail is referenced requiring it. Design Bureau will input a quantity of one. The Contracts and Specifications Bureau will then determine the contract period and change the quantity accordingly.

- Mobilization: The designer shall include this item in all projects. If the Design Bureau and Bridges and Structures Bureau have a combined project, the bureau creating the title sheet will add this item.

- Field Lab: The Contracts and Specifications Bureau will send the Design Bureau and Local Systems a copy of its criteria for determining when a field lab is required on a project. The Design Bureau will add this item when it is required.

- Field Office: This item will be determined at the field exam. The Design Bureau will add this item if it is necessary.

- Trainees: This item will only be included on state projects. The Contracts and Specifications Bureau will notify the designer 12 weeks before letting (2 weeks before turn-in) of the quantity if it

is required. If the Design Bureau and Bridges and Structures Bureau have a combined project, the bureau creating the title sheet will add this item.

- Clearing and Grubbing: The field will send the quantity for this item directly to the designer. This includes area and/or count quantities. This information may be sent any time after field exam and prior to 12 weeks before letting.

- Construction Survey: This item shall be included for all projects involving new and replacement structures (culvert and bridge), deck replacements, and widenings. This item is typically not included for deck overlay projects or other project types, however, there may be exceptions in special circumstances.

- Quality Management - Asphalt (QM-A): The Construction and Materials Bureau will notify the designer when this item is required.

- Railroad Liability Insurance: Upon review of the project concept, the Rail Transportation Bureau will update PPMS indicating if there will be railroad involvement. If a railroad is involved the lead Bureau will add this item.

The Excavation Classification Line elevation, which is used for calculating structural excavation quantities and sets the limits between Class 20 Excavation and Class 21 Excavation, shall be determined as follows.

(1) On the bridge TS&L sheet prepared by the Preliminary Bridge Design Unit the designer should find the average low water elevation and average design streambed elevation.
(2) Determine the elevation of the Excavation Classification Line as the higher of (a) the average low water elevation and (b) the average design stream bed elevation plus one foot.

The method of measurement for structural excavation quantities may be found in IDOT SS 2402.04. The vertical plane boundary dimensions for Class 21 Excavation are not explicitly defined in the Specifications, but are to be indicated in the contract documents per IDOT SS 2402.04, A, 3. Designers shall ordinarily determine quantities for Class 21 Excavation based on the same vertical plane boundary dimensions used for Class 20 Excavation [e.g. IDOT SS 2402.04, B, 2]. The boundaries assumed for Class 21 Excavation shall be indicated in the contract documents, preferably by note in the Bid Item Estimate Reference Information.

### 1.8.2.2 General notes

Reserved.

## 1.8.3 Situation plan

See the information provided for preliminary designers in the Preliminary section [BDM 3.2.9] and see Bridge Plan Review Checklist: 4. Situation Plan.

See the information provided for preliminary and final designers in BDM C3.3.4 with respect to additional situation plan requirements for overpass projects involving the BNSF and UP railroads.

BDM 3.7.3.3 and 3.7.3.4 describes the requirements for the development of the berm slope location table (BSLT) and the recoverable berm location table (RBLT) as prepared by the Preliminary Design Unit. The bench at the top of the berm slope is typically set at 3 feet wide and 2 feet above the bottom of the abutment footings. The location and elevation of the abutment footing may vary somewhat between preliminary and final design as the bridge design is refined. The berm terrain model developed by Preliminary Design does not typically need to be updated by Final Design if the elevation of the abutment footing is only adjusted by ±6 inches or, alternatively, if the abutment centerline station changes by ±18”. The designer should consult with the supervising Unit Leader to determine whether an adjustment to the berm terrain is desirable if these limits are exceeded. If an adjustment to the berm terrain model is

deemed appropriate the Final Design Unit shall make the adjustments to the Situation Plan and the corresponding tables.

### 1.8.4 Staking coordinates and staking diagram

Substructure staking coordinates shall be provided in an E-file (BDM 1.14.1) and in a table in the plan set for all new and replacement bridges. Typically, the Iowa Regional Coordinate System (IaRCS) zone in which the structure resides will be the substructure staking coordinate system used. The survey documentation file should list the coordinate system assigned to each project. Substructure staking coordinates are formatted as X (Easting) and Y (Northing). Three sets of coordinates shall be provided for each substructure unit. The coordinates shall be taken along the centerline of a substructure unit at the centerline of approach roadway and each edge of the deck. Instructions for producing substructure staking coordinates can be found at https://iowadot.gov/bridge/tools/Bridge%20Staking%20Data%20Instructions.pdf.

The designer shall provide a staking diagram for the following types of bridge projects:

- Dual bridges on interstate or other four-lane primary roads,
- Bridges with special widths for climbing lanes, sidewalks, or shared use paths,
- Tapered bridges,
- Other straight bridges for which “centerline of approach roadway” does not coincide with centerline of bridge roadway, and
- Bridges along curved alignments.

For straight bridges the “centerline of approach roadway” is the primary staking control. To avoid confusion, the centerline of bridge roadway shall not be shown on the staking plan. The designer should designate the bridge centerline as “centerline of bridge” and dimension the offset from “centerline of approach roadway”. The designer may show the “centerline of profile grade” but shall not reference it to “centerline of approach roadway”.

For horizontally curved bridges the primary control line is a chord baseline defined at each end by the intersection of the centerline of the abutment and centerline of approach roadway or approach baseline.

The staking diagram should show dimensions from “centerline survey” or “centerline approach roadway” to the following:

- Centerline of abutment footings and pier footings,
- Outside limits of abutment footings,
- Gutterline location at abutments, and
- Centerline of P10L pier locations.

The designer also shall show non-zero skew angles of abutments and piers.

See also Bridge Plan Review Checklist: 5. Staking Diagram – New Construction.

### 1.8.5 Substructure general

See Bridge Plan Review Checklist: 6. Substructure – General – New Construction.

### 1.8.6 Pier details

See the detailing information provided for final designers in the Piers section [BDM 6.6.4] and see Bridge Plan Review Checklist: 7. Pier Details – New Construction.

### 1.8.7 Abutment details

See the detailing information provided for final designers in the Abutments section [BDM 6.5.4] and see Bridge Plan Review Checklist: 8. Abutment Details – New Construction.

### 1.8.8 Superstructure general

See Bridge Plan Review Checklist: 9. Superstructure Details – General – New Construction.

#### 1.8.8.1 CWPG

See the detailing information provided for final designers in the Steel Girders and Beams section [BDM 5.5.1.4.2] and see Bridge Plan Review Checklist: 10. Superstructure Details – CWPG – New Construction.

#### 1.8.8.2 PPCB

See the detailing information provided for final designers in the Pretensioned Prestressed Concrete Beams section [BDM 5.4.1.4.2] and see Bridge Plan Review Checklist: 11. Superstructure Details – PPCB – New Construction.

### 1.8.9 Repair/overlay details

See the information provided for final designers in the Bridge and Culvert Repair section [BDM 12.1.9.1] and see Bridge Plan Review Checklist: 12. Details – Repair/Overlay Projects.

### 1.8.10 Miscellaneous details

Reserved.

#### 1.8.10.1 Barrier rails

See the information provided for final designers in the Railings section [BDM 5.8.1] and see Bridge Plan Review Checklist: 13. Barrier Rail.

#### 1.8.10.2 Expansion devices

See the information provided for final designers in the Expansion Joints section [BDM 5.8.3] and see Bridge Plan Review Checklist: 14. Expansion Device.

#### 1.8.10.3 Subdrains

See Bridge Plan Review Checklist: 15 Subdrain/Slope Protection Details.

#### 1.8.10.4 Slope protection

See Bridge Plan Review Checklist: 15 Subdrain/Slope Protection Details.

#### 1.8.10.5 Lighting

See Bridge Plan Review Checklist: 16. Lighting Details.

#### 1.8.10.6 Approach sidewalk

See Bridge Plan Review Checklist: 18. Approach Sidewalk.

#### 1.8.10.7 Other

Reserved.

### 1.8.11 Aesthetics

See Bridge Plan Review Checklist: 17. Aesthetics.

### 1.8.12 Soils sheets

For bridge and culvert projects one or more soil profile sheets will be provided by the Soils Design Unit of the Design Bureau, and any additional sheets should be placed in the plan set after the last structural design sheet.

### 1.8.13 Roadway plans

For a typical bridge or culvert project one or more roadway sheets will be provided by the Design Bureau. If needed the roadway sheets will include the traffic control plan. The first roadway sheet will have an engineer's seal-certification-signature block for the roadway design, and the sheet and any additional sheets should be placed in the plan set after the last geotechnical design sheet.

See also Bridge Plan Review Checklist: 19. Roadway Plans.

### 1.8.14 Signed standard plans

Projects that include signed standard plans (J-series, H-series, RS-series, single RCBC, twin RCBC, triple RCBC, flume box culvert, overhead sign truss, and roadside dynamic message sign support standards), shall include the signed sheets, referenced on the Title Sheet in the English Standard Bridge Plans table, in a multi-page PDF file to a subfolder in the Contracts plan turn-in folder.

## 1.9 Culvert plan preparation

Although plans for a culvert are prepared by the Bridges and Structures Bureau or consultants to the Bureau, the plans must be coordinated with other bureaus associated with the project. The culvert will be part of a highway project and thus the culvert plans must fit with plans prepared by the Design Bureau or consultants to that bureau. When complete the culvert plans are turned-in to the Contracts and Specifications Bureau and must meet its requirements.

Culvert plans follow standard formats, and the design technician is required to start with the Bureau's CADD seed files at: https://iowadot.gov/bridge/tools/CONNECT%20Seed%20Files.pdf. Additional resources covering topics such as models, fonts, levels, and features are available on the CONNECT Applications webpage.

Also, the CONNECT Applications webpage includes instructions for various workflow topics such as:

- RCB Culvert Design Workflow,
- Project folder structure in ProjectWise,
- Consultant project folder structure in ProjectWise, and
- Using V8i Standards in CONNECT.

Many of the detailed items on culvert plans, such as title block and location map, are covered in the Culvert Plan Review Checklist on the Bridge and Culvert Plan Checklist page (https://iowadot.gov/bridge/Design-Policies/Bridge-and-Culvert-Plan-Checklist). For general plan items see Culvert Plan Review Checklist: 1. General – All Projects.

Generally, culvert plans are organized in the sequence indicated in the sub-articles that follow.

### 1.9.1 Title sheet

See the discussions of engineers' seals and traffic data for bridge projects [BDM 1.8.1.1 and 1.8.1.2] and Culvert Plan Review Checklist: 2. Title Sheet – All Projects.

### 1.9.2 First sheet

See the discussion of quantities [BDM 1.8.2.1] and Culvert Plan Review Checklist: 3. First Sheet of Design – All Projects.

### 1.9.3 Situation plan

See Culvert Plan Review Checklist: 4. Situation Plan.

### 1.9.4 Repair/extension project details

See Culvert Plan Review Checklist: 5. Details – Repair/Extension Projects.

### 1.9.5 Reinforced concrete

See Culvert Plan Review Checklist: 6. RCB Culverts.

### 1.9.6 Roadway plans

See Culvert Plan Review Checklist: 7. Roadway Plans.

### 1.9.7 Signed standard plans

Projects that include signed standard plans (J-series, H-series, RS-series, single RCBC, twin RCBC, triple RCBC, flume box culvert, overhead sign truss, and roadside dynamic message sign support standards), shall include the signed sheets, referenced on the Title Sheet in the English Standard Culvert Plans table, in a multi-page PDF file to a subfolder in the Contracts plan turn-in folder.

## 1.10 Sign support structure plan preparation

Projects that include overhead bridge-type sign truss standard (SOST-11) sheets, overhead cantilever-type sign truss standard (SCST-17) sheets, and roadside dynamic message sign support standard (RDMS-13) sheets typically reference the applicable signed standard sheets in a tabulation on plans developed by the Traffic and Safety Bureau. Review of standard sign support structure designs by the Bridges and Structures Bureau for specific Traffic and Safety Bureau projects is required if any of the design parameters (e.g., maximum sign height, maximum total sign area, horizontal and vertical sign offset) exceeds the allowable values shown on the signed standard sheets.

When design plans for custom sign support structures are prepared by the Bridges and Structures Bureau or consultants to the Bureau, the plans must be coordinated with the Traffic and Safety Bureau. The sign support structures will be part of a traffic signing project and thus the sign support structure plans must fit with plans prepared by the Traffic and Safety Bureau or consultants to that bureau. When complete, the sign support structure plans are turned-in to the Contracts and Specifications Bureau and must meet its requirements.

## 1.11 Quality Control/Quality Assurance Plan

The Quality Control/Quality Assurance (QC/QA) Plan describes the methodology and procedures by which the Iowa DOT ensures in-house produced new bridge designs are in accordance with nationally recognized design policies, are independently checked, and are reviewed. The QC/QA Plan will document the checking and review process and produce a verifiable record [BDM 1.11.5, C1.11.5] to show that the QC/QA process was followed during the project. The QC/QA process enhances plan quality by doing the following:

- Providing uniformity and consistency in the development of plans,
- Ensuring compliance with Iowa DOT policies, procedures, and standards,
- Minimizing plan errors and discrepancies,
- Ensuring proper coordination between other partners in the design process,
- Minimizing plan changes after project is turned-in to the Contracts and Specifications Bureau, and
- Improving project constructability and bid ability.

### 1.11.1 Design team

The Design Team typically consists of a designer, design technician, checker, and Transportation Engineer Manager (TEM). The engineer of record (EOR) will be a licensed Professional Engineer in the

State of Iowa and will sign the design plan documents. The preference would be to have the designer as the EOR; however, the EOR could be the designer, checker, or TEM depending on the makeup and qualifications of the team members. The Design Team makeup is at the discretion of the TEM based on project complexity, design elements, and use of pre-engineered standards. This discretion relates directly to the risk involved in errors associated with various aspects of the design plan.

### 1.11.2 Plan preparation tools

Design plans shall be developed in accordance with the AASHTO LRFD Bridge Design Specifications and the Iowa DOT Bridge Design Manual (BDM). The BDM consists of standard design practices approved by the bridge engineering staff for use in design plan preparation. The BDM is maintained by the Methods Unit and Policy Group who meet periodically to discuss design issues and document Bureau policy for use by in-house staff and consultants. In addition the BDM provides a listing of notes, along with commentary, which can be incorporated into the final design plans.

Other items available to the designer and design technician to aid in the plan development are Standard Plan Sheets, Signed Standard Plans, and plan development check lists [BDM 1.8]. The designer must also be aware of the requirements documented in the Iowa DOT Standard Specifications for Highway and Bridge Construction, Developmental Specifications, Special Provisions, checklists, Design Manual developed by the Design Bureau, Construction Manual developed by the Construction and Materials Bureau, and the Instructional Memorandums (IM) developed by the Construction and Materials Bureau.

The Bureau maintains locally developed spreadsheets for use in design [BDM 1.13] as well as libraries and automation tools for use with MicroStation [BDM 1.8]. The Bureau also maintains licenses for commercial bridge design software packages [BDM 1.13].

### 1.11.3 Quality control

Quality control is the responsibility of the designer, design technician, and checker. These project team members shall use the tools noted above to develop a project design plan. Responsibility of each team member is listed below. Team members shall work independently to perform their roles and then communicate/discuss issues based on their understanding of the Bureau policy in order to arrive at a mutually acceptable design. Discussions may involve the Bridge Engineer, Bridge Project Development Engineer, Chief Structural Engineer, Methods Engineer, Transportation Engineer Manager, or other key staff in the Bridges and Structures Bureau. Resolution of design issues should be documented in the engineer's design calculations and checklists.

#### 1.11.3.1 Designer

The designer will be responsible for development and assembly of the structure plans. This includes listening to the concerns of the design technician and checker involving perceived problems with the plans and making decisions as to the appropriateness of the concerns. If the designer is not the EOR, or the QA review identifies issues for resolution, the final decision could be made by others associated with the project. Steps in the project development process include:

- Verify the type, size, location, grade, and geometrics of the proposed structure in order to confirm correct clearances, span arrangements, and proposed structure type.
- Identify Standard Plan details and appropriate Signed Design Standards to be used in the design plan.
- Review the BDM and all related specifications pertaining to the type of structure being built.
- Design all structural components, or use appropriate standards and provide information concerning special details needed for the structure to adequately relay the conceived design to the detailer. Documentation of all computations including computer generated data shall be available for the file.
- Specify all components by size and material.
- Review all sheets submitted by other bureaus for inclusion into the final project plans.
- Finalize plans by verifying details and notes.

Optional information to be provided by the designer:

- Calculate all quantities. Documentation of all computations including computer generated data shall be available for the file.
- Provide sketches and notes needed for the proposed structure.
- Fill in all missing data on applicable Standard Plan sheets.

### 1.11.3.2 Design technician

The design technician will be responsible for verifying the application of proposed components of the plan. This includes bringing perceived errors and omissions to the attention of the designer and the following:

- Review the type, size, location, grade and geometrics of the proposed structure to understand the aspects of the project.
- Compile all necessary notes, Standard Design sheets, and additional special details needed to assemble a set of design plans.
- Detail the proposed structure by typing or importing any nonstandard notes, attaching the related standard notes, completing the Standard Design sheets, and adding additional special detail sheets as the project requires [BDM 1.8].
- Calculate or verify elevations. Calculate the rebar number, weights/mass, and lengths based on given splices or development lengths.

Optional information to be provided by the design technician:

- Develop the notes and special details needed to complete a set of design plans based on verbal communication from the designer.
- Calculate bid item quantities. Documentation will be available for the file.

### 1.11.3.3 Checker

The checker will be responsible for adequacy of all structural components and overall plan intent. This includes making the designer and design technician aware of perceived problems in the design plans and the following:

- Review the design plans for completeness, consistency, and constructability according to standard design, detailing, and construction practice.
- Review the BDM and all related specifications pertaining to the type of structure being built.
- Analyze all structural components to verify the proposed structure is properly designed. Analysis shall be performed independently of any design calculations prepared during the initial design. Original design assumptions can be supplied by the designer however the checker will make an independent decision concerning the validity of the design assumptions. Documentation of all computations including computer generated data shall be available for the file.
- Verify all components by size and material.
- Verify all notes and specifications.

Optional information to be provided by the checker:

- Calculate all bid item quantities. Documentation shall be available for the file.

## 1.11.4 Project documentation

The Bridges and Structures Bureau is moving to an entirely electronic (i.e. paperless) system with respect to all project documentation. The older system which involved storing material in yellow manila paper file envelopes is no longer being supported. Additional information about electronic storage locations and Asset ID generation is found in BDM C1.11.4.

Projects in the Bridges and Structures Bureau typically are identified with a project file number, design number, program improvement number (PIN), and a project number. These numbers are assigned during the preliminary engineering process.

All projects involve assets such as bridges, bridge-size culverts, culverts, sign trusses, noise walls, etc. Every asset will be assigned an Asset ID in the Road Asset Management System (RAMS) when a project is initiated if an Asset ID does not already exist. FHWA numbers are used as Asset IDs for bridges and bridge-size culverts. Other structure types utilize Asset IDs as described in supplementary documentation which is currently under development. All Asset IDs generated in RAMS will be available in the Structure Inventory and Inspection Management System (SIIMS). All assets in SIIMS will be linked to an Asset ID subfolder in the ProjectWise document management system. (There is no need to place duplicate files in SIIMS if they are already contained under the Asset ID subfolder in ProjectWise since the information will be linked to SIIMS.) An Asset ID subfolder will be created in ProjectWise when a project is initiated if an Asset ID subfolder does not already exist. Each new project for an asset will have a phase number subfolder under the Asset ID subfolder for that asset. Each phase number subfolder will have additional subfolders for various project documentation such as design plans, as-built plans, file envelope correspondence, load rating information, pile logs, shop drawings, falsework plans, erection plans, etc. All the information in these subfolders will be automatically transferred for storage in the Electronic Records Management System (ERMS) at project completion.

The File Envelope Correspondence subfolder in ProjectWise should contain the following information (previously placed in the yellow manila paper file envelopes), as applicable:

- Project concept
- Structure type, size, and location (TS&L)
- Preliminary project cost
- Design Criteria sheet
- Design calculations
- Environmental documentation
- FHWA clearances
- Project correspondence

The following checklists are provided for review of bridge and culvert designs prepared by consulting engineers and by Bureau staff (available on the Internet at https://iowadot.gov/bridge/Design-Policies/Bridge-and-Culvert-Plan-Checklist):

- Bridge Plan Review Checklist
- Culvert Plan Review Checklist
- CADD Review Checklist

The EOR will be responsible for maintaining and submitting a complete project design file upon completion of the design process. This information along with the contract design plans and specifications will be submitted to the TEM for final review and submittal to the Contracts and Specifications Bureau for letting.

The EOR shall place their entire final set of design calculations in the appropriate subfolder in ProjectWise. The design calculations shall, at a minimum, include all structural calculations which may involve software input files, software output files, spreadsheets, and hand calculations. Designers may, but are not required to, include non-structural calculations such as quantity calculations and elevation calculations. In general, designers should avoid placing intermediate or iterative sets of design calculations in this subfolder in order to avoid clutter. Designers shall include a title page document which describes the files being stored in the subfolder. The title page also shall include the information shown in BDM C1.11.5. Files generally shall be stored with descriptive file names. Projects which do not involve structural design calculations need not include any calculations in the subfolder.

### 1.11.5 Quality assurance

Upon project assignment to the TEM for final design, the manager shall select a Design Team to prepare the final contract documentation for letting. The Design Team members will be assigned based on complexity of the project, member experience, and available staffing. The TEM will be responsible for mediating and resolving issues presented by team members for resolution. The TEM shall be made

aware of and concur with all instances where the design deviates from approved Bureau standards and policies.

Upon completion of the project and presentation to the TEM for submittal to the Contracts and Specifications Bureau for letting, the TEM shall review the file documentation for completeness and review the plans for overall conformance to Bureau policy. The project plans will then be distributed to other Iowa DOT bureaus, the appropriate district, and the FHWA (when required) for comment. Any comments received shall be reviewed with the EOR for necessary changes to the plan.

The TEM will review the Quality Control/Quality Assurance Record [BDM C1.11.5] stored by the EOR as a title page document as described in BDM 1.11.4. This record shall include the basic project information along with the signatures of the project designer, design technician, checker, and TEM.

The TEM shall then submit the final plans and specifications to the Contracts and Specifications Bureau.

### 1.11.6 Post-letting involvement

After letting, a member of the Design Team will be responsible for the review on any working drawings required for the project [BDM 1.17]. In addition, any structural design issues will be directed to the Design Team by the Construction and Materials Bureau for resolution.

On occasion, the Design Team members will conduct field reviews for observation and discussion of specific design/construction issues. Information gathered during these reviews that highlights inconsistencies with current bridge design policy will be documented and shared with the Bridge Methods Engineer for resolution of policy issues.

If revisions to the design plans are required after the letting due to a change in site conditions assumed in the design preparation or an error found in the original design plans, the Design Team will develop a formal revision to the design plans. Documentation of the revision shall be in accordance with current policy for issuing plan revisions. The EOR (if available) will be responsible for the revision documentation and placing it in ProjectWise. The TEM and EOR will be responsible for noting these revisions on the Quality Control/Quality Assurance Record. In addition, revision documentation will be sent to the FHWA when applicable.

## 1.12 Cost estimates

Final designers in the Bureau and consulting designers shall prepare construction cost estimates as follows.

(1) Verification of preliminary bridge costs (B01 preliminary design cost estimate) based on concept information. For a project with a consultant engineer this verification is performed by the BSB Consultant Coordination Unit.
(2) Concept (B00) Estimate - Cost estimate for projects where Final Design writes the project concept (e.g. overlays, MB and bridge repair projects).
(3) 50 Percent Plans Estimate - Update bridge and large project ($500,000 or more) construction costs based on rough bid item quantities after completion of design and before final detailing and checking is complete.
(4) B03 or B04 Estimate - Update of design costs based on final bid item quantities prior to final plan turn-in.
(5) Annual Estimate - Upon request from the supervising Unit Leader, perform a cost estimate if the existing cost estimate is greater than 6 months old for project programming review purposes.

B00 and B01 cost estimates are typically parametric costs estimates based on the design parameters (e.g. unit cost per square foot of deck area for a particular bridge type). 50 percent plans, B03 and B04 cost estimates are bid-item based estimates.

Currently the Iowa DOT is operating both in PPMS and in iPDWeb. The highway program is being managed using PPMS. Because of this the following approach for cost estimating is required:

- Estimate construction cost in iPDWeb (present day dollars). Account for all anticipated costs with one or more of the following: bid items, parametric items, and percent based bid items. Instructions for accessing and using the iPD software are available at https://iowadot.gov/bridge/programs/iPDWeb%20Project%20Cost%20Estimating%20for%20OBS.pdf. Consult BDM 3.8 and 4.5.11 for additional guidance on B00 and B01 cost estimates for bridges and culverts, respectively.
- Enter the cost developed from iPDWeb into PPMS. The Consultant Coordination Unit will enter iPDWeb costs into PPMS for consultants. Choose the programmed fiscal year for the project in PPMS. PPMS will automatically apply a 4.5 percent inflation rate per year. Enter contingency into PPMS per the rubric in BDM 3.8 and 4.5.11.

The designer shall report the cost estimates to the supervising Unit Leader, who will compare each estimate with previous estimates in PPMS.

## 1.13 Software

Some of the software used by the Iowa DOT to design bridges and culverts and to prepare plans is available through the Automation Tools section of the Bridges and Structures Bureau web site (https://iowadot.gov/bridge). The Bridge Information System (BRIS) application, which can only be accessed by Iowa DOT employees, is available on the Iowa DOT website at (https://secure.iowadot.gov/bris/). Commercial software also is installed separately on workstations or is available through a network shortcut under license agreements. Engineering consultants are responsible for downloading Iowa DOT software and obtaining licenses for commercial software as needed.

The Iowa DOT requires that all plans be prepared with MicroStation software. Additionally, the Highway Administration has agreed-upon CADD standards (fonts, seed files, level attributes, libraries, and other standards) for use of the software. The Bridges and Structures Bureau rules for applying these standards are given in the files hyperlinked on the Bureau's web site CONNECT Applications documentation page (https://iowadot.gov/bridge/Automation-Tools/CONNECT-Applications). The designer and design technician should consult the page for all information regarding the use of MicroStation.

For projects that involve repair, extending, widening, demolition, or other work involving existing structures, the designer needs access to inspection reports and other information about the structures. This information is available through SIIMS, for which the user needs an Enterprise A&A ("A&A" = "Authentication and Authorization") account. Bureau personnel automatically have an account, but engineering consultants must obtain an account through the instructions given on the main page of the application (https://siims.iowadot.gov/default.aspx).

Hydraulic design programs developed by the Bureau are available from the Preliminary Design software web page (https://iowadot.gov/bridge/Automation-Tools/Preliminary-Design-Software).

BRIS is an Oracle database program with a web-based user input interface, which houses an inventory of bridge project work that can be queried. The primary benefit of BRIS for many designers and detailers is the ability to search for previously designed bridges, culverts, and other highway structures so that standard Bureau practices are followed and details are reutilized effectively. The designer is required to enter the BRIS data for a project with an assigned design number when design is completed. Data collection information is given in the BRIS Manual accessible from the start-up page for the program.

Final design software developed by the Bureau is available from the Final Design software web page (https://iowadot.gov/bridge/Automation-Tools/Final-Design-Software).

BIAS 2000 is software for consultant use developed by the Iowa DOT for contracting state and local projects.

## 1.14 Plan turn-in

A list of critical dates associated with each contract letting other than dates for the FHWA review submittal and D04 event is maintained by the Contracts and Specifications Bureau (https://iowadot.gov/contracts/lettings/CRITDATE.pdf?ver=2018-01-25-141506-297). The plan turn-in date for a specific project is established in the Bureau by the Bridge Project Development Engineer and by design contract with engineering consultants. On or before that date the following are to be submitted to the Contracts and Specifications Bureau.

- Completed project plan set (pdf),
- Standard Plans (pdf) when applicable,
- Non-contract E-files when applicable
- Completed bid item list in PPMS and
- Final cost estimates for both Bridge and Roadway items in PDF format from iPDWeb. At plan turn-in or the B04 event, the BSB Final Design Unit or Consultant Coordination Unit reviewer shall copy the file to the appropriate letting subfolder at this location W:\Highway\Contracts\CostEstimates. The file naming convention is “Contract ID_DesignEvent Cost Estimate.pdf” (e.g., 50-0144-067_B03 Cost Estimate.pdf).

Plans for FHWA oversight projects are to be sent to the Iowa office of the Federal Highway Administration (FHWA) for review. Final or 100 percent unapproved plans for review should be sent to FHWA 3 to 6 weeks before the Contracts and Specifications Bureau’s turn-in date. The 3 to 6-week period allows FHWA personnel to return comments to be addressed before turn-in.

The project plan set may include both grayscale and color multi-page PDF files, as well as a multi-page cross section PDF file. The Design Bureau *Design Manual* gives the latest detailed instructions for preparing the project plan set [DB DM 1H-1 and 21E-4].

Any Special Provisions (.doc or .docx) required by the plan set are to be submitted to the Specifications Section. All applicable Developmental Specifications and Special Provisions for the project shall be applied in PPMS prior to plan turn-in.

Consultants are required to submit the items listed above to the Bridges and Structures Bureau for review 2 weeks before plan turn-in as discussed in *Conducting Business with the Iowa DOT Bridges and Structures Bureau* [BDM 1.4].

The Contracts and Specifications Bureau reviews the proposed contract documents and may ask for revised plan sheets. After the review and any changes, the Bridges and Structures Bureau updates the final MicroStation CADD file and PDF plan set.

The supervising Unit Leader or appointed Consultant Reviewer is responsible for the following at or before plan turn-in:

- Turning in the final BSB combined multi-page PDF plan set to the Contracts and Specifications Bureau.
- Verifying that the final BSB combined multi-page PDF plan set contains the appropriate PDF files from the Design Bureau including the Soils Design Unit.
- Copying the combined multi-page PDF plan set to the Contracts plan turn-in folder.
- Copying a separate multi-page PDF file containing any signed sheets or standard plans referenced on the design plan set title sheet into a subfolder in the Contracts plan turn-in folder.
- Marking the Cost Estimate complete in iPDWeb.
- Copying the final cost estimates for Bridge and Design into the Contracts cost estimate folder.
- Requesting in PPMS the use of applicable Developmental Specifications and Special Provisions.
- Inputting the B03 or B04 date, project coordinates, and cost estimates into PPMS.

The sub-articles below describe the items that shall be completed by the designer in the weeks leading up to plan turn-in. The Design Team is responsible for the completion of all items in the sub-articles.

### 1.14.1 E-file submittals

The following E-file submittals are required when appropriate:

- Bridge and culvert repairs
  - Existing plans
  - Signed standards
- RCB culverts
  - Existing culvert plans
  - Signed culvert standards
- CCS bridges
  - Existing bridge plans
  - Signed bridge standards
  - Top-of-slab elevations spreadsheet
  - Substructure staking coordinates
  - Boring logs only (not full S04 report)
- PPCB bridges
  - Existing bridge plans
  - Signed bridge standards
  - Top-of-deck elevations spreadsheet
  - Bridge deck grade adjustment spreadsheet
  - PPC beam data spreadsheet
  - Substructure staking coordinates
  - Boring logs only (not full S04 report)
- Steel girder bridges
  - Existing bridge plans
  - Signed bridge standards
  - Top-of-deck elevations spreadsheet
  - Bridge deck grade adjustment spreadsheet
  - Substructure staking coordinates
  - Boring logs only (not full S04 report)

The file naming convention for Microstation V8 E-files can be found at https://iowadot.gov/bridge/automation-tools/microstation-documentation in the “Folder Structure” and “Consultant Folder Structure” documents. The file naming convention for MicroStation CONNECT E-files can be found at https://iowadot.gov/bridge/Automation-Tools/CONNECT-Applications in the “Folder Structure” and “Consultant Folder Structure” documents.

Substructure staking coordinates and the instructions for producing them are discussed more fully in BDM 1.8.4 and at https://iowadot.gov/bridge/tools/Bridge%20Staking%20Data%20Instructions.pdf.

### 1.14.2 Plan coordination

For bridge replacement projects the Design Bureau has prepared a flow chart for its work that includes the defined events in the design process and plan turn-in [DB DM 1D-1]. The flow chart and its associated task lists indicate what the bridge designer can expect from the Design Bureau when the Bridges and Structures Bureau has the lead for a project.

When the Bridges and Structures Bureau does not have the lead, plans provided to another bureau, such as retrofit rails for Design Bureau projects, need to be submitted by the scheduled B04 event date. When the Bridges and Structures Bureau does have the lead it also can expect that plans from other bureaus, such as the geotechnical design sheets and roadway design sheets, are available by the scheduled event date (S04 and D04).

When receiving plan sheets from another bureau the Design Team shall, at a minimum, verify the following:

- Every sheet has the project number and file number printed on it.

- The information on the plans is consistent with the BSB design plans.
- For plans that include approach pavement, the appropriate abutment designation (M for movable and F for fixed) is indicated. Integral abutments and semi-integral abutments are considered moveable because they will move against and away from the approach pavement when the bridge expands and contracts. Stub abutments are considered fixed because the stub abutment backwall does not move with respect to the expansion and contraction of the bridge.

For projects that are tied in the Contract letting process, the Design Team should work carefully with the Design Bureau to coordinate the plan sets. Work items such as longitudinal grooving, guardrail, bridge berm grading, culvert backfill, and the Prevention Pollution Plan are often located in a separate plan set associated with the Project Contract and need to be tied with a plan note referencing the project number of the other project.

### 1.14.3 Prior to plan turn-in

The Design Team is responsible for completing the following items a minimum of three weeks before plan turn-in:

- Obtain the final D04 road sheets and S04 soil sheets for BSB led projects.
- For both review (i.e., 100 percent unapproved) and final plan sets, combine the PDF file(s) from the Design Bureau (including the Soils Design Unit) with the BSB PDF file and place the combined multi-page PDF file in the appropriate design event subfolder (e.g., B03, B04) under the Design Events subfolder under the Bridge subfolder in the appropriate ProjectWise project directory (e.g., pw:\\NTPwint1.dot.int.lan:PWMain\Documents\Projects*ProjectDirectory*\Bridge\Design Events*DesignEvent*). Also place applicable standard plans and E-files in the appropriate subfolders under the design event subfolder. The Unit Leader will route the review plans and final plans to the appropriate bureau and district personnel.
- Complete the electronic BRIS form that is accessible at https://secure.iowadot.gov/bris/. This form is initiated automatically at the B03 or B04 event date; therefore, the design engineer or technician will wait until after plan turn-in to complete the BRIS form.
- Verify the Design Criteria sheet is complete for all new and replacement bridges. Place a copy in the Final Design subfolder under the appropriate phase (i.e., project) subfolder under the appropriate Asset ID subfolder in ProjectWise (e.g., pw:\\NTPwint1.dot.int.lan:PWMain\Documents\Highway\Bridge\Assets\Bridges and Culverts*AssetID**Phase*\File Envelope Correspondence\Final Design).
- Verify that PPMS bid items are complete [BDM 1.14.4].
- Verify that the Bridge 2000 documentation is completed for new and replacement bridges and bridge-sized culverts.
- Create a Load Analysis and Rating System (LARS) input file for new and replacement bridges. Place both the .txt and .xls versions of the LARS input file in the Load Rating subfolder under the appropriate phase (i.e., project) subfolder under the appropriate Asset ID subfolder in ProjectWise (e.g., pw:\\NTPwint1.dot.int.lan:PWMain\Documents\Highway\Bridge\Assets\Bridges and Culverts*AssetID**Phase*\Load Rating). Input file creation may be postponed if necessary, but must be completed before the construction work is finished.
- For minor bridge repairs or rehabilitation projects (e.g., retrofit rails, deck overlays, and deck replacements), email a link of the plan set to the Bridge Rating Engineer, to be used for modification of the LARS file.
- For bridge repairs that modify the superstructure design (e.g., beam replacements or other major bridge rehabilitation projects), create a new LARS input file and follow the procedure above corresponding to new bridges.
- Complete the B03 or B04 cost estimate in iPDWeb and place a PDF report in the Cost Estimate subfolder under the Contract ID subfolder under the design event subfolder under the Design Events subfolder under the Bridge subfolder in the appropriate ProjectWise project directory (e.g., pw:\\NTPwint1.dot.int.lan:PWMain\Documents\Projects*ProjectDirectory*\Bridge\Design Events*DesignEvent**Contract ID*\Cost Estimate).

- Fill out the Bridge Plan Review Checklist for bridges, the Culvert Plan Review Checklist for culverts, and the CADD Review Checklist.
- Place all applicable E-files in the *ContractID*_eFiles_(Bridge) subfolder under the design event subfolder under the Design Events subfolder under the Bridge subfolder in the appropriate ProjectWise project directory (e.g., pw:\\NTPwint1.dot.int.lan:PWMain\Documents\Projects*ProjectDirectory*\Bridge\Design Events*DesignEvent**ContractID*_eFiles_(Bridge)).
- If time permits, the design technician should complete maintenance sketches for new and replacement bridges/bridge size culverts for review by the Assistant Maintenance Engineer.

### 1.14.4 PPMS bid items for plan turn-in

The BSB Design Team or appointed Consultant Reviewer are responsible for inputting the correct bid items shown in the BSB project plans under the correct bid divisions. BSB staff can enter bid items into PPMS. Where BSB is the lead bureau (B03 plans), bid items for sheets submitted to BSB by other bureaus (Design Bureau or Districts) are to be input by those bureaus under separate division(s) after the BSB bid division. For B04 plans, BSB should enter all bid items for the project under the BSB bid division after the other divisions.

The Contracts and Specifications Bureau will use the PPMS bid items and quantities for the proposal; therefore, it is critical that the bid divisions in PPMS are accurate. The lead bureau turning in the project plans is responsible for ensuring all the bid item divisions are in the correct order by the day of plan turn-in to the Contracts and Specifications Bureau.

## 1.15 Plan changes after plan turn-in

Although it is expected that most plan sets will be in final condition at turn-in, there are provisions for changes.**Error! Hyperlink reference not valid.** These procedures for making plan changes are listed and maintained by the Contracts and Specifications Bureau in the document “Plan Changes and Addendums”.
(https:/iowadot.gov/contracts/electronicplanspecs/Plan_Changes_and_Addendums_Contracts.pdf )

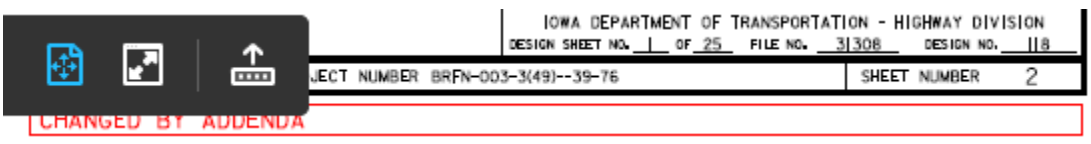
### 1.15.1 Plan changes prior to advertising

The Contracts and Specifications Bureau accepts plan changes, without an addendum, just prior to the time the project is advertised. This is typically two weeks after turn-in or an agreed upon timeframe. The lead Bureau (Contracts Plan Submitter) that was responsible for plan turn-in shall also be responsible for communicating the intent of the plan changes and submitting the plan changes to the Contracts and Specifications Bureau.

### 1.15.2 Plan Changes after advertising - Addendum

After plans have been advertised, corrections to the plans require an addendum so that all project bidders are informed of the changes. For an addendum, a request to issue an addendum must be sent to the Contracts and Specifications Bureau proposal engineer. The Contracts and Specifications Bureau decides whether the change or error correction warrants an addendum or a revision. Addendum requests may also be originated by the Contracts and Specifications Bureau if an error correction or change is required to let the project. If the designer of BSB is not the Contracts Plan Submitter, the designer who submitted the plans must be notified and copied on the Addendum.

For addenda to plan sheets, add the BSB Microstation “BrgFinal” library “ADDENDUM” cell to the lower right edge of the sheets that are affected by the change as shown below in the example.



## 1.16 Plan revisions

Following the project letting, plan revisions can be issued. Plan revision sheets shall show deletions crossed-through and encircled by clouds. Changes and additions also shall be encircled by clouds, so that the revisions are easy to see. Plan revisions should be coordinated with the Resident Construction Engineer so the appropriate contract modification can be written if necessary.

Instructions for creating revision sheets in MicroStation are given on the V8 bridge documentation page on the BSB web site (http://www.iowadot.gov/bridge/v8docs.htm).

## 1.17 Working drawing and calculation submittals

The Bureau reviews working drawing and calculation submittals to ensure that the structural adequacy of the design is maintained as detailed on the original design drawings. For typical projects IDOT SS 1105.03 lists the required working drawing submittals. Recommended submittals for calculations are listed in BDM Chapter 13 under CADD Note E65. CADD Note E65 also includes recommendations for when certification by an Iowa P.E. should be required. The review of working drawings submitted by a contractor covers only requirements for strength and arrangement of component parts and does not cover bills of material. The extent of the working drawing and calculation review will vary with each design. Review of calculations generally should be cursory in nature and only occasionally involve a more detailed look at a particular item of interest. For complex designs the reviewer shall discuss in advance the extent of the working drawing and calculation review with the supervising Unit Leader.

When reviewing ~~shop~~ working drawings, the reviewer shall do the following:

- P~~p~~lace a small red check mark next to all items verified to be correct on the drawing and make any additions or corrections to the drawing in red. Scanned copies of checked drawings shall be legible. To ensure legibility of the scanned copies, the reviewer shall not use highlighters to check ~~shop~~ working drawings.
- Every page of a working drawing submittal shall be stamped every time it is submitted. The only exception is for calculation submittals which will typically only require a stamp on the cover sheet.
- Each stamped page will indicate one of the three status options as shown in Figure 1.17: “No Exceptions Taken”, “Make Corrections (No Resubmittal Necessary)”, “Revise and Resubmit”.

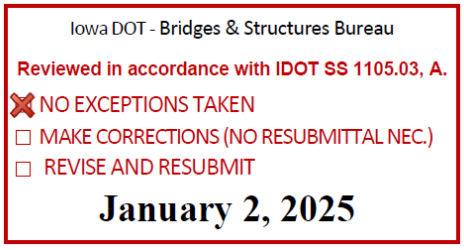



**Figure 1.17. Working drawing review stamp**

Working~~Shop~~ drawings for bridges with steel superstructures shall be reviewed according to the guidelines in the Steel Girders and Beams section of this manual [BDM 5.5.1.4.3]. Steel girder erection submittals are covered in more detail in BDM 5.5.1.4.4.

The Bureau also reviews shoring plans when such plans are required. In general a shoring plan review follows the guidelines for working~~shop~~ drawing review.

The DOT may reject a submittal if the file naming convention does not reasonably conform to the file naming standards in the contract plan documents. The letter from the DOT to the AGC in BDM C1.17 specifies the conditions for rejection more fully. A designer shall not reject a submittal based on file naming convention without approval from the Supervising Unit Leader.

## 1.18 Local systems review

Local Public Agency (LPA) structures shall be reviewed by the Bridges and Structures Bureau if the structures are either on the National Highway System (NHS) or federally funded using non-standard designs. LPA structures designated for review will need to go through either a cursory review or an in-depth review. If the structure is on the NHS, then an in-depth review will be required. All other structures will only require cursory reviews. In-depth reviews will generally be assigned to the Consultant Coordination Unit. In rare cases, the Final Design Units may be assigned in-depth reviews. In-depth reviews shall use the Bridge Checklist. Cursory reviews will be assigned to the Final Design Units and checked using the LPA Cursory Review Items for Bridge and Culvert Plans as listed in the commentary of this section.

The review engineer is responsible for completing the review in conformance with the Instructional Memorandum for LPA Bridge or Culvert Plans, I.M. 3.500. The review engineer shall return the cursory review comments or in-depth check plans to the LPA in an email in accordance with the memorandum. Every review email shall include only one of the following three status statements:

- Status: This project was not reviewed by the Iowa DOT Bridges and Structures Bureau since the project involves a standard bridge which is not located on the National Highway System.
- Status: The Iowa DOT Bridges and Structures Bureau review comments for this project do not require a response or resubmittal from the Owner.
- Status: The Iowa DOT Bridges and Structures Bureau review comments for this project require a response from the bridge designer on behalf of the Owner.

The last status statement shall only be included in the email if one or more review comments addressed an issue pertaining to safety, structural capacity, constructability or some other significant issue.

Links to NHS:

http://www.iowadot.gov/systems_planning/pdf/nhs_map.pdf
http://www.fhwa.dot.gov/planning/national_highway_system

Link to Bridge Plan Review Checklist, Culvert Plan Review Checklist, and CADD Review Checklist:

https://iowadot.gov/bridge/Design-Policies/Bridge-and-Culvert-Plan-Checklist

Link to Instructional Memorandum for LPA Check and Final Bridge or Culvert Plans, I.M. 3.500:

https://www.iowadot.gov/local_systems/publications/im/3500.pdf

## 1.19 OSHA fall protection

While many structures that present worker fall risks may not require permanent physical fall protection devices to comply with Occupational Health and Safety Administration (OSHA) requirements, the design of some structures may be required to include them. Fall protection can be provided by permanent fence or railing, continuous cable tie-offs, D-bolt tie-offs, concrete barriers, or similar devices. Decision-making regarding which type of protective device is used can be affected by project factors such as public access, constructability, ease of maintenance, and aesthetics. In many cases, installation of a permanent fall protection device is unnecessary, is not possible, or is problematic for other reasons such as traffic safety. In these cases, permanent physical fall protection may be replaced by a Fall Protection Plan for workers in accordance with OSHA guidelines.

### 1.19.1 Applicable OSHA citations

Non-Construction Drop Elevation (4 feet max.) - Occupational Safety and Health Standards Part 1910.28(b)(1); https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.28 ; also see general summary here: https://www.osha.gov/fall-protection (lists 4 feet max. for “general industry”, 6 feet max. for “construction industry”).

Fall Protection Railing (42-in. min. height + mid-height rail min.) - Occupational Safety and Health Standards Part 1910.29(b); https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.29

and Safety and Health Regulations for Construction Part 1926.502(b); https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.502

## 1.19.2 Structures requiring OSHA fall protection

All structures that include features representing worker fall hazards with a drop of more than 4 feet require some form of fall protection for workers engaged in maintenance and other activities adjacent to the drop. Fall protection may either be provided by a permanent physical device or by a Fall Protection Plan employed by workers near the fall hazard. Example structures include bridges, retaining walls, culvert headwalls, and drop inlets. If the structure includes pedestrian or bicyclist fall protection, no additional measures are typically required if the only drop is from the pedestrian facility supported on or by the structure. If Access Control fencing is installed on the structure or immediately adjacent so that the drop is protected, no additional measures are typically required.

If the structure with a drop is accessible to the public, it is typically desirable to include permanent fall protection in the form of an AASHTO-compliant railing or fence. This is because AASHTO-compliant railings have more stringent pass-through requirements than OSHA railings. Chain link fence with 42-inch minimum height provides both OSHA and AASHTO fall protection for pedestrians only. If a trail or other multi-use path is adjacent, use 48-inch minimum height fence. In some cases, if pedestrian access is highly unlikely or incidental in nature, an OSHA-compliant railing is sufficient.

## 1.19.3 Types of physical OSHA fall protection devices

The following permanent physical fall protection devices can currently be considered compliant with OSHA:

- Chain link fence at least 42 inches in height (also AASHTO-compliant, but for pedestrians only)
- Any AASHTO-compliant railing or fence at least 42 inches in height
- Metal tube or pipe railing at least 42 inches in height with at least one centered mid-height horizontal tube or pipe
- Cable railing at least 42 inches in height with at least one centered mid-height cable
- Concrete traffic barrier or a combination steel-on-concrete traffic barrier at least 42 inches in height*
- Continuous cable securely mounted to a structure above and adjacent to a drop, to which a worker could tie off a body harness and fall-arrest system
- D-bolts securely mounted to a structure at 6-foot maximum horizontal spacing above and adjacent to a drop, to which a worker could tie off a body harness and fall-arrest system
- A structural metal grate suitable for pedestrian loads, such as for covering a drop inlet

*Note that it is not advisable to add non-crash tested metal railings to crash tested barriers as a means of meeting OSHA requirements.

See the Commentary section for detailed project examples of each type of OSHA fall protection listed above.

## 1.19.4 Retaining wall fall protection

Retaining walls that are accessible to the public should include Access Control fence along the entire length of the wall.

Retaining walls that are inaccessible to the public and include a drop of more than 4 feet require OSHA fall protection in the form of a physical device or usage of a Fall Protection Plan. If chain link fence is used as fall protection, it is often preferable to use chain link fabric that stops 6 inches short of the local grade so the fence is less likely to collect wind-blown trash. A 42-inch fence with 36-inch fabric and a tension wire at the bottom of the fabric is the usual solution. In some cases, it may be desirable to combine the OSHA fall protection with Access Control and use a tall fence on or immediately adjacent to the top of the wall. If the top of wall includes a concrete drainage trough, it is preferable to place the fall protection on the top of the wall so that trough-related maintenance activities are fall-protected.

If there is no pedestrian path immediately adjacent to a wall-mounted fence, specify a tension wire at the bottom of the fence fabric instead of a bottom pipe rail. If a pedestrian facility is present, use a bottom pipe rail. Fences 5 feet tall and shorter also do not require end panel mid-height brace rails, only diagonal turnbuckle tensioners to create stability.

When walls are tiered, the drop from the lower wall may be protected by a continuous cable tie-off attached to the face of the upper wall. The drop from the upper wall may be protected by an OSHA-compliant device or a Fall Protection Plan if inaccessible to the public, or by Access Control fence if accessible to the public.

### 1.19.5 MSE wall-supported fall protection

When bridge abutments are wrapped with MSE retaining walls on the sides and front face, a vertical step condition typically occurs at the abutment wing. If the top of wall alongside the abutment wing and diaphragm allows space for a worker to stand, OSHA fall protection or usage of a Fall Protection Plan is required. For aesthetic reasons and due to the short-term incidental nature of maintenance work in this area, it is preferable to use D-bolts embedded in the abutment concrete for this condition rather than railing or fence on top of the wall coping. D-bolts spaced at maximum intervals of 6 feet will allow a worker to securely tie off a body harness and fall arrest system.

For MSE-supported bridge abutment foreslopes where the wall extends past the abutment and down the slope to the toe of berm, OSHA fall protection is required. When this area is inaccessible to the public, an OSHA-compliant device or Fall Protection Plan may be employed. If fence or railing is used, the device may be terminated when the drop measures less than 4 feet. When this condition is accessible to the public, especially in urban areas or when there is a pedestrian path at the toe of the berm slope, a chain link fence or other AASHTO-compliant device should be used. The entire length of wall along the slope should be protected.

### 1.19.6 RCB headwall fall protection

RCB culvert headwalls in rural roadway ditches do not typically include OSHA railings, since these structures are well-marked for field maintenance activity and appropriate measures are taken to avoid falls when work occurs near these structures. RCB culvert headwalls in heavily populated areas or near pedestrian or bicycle paths should receive an AASHTO-compliant railing or fence, as should headwalls of all pedestrian tunnel RCBs.

RCB headwall-mounted chain link fence does not require a bottom pipe rail unless the parapet is immediately adjacent to a pedestrian path. Use tension wire at the bottom of the chain link fabric if no path is present.

For culvert headwalls in urban areas, the immediate context should be considered before determining the appropriate fall protection device. For example, a RCB culvert headwall embedded in a residential area should receive an AASHTO-compliant railing or fence rather than an OSHA-compliant device or Fall Protection Plan. In addition, drops of less than 4 feet should be considered for fall protection when pedestrians, especially children, might use the immediate area surrounding the structure. The likelihood of public activity and the presence of schools, parks, or other recreational areas nearby should be taken into consideration when selecting a fall protection device and the extent of coverage. When Access Control fencing excludes pedestrian access to the RCB culvert headwall, the headwall should be made OSHA compliant either through a fall protection railing or confirming that a Fall Protection Plan will be employed.

### 1.19.7 Drop inlet fall protection

Drop inlets should typically receive an OSHA railing so that the fall is protected, and so that debris capture and impacts to water flow into the inlet are minimized. OSHA railing on some drop inlets may present a traffic hazard, especially within the clear zone of the roadway, and may be omitted in some

cases. In urban areas, either an OSHA railing or a hinged, lockable cover grate may be used, depending on the proximity to pedestrian facilities and the likelihood of pedestrian presence near the structure. Whenever children may be present, it is preferable to use a cover grate. When Access Control fencing excludes pedestrian access to the drop inlet, the drop inlet should be made OSHA compliant either through a fall protection railing or by confirming that a Fall Protection Plan will be employed.