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## 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 Bridge Design 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 IA DOT Office of Bridges & Structures” [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.

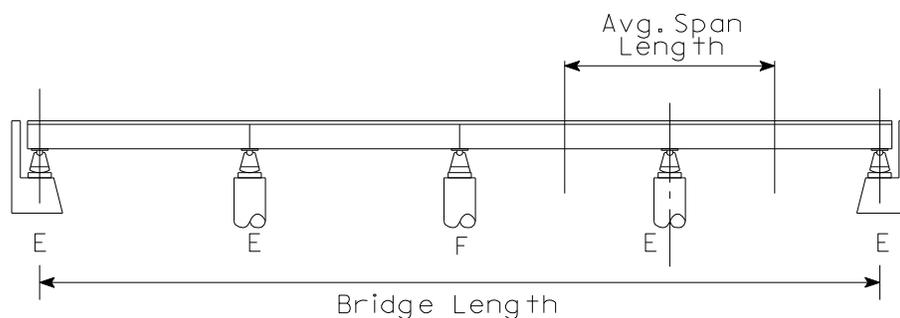


Figure notes:

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

**Figure 1.2-1. Length definitions**

**Built-in wearing surface (BWS)** is taken as the top one-half inch 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.

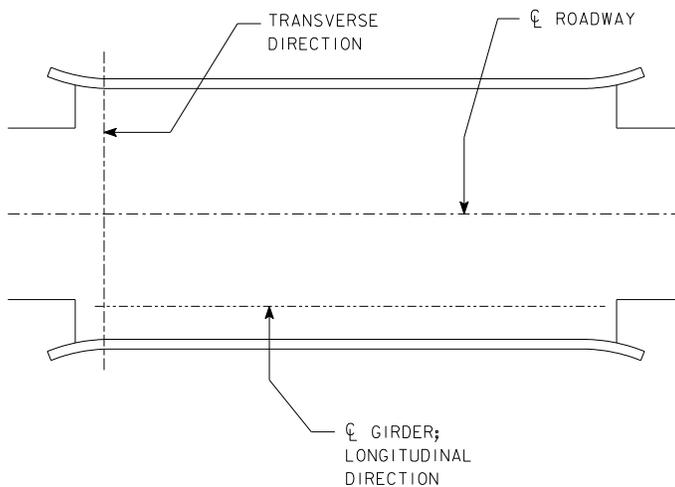
**File** includes hard copy information in the physical envelope and electronic information in the project directory. References to file in this section of the Bridge Design Manual will be refined in the future.

**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/](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.

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

**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 *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 Bridge Design Unit, Final Design Unit, or Consultant Coordination Unit.

### 1.3 Abbreviations and notation

**ASL**, average span length

**BARS**, Bridge Analysis and Rating System

**BL**, bridge length

**BRIS**, Bridge Information System

**BSB**, Bridges and Structures Bureau, formerly OBS

**BWS**, built-in wearing surface

**CCS**, continuous concrete slab

**CPRC**, Culvert Plan Review Checklist

**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

**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**, project identification number

**POI**, point of intersection of pavement surface cross slopes that defines the profile grade location

**PCB**, pretensioned prestressed concrete beam

**PRC**, Plan Review Checklist

**PRCN**, Plan Review Checklist Notes

**PSS**, Project Scheduling System

**QA**, quality assurance

**QC**, quality control

**QM-A**, Quality Management - Asphalt

**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, 17<sup>th</sup> 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, 8<sup>th</sup> Edition (2017)* with article, table, or figure number.

[AASHTO-Temp article, table, or figure] refers to *Guide Design Specification for Bridge Temporary Works* with article, table, or figure number.

[AASHTO-Sign article, table, or figure] refers to AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5<sup>th</sup> Edition 2009* with article, table, or figure number.

[BDM article, table, figure, or note] refers to *LRFD Bridge Design Manual* with article, table, figure, or plan note number. (Available on the Internet at: <https://iowadot.gov/bridge/Design-Policies/LRFDesignmanual>)

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

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

[IDOT SS article] refers to Iowa Department of Transportation *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 Division “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 Division *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 Division “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 Division “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 Department of Transportation 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, First Edition*. Washington: AASHTO, 2008.

American Concrete Institute (ACI). *Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02)*. Farmington Hills: ACI, 2002.

American Institute of Steel Construction (AISC). *Steel Construction Manual, Thirteenth Edition*. Chicago: AISC, 2005.

American Railway Engineering and Maintenance-of-Way Association (AREMA). *Manual for Railway Engineering—2002 Edition*. Landover: AREMA, 2002.

American Society for Testing and Materials (ASTM). *2001 Annual Book of ASTM Standards*. West Conshohocken: ASTM, 2001.

American Welding Society (AWS). *Bridge Welding Code, AWS D1.5-2002* with 2003 interim revision. Miami: AWS, 2002.

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.

National Steel Bridge Alliance (NSBA). *Highway Structures Design Handbook*. Chicago: NSBA, 1993.

Bridges and Structures Bureau. *Conducting Business with the IA DOT Office of Bridges & Structures*. Ames: Bridges and Structures Bureau, February 2016. (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://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*. Chicago: PCI, 1997 with revisions through 2004. (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](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% to accommodate construction tolerances on the low side of the PROWAG 2% 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.

At this time 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 it is clear that 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%, bridging all joints that may be wider than ½ inch, beveling all vertical surface discontinuities more than ¼ inch, and limiting all vertical surface discontinuities to ½ 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

At this time 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%. Although the Design Bureau uses a target 1.5% slope, bridge sidewalks generally are constructed more accurately than sidewalks on grade. Drainage is a concern, and the designer should be alert to situations that would cause ponding of water. The plan note needs to be worded carefully so that the contractor provides adequate drainage slope but does not exceed a 2% 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 ½ 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 ½ inch. Elevation discontinuities between ¼ inch and ½ 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%. 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 ½ 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.

A couple 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**

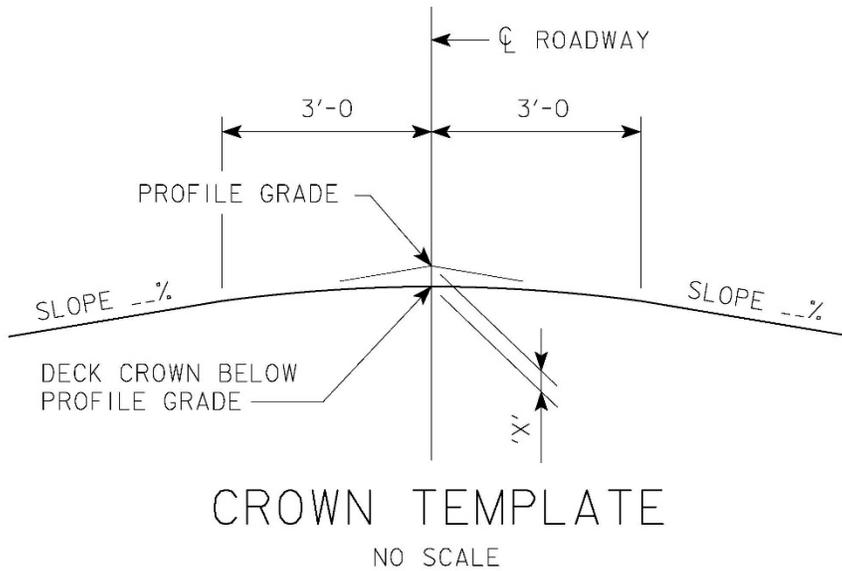
### **1.7.1 Profile grade line**

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:

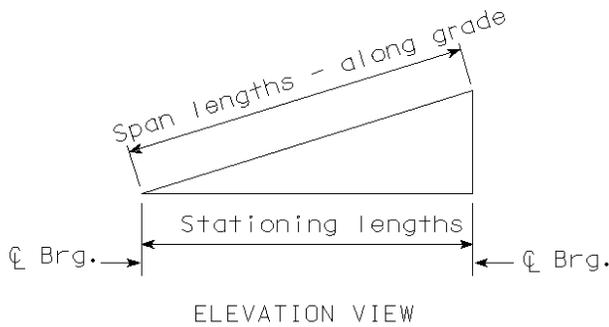
- Horizontal versus along grade dimensioning with respect to span and beam lengths.
- The effect of deck and end beam slope on the detailing of expansion joints.
- Clearance between the bottom flange of beams and the edge of abutment footings or pier caps.

- 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.

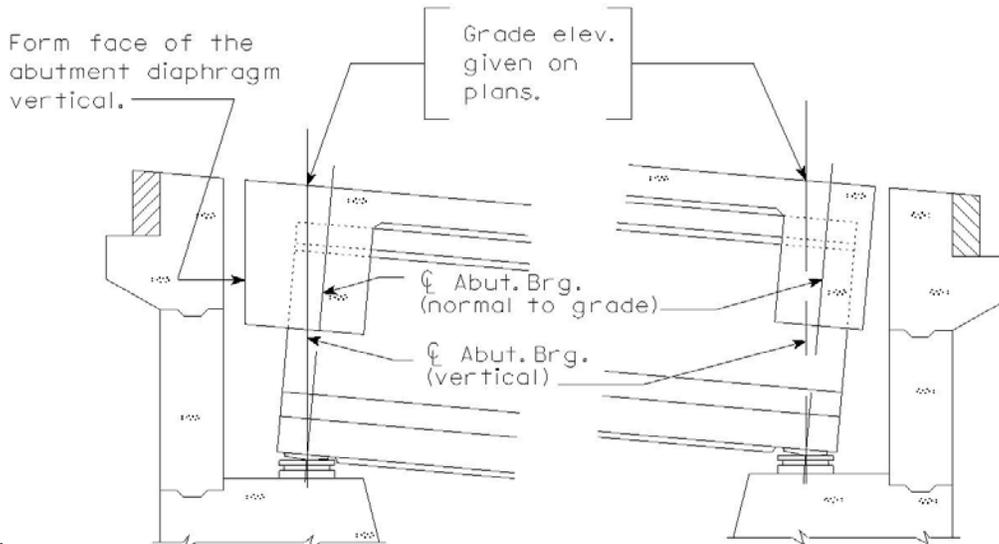
Bridge stationing shall be measured along the horizontal from centerline to centerline of bearings (vertical), but individual spans and bridge length are to be measured along the grade from the centerline to centerline of bearings (normal to grade) based on standard beam lengths as indicated in Figure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



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

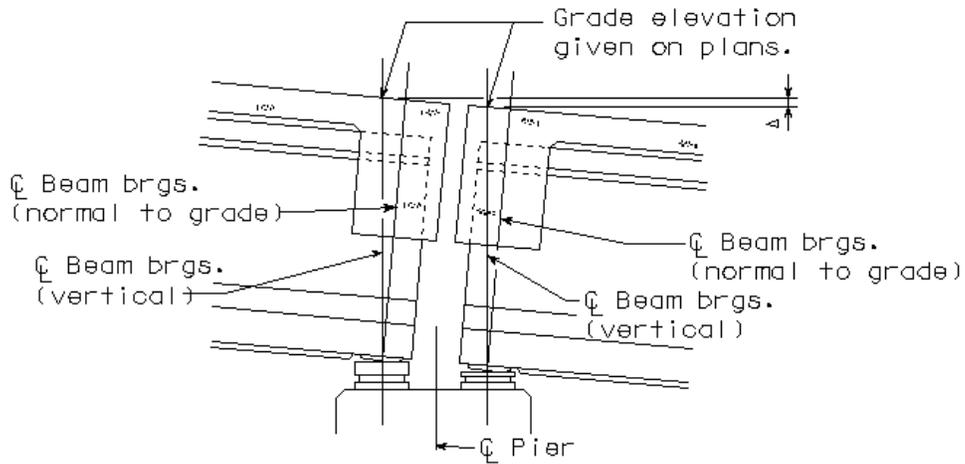
The situation plan should dimension the horizontal lengths of the bridge, centerline to centerline of abutment bearings and centerline to centerline of spans, and the corresponding stations. The plan should also include the dimension lengths from centerline to centerline of abutment bearings and face 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.



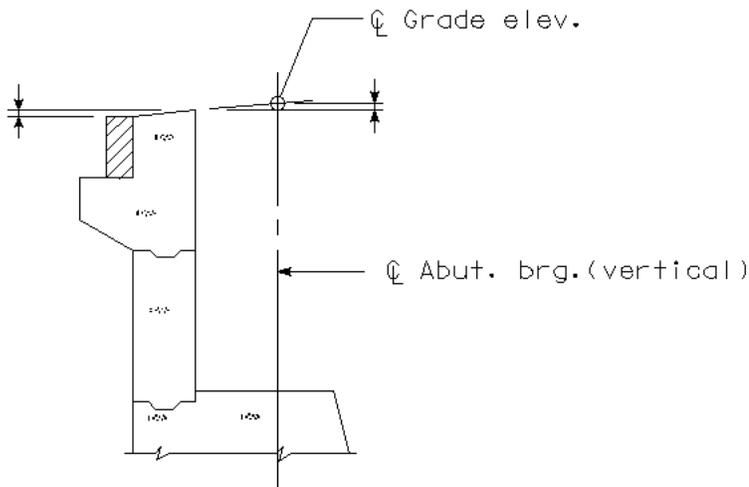
**Figure 1.7.2-2. Partial longitudinal section along centerline of roadway at abutments, with grade variations**

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.

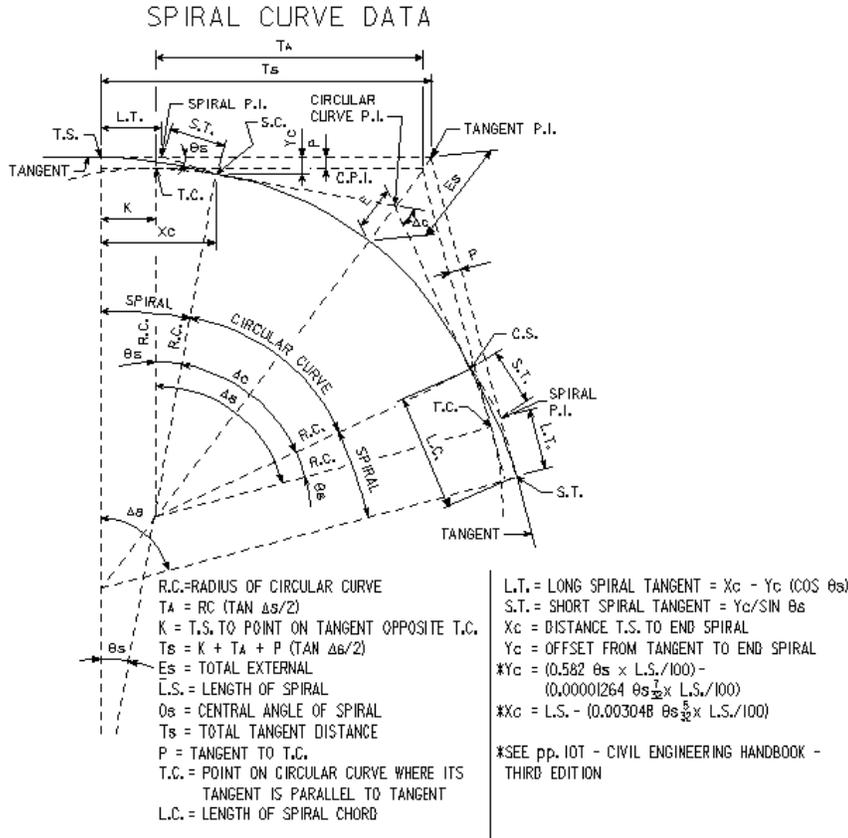


Figure 1.7.3. Spiral curve information

### 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.

When starting a plan set for a project the design technician or designer should read and follow the document "Procedure for Beginning V8Projects", which is accessible from the Projects link on the V8 Bridge Documentation web page (<https://iowadot.gov/bridge/Automation-Tools/MicroStation-V8-Tools>)

Bridge plans follow standard formats established with MicroStation V8 seed files (<http://www.iowadot.gov/bridge/v8tools.htm>). Additional resources available on the same V8 Bridge Tools page are the following:

- Cell libraries,
- DGN libraries,

- Font resources, and
- Color tables.

Also, on the V8 Bridge Documentation page (<https://iowadot.gov/bridge/Automation-Tools/MicroStation-Documentation>) instructions and discussions for the following items are available:

- Project Folder Structure in ProjectWise,
- Seed files,
- Models,
- Levels,
- Revisions,
- Scaled details,
- Standards, and
- Modifications.

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

- Plan Review Checklist (PRC) and
- Plan Review Checklist-Notes (PRCN).

For plans in general see PRC and PRCN: 1. General – All Projects.

Generally bridge plans are organized in the sequence indicated in the subarticles that follow.

## 1.8.1 Title sheet

See also Plan Review Checklist (PRC): 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 detail design Unit leader's seal
Hydraulic	Designer's seal	Preliminary bridge 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, Norman L. McDonald, 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 Plan Review Checklist (PRC) and Plan Review Checklist Notes (PRCN): 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 on the first sheet are determined by the designer, with consideration of the guidelines below, and entered into the Project Scheduling System (PSS) 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 “Bid items application” tool available from the Consultant/Designer Resources page on the Bureau web site is used by the consultants. This tool automatically puts the bid items into PSS.

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 Bureaus of Design and Bridges and Structures have a combined project, the Bureau creating the title sheet will add this item.
- **Field Lab:** The Contracts and Specifications Bureau will send the Bureaus of Design 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 Bureaus of Design and Bridges and Structures have a combined project, the Bureau creating the title sheet will add this item.

- Clearing & 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: The field should notify the designer when this item is required. The field must notify the designer prior to 12 weeks before letting. This item should always be added to incentive/disincentive projects. The field must send a copy of the request to the Construction and Materials Bureau.
- Quality Management - Asphalt (QM-A): The Construction and Materials Bureau will notify the designer when this item is required.

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) In the bridge envelope the designer should find Iowa DOT Form 621004 (Form 1-F) "Field Notes for Bridges and Large Culverts-Primary Road System". Item No. 7 on the form has the average low water elevation and average streambed elevation.
- (2) Determine the elevation of the Excavation Classification Line as the higher of (a) the low water elevation and (b) the average 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 Plan Review Checklist (PRC): 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.

### **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 Project Scheduling System (PSS) 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 Plan Review Checklist (PRC): 5. Staking Diagram – New Construction.

### **1.8.5 Substructure general**

See Plan Review Checklist (PRC): 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 Plan Review Checklist (PRC) and Plan Review Checklist Notes (PRCN): 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 Plan Review Checklist (PRC) and Plan Review Checklist Notes (PRCN): 8. Abutment Details – New Construction.

### **1.8.8 Superstructure general**

See Plan Review Checklist (PRC) and Plan Review Checklist Notes (PRCN): 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 5.5.2.4.2] and see Plan Review Checklist (PRC) and Plan Review Checklist Notes (PRCN): 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 Plan Review Checklist (PRC): 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 Plan Review Checklist (PRC) and Plan Review Checklist Notes (PRCN): 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 Plan Review Checklist (PRC): 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 Plan Review Checklist (PRC): 14. Expansion Device.

#### **1.8.10.3 Subdrains**

See Plan Review Checklist (PRC): 15 Subdrain/Slope Protection Details.

#### **1.8.10.4 Slope protection**

See Plan Review Checklist (PRC): 15 Subdrain/Slope Protection Details.

#### **1.8.10.5 Lighting**

See Plan Review Checklist (PRC): 16. Lighting Details.

#### **1.8.10.6 Approach sidewalk**

See Plan Review Checklist (PRC): 18. Approach Sidewalk.

#### **1.8.10.7 Other**

Reserved.

### **1.8.11 Aesthetics**

See Plan Review Checklist (PRC): 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, 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 Plan Review Checklist (PRC): 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 MicroStation V8 seed files (available on the Internet at: <https://iowadot.gov/bridge/Automation-Tools/MicroStation-V8-Tools>). Additional resources available on the same V8 Bridge Tools page are the following:

- Cell libraries,
- DGN libraries,
- Font resources, and
- Color tables.

Also, on the V8 Bridge Documentation page (<https://iowadot.gov/bridge/Automation-Tools/MicroStation-Documentation>) instructions and discussions for the following items are available:

- Seed files,
- Models,
- Plats,
- Levels,
- Revisions,
- Scaled details,
- Projects,
- Standards, and
- Modifications.

Many of the detailed items on culvert plans, such as title block and location map, are covered in the Culvert Plan Review Checklist (CPRC) on the Bridge and Culvert Plan Checklist page (<https://iowadot.gov/bridge/Design-Policies/Bridge-and-Culvert-Plan-Checklist>). For general plan items see CPRC: 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 (CPRC): 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 (CPRC): 3. First Sheet of Design – All Projects.

### 1.9.3 Situation plan

See Culvert Plan Review Checklist (CPRC): 4. Situation Plan.

### 1.9.4 Repair/extension project details

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

### **1.9.5 Reinforced concrete**

See Culvert Plan Review Checklist (CPRC): 6. RCB Culverts.

### **1.9.6 Roadway plans**

See Culvert Plan Review Checklist (CPRC): 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 structure and other plan preparation**

Reserved.

### **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 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.

Additionally the Bureau maintains locally developed spreadsheets for use in design [BDM 1.13] and libraries and automation tools for use with MicroStation [BDM 1.8], and the Bureau 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

Projects in the Bridges and Structures Bureau will typically be identified with a project file number, design number, project identification number (PIN), and a project number. These numbers will be assigned during the preliminary engineering process. The design file will be associated with the project file number. This file will contain the following information, as applicable:

- Project concept
- Structure type size and location (TS&L)
- Preliminary project cost
- Design calculations
- Bid item quantity calculations
- Environmental documentation
- FHWA clearances
- Project correspondence

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

- Plan review checklist (PRC)
- Plan review checklist - notes (PRCN)
- Culvert plan review checklist (CPRC)

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.

### 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.

After the review process, the TEM will prepare the Quality Control/Quality Assurance Record [BDM C1.11.5] for inclusion in the project file. 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. The project file documentation will be stored in the Bridges and Structures Bureau until it is electronically scanned for permanent storage.

### **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 the original design file. The TEM will be responsible for noting these revisions on the Quality Control/Quality Assurance Record in the design file. 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 (B1 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 (B0) Estimate - Cost estimate for projects where final design writes the project concept (e.g. overlays, MB and bridge repair projects).
- (3) 50% 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) B3 or B4 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.

B0 and B1 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% plans, B3 and B4 cost estimates are bid-item based estimates.

Currently the Iowa DOT is operating both in the Project Scheduling System (PSS) and in iPDWeb. The actual highway program is still being managed using PSS. 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. Estimates in iPDWeb shall not include any contingency or risk. 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 B0 and B1 cost estimates for bridges and culverts, respectively.
- Enter the cost developed from iPDWeb into PSS. The Consultant Coordination Unit will enter iPDWeb costs into PSS for consultants. Choose the programmed fiscal year for the project in PSS. PSS will automatically apply a 4.5% inflation rate per year. Enter contingency into PSS per our 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 the Project Scheduling System.

### 1.13 Software

Some of the software used at the Iowa DOT during bridge and culvert design and plan preparation is available through the Automation Tools section of the Bridges and Structures Bureau web site (<https://iowadot.gov/bridge>). The BRIS (Bridge Information System) application is available on Bureau workstations through a network shortcut. Commercial software also is installed separately on workstations or 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 Division 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 the options are given in the files hyperlinked on the Bureau's web site MicroStation V8 documentation page (<https://iowadot.gov/bridge/Automation-Tools/MicroStation-Documentation>). The designer and design technician should consult the page for all information regarding the use of MicroStation V8.

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. That information is available through the SIIMS (Structure Inventory and Inspection Management System) web application, for which the user needs an Enterprise A&A account. Bureau personnel have accounts, but for engineering consultants, instructions for obtaining an account are given on the main page for the application (<https://siims.iowadot.gov/default.aspx>).

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

BRIS (Bridge Information System) 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 advantage for many designers and detailers is the ability to search BRIS for previously designed bridges, culverts, and other highway structures so that standard bureau practices are followed and details are effectively reutilized. 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 bridge 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. See BDM 1.8.2.1 Bid items and quantities for more information.

## 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 PSS and
- Final cost estimates for both Bridge and Roadway items in pdf format from iPDWeb.

Plans for FHWA oversight projects are to be sent to the Iowa office of the Federal Highway Administration (FHWA) for review. Final or 100% unapproved plans for review should be sent to FHWA three to six weeks before the Contracts and Specifications Bureau's turn-in date. The three to six 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's 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 PSS prior to plan turn-in.

Consultants are required to submit the items listed above to the Bridges and Structures Bureau for review two weeks before plan turn-in as discussed in *Conducting Business with the IA DOT Office of Bridges & Structures* [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 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 prints to the Contracts and Specifications Bureau.
- The supervising Unit Leader will verify that the final BSB combined multi-page PDF file contains the appropriate PDF files from Design and Soils Bureau.
- The supervising Unit Leader will copy the combined multi-page PDF file to the Contracts PlanTurnIn folder.
- A separate multi-page PDF file containing any signed sheets or standard plans referenced on the 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 PSS the use of applicable Developmental Specifications and Special Provisions.
- Input of the B3 or B4 date, project coordinates, and cost estimates into PSS.

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
- 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
- Steel girder bridges
  - Existing bridge plans
  - Signed bridge standards
  - Top of deck elevations spreadsheet
  - Bridge deck grade adjustment spreadsheet
  - Substructure staking coordinates

The file naming convention for E-files can be found on the web page at <https://iowadot.gov/bridge/automation-tools/microstation-documentation> 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 & D04).

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

- Every sheet should have the project number and file number printed on it.
- Check information on the plans for consistency with the Bridge Design plans.

- For plans that include approach pavement, check for appropriate abutment designation (M for movable and F for fixed). 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 backwall does not move with respect to the expansion and contraction of the bridge.

For projects that are tied in the Contract letting process, 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 needs 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 D4 road sheets and S4 soil sheets for BSB led projects.
- For both Review and Final sets, combine the PDF files from Design and Soils with the BSB PDF file and copy the combined multi-page PDF file to the design event folder in the ProjectWise subdirectory under the BRFinal directory.
- Turn in the final multi-page PDF prints from all Bureaus and file envelope(s) to the Unit Leader. Place all final multi-page PDF files from all Bureaus in the project subdirectory under the BRFinal directory. This includes applicable standard plans and E-files. The Unit Leader will route final or 100% unapproved plans for review to the appropriate Bureaus and District personnel.
- Complete the electronic BRIS form using the BRIS Information System on the web. This form is initiated by the B3 or B4 event date; therefore, the design engineer or technician will wait until after plan turn-in to complete the BRIS form.
- When checking the file envelope, do not erase anything. Place a line through any incorrect information and add the updated information to maintain a history of the changes.
- Complete/Verify the Design Criteria sheet is complete for all new and replacement bridges. Place a copy in the file envelope.
- Verify that PSS bid items are complete [1.14.4].
- Verify that the Bridge 2000 is completed for new and replacement bridges and bridge sized culverts. Place a copy in the file envelope.
- Create a new LARS program run for new bridges and bridge replacements. Email the Bridge Rating Engineer with the input files (.txt and excel files), and they will store the LARS file as needed. This may be postponed if necessary, but must be completed before the construction work is completed.
- 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 Rating Engineer, and they will modify 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 program and follow the same procedure above similar to new bridges.
- Complete the B3 or B4 cost estimate in iPDWeb and send a pdf version to the Unit Leader.
- Fill out the "Bridge, Culvert, and Notes Plan Review Checklists".
- Turn in all E-files. Place these in the same directory as the pdf plan prints (BRFinal directory).
- 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 PSS 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 bridge project plans under the correct Bid Divisions. BSB employees can enter them directly into PSS, while Consultants use the "Bid Item Application" tool. Where BSB is the lead Bureau

(B03 plans), bid items for sheets submitted to BSB by other Bureaus (Design Bureau or District Offices) 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 bridge bid division behind the other divisions.

Contracts and Specifications Bureau will download the PSS bid items and quantities into the proposal; therefore, it is critical that the bid divisions in PSS are arranged in the same order they occur in the project plans. The lead Bureau who is turning in the project plans is responsible to ensure all the bid item divisions are in the correct order by the day of Plan Turn-in to 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. 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](https://iowadot.gov/contracts/electronicplanspecs/Plan_Changes_and_Addendums_Contracts.pdf))

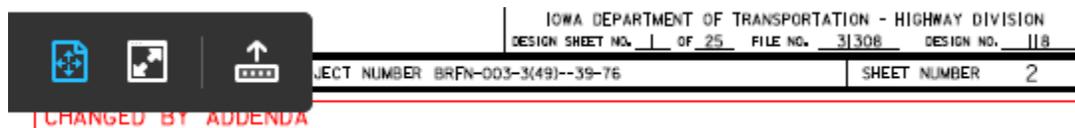
### 1.15.1 Plan changes prior to advertising

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 addendums to plan sheets, add the Bridge Bureau’s “ADDENDUM” cell located in the “BrgFinal” library of MicroStation 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 are to show a deletion crossed-through and it and any associated changes encircled with a cloud, so that the entire change is 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 Bureau’s web site (<http://www.iowadot.gov/bridge/v8docs.htm>).

## 1.17 Shop drawings

The Bureau reviews shop drawings to ensure that the structural adequacy of the design is maintained as detailed on the original design drawings. 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 shop drawing review will vary with each design. For complex designs the reviewer shall discuss in advance the extent of the shop drawing review with the supervising Unit Leader.

When reviewing shop drawings the reviewer shall place a small red check mark by all items checked correct on the drawing and make any additions or corrections to the drawing in red. So that scanned copies of the checked drawings are legible the reviewer shall not use highlighters.

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 5.5.2.4.3].

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

## 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 Check and Final Bridge or Culvert Plans, I.M. 3.510. The review engineer shall return their cursory review comments or in-depth check plans to the LPA in accordance with the memorandum.

NHS links:

[http://www.iowadot.gov/systems\\_planning/pdf/nhs\\_map.pdf](http://www.iowadot.gov/systems_planning/pdf/nhs_map.pdf)

[http://www.fhwa.dot.gov/planning/national\\_highway\\_system](http://www.fhwa.dot.gov/planning/national_highway_system)

Bridge Plan Review Checklist link:

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

Instructional Memorandum for LPA Check and Final Bridge or Culvert Plans, I.M. 3.510, link:

[https://www.iowadot.gov/local\\_systems/publications/im/3500.pdf](https://www.iowadot.gov/local_systems/publications/im/3500.pdf)