# OHIO DEPARTMENT OF TRANSPORTATION

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October 15, 2010

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Bridge Standards Engineer

Re: 2010 Fourth Quarter Revisions

Revisions have been made to the ODOT Bridge Design Manual, January 2004. These revisions shall be implemented on all Department projects with a Stage 1 plan submission date after October 15, 2010.

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

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

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

The January 2004 edition of the Bridge Design Manual may be downloaded at no cost using the following link:

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

Attached is a brief description of each revision.

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# Summary of Revisions to the January 2004 ODOT BDM

| BDM Section | Affected Pages | Revision Description |
|---|---|---|
| 209.9 | 2-43 | The required height for bicycle railing on bridges has been revised to be consistent with the AASHTO Guide for the Development of Bicycle Facilities. |
| 304.4.3 | 3-86 | This change came as a request from the fabricators. Failure to show a dimensional reference from the TST-1-99 post spacing to the beam ends, often results in project delays while the fabricator requests information in order to finalize the shop drawings. |
| 305.2 | 3-88 | This revision clarifies when designers should investigate the need for bridge fencing. |
| 305.5 | 3-90 through 3-90.2 | This revision introduces an optional mesh for vandal fencing in lieu of chain-link. |
| 503 | 5-3 | This revision eliminates conflicts with ODOT reference documents. |
| 602.3 | 6-7 | This revision eliminates conflicts between governing specifications for the design of bridges carrying rail traffic. |
| 605.1 | 6-14 through 6-14.2 | This new note addresses the installation of piling for MSE wall supported abutments. |
| 702.12 | 7-10 | This section was revised to eliminate confusion between "surface" course and "wearing" course. |
| 900 | 9-1 through 9-38 & Fig. 901 through Fig. 909 | This is a complete revision of BDM Section 900 – Bridge Load Rating. This revision incorporates FHWA's 10/30/2006 policy memorandum "Bridge Load Ratings for the National Bridge Inventory", including the implementation of Load and Resistance Factor Rating (LRFR) for new bridges. |

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measured from centerline of tracks, and 22’-0” [6.7 meters] vertical, measured six feet [1.8 meters] from centerline of tracks, wherever possible.

## 209.9 BICYCLE BRIDGES

Reference should be made to ODOT’s most current design guidelines and Section 300 of this Manual. The current design guidelines can be obtained from ODOT’s Office of Multi-Modal Planning. For new structures generally the minimum bridge width should be the same as the width of the paved bicycle path and approach shoulders. A minimum transverse slope of 1/4 inch per foot [0.021] sloped in one direction should generally be used. Bicycle railings should be a minimum of 3’-6” [1065 mm] high. Except as noted herein, refer to AASHTO Section 2.7.2 for additional bicycle railing design requirements. If an occasional maintenance vehicle is going to use the bridge, the railing should only be designed as a bicycle railing. The type of bridge deck joints used should be bicycle safe.

If a timber deck is used, a 1½ inch [38 mm] minimum thickness of Item 448, Asphalt Concrete Surface Course, Type 1, PG64-22, shall be applied in order to provide an abrasive skid resistant surface. Consult the Office of Structural Engineering for recommendations before specifying other alternative surfaces.

## 209.10 PEDESTRIAN BRIDGES

Pedestrian facilities shall meet the grade and cross slope requirements specified in Volume One, Section 306.2.5 of the ODOT Location & Design Manual. For pedestrian bridges over highways an additional one foot [300 mm] of vertical clearance shall be provided. The current AASHTO design guide for pedestrian bridges should be followed.

If a timber deck is used, a 1½ inch [38 mm] minimum thickness of Item 448, Asphalt Concrete Surface Course, Type 1, PG64-22, shall be applied in order to provide an abrasive skid resistant surface. Other alternative surfaces may be used if approved by the Department.

## 209.11 SIDEWALKS ON BRIDGES

Sidewalks should be provided where significant pedestrian traffic is anticipated and/or the approach roadway has sidewalks or requires provisions for future sidewalks. Refer to Volume One, Section 306.4 of the ODOT Location & Design Manual for specific pedestrian traffic requirements. The width of the bridge sidewalk is generally the width of the approach sidewalk plus 12 inches [300 mm], with the widths typically between 5 and 6 feet [1500 and 1800 mm] wide.

An 1/4 inch per foot [0.02] cross slope should be provided to drain the sidewalk towards the curbline. The sidewalk height shall be 8 inches [203 mm] on the bridge, tapering down to the approach curb height within the length of the approach slab.

A detail of the standard curb (height, face slope, and corner rounding) should be given. Refer to Section 300 of this Manual for vandal protection fencing requirements.

## 209.12 MAINTENANCE AND INSPECTION ACCESS

Maintenance and inspection access requirements should be included in the Structure Type Study, Narrative of Bridge Alternatives. For multiple span bridges with 8 feet [2400 mm] or deeper girders, an inspection handrail located on the girders should be provided. Also catwalks should be considered. Safety cables and other fall arrest systems should be considered in addition to handrails and catwalks. Provisions for maintenance and inspection access should be provided for fracture critical girders, cross girders and bents that cannot be inspected from a snooper. The use of fracture critical members is strongly discouraged. For these types of structures, consult the Office of Structural Engineering for details and recommendations. Additional information is provided in “FHWA Guidelines for Providing Access to Bridges for Inspections”, dated November 1985.

## 209.13 SIGN SUPPORTS

Research has shown that overhead sign supports located on bridges are highly susceptible to fatigue damage. Every effort shall be made to locate overhead sign supports off of bridge structures. When this is not possible, only two locations on the structure are acceptable and are listed below in order of preference:

A. Mounted directly to the substructure unit.

B. Mounted to the superstructure directly over a substructure unit.

Sign supports attached to the fascia of overpass bridges, as shown on Standard Construction Drawings TC-18.24 and TC-18.26, should also be avoided. Consult with the District Bridge Engineer before specifying their use.

For each of the above listed barrier types, designers are required to confirm the structural adequacy of the concrete deck slab as described in the "Concrete Deck Design" Section 302.2 of this manual.

All concrete parapet type barriers shall be designed and detailed as follows:

A. All horizontal reinforcing steel shall be detailed as continuous for the total length of the structure.

B. Crack control joints shall be sawed into the concrete parapets. The distance between the saw-cut joints on the structure shall be between 6'-0" and 10'-0". The detailed locations of the crack control joints and vertical reinforcing bars shall be shown in the contract plans for all parapet types.

C. The saw-cut crack control joint shall be detailed as 1 ¼ inch deep and shall be filled with a polyurethane or polymeric material conforming to ASTM C920, Type S. The bottom one-half inch of both the inside and outside face shall be left unsealed to allow any water that enters the joint to escape. This requirement is established in the Standard Bridge Drawings; however, a plan note is required for special designs. See Section 600.

### 304.4.2 DEEP BEAM BRIDGE GUARDRAIL (DBR-2-73)

This railing configuration does not meet the Department's minimum NCHRP 350 acceptance criteria (i.e. TL-3) for use on any project unless supported by the selection procedures described in Section 304.1 of this manual. In no case, shall this railing system be used on an overpass structure or a project where the finished deck surface is greater than 25 feet above the normal water surface elevation or final ground line.

When a structure is included in a project, as defined in Section 304.1 of this manual, existing Deep Beam Bridge railing shall be replaced with a system meeting the minimum requirements for the project's specific location.

The standard configuration for this rail type does not meet the minimum requirements specified by AASHTO for pedestrian and bicycle railings and shall not be used where pedestrian or bicycle traffic is expected. A modified railing design meeting these requirements and using the Type 1 post design may be justified.

Use of Type A anchors, as detailed on the Standard Bridge Drawing, is not recommended. The Type B alternative is recommended because they are easier to install in a deck or box beam and easier to replace if damaged in a collision.

Designers should recognize that variable post lengths may be required along the length of a structure due to beam camber. A design data sheet is available from the Office of Structural Engineering to address these concerns.

### 304.4.3 TWIN STEL TUBE BRIDGE RAILING (TST-1-99)

This railing configuration was developed as a replacement to the Deep Beam Bridge Guardrail system on projects requiring a higher NCHRP acceptance level. The Twin Steel Tube Bridge Railing is for use over rural stream crossings on two (2) lane routes with an ADTT in one direction less than 2500 where the finished deck surface is less than 25 feet above the normal water surface elevation or final ground line. This system shall not be used on an overpass structure.

The standard configuration for this rail type does not meet the minimum requirements specified by AASHTO for pedestrian and bicycle railings and shall not be used where pedestrian or bicycle traffic is expected. A modified railing design meeting these requirements may be justified.

The required bridge terminal assembly section used to transition from Type 5 or 5A approach roadway guardrail to the bridge railing is detailed on Standard Construction Drawing GR-3.6.

The typical post spacing is 6'-3". The standard drawing enables the designer to reduce the first, last and one additional post spacing per span on each side of the bridge to account for construction clearances. The designer should carefully review the position of the posts that are near the corner of a structure for possible interference with wingwalls, tie rods, etc. For box beam bridge types, post spacing dimensions shall be referenced to each box beam end.

The site plan shall show the station of the center of the first inlet-mounted post on each corner of the bridge.

### 304.4.4 BRIDGE RETRO-FIT RAILING, THRIE BEAM BRIDGE RAILING FOR BRIDGES WITH SAFETY CURBS (TBR-91)

Thrie beam railing, as described on Standard Bridge Drawing TBR-91, is for use as a provisional upgrade on structures with safety curb and parapets where a safety upgrade is required under Section 304.1, and the structure will be rehabilitated or replaced in the near future.

The Office of Structural Engineering does not generally recommend this alternative because of the potential for high maintenance costs. A more suitable alternative is concrete refacing of existing safety curb and parapets to either a New Jersey or Single Slope shape. See Section 400 of this Manual for additional information on refacing of safety curb and parapets.

### 304.4.5 PORTABLE CONCRETE BARRIER (PCB-91)

This system is for use on construction projects to protect project personnel and to provide a temporary barrier system when a permanent bridge railing system does not exist. Application guidelines for PCB-91 are provided in Design Data Sheet, PCB-DD, available at the Office of Structural Engineering web site.

The designer is required to detail the installation requirements, including the number of anchor bolts per barrier, in the bridge plans. The pay item for this barrier system is Item 622 - Portable Concrete Barrier, 32 inch, Bridge Mounted. Although temporary railing is to be specified and completely described in the bridge plans, temporary railing is a roadway item and shall be included in the roadway quantities.

On projects where maintaining minimum lane widths during a construction phase is not possible due to limited bridge width, the use of a top mounted steel post and tubular steel rail system, similar to the Twin Steel Tube bridge guardrail, may be justified. The railing, post and anchorage designs of these systems are to be in accordance with the AASHTO LRFD Bridge Design Specifications, 2$^{nd}$ Edition, Sections A13.1-3.

### 304.4.6 BRIDGE SIDEWALK RAILING WITH CONCRETE PARAPETS (BR-2-98)

This railing system is for use on bridges with sidewalks at least 5'-0" wide and a curb height of 8 inches. Although this system is essentially a combination railing system, it may also be used without a sidewalk in applications where pedestrian traffic is not a concern.

Where Vandal Protection Fencing is required, the fencing shall be installed behind the steel tubing as shown in Figure 327. However, the steel tubing may be omitted if the concrete parapet height is 32" or greater. See Figure 326. If the tubing is omitted, the fencing should extend the full length of the concrete parapet and the additional 18" parapet height at each end, as detailed in the standard, is not required.

The concrete parapet shall be designed and detailed as follows:

A. All horizontal reinforcing steel shall be detailed as continuous for the total length of the structure.

B. Crack control joints shall be sawed into the concrete parapets. The distance between the saw-cut joints on the structure shall be between 6'-0" and 10'-0". The detailed locations of the crack control joints and vertical reinforcing bars shall be shown in the contract plans.

C. The saw-cut crack control joint shall be detailed as 1 ¼ inch deep and shall be filled with a polyurethane or polymeric material conforming to ASTM C920, Type S. The bottom one-half inch of both the inside and outside face shall be left unsealed to allow any water that enters the joint to escape. This requirement is established in the Standard Bridge Drawing; however, a plan note is required for special designs. See Section 600.

# 305 FENCING

## 305.1 GENERAL

The primary purposes of protective fencing are to provide for the security of pedestrians and to discourage the throwing or dropping of objects from bridges onto lower roadways, railroads, boat lanes or occupied property. In addition, fence may be needed on high level bridges where wind may threaten to blow pedestrians or occasional stranded motorists off the bridge and on bridges where there is a danger that the outside parapet may be mistaken for a median barrier, causing persons to jump over the parapet in emergency situations in periods of darkness. These situations should be treated on a case-by-case basis.

Since a falling object problem could occur at any bridge accessible to pedestrians, it is necessary to consider installation of protective fencing at such locations.

Generally, fencing attached to bridge structures for the protection of traffic and pedestrians should conform to the Vandal Protection Fencing Standard Bridge Drawing. The designer may need to enhance this standard to deal with requirements for the specific structure.

## 305.2 WHEN TO USE

Designers shall investigate the need for fencing during the Red Flag Summary when a bridge is included in the one of the following construction project types: new construction, complete deck replacements, replacement of deteriorated concrete deck edges, superstructure widenings and rigid concrete overlays. Pedestrian Fencing may be required when a total of 10 points or greater is achieved for a structure according to the following criteria. The designer should use this procedure as a general guide as to the need for fencing. The affected district should also be consulted for their input. The list is not to be construed as all-inclusive. Other rationale may be used on a case-by-case basis. Similarly, retrofitting of bridges that qualify according to the total index number is not mandatory if adequate justification for not doing so can be documented.

| | JUSTIFICATION ITEM | INDEX POINTS |
|---|---|---|
| A. | Overpass within an urbanized area of 50,000 or more population | 2 |
| B. | Overpass with sidewalks but not in an urbanized area as defined in (A) ("Sidewalk" does not include safety curbs 2'-3" [685 mm] or less in width) | 2 |
| C. | Overpass which is unlighted | 2 |
| D. | Overpass not a main thoroughfare, i.e., on collectors or local streets | 2 |
| E. | Overpass within ½ mile [0.8 km] of another overpass exclusive of pedestrian bridges, having or requiring protection | 2 |
| F. | Overpass within ½ mile [0.8 km] of another overpass having previous reports of falling objects | 4 |
| G. | Overpass within 1 mile [1.6 km] of a school, playground or other pedestrian attraction | 4 |
| H. | Bridges over any feature which has a high count of boat, rail, vehicular or pedestrian traffic, or includes damage-sensitive property | 4 |
| I. | Overpass which has had prior reported incident of falling objects | 6 |
| J. | Overpass which is used exclusively by pedestrians | 10 |

"OVERPASS" is a bridge over a highway or a railroad.

Justification Items (E), (F) and (G) do not apply to overpasses carrying Freeway routes as defined in ORC 4511.01 where pedestrians are prohibited per ORC 4511.051.

## 305.3 FENCING CONFIGURATIONS

For structures with sidewalks, the top of fence should be a minimum height of 8 feet [2450 mm] above the sidewalk. For a greater degree of protection against objects being thrown from the bridge, the fence may be curved to overhang the sidewalk. For curved fence the posts should be vertical for approximately 8 feet [2450 mm] above the sidewalk before curving inward over the sidewalk. The overhang should be at least 1 foot [300 mm] less than the width of the sidewalk, with a maximum overhang of 3'-7" [1100 mm]. The slope of the straight overhanging portion should be 1 vertical to 4 horizontal. The radius of the connecting arc should be 32 inches [815 mm]. See Figures 326 & 327.

For narrow pedestrian bridges, bent pipe frames are generally used with pipe bend radii of 24" [600 mm] at the upper corners and the start of the radii about 8 feet [2450 mm] above the sidewalk surface. The fabric should start at the deck line, top of curb or parapet and may stop at the upper end of the bent portion of the frame.

Fabric on the top horizontal area of the frame is sometimes not installed because adventurous youngsters tend to walk on the top of the enclosure. See Figure 328 for an illustration of this configuration. To try to eliminate the adventurous youngster problem, some pedestrian bridges have used a frame design that comes to a peak at the center of the structure, similar to a house roofline.

Chain link fabric should not have an opening at the bottom through which large objects could be pushed. A detail to close the bottom of a fencing section is included on the standard bridge drawing. The closure plate detail is required for all fence configurations that have tension wire at the bottom of the fence fabric.

Posts and frames may be either plumb or perpendicular to the longitudinal grade of the bridge, subject to considerations of aesthetics or practicality of construction. Complete details of base plates, pipe inserts or other types of base anchorage shall be provided on the plans. If applicable to the specific project, details from the standard bridge drawing may be referred to in the project plans.

## 305.4 SPECIAL DESIGNS

The following information is given the designer as a basis for specialized designs. It is not intended for designers to develop their own requirements in lieu of the standard bridge drawing.

For fence installation projects on new structures, the installation of a traffic railing (steel tubing) is not required if the top concrete parapet or concrete wall is 32" [813 mm] above roadway for structures without sidewalks or 32" [813 mm] above the top of sidewalk for structures with sidewalks. See Figure 326.

For special fence designs, plan notes shall be required to define materials, traffic maintenance, construction procedures and other requirements. The designer should follow the example of standard bridge drawing for development of required notes.

## 305.5 FENCE DESIGN GENERAL REQUIREMENTS

Fencing mesh should consist of either of the following materials:

A. Chain-link wire mesh with one inch [25 mm] diamonds. The core wire shall be 11 gage [3.05 mm] with a Polyvinyl chloride coating. (C&MS 710.03)

B. Welded wire fabric with ½” x 3” [12 mm x 75 mm] opening size. The core wire shall be 10.5 gage [3.25 mm]; galvanized after welding (1.2 oz zinc/ft$^2$), and PVC coated (10 mil [0.25 mm]).

Brace and bottom rails shall be clamped to posts or post frames.

The top rail, if any, of a free-standing fence should be continuous over two or more posts and suitable cap fittings provided.

Bent pipe frames for narrow pedestrian bridges are permitted. Bent pipe frames for narrow pedestrian bridges should be fabricated in two or more sections and field spliced at the top with sleeves bolted to the frame sections.

To prevent pipe blow-ups during galvanizing, both ends of pipe should be open. Therefore base plates should have holes in them almost equal to the pipes' inside diameter.

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I. The road surface on the temporary structure shall have antiskid characteristics, crown, drainage and superelevation in accordance with all ODOT and AASHTO publications.

## 504 GENERAL NOTES

The designer should provide plan note(s) with the Temporary Structure plans similar to the following:

A. The Contractor may substitute used or alternate members for the members shown on the Temporary Structure Plans, provided that the strength of the substitute or alternate member is equal to or greater than the original member. Maintain waterway opening size and required clearances. Submit calculations for the substitute or alternate member according to 502. Use only new bolts.

B. Structural steel need not be painted.

The following instructions are provided to assist in developing the necessary general notes.

When 513 Structural Steel is specified in the plans, only the following CMS descriptions shall apply:

A. Straightening ........................................513.11

B. Holes for High Strength and Bearing Bolts ........................................513.19

C. High Strength Steel Bolts, Nuts and Washers ........................................513.20

D. Welding ........................................513.21

E. Nondestructive Testing ........................................513.25

F. Shipping, Storage and Erection........................................513.26

When 511 Class "C" is specified in the plans, 511.18 shall be waived.

The following notes shall be included in the Structure General Notes. In the roadway plans the pay item description “614 Maintenance of Traffic” shall include an “as per Plan.” Coordination with the roadway plans for this item is required.

A. MAINTENANCE: Maintain all portions of the temporary structure in good condition with regard to strength, safety and ridability. The Department will consider this maintenance to be incidental to Item 614, Maintaining Traffic. Maintain the waterway opening shown on the plans at all times. If debris accumulates within the waterway opening or on any part of the structure promptly remove the debris. The Department will compensate for debris removal according to 109.05.

B. CLOSING OF THE TEMPORARY STRUCTURE: If for any reason or at any time the temporary structure's ability to safely carry traffic is in question, immediately take the actions necessary to protect traffic, repair and reopen the temporary structure. When closing a temporary structure for this purpose, immediately notify the Engineer and the appropriate law enforcement agency. Water elevations exceeding the design (5) year highwater elevation or an excessive accumulation of debris within the waterway opening shall be sufficient reasons to close the temporary structure. Mark the design (5) year highwater elevation with fluorescent paint on the temporary structure, at a visible location. The Department will consider the costs associated with closing the temporary structure to be incidental to Item 614, Maintaining Traffic.

Ultimate Strength = 1860 MPa
Initial stress = 1395 MPa (Low relaxation strands)

** Revise the prestressed concrete strength values for final strength and strength at release if a design strength is different than the values listed above. Also, modify the diameter and area of the strands as required.

## 602.3 FOR RAILWAY PROJECTS

For structures carrying railroad traffic, provide the following notes on the project plans:

**[9]** DESIGN SPECIFICATIONS: This structure conforms to the requirements of the "Manual for Railway Engineering" by the American Railway Engineering and Maintenance-of -way Association, XXXX * Edition.

CONSTRUCTION AND MATERIAL SPECIFICATIONS: State of Ohio, Department of Transportation, dated January 1, XXXX. *

* Designer should fill-in current edition and latest interims.

**NOTE TO DESIGNER:** Note **[2A]** may be required if special criteria or distributions have been used for the design of this rail structure. See **[2A]** and determine if a modified note is required for inclusion.

Use the following note, modified as necessary to meet AREMA and/or a specific railroad criterion, with all railroad structures.

**[10]** DESIGN DATA :

Design Loading - Cooper E-80 with diesel impact (or specific railroad criteria)

Concrete __*__ - unit stress 1500 psi (superstructure)
Concrete __*__ - unit stress 1333 psi (substructure)

\# Concrete S Modified - unit stress 1300 psi (drilled shaft)

* Class S or Class HP Concrete for superstructure
Class C or Class HP Concrete for substructure

\# Only included if drilled shafts are being constructed

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 27,000 psi
A709 Grade 36 - yield strength 20,000 psi

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

Reinforcing steel - ASTM A615-unit stress 24,000 psi

**[10M]** DESIGN DATA :

Design Loading - Cooper E-80 with diesel impact (or specific railroad criteria)

Concrete __*__ - unit stress 10.3 MPa (superstructure)
Concrete __*__ - unit stress 9.2 MPa (substructure)

# Concrete S Modified - unit stress 1300 psi (drilled shaft)

* Class S or Class HP Concrete for superstructure
Class C or Class HP Concrete for substructure

# Only included if drilled shafts are being constructed

** Structural Steel

ASTM A709 Grade 50W or A709 Grade 50 - yield strength 186 MPa
A709 Grade 36 - yield strength 138 MPa

** If more than one grade of steel is selected, the description shall clearly indicate where the different grades are used in the structure.

Reinforcing steel - ASTM A615M-unit stress 167 Mpa

## 602.4 DECK PROTECTION METHOD

If any of the following deck protection method(s) have been specified in the plans, include the following note in the Design Data section of the Structure General Notes (modify as necessary for the specific structure):

**[11]** DECK PROTECTION METHOD:

Epoxy coated reinforcing steel

**[20]** SUBSTRUCTURE CONCRETE REMOVAL: Remove concrete by means of approved pneumatic hammers employing pointed and blunt chisel tools. Hydraulic hoe-ram type hammers will not be permitted. The weight of the hammer shall not be more than 35 pounds [16 kilograms] for removal within 18 inches [450 mm] of portions to be preserved. Outside the 18 inch [450 mm] limit, the contractor may use hammers not exceeding 90 pounds [41 kilograms] upon the approval of the Engineer. Do not place pneumatic hammers in direct contact with reinforcing steel that is to be retained in the rebuilt structure.

## 604 TEMPORARY STRUCTURE CONSTRUCTION

Include the applicable portions of the following temporary structure note on the plans if the bridge roadway width is other than 23 feet [7 meters], or if the use of the existing structure is part of the temporary road. See Section 500 for additional information.

**[21]** TEMPORARY STRUCTURE roadway width shall be ______ feet [meters]. The existing structure may be moved and used for the temporary structure without strengthening.

## 605 EMBANKMENT CONSTRUCTION

For all substructures units where embankment construction is involved, provide appropriate embankment construction notes in the Structure General Notes. Consult the Office of Structural Engineering for the recommended notes to use at a specific project site.

### 605.1 FOUNDATIONS ON PILES IN NEW EMBANKMENTS

The following construction method helps to eliminate any lateral forces on the piles and abutment due to the construction of the embankment, settlement of the subgrade under the embankment and poor construction of the embankment if the piles were driven before the embankment is placed.

For structures with abutments on piles placed in new embankments use the following note:

**[22]** PILE DRIVING CONSTRAINTS: Prior to driving piles, construct the spill through slopes and the bridge approach embankment behind the abutments up to the level of the subgrade elevation for a minimum distance of _*_ behind each abutment. Do not begin the excavation for the abutment footings and the installation of the abutment piles until after the above required embankment has been constructed.

* Generally 200 feet [60 meters]. May be defined by station-to-station dimensions.

For structures with abutments and piers on piles placed in new embankments use the following note:

**[22a]** PILE DRIVING CONSTRAINTS: Prior to driving piles, construct the spill through slopes and the bridge approach embankment behind the abutments up to the level of the subgrade elevation for a minimum distance of _*_ behind each abutment. Do not begin the excavation for the abutment footings and the installation of the abutment and pier piles, for pier(s)__**__, until after the above required embankment has been constructed.

* Generally 200 feet [60 meters]. May be defined by station-to-station dimensions.

** Identify specific piers.

For structures with wall type abutments on piles placed in new embankment use the following note:

**[23]** PILE DRIVING CONSTRAINTS: Prior to driving piles at the abutments, construct the bridge approach embankment behind the abutments up at a 1:1 slope from the top of the heel of the footing* to the subgrade elevation and for a minimum distance of 250 feet [75 meters] behind the abutments. Do not begin the installation of the abutment piles until after the above required embankment has been constructed. After the footing and the breastwall have been constructed, construct the embankment immediately behind the abutments up to the beam seat elevation and on a 1:1 slope up to the subgrade elevation prior to setting the beams on the abutments.

* In some cases the bottom of the heel may be used.

For MSE wall supported abutments with driven piles use the following note:

**[23a]** PILE DRIVING CONSTRAINTS: Prior to driving abutment piles to the Ultimate Bearing Value (UBV) or to refusal on bedrock, construct the MSE wall and the bridge approach embankment behind the abutment up to the bottom of the footing for a minimum distance of _*_ behind each abutment. The Contractor may pre-drive abutment piles before constructing MSE walls. Pre-driving consists of installing the abutment piles into the soil only as far as necessary so that the pile will remain vertical during MSE wall construction. If pre-driving piles, install pile sleeves around piles before constructing the MSE wall. At least three feet of pile must extend above the top of the pile sleeve to meet the requirements of CMS 507.09 regarding splices. Do not drive abutment piles to the UBV or to refusal on bedrock until after the above required MSE wall and embankment have been constructed and a _**_ calendar day waiting period has elapsed. The Engineer may adjust the length of the waiting period based on settlement platform readings. After the specified waiting period has elapsed, drive abutment piles to the UBV or to refusal on bedrock. In order to remove any negative skin friction that has developed during the waiting period, drive each abutment pile a distance of at least 0.5 inch.

If not pre-driving abutment piles, install the abutment piles through pile sleeves after the above required MSE wall and embankment have been constructed and the specified waiting period has elapsed.

* Generally 200 feet [60 meters]. May be defined by station-to-station dimensions.
** Estimate the length of the waiting period by determining the time required for 90% of primary settlement to occur.

## 605.2 FOUNDATIONS ON SPREAD FOOTINGS IN NEW EMBANKMENTS

The following construction method helps to eliminate any lateral forces on the foundation due to the construction of the embankment and/or settlement of the subgrade under the embankment. For stub abutments on spread footings being constructed in new embankments provide note **[26]** or **[27]** and the following note:

**[24]** CONSTRUCTION CONSTRAINTS: Prior to constructing the spread footing foundations, construct the bridge approach embankments behind the abutment up at a 1:1 slope from the bottom of the heel of the footing to the subgrade elevation and for a minimum distance of 250 feet [75 meters] behind the abutments. After the abutment footing and breastwall are completed and prior to setting superstructure members, construct the embankment immediately behind the abutment up to the beam seat elevation and on a 1:1 slope up to the subgrade elevation, with Type B granular material conforming to 703.16.C.

**NOTE TO DESIGNER:** Modify the note, as appropriate, for piers constructed on a spread footing foundation.

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Calculated deflection due to dead load applied after the beams are set (weight of surface course, railings, sidewalks, etc.) is ____ inches [mm].
The vertical curve adjustment to the topping thickness at midspan is _____ inches [mm] upward.

The vertical curve adjustment to the topping thickness at each bearing is _____ inches [mm] upward/downward.

(1) The thickness of the intermediate asphalt course shall be 1½ inches [38 mm]. No variation in thickness is required.

(2) The thickness of the intermediate asphalt course shall vary from 1½ inches [38 mm] at each centerline of beam bearing to _____ inches [mm] at midspan.

(3) The thickness of the intermediate asphalt course shall vary from _____ inches [mm] at each centerline of beam bearing to 1½ inches [38 mm] at midspan.

**[76a]** Calculated camber at the time of release is ______ inches [mm].

Calculated camber at time of paving is ______ inches [mm].

Long term camber is ______ inches [mm].

Calculated deflection due to dead load applied after the beams are set (weight of surface course, railings, sidewalks, etc.) is ____ inches [mm].

The vertical curve adjustment to the topping thickness at midspan is _____ inches [mm] upward.

The vertical curve adjustment to the topping thickness at each bearing is _____ inches [mm] upward/downward.

(1) The concrete thickness shall be 6 inches [150 mm]. No variation in thickness of concrete is required.

(2) The concrete thickness shall vary from 6 inches [150 mm] at each centerline of beam bearing to _____ inches [mm] at midspan.

(3) The concrete thickness shall vary from _____ inches [mm] at each centerline of beam bearing to 6 inches [150 mm] at midspan.

**NOTE TO DESIGNER:** The calculated camber at the time of release is (B – C), at the time of paving is (1.8B - 1.85C), and long term is (2.45B – 2.40C). The calculated deflection due to dead load applied after the beams are set is (D + E). The vertical curve adjustment at midspan is (F) when F > 1.8B - 1.85C - D - E. The vertical curve adjustment at each bearing is (F) when F

< 1.8B - 1.85C - D - E and may be upward for sag curves or downward for crest curves. Remove the reference to the vertical curve adjustment that does not apply.

Conclude note **[76]** with note (1), (2) or (3) as appropriate. Note (1) should be used when after placement of the topping, the top surface of the beam parallels the profile grade. Note (2) should be used when F > 1.8B - 1.85C - D - E. Note (3) should be used for all other cases.

For non-composite designs, include in the bridge plans a diagram similar to Figure 702 showing the thickness of the Item 448 Intermediate course and the Item 448 surface course at each centerline of bearing and at midspan.

For composite design, show a longitudinal superstructure cross section in the plans detailing the total Topping Thickness at each centerline of bearings and at midspan. Also show screed elevation tables similar to 701.1.

Use the following note when the length of the box beam, measured along the grade, differs from the length, measured horizontally, by more than 3/8" [10mm]:

**[95]** NOTE TO FABRICATOR: The dimensions measured along the length of the beam, marked with a *, do not contain an allowance for the effect of the longitudinal grade. Include the proper allowance for these dimensions in the shop drawings.

**NOTE TO DESIGNER:** Indicate the dimensions that require a grade adjustment with an asterisk or some other easily recognizable symbol and include that symbol in the note above.

## 702.12 ASPHALT CONCRETE WEARING COURSE

Place note **[77]** on the plans for prestressed concrete box beam bridges having an asphalt concrete wearing course. If the nominal thickness of 448 varies from the 1½" [38 mm] shown, revise the note accordingly.

While this note specifies how to place only the two 448 bid items, the designer should recognize that two Item 407 tack coat items are also required. One tack coat is applied before the intermediate asphalt concrete course. The other tack coat is applied between the intermediate and surface course.

**[77]** ASPHALT CONCRETE WEARING COURSE shall consist of a variable thickness of 448 asphalt concrete intermediate course, Type 2, PG64-28 and a 1½" [38 mm] thickness of 448 asphalt concrete surface course, Type 1H. Place the 448 intermediate course in two operations. The first portion of the course shall be of 1½" [38 mm] uniform thickness. Feather the second portion of the course to place the surface parallel to and 1 ½" [38 mm] below final pavement surface elevation.

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# SECTION 900 – BRIDGE LOAD RATING

## 901 PURPOSE

The purpose of this Section is to provide consistency and uniformity in procedures, guidelines and policies for determining safe live load carrying capacity or load rating of the highway bridges in the State of Ohio.

## 902 SCOPE

The guidelines, policies and recommendations provided in this Section are meant to assist Bridge Owners by establishing evaluation practices that meet the Ohio Revised Code (ORC), the National Bridge Inspection Standards (NBIS), ODOT Bridge Design Manual (BDM) and American Association of State Highway Transportation Officials (AASHTO). The intent is to establish standardized load rating procedures to conform FHWA reporting requirements and posting of bridges throughout the State of Ohio.

## 903 APPLICABILITY

The provisions of this Section apply to all highway structures in Ohio, which qualify as bridges in accordance with the definition for a bridge set in this Section. These provisions may be applied to smaller structures which do not qualify bridges as such.

## 904 QUALITY MEASURES

To maintain the accuracy and consistency of load rating, the bridge owners should implement appropriate quality assurance and quality control (QA/QC) measures. Typical quality control procedures include the use of checklists to ensure uniformity and completeness, the review of reports and computations by a person other than originating individual and periodic field review of the inspection teams and their work.

Each load rating analysis shall be performed and reviewed by two different individuals. or reviewed by a Professional Engineer (PE) registered in the state of Ohio. The same PE shall then sign and stamp (seal) the final load rating report before submission to the bridge owners.

## 905 DEFINITIONS AND TERMINOLOGY

**ASR:** Allowable Stress Rating

**ADTT:** Average Daily Truck Traffic volume in one direction

**Bridge:** A structure including supports over a depression or an obstruction such as water, highway, or railway; having a roadway to carry vehicular traffic and having an opening measured along the centerline of the roadway of 10 ft. [3.048 m] or more between under-copings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes. It may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

**Bridge Management System (BMS):** A system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation, and replacement of bridges.

**Buried structure:** A structure, including a flat slab, an arch, a frame, a box section, etc., that have a fill or pavement material of 2 ft. [600 mm] or more on top of it.

**Collapse:** A major change in the geometry of the bridge rendering it unfit for its intentional use.

**Condition Rating:** The result of the assessment of the functional capability and the physical condition of bridge components by considering the extent of deterioration and other defects. Generally, Condition Rating is evaluated on a scale 0 through 9 (where 9 is the best) and also referred as General Appraisal.

**Exemption List:** A list of structures exempt from the requirements of load rating given in this section.

**Failure:** A condition where a limit state is reached or exceeded. This may or may not involve collapse or other catastrophic occurrences.

**FHWA:** Federal Highway Administration – U.S. Department of Transportation

**Inventory Rating:** Load ratings based on the inventory level allow comparisons with the capacity for new structures and, therefore result in a live load, which can safely utilize a structure for an indefinite period of time.

**Health Index:** An indicator of the structural health of an element, a bridge or a group of bridges expressed as a value (0 to 100), where 0 corresponds to the worst possible condition and 100 corresponds to best possible condition

**LFR:** Load Factor Rating

**Limit State:** A condition beyond which a bridge or a component ceases to satisfy the criteria for which it was designed

**Load Effect:** The response (axial force, shear force, bending moment, torque) in a member or an element due to the loading

**Load Factor:** A load multiplier accounting for the variability of the loads, the lack of accuracy in analysis, and the probability of simultaneous occurrence of different loads.

**Load Rating:** The determination of the live-load carrying capacity of a bridge

**<u>Long span bridge</u>:** Any single or multi span bridge that has at least one span greater than 200 ft. [61 m].

**<u>LRFD</u>:** Load and Resistance Factor Design

**<u>LRFR</u>:** Load and Resistance Factor Rating

**<u>NBI</u>:** National Bridge Inventory, the aggregation of structure inventory and appraisal data collection to fulfill the requirements of National Bridge Inspection Standards (NBIS)

**<u>NBIS</u>:** National Bridge Inspection Standards, Federal regulations establishing requirements for inspection procedures, frequency of inspection, a bridge inspection organization, qualification of personnel, inspection reports, and preparation and maintenance of bridge inventory records. The NBIS applies to all structures defined as NBIS bridges located on or over all public roads.

**<u>NBIS Bridge</u>:** A structure including supports over a depression or an obstruction such as water, highway, or railway; having a roadway to carry vehicular traffic and having an opening measured along the centerline of the roadway of more than 20 ft. [6.01 m] between under-copings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes. It may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

**<u>Nominal Resistance</u>:** Resistance of a component or connection to load effect, based on its geometry, permissible stresses, or specific strength of materials

**<u>Non-buried Structure</u>:** A structure, including a flat slab, an arch, a frame, a box section, etc., that have a fill or pavement material of less than 2'-0" [600 mm] on top of it.

**<u>Operating Rating</u>:** Load ratings based on the operating rating level generally described the maximum permissible live load to which the structure may be subjected. Allowing unlimited numbers of vehicles to use the bridge at operating level may shorten the life of the bridge.

**<u>OPI</u>:** Organizational Performance Index; A set of Indicators to measure the overall condition of bridges at the District or network level based on the several appraisal ratings

**<u>ORC</u>:** Ohio Revised Code (as amended and adopted)

**<u>OSE</u>:** ODOT Office of Structural Engineering

**<u>Owner</u>:** Agency having jurisdiction over the bridge

**<u>Pavement of a roadway</u>:** The pavement of a roadway includes all the paved or unpaved portions of a roadway including graded shoulders that may support vehicular traffic.

**<u>PDF</u>:** Portable Document Format, a type of industry standard, electronic file format developed by the Adobe Corporation.

**Posting:** Signing a bridge for load restriction

**Preliminary Design:** The date when Federal-aid funds are obligated for the studies or design activities related to identification of the type, size, and/or location of bridges. For ODOT projects following the Project Development Process (PDP), this date corresponds to the initiation of Step 1 for a Minimal Project, Step 3 for a Minor Project or Step 6 for a Major Project.

**Quality Assurance:** The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify and measure the quality level of the entire bridge inspection and load rating program.

**Reliability Index:** A computed quantity defining the relative safety of a structural element or structure expressed as the number of standard deviations that the mean of the margin of safety falls on the safe side.

**Resistance Factor:** A resistance multiplier accounting for the variability of material properties, structural dimensions, workmanship and the uncertainty in the prediction of resistance

**RF:** Rating Factor, an indicator of live load carrying capacity of a member or a bridge

**Safe Load Capacity:** A live load that can safely utilize a bridge repeatedly over the duration of a specified inspection cycle

**Service Limit State:** Limit state related to stress, deformation and cracking

**Serviceability:** A term that denotes restrictions on stress, deformation, and crack opening under regular service conditions

**Serviceability Limit State:** Collective term for service and fatigue limit states

**Strength Limit State:** Safety limit state relating to strength and stability

**Superload:** In Ohio, a Superload is any highway vehicular load with the total gross load equal to or more than 120,000 pounds (60 tons) or [54,431 kg].

**Target Reliability:** A desired level of reliability in a proposed evaluation

## 906 REFERENCES FROM OHIO REVISED CODE

References from the ORC related to bridge load rating, posting are given below:

**5577.071 Reduction of weight of vehicle or load or speed on deteriorated or vulnerable bridge.**

(A) When deterioration renders any bridge or section of a bridge in a county insufficient to bear the traffic thereon, or when the bridge or section of a bridge would be damaged or destroyed by heavy traffic, the board of county commissioners may reduce the maximum weight of vehicle and load, or the maximum speed, or both, for motor vehicles, as prescribed by law, and prescribe whatever reduction the condition of the bridge or section of the bridge justifies. This section does not apply to bridges on state highways.

(B) A schedule of any reductions made pursuant to division (A) of this section shall be filed, for the information of the public, in the office of the board of county commissioners in each county in which the schedule is operative. A board of county commissioners that makes a reduction pursuant to division (A) of this section shall, at least one day before a reduction becomes effective, cause to be placed and retained on any bridge on which a reduction is made, at both ends of the bridge, during the period of a reduced limitation of weight, speed, or both, signs of substantial construction conspicuously indicating the limitations of weight or speed or both which are permitted on the bridge and the date on which these limitations go into effect. No person shall operate upon any such bridge a motor vehicle whose maximum weight or speed is in excess of the limitations prescribed. The cost of purchasing and erecting the signs provided for in this division shall be paid from any fund for the maintenance and repair of bridges and culverts.

(C) Except as otherwise provided in this division, no reduction shall be made pursuant to division (A) of this section on a joint bridge as provided in section 5591.25 of the Revised Code unless the board of county commissioners of every county sharing the joint bridge agrees to the reduction, the amount of the reduction, and how the cost of purchasing and erecting signs indicating the limitations of weight and speed is to be borne. A board of county commissioners may make a reduction pursuant to division (A) of this section on a section of a joint bridge, without the agreement [of] any other county sharing the bridge, if the section of the bridge on which the reduction is to be made is located solely in that county.

**5591.42 Carrying capacity of bridges - warning notice.**

The board of county commissioners together with the county engineer or an engineer to be selected by the board, or the director of transportation, may ascertain the safe carrying capacity of the bridges on roads or highways under their jurisdiction. Where the safe carrying capacity of any such bridge is ascertained and found to be less than the load limit prescribed by sections 5577.01 to 5577.12 of the Revised Code, warning notice shall be conspicuously posted near each end of the bridge. The notice shall caution all persons against driving on the bridge a loaded conveyance of greater weight than the bridge’s carrying capacity.

Effective Date: 11-02-1989

## 907 BRIDGE FILES (RECORDS)

Bridge owners should maintain a complete, accurate and current record of each bridge under their jurisdiction. Complete information, in good usable form, is vital to the effective management of bridges. Such information provides a record that may be important for repair, rehabilitation, replacement and future planning of the bridges.

Items that should be assembled as part of the bridge record are discussed below. Some or all of the information pertaining to a bridge may be stored in electronic format as part of a bridge management system.

## 907.1 CONSTRUCTION PLANS

Each bridge record should include one clear and readable set of all drawings used to construct, repair and/or rehabilitate the bridge. In lieu of hard copies, the construction plans may be stored in an electronic format in such a way that clear and readable paper copies can easily be reproduced from the electronic records.

## 907.2 CONSTRUCTION & MATERIAL SPECIFICATIONS

Each bridge record should include the reference to the construction and material specification used during the construction of the bridge. Where general technical specifications were used, only the special technical provisions need to be incorporated in the bridge record.

## 907.3 SHOP AND WORKING DRAWINGS

One set of all shop and working drawings approved for the construction or repair of a bridge should be saved or preserved as a part of the bridge record.

## 907.4 AS-BUILT DRAWINGS

Each bridge record should include one set of final drawings showing the "as-built" condition of the bridge, complete with signature of the individual responsible for recording the as-built conditions.

## 907.5 CORRESPONDENCE

Include all pertinent letters, memoranda, notice of project completion, telephone memo and other related information directly concerning the bridge in chronological order in the bridge record.

## 907.6 INVENTORY DATA

A complete inventory of a bridge in the ODOT BMS shall be done as soon as a bridge is open to traffic. FHWA mandates an ODOT bridge shall be inventoried within 90 days and a Non-ODOT bridge shall be inventoried within 180 days from the day the bridge was open to traffic. The same rule applies to modifications in the inventory record of replaced bridges or the bridges that have been reopened after the repairs are done. Initial inventory can be completed using the bridge plans. However, a history of dates of physical closing or opening of the traffic on the bridge should be maintained in the bridge record.

## 907.7 INSPECTION HISTORY

Each bridge record should include a chronological record of the date and the type of all inspections performed on the bridge. When available, scour, seismic, wind and fatigue evaluation studies; fracture critical information; deck evaluations; field load testing; and corrosion studies should be part of the bridge record.

## 907.8 PHOTOGRAPHS

Each bridge record should at least contain photographs of the bridges showing, top view, approach views and the elevation. Other photos necessary to show major defects, damages, or other important features, such as utilities on or under the bridge, should also be included.

## 907.9 RATING RECORDS

The bridge record should include a complete record of the determination of the bridge's load-carrying capacity.

## 907.10 ACCIDENT DATA

Details of accidents or damage occurrences, including date, description of accident, member damage and repairs, supported by photographs and investigation reports should be included in the bridge record.

## 907.11 MAINTENANCE AND REPAIR HISTORY

Each bridge record should include a chronological record documenting the maintenance and repairs that have occurred since the initial construction of the bridge. Include details such as date, description of project, contractor cost and related data for in-house projects.

## 907.12 POSTING HISTORY

Each bridge record should include a summary of all posting actions taken for the bridge, including load capacity calculations, date of posting and description of signing used.

# 908 GENERAL

For load rating of new bridges, BDM Sections 911 through 925 shall apply.

For load rating of existing bridges, BDM Sections 911 through 924 & 926 shall apply.

## 909 UNIT WEIGHTS & DENSITIES

The following assumptions should be made while performing the load rating analysis, unless more accurate site information is available:

A. Unit weight of soil .................................................................... 120 lb/ft$^3$ [18.9 kN/m$^3$]

B. Unit weight of asphalt.................................................................. 145 lb/ft$^3$ [22.8 kN/m$^3$]

C. Unit weight of concrete ................................................................ 150 lb/ft$^3$ [23.6 kN/m$^3$]

D. Unit weight of latex modified concrete ............................................ 150 lb/ft$^3$ [23.6 kN/m$^3$]

E. Water density ........................................................................... 62.4 lb/ft$^3$ [9.8 kN/m$^3$]

## 910 STRUCTURES EXEMPT FROM LOAD RATING

Following types of buried structures are exempt from load rating under the provisions of this Section.

A. Circular plastic pipes

B. Circular concrete pipes

C. Buried metal frames

D. Junction chambers

E. Stone arches

F. Manholes

G. Inlets and outlets

## 911 WHICH PORTION OF BRIDGES SHALL BE LOAD RATED

Any bridge or structural member of a bridge that would carry highway traffic shall be load rated. Members of substructures need not be routinely checked for load capacity. Substructure elements such as pier caps and columns should be checked in situations where the owner or the rating engineer has reason to believe that their capacity may govern the capacity of the bridge.

## 912 PROCEDURE FOR RATING

A. The relative strength ratings for each bridge shall be determined in the following manner:

    1. A careful field inspection of the existing bridge shall be made by the District Bridge Engineer and/or other qualified structural engineer to determine its condition, and the percent of effectiveness of the various members for carrying load. All information shown in the Bridge Inventory and Inspection Records shall also be carefully checked and revised as necessary to show the current condition of the bridge.

2. New (proposed) bridges shall be load rated at the design stage per BDM Section 925
3. Using pertinent current information, the District Bridge Engineer shall determine the Inventory, Operating, and Ohio Legal Load Ratings for the structure.
4. The yield stresses for the construction materials in older bridges, for which plan information is not available, can generally be determined using the date of construction.
5. The District Bridge Engineer shall submit to the Structure Rating Engineer a complete condition report and the original copy of the rating calculation sheets or computer input data sheets for each bridge under his/her jurisdiction.
6. The Structure Rating Engineer shall review the submitted material and return a copy of the final calculations or computer output to the District Bridge Engineer, along with any recommendations concerning the proposed ratings.

## 913 WHEN LOAD RATING SHALL BE REVISED

The load rating of a bridge should be revised when:

A. There is a physical change in the condition of a structural member of the bridge
B. Rusting or damage to a slab, beam, girder or other structural element that has resulted in section loss
C. There is structural damage to steel, like a hit by a vehicle, excessive deflection or elongation under temperature or highway loads
D. When the inspection general appraisal rating of the superstructure of a bridges drops below 5
E. There is an addition of a new beam or girder
F. A new deck is added or the existing deck width is changed
G. There is a change in the dead load on the superstructure, like addition or removal of wearing surfaces, addition or removal of sidewalks, parapets, railings, etc.

The load rating of a bridge does not need to be revised when:

A. The change in the thickness of external wearing surface is less than 1 inch [2.54 cm]
B. The change in the dead load on a beam member is not more than 10 pounds per ft.

## 914 ANALYSIS OF BRIDGES WITH SIDEWALKS

A pedestrian load of 75 pounds per square feet shall be applied to all sidewalks wider than 2.0 ft. and considered simultaneously with the live load in the vehicle lane.

Sidewalk load shall not be used for Special or Permit Load Analysis per BDM Section 916.

## 915 ANALYSIS OF MULTILANE LOADING

Traffic lanes to be used for rating purposes shall be in accordance with AASHTO.

AASHTO reduction factors for multiple lane loadings shall be applied where appropriate.

For rating analysis of floor beams, trusses, non-redundant girders or other non-redundant main structural members, position identical rating vehicles in one or more of the through traffic lanes on the bridge, spaced and shifted laterally on the deck, within the traffic lanes, so as to produce the maximum stress in the member under consideration.

## 916 ANALYSIS FOR SPECIAL LOAD OR SUPERLOAD

When a structure is required, in the Scope of Services, to be analyzed for special or Superload vehicle, a second analysis shall be performed for a single lane loading of the special or Superload vehicle condition. The special or Superload vehicle shall be placed laterally on the structure to produce maximum stresses in the critical member under consideration.

The analysis for special or Superload vehicle shall be performed at the operating level only.

## 917 LOAD RATING OF LONG SPAN BRIDGES

This section applies to long span bridges as defined in BDM Section 905.

### 917.1 WHEN THE LOAD RATING SHALL BE DONE

Perform the load rating of long span bridges according to BDM Sections 925.3.3, 926.3.2, or 926.4.2.

### 917.2 HOW THE LOAD RATING SHALL BE DONE

#### 917.2.1 INVENTORY & OPERATING LEVEL RATING USING HL-93 LOADING

The live load shall be applied as per AASHTO LRFD Design Specification.

#### 917.2.2 INVENTORY & OPERATING LEVEL RATING USING HS20 TRUCK

The live load shall be applied as follows:

A. In the right-most lane, place a series of HS20 trucks to simulate a train of vehicles. The vehicle train shall consist of the HS20 trucks spaced with 30 ft. clear distance between the rear axle of the leading vehicle and the front axle of the trailing vehicle. The distance between the second axle and the rear axle shall be fixed at 14.0 ft. Place as many fixed-axle spacing HS20 trucks as necessary to produce the maximum load effect on the component to be rated. No partial HS20 trucks shall be used.

B. In all other lanes in the same direction, simultaneously place single, variable-axle spacing HS20 trucks positioned to produce the maximum load effect on the component to be rated. Apply the multiple presence factors, AASHTO Standard Specification for Highway Bridges - Section 3.12, accordingly.

C. For bridges with two-way traffic, apply the live load as described in A. and B. above to the lanes in the opposite direction.

### 917.2.3 OPERATING LEVEL RATING USING OHIO LEGAL LOADS

The provisions of BDM Sections 925 or 926 shall apply except the live load application shall be in accordance with BDM Section 917.2.3.1, 917.2.3.2 or 917.2.3.3.

### 917.2.3.1 BRIDGES WITH THREE OR MORE LANES

If no permit vehicle is present, apply the following live load:

A. In the right-most lane, place a series of Ohio 5C1 vehicles. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used.

B. In all other lanes in the same direction, simultaneously place single 5C1 vehicles. These vehicles shall be positioned to produce the maximum live load effect on the component to be rated. Apply the multiple presence factors, AASHTO Standard Specification for Highway Bridges - Section 3.12, accordingly.

C. For bridges with two-way traffic, apply the live load for the opposing traffic in the same manner as the one-way traffic.

If a permit load vehicle is present, apply the following live load:

A. In the right-most lane, place one permit load vehicle positioned to produce the maximum live load effect on the component to be rated. In the adjacent lane, place a series of Ohio 5C1 vehicles. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used.

B. In all other lanes in the same direction, simultaneously place single 5C1 vehicles. These vehicles shall be positioned to produce the maximum live load effect on the component to be rated. Apply the multiple presence factors, AASHTO Standard Specification for Highway Bridges - Section 3.12, accordingly.

C. For bridges with two-way traffic, place a series of Ohio 5C1 vehicles in the right-most lane. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used. In all remaining lanes, simultaneously place single 5C1 vehicles. These vehicles shall be positioned to produce the maximum live load effect on the component to be rated. Apply the multiple presence factors, AASHTO Standard Specification for Highway Bridges - Section 3.12, accordingly.

### 917.2.3.2 BRIDGES WITH TWO LANES

<u>If no permit vehicle is present, apply the following live load</u>:

A. In the right-most lane, place a series of Ohio 5C1 vehicles. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used.

B. For bridges with one-way traffic, in the other lane simultaneously place a single 5C1 vehicle positioned to produce the maximum live load effect on the component to be rated.

C. For bridges with two-way traffic, in the other lane place a series of Ohio 5C1 vehicles. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used.

<u>If a permit load vehicle is present, apply the following live load</u>:

A. In the right-most lane, place one permit load vehicle positioned to produce the maximum live load effect on the component to be rated.

B. In the other lane, place a series of Ohio 5C1 vehicles. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used.

### 917.2.3.3 BRIDGES WITH A SINGLE LANE

<u>If no permit vehicle is present</u>:

The live load shall be a series of Ohio 5C1 vehicles. The 5C1 vehicles should be spaced such that the distance between the rear axle of the leading vehicle and the front axle of trailing vehicle shall be 36 ft. Place as many 5C1 vehicles as necessary to produce the maximum load effect on the component to be rated. No partial 5C1 vehicles shall be used.

<u>If a permit vehicle is present</u>:

The live load shall be the one permit vehicle positioned to produce the maximum live load effect on the component to be rated.

## 918 BRIDGE POSTING FOR REDUCED LOAD LIMITS

### 918.1 PURPOSE

The Procedure outlined in this section is to be followed for posting warnings of bridge strength deficiencies on ODOT bridges.

### 918.2 REFERENCE

Ohio Revised Code, Section 5591.42:

### 918.3 PROCEDURE FOR POSTING

A. When the Operating Rating of the bridge is determined to be less than 100% of the Ohio legal load and the bridge cannot be strengthened immediately to a rating of 100% or above, the following procedures shall be used:

   1. The District Bridge Engineer shall:

      a. Establish a rating and submit to the OSE Structure Rating Engineer, a written request for the bridge posting. (See BDM Section 918.6 for required content of request.)

      b. After the Director signs the posting request, the District Roadway Services Manager shall prepare, erect and maintain all necessary signs until the bridge is either strengthened or replaced.

   2. The District Bridge Engineer shall update all Bridge Inventory and Inspection records to show the latest official posted capacity.

   3. After the posting request is signed, the Structure Rating Engineer shall send a copy to the: District Bridge Engineer; Manager, Hauling Permits Section of the Office of Highway Management; Superintendent of State Highway Patrol; Executive Director Ohio Trucking Association; the Board of County Commissioners; and the County Engineer where the structure is located.

B. Special treatment shall be applied to legal load ratings of 95% or higher and also to legal load ratings of 15% or less as follows:

   1. Because of the use of some judgmental data in the rating computations, bridges with a calculated load reduction of 5% or less, after rounding, shall not be posted. These structures shall be rated at 100% of legal load.

   2. For calculated load reductions of 85% or more, after rounding, the bridge must be considered for "closing" to all traffic until it can be rehabilitated or replaced.

C. Where posting of a bridge is determined necessary and no unusual or special circumstance at the bridge dictates otherwise, Ohio standard regulatory signs shall be placed in sufficient numbers and at the specific locations required below.

1. Example of standard wording to be used on signs is given in Figure 905.
2. Bridge Ahead signs shall be erected at intersecting state roads located just prior to the bridge to allow approaching vehicles to by-pass the bridge or turn around safely with a minimum of interference to other traffic.
3. Bridge Weight Limit signs shall be erected at each end of the structure.

**Table 918.3-1: ODOT Bridge Posting Policy**

| Controlling RF = Min. RF of Ohio Legal Loads at Operating Stress Level<br>% Ohio Legal Value = Controlling RF x 100 | | |
|---|---|---|
| **% Ohio Legal Value** | **Reported % Ohio Legal in BMS** | **Posting for Reduced Loads Needed** |
| ≥150% | 150% | NO |
| ≥100% and <150% | Actual percentage rounded to the nearest 5 (i.e. 100, 105, 110, 115, etc.) | NO |
| ≥92.5% and <100% | 100% | NO |
| <92.5% | Actual percentage rounded to the nearest 5 (starting with 90%, 85%, 80%, etc.) | YES |

## 918.4 PROCEDURE FOR RESCINDING POSTING

A. When a posted bridge has been strengthened or replaced and no longer needs posting, the District Bridge Engineer shall forward to the Structure Rating Engineer a written request to rescind the existing signed posting. The request shall include a complete statement of the reason for the action as specified in BDM Section 918.6.

B. The Structure Rating Engineer shall review the data submitted by the District Bridge Engineer and upon concurrence shall forward to the Director a request to rescind the posting.

C. The Structure Rating Engineer shall distribute copies of the rescind notice as described in Section 918.3.A.3.

## 918.5 PROCEDURE FOR CHANGING POSTING

When the rated capacity of bridge changes, so as to require a revised posting level, the procedures in BDM Section 918.3 apply and in addition, the existing posting must be rescinded as set forth in BDM Section 918.4.

## 918.6 REQUIRED INFORMATION FOR POST, RESCIND AND CHANGE REQUESTS

The following minimum information is required on all post, rescind and change requests:

A. Posting Request (Reduction in Load Limits)
   1. County in which bridge is located
   2. Current Bridge Number
   3. Structure File Number
   4. Feature intersected (over or under bridge)
   5. Tonnage unit requested for the four typical legal vehicles.
   6. Existing rating of bridge expressed as a percent of legal load or tons.
   7. Explanation as to why posting is required
   8. Attach copies of all official documentation for any associated actions by involved agencies other than the state.

B. Rescinding Request (Removal of Existing Load Limits)
   1. County in which bridge is located
   2. Current Bridge Number
   3. Structure File Number
   4. Feature intersected (over or under bridge)
   5. Existing posting (% reduction or weight limit currently in effect)
   6. Date existing posting was effective
   7. Explanation as to why posting restrictions can now be removed (show contract project numbers or indicate force account or other work method used to correct problem)
   8. New load rating for the rehabilitated or new structure

C. Change Request (Revision of Existing Posted Limits)
   1. County in which bridge is located
   2. Current Bridge Number
   3. Structure File Number

4. Feature intersected (over or under bridge)
5. Existing posting (weight limit currently in effect)
6. Revised posting request
7. Date of existing posting
8. Explanation as to why posting change is necessary (include project numbers etc. involved)

## 919 SOFTWARE TO BE USED FOR LOAD RATING

One of the following computer programs to be used for the load rating of bridges, as applicable.

A. AASHTO Virtis: Virtis is a load rating and analysis product developed and licensed by AASHTO. Virtis can rate the bridges by LRFR and LFR methods.

   (http://aashto.bakerprojects.com/virtis/).

B. Bentley Bridge-Key: Bridge-Key is a bridge modeler and bridge analysis software package. Bridge-Key is maintained and licensed by the Bentley Systems. It can load rate bridges by LRFR and LFR methods. (http://www.bentley.com)

C. AASHTO BARS-PC: BARS-PC is the default bridge analysis and load rating program by LFR method for all bridges designed prior to October 1, 2010. BARS-PC is available from ODOT for a nominal charge of material and shipping.

D. BRASS-Culvert: BRASS-Culvert can load rate reinforced concrete flat-topped 3-sided frames and 4-sided boxes buried under the fill by LRFR and LFR methods. BRASS-Culvert software shall be used for the analysis of concrete box sections and three sided concrete frames. BRASS family of programs is developed, maintained and licensed by the Wyoming Department of Transportation. For analysis requirements using BRASS-Culvert see BDM Section 922.

E. LARSA 4D: Finite element analysis programs by LARSA, Inc., 105 Maxess Road, Melville Corporate Center, Suite 115N, Melville, NY 11474 (http://www.larsausa.com).

For the analysis of arches and other special structures that cannot be modeled using any of the programs A through D above, contact the OSE for pre-approval of the software of consultant's choice.

Also, contact the OSE prior to using any computer program other than A through E above. The Department will not accept load rating performed using any software not pre-approved for that bridge.

## 920 LOAD RATING REPORT SUBMISSION

The load rating report shall be submitted to the project manager, District Bridge Engineer or the respective owner (in case of a non-ODOT bridge). The submission shall include two (2) printed copies and one electronic copy of the Load Rating Report and one copy of the electronic input data files. The Load Rating Reports shall be signed, sealed and dated by an Ohio Registered Engineer.

For an ODOT-bridge the District Bridge Engineer will send one printed copy, an electronic copy of the report, the electronic data files and a copy of the final bridge plans to the OSE for review.

The report must list final inventory and operating ratings of each main bridge member, overall ratings of each structure unit (mainline, ramps, etc.), and the final ratings of the entire bridge summarized in a tabular form. The ratings of each member and the overall ratings of the structure shall be presented for each Ohio Legal Load and either AASHTO HS20-44 or HL-93 live load.

An example of a Load Rating Report Summary is given as Figure 908.

For existing bridges, the report shall state how the material properties were determined. Any specific details about the current conditions and bridge geometry shall be listed.

All calculations related to the load rating should be a part of the load rating report.

Submit copies of the input & output computer files in electronic format. Input files must be error free and ready to be run. The rating engineer shall any changes in the input files as a result of ODOT review.

## 921 LOAD ANALYSIS USING AASHTO VIRTIS PROGRAM

### 921.1 GENERAL

Virtis program is a load rating program licensed from AASHTO. Virtis is a Windows based program and can load rate a variety of bridges by LFR as well as LRFR method.

Virtis Vehicle library can be customized to include ODOT Legal Loads. Alternatively Virtis library can be requested from OSE.

### 921.2 VIRTIS LOAD RATING REPORT SUBMISSION

The load rating report shall be submitted to the project manager, District Bridge Engineer or the respective owner (in case of a non-ODOT bridge). The submission shall include two (2) printed copies and one electronic copy of the Load Rating Report and one copy of the electronic input data files. The Load Rating Reports shall be signed, sealed and dated by an Ohio Registered Engineer.

For an ODOT-bridge the District Bridge Engineer will send one printed copy, an electronic copy of the report, the electronic data files and a copy of the final bridge plans to the OSE for review.

The report must list final inventory and operating ratings of each main bridge member, overall ratings of each structure unit (mainline, ramps, etc.), and the final ratings of the entire bridge summarized in a tabular form. The ratings of each member and the overall ratings of the structure shall be presented.

An example of a Load Rating Summary Report is given as Figure 908.

For existing bridges, the report shall state how the material properties were determined. Any specific details about the current conditions and bridge geometry shall be listed.

All calculations related to the load rating should be a part of the load rating report.

### 921.3 VIRTIS COMPUTER INPUT AND OUTPUT FILES

Submit the error-free and working electronic copies of the input file exported as an "XML" file.

In addition to the electronic input data file, the rating report shall also include copies of the computer rating summary and the rating summary report. The rating report can be submitted as a "PDF" file or a printed hard copy.

## 922 LOAD ANALYSIS USING BRASS-CULVERT PROGRAM

### 922.1 GENERAL

BRASS (Bridge Rating and Analysis System) is a family of several structural analysis modules, such as BRASS-Culvert, BRASS-Girder, BRASS-Pole, etc. BRASS-Culvert program can be used to analyze reinforced concrete three-sided flat-topped frames and four-sided box sections.

If haunch dimensions are different, use the smallest dimension in the analysis.

BRASS can run on any Microsoft Windows compatible machine.

BRASS data files should use the same naming convention as the BARS-PC data files.

BRASS Vehicle library can be customized to include ODOT Legal Loads.

### 922.2 BRASS CAPABILITIES

BRASS program can analyze single-cell and multi-cell reinforced concrete box structures and frames.

Technical support on BRASS program is available to the BRASS licensed users from the Wyoming Department of Transportation.

### 922.3 BRASS COMPUTER INPUT AND OUTPUT FILES

Follow the Report submission guidelines given in BDM Section 920.

Also submit the error-free and working electronic copies of the input & output files with extensions “dat,” “cus” and “xml.”

In addition to the electronic input data file, each copy of the rating report shall also include hard (printed) copies of the computer input and output files.

## 923 LOAD RATING ANALYSIS USING BARS-PC

### 923.1 GENERAL

The BARS-PC is the PC version of the AASHTO BARS (Bridge Analysis and Rating System) program that can analyze and load rate structures based on the AASHTO Specifications.

BARS-PC program installation CD is available for use on ODOT Projects, from the OSE at a nominal cost.

The OSE will provide limited technical support to install and execute the program.

BARS-PC program is not compatible Windows 7 or later operating systems. BARS-PC cannot perform rating based on the LRFR method.

The types of material, methods of construction, bridge member and types of section that can be handled by BARS-PC are provided in the BARS User’s Manual that can be downloaded from the OSE-Bridge Management website.

Figures 906 and 907 provide general information about ODOT Allowable Stresses in bending and shear and material strengths based on the year of construction. These material properties are different from those given in AASHTO BARS Manual 2, Appendix A. However, they are used as default values in the BARS-PC customization file prepared by ODOT, which is available from Structure Rating website. Any material stresses and specifications specified on the design plans shall supersede the values given in Figures 906 and 907.

The rater is cautioned to pay extra attention to the design plans and the year of construction, when determining material strengths for structures built during transition years of Figures 906 and 907 (e.g., for member type SS, years 1964-68, or 1988-93, etc.), as materials may have been substituted.

### 923.2 BARS-PC ANALYSIS – GENERAL GUIDELINES

All information in a BARS-PC input data file shall be entered in uppercase with “Caps Lock ON.”

The first six digits from left of the Structural File Number (SFN) of the bridge with prefix "R" and extension "dat" shall be used as the input data file name. The same first six digits of the SFN shall be used as Structure Group ID No. on all BARS-PC data input cards. For example, if the SFN of a bridge is 4729854, the input file name should be named as "R472985.DAT" and the Structure Group ID No. will be "472985."

If a SFN has not been assigned to a new structure, contact Structure Inventory Section in the OSE to get a SFN for the structure.

All BARS-PC input files shall have the word "NEW" in columns 9-11 and the letter "X" in column 17 of card type AA.

All BARS-PC input files shall have the bridge rater's initials and company/office abbreviations in the columns 15-22 of card type 01 and columns 9-16 of card type 02.

All structures rated by BARS-PC using LF method shall have letter "L" in column 65 of card type 05.

All structures rated by BARS-PC shall have letter "F" in column 66 of card type 05.

All structures rated using BARS program shall have a three-digit Structure Type Code in columns 41-46 of card type 02. The three-digit code shall be selected based on the material, type and the description of the main members according to Structure Type Codes of ODOT Bridge Inventory Coding Guide. For example, Concrete Slab Continuous shall be coded as "112" and Steel Beam Simple Span shall be coded as "321."

The complete seven digit SFN shall be entered in columns 9-16 of card type 05.

The original method of construction and the loading used for the design of the bridge shall be explicitly stated on card type 06.

The assumptions made to model a structural member or unit for computer analysis shall also be stated on card type 06.

The live load distribution factors for the single lane loading shall be given on the card type 6.

If space on card type 06 (maximum of six cards of type 06) is not sufficient, additional information can be included with the load rating report for ODOT review.

BARS (mainframe) and BARS-PC programs do not recognize standard steel rolled beams, Prestressed I-girder or Prestressed box beam sections. Standard rolled beams shall be coded on card type 12 in terms of flange and web plates. Prestressed I-girders and box beams shall be coded on card type 15 with special attention given to the type, area and strength of the prestressing strands.

When using BARS-PC to load rate multi-span prestressed structures, each member shall be analyzed as a simply supported member.

### 923.3 BARS-PC LOAD RATING REPORT SUBMISSION

Follow the load rating report submission guidelines given in the BDM Section 920.

### 923.4 BARS-PC COMPUTER INPUT AND OUTPUT FILES

In addition to the electronic input data file, each copy of the rating report shall also include hard (printed) copies of the computer input and output files.

Some computer programs generate several output files during the process of analysis. Include those files that contain information. For example, the load rating analysis report of a steel beam bridge using BARS-PC shall contain printed copies of the following files:

A. lista.lis

B. rate2.lis

C. summary.lis

D. flex.lis

## 924 LOAD RATING OF BRIDGES USING LRFR SPECIFICATIONS

### 924.1 APPLICABILITY OF AASHTO DESIGN SPECIFICATIONS

This Section is consistent with the current AASHTO LRFD Bridge Design Specifications. Where this Section is silent, the current AASHTO LRFD Bridge Design Specification shall govern.

### 924.2 GENERAL LOAD RATING EQUATION

The following general equation shall be used in determining the load rating of each component and connection subject to a single force effect (axial force, flexure or shear) [MBE 6A.4.2]:

$$RF = \frac{C - (\gamma_{DC})(DC) - (\gamma_{DW})(DW) \pm (\gamma_P)(P) - (\gamma_{SW})(SW*)}{(\gamma_{LL})(LL)(1 + IM/100)}$$

For Strength Limit States:

$$C = \varphi_c \cdot \varphi_s \cdot \varphi_n \cdot R_n$$

Where the following lower limit shall apply:

$$\varphi_c \cdot \varphi_s \geq 0.85$$

For Service Limit States:

$$C = f_R$$

Where:

$C$ = Capacity

$DC$ = Dead load effect due to structural components and attachments

$DW$ = Dead load effect due to wearing surface and utilities

$f_R$ = Allowable stress specified in LRFD Code

$IM$ = Dynamic load allowance expressed as percentage (%)

$LL$ = Live Load effect

$P$ = Permanent loads other than dead loads, such earth pressure, shrinkage etc.

$RF$ = Rating Factor

$R_n$ = Nominal member resistance

$SW^*$ = Sidewalk load effect only to be applied when a sidewalk is present

$\gamma_{DC}$ = Load factor for DC load

$\gamma_{DW}$ = Load factor for DW load

$\gamma_{LL}$ = Evaluation live load factor

$\gamma_p$ = Load factor for P load = 1.0

$\gamma_{SW}$ = Load factor Sidewalk load = 0.5 (to reflect actual service condition.)

$\varphi_c$ = Condition factor

$\varphi_s$ = System factor

$\varphi$ = LRFD Resistance factor

For Limit States and factors see BDM Section 924.3.

## 924.3 LIMIT STATES AND LOAD FACTORS FOR LOAD RATING

Strength is the primary limit state for load rating; service and fatigue limit states are selectively applied in accordance with the provisions of AASHTO Manual of Bridge Evaluation [MBE 6A.4.2]:

For Inventory and Operating Rating for AASHTO HL-93 Loading, use the following limit states and load factors:

**Table 924.3-1: LRFR Design Load Limit States and Load Factors**

| Bridge Type | Limit State | Dead Load $\gamma_{DC}$ | Dead Load $\gamma_{DW}$ | HL-93 Loading Inventory $\gamma_{LL}$ | HL-93 Loading Operating $\gamma_{LL}$ |
|---|---|---|---|---|---|
| Steel | Strength I | 1.25 | 1.50 | 1.75 | 1.35 |
| | Service II | 1.00 | 1.00 | 1.30 | 1.00 |
| | Fatigue | 0.00 | 0.00 | 0.75 | |
| Reinforced Concrete | Strength I | 1.25 | 1.50 | 1.75 | 1.35 |
| Prestressed Concrete | Strength I | 1.25 | 1.50 | 1.75 | 1.35 |
| | Service III | 1.00 | 1.00 | 0.80 | |
| Wood | Strength I | 1.25 | 1.50 | 1.75 | 1.35 |

For Rating for Ohio Legal Loads, use the following limit states and load factors:

**Table 924.3-2: Legal Loads Limit States and Load Factors**

| Bridge Type | Limit State | Dead Load $\gamma_{DC}$ | Dead Load $\gamma_{DW}$ | Ohio Legal Loads $\gamma_{LL}$ |
|---|---|---|---|---|
| Steel | Strength I | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |
| | Service II | 1.00 | 1.00 | For all ADTT -- 1.30 |
| Reinforced Concrete | Strength I | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |
| | Service I | 1.00 | 1.00 | |
| Prestressed Concrete | Strength I | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |
| | Service III | 1.00 | 1.00 | 1.00 |
| Wood | Strength I | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |

For Rating for Special and Permit Loads, use the following limit states and load factors:

**Table 924.3-3: Permit Load Limit States and Load Factors**

| Bridge Type | Limit State | Dead Load $\gamma DC$ | Dead Load $\gamma DW$ | Permit or Special Loads $\gamma_{LL}$ |
|---|---|---|---|---|
| Steel | Strength II | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |
| | Service II | 1.00 | 1.00 | 1.00 |
| Reinforced Concrete | Strength II | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |
| | Service I | 1.00 | 1.00 | 1.00 |
| Prestressed Concrete | Strength II | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |
| | Service I | 1.00 | 1.00 | 1.00 |
| Wood | Strength II | 1.25 | 1.50 | Unknown ADTT -- 1.80<br>ADTT ≥ 5000 -- 1.80<br>ADTT = 1000 -- 1.65<br>ADTT ≤ 100 -- 1.40 |

## 924.4 DYNAMIC LOAD ALLOWANCE (IM)

A. A dynamic load allowance of 33% shall be used for all non-buried bridges except for fatigue evaluation.

B. For fatigue evaluation a dynamic load allowance of 15% shall be used.

C. Dynamic load allowance shall only be applied to truck or tandem portion of HL-93 loading (dynamic load allowance shall not be provided to lane portion).

D. Dynamic load allowance needs not to be applied to wood components of a bridge.

E. Dynamic allowance may be ignored for slow moving (speed less than 10 mph) special or permit loads under controlled conditions.

F. For buried bridges, dynamic allowance (IM) shall be taken as:

$IM = 33\ (1.0 - 0.125\ DE) \geq 0\%$ ............................................................ [AASHTO 3.6.2.2-1]

Where:

DE = the minimum depth of cover above the structure (ft)

## 924.5 CONDITION FACTOR ($\varphi_c$)

A Condition Factor shall be applied to the calculated capacity of the structure, as follows:

**Table 924.5-1: Condition Factors [MBE 6A.4.2.3]**

| Structural Condition of a member | NBI General Appraisal | Condition Factor $\varphi_c$ |
|---|---|---|
| Good or Satisfactory | 6 or higher | 1.00 |
| Fair | 5 | 0.95 |
| Poor | 4 or lower | 0.85 |

## 924.6 SYSTEM FACTOR ($\varphi_S$)

System factors are multiplied to the nominal resistance to reflect the level of redundancy of the complete superstructure [MBE 6A.4.2.4]. Bridges that are less redundant will have their factored member capacities reduced.

The following system factors may be used for Flexural and Axial Effects:

**Table 924.6-1: System Factors [MBE 6A.4.2.4]**

| Superstructure Type | $\varphi_S$ |
|---|---|
| Welded members in two-girder/truss/arch bridges | 0.85 |
| Riveted members in two-girder/truss/arch bridges | 0.90 |
| Multiple eyebar members in truss bridges | 0.90 |
| Three-girder bridges with girder spacing 6 ft. | 0.85 |
| Four-girder bridges with girder spacing ≤ 4 ft. | 0.95 |
| Floor beams with spacing > 12.0 ft. and non-continuous stringers | 0.85 |
| Redundant stringer subsystems between floor-beams | 1.00 |
| All other girder and slab bridges | 1.00 |

## 924.7 RESISTANCE FACTOR ($\varphi$)

Resistance factor ($\varphi$) for the load rating has the same value as for a new design as given in AASHTO LRFD Specification. Also, $\varphi = 1.0$ for all non-strength limit states [MBE C6A.4.2.1]. See appropriate section in the LRFD Specification for recommended values for resistance factors [LRFD 5.5.4.2, 6.5.4.2, 8.5.2, 12.5.5]

Some of the commonly used Resistance Factors are given here:

**Table 924.7-1: Resistance Factors**

| Type | φ |
|---|---|
| Tension controlled reinforced concrete section | **0.90** |
| Tension controlled prestressed concrete section | **1.00** |
| Shear and torsion in normal weight concrete | **0.90** |
| Flexure in steel | **1.00** |
| Shear in steel | **1.00** |
| Axial Compression in steel only | **0.90** |
| Axial Compression in composite | **0.90** |
| Shear connectors, steel | **0.85** |
| Web crippling, steel | **0.80** |
| For block shear | **0.80** |
| For shear rupture in connection element | **0.80** |
| For weld metal in partial penetration and fillet weld | **0.80** |
| Flexure in wood | **0.85** |
| Shear in wood | **0.75** |
| Wood connections | **0.65** |
| RC cast-in-place buried box structures in flexure | **0.90** |
| RC cast-in-place buried box structures in shear | **0.85** |
| RC precast buried box structures in flexure | **1.00** |
| RC precast buried box structures in shear | **0.90** |
| RC precast buried 3-sided structures in flexure | **0.95** |
| RC precast buried 3-sided structures in shear | **0.90** |
| Structural steel pipe, minimum wall area & buckling | **1.00** |
| Structural steel pipe, minimum longitudinal seam strength | **0.67** |

### 924.8 EFFECT OF SKEW

Effect of skew on the distribution of live loads shall be considered according to AASHTO LRFD Specifications (LRFD 4.6.2.2.2 and 4.6.2.2.3).

## 925 LOAD RATING OF NEW BRIDGES

### 925.1 LOADS TO BE USED FOR LOAD RATING

All new and replacement bridges starting preliminary design, as defined in BDM Section 905, **after October 1, 2010**, shall be load rated at inventory and operating levels by the AASHTO LRFR method to comply with FHWA requirements. The load to be used for inventory and operating rating based on LRFR method shall be AASHTO's HL-93 loading (truck & lane or tandem & lane), according to Figure 902.

All bridges shall also be load rated for four Ohio Legal Loads (2F1, 3F1, 4F1, and 5C1) at operating level using the same method of analysis as used for inventory and operating ratings above. The four Ohio legal loads (2F1, 3F1, 4F1 and 5C1) are given in Figure 903.

All trucks used for analysis shall have transverse spacing, between centerline of wheels or wheel groups, of 6 ft. [1.830 m].

For long span bridges as defined in BDM Section 905, use the special load configurations given in BDM Section 917.

The inventory and operating ratings for the AASHTO HL-93 loading shall be expressed in terms of rating factors, rounded off to the nearest two decimal points. The operating ratings for each of the Ohio Legal Loads shall also be expressed in terms of rating factors of respective legal load rounded off to the nearest two decimal points. The summary rating for all of the Ohio Legal Loads shall be the smallest rating factor of the four vehicles expressed as a percentage rounded off to the nearest 5 (i.e., multiplied by 100).

The owner may also require load rating to be done for special loads in addition to those specified here. The owner shall provide full configurations of the special load, including axle weights and spacing, number of tires on each axle, tire gauges and overall dimensions of the load. All special loads to be analyzed by the LRFR method of analysis at the operating level as per BDM Section 916 unless specified otherwise by the owner.

## 925.2 LOAD RATING OF NEW BURIED BRIDGES

### 925.2.1 CAST-IN-PLACE CONCRETE BOX & FRAME STRUCTURES

A. Cast-in-place bridges shall be load rated by the designer of the bridge.

B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see BDM Section 922.

### 925.2.2 PRECAST CONCRETE BOXES

#### 925.2.2.1 PRECAST CONCRETE BOXES OF SPAN GREATER THAN 12-FT

A. The load rating analysis will be performed by the OSE.

B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see BDM Section 922.

#### 925.2.2.2 PRECAST BOXES OF SPAN EQUAL TO OR LESS THAN 12-FT

A. Manufacturer shall submit the actual information about the dimensions and reinforcing bars/cage to the OSE along with the shop drawings before the placement of structure.

B. The load rating analysis will be performed by the OSE.

### 925.2.3 PRECAST FRAMES, ARCHES, AND CONSPANS & BEBO TYPE STRUCTURES

A. The load rating analysis will be performed by the manufacturer.
B. Load rating report shall be submitted along with the shop drawings before the placement of the precast units.
C. Use the design software to load rate the structure.

### 925.2.4 ANALYSIS OF CONCRETE BOX SECTIONS & FRAMES

Unless more accurate soil data exits, calculate the rating based on a lateral pressure as specified in AASHTO.

Apply live load surcharge according to AASHTO.

Effect of soil-structure interaction shall be taken into account according to AASHTO.

Assume hinged connections between the walls and the top and bottom slabs unless there is adequate reinforcing steel continuous between the slab and the walls at the joint. In that case continuity between the slab and the walls can be assumed.

## 925.3 LOAD RATING OF NON-BURIED STRUCTURES

### 925.3.1 GENERAL

All structures including flat slabs, arch structures, frames, box sections, etc., having a fill or pavement material of less than 2’-0” [600 mm] on top of the structures shall be load rated according to the provisions of this Section.

All main structural members of the superstructure affected by live load shall be analyzed.

### 925.3.2 HOW THE LOAD RATING SHALL BE DONE

The designer shall analyze and load rate all spans which are designed to carry vehicular traffic.

The load rating analysis shall be based on the final design plans. At the inventory level, the load rating shall be equal to or greater than the design loading.

All members shall have actual net section and current conditions incorporated into the member’s analysis.

Bridge members designed as non-composite with the deck slab should be analyzed as non-composite.

All dead loads are to be calculated based on the actual field conditions. Future dead loads shall not be applied, unless directed otherwise.

Total thickness of the composite concrete slab shall be used in load rating for the calculations of section properties. Do not subtract for the monolithic wearing surface.

Live load distribution factors, as defined in the current AASHTO LRFD, shall be used.

### 925.3.3 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

The load rating of new bridges shall be done as per following:

#### 925.3.3.1 BRIDGES DESIGNED UNDER MAJOR OR MINOR PLAN DEVELOPMENT PROCESS

For bridges designed under the Major or Minor Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

#### 925.3.3.2 BRIDGES DESIGNED UNDER MINIMAL PLAN DEVELOPMENT PROCESS

For bridges designed under the Minimal Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

#### 925.3.3.3 BRIDGES DESIGNED UNDER MINOR DESIGN-BUILD PROCESS

For bridges designed as part of a Minor Design-Build project, perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

#### 925.3.3.4 BRIDGES DESIGNED UNDER MINIMAL DESIGN-BUILD PROCESS

For bridges designed as part of a Minimal Design-Build project, perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

#### 925.3.3.5 BRIDGES DESIGNED UNDER VALUE ENGINEERING CHANGE PROPOSAL

For bridges re-designed under a Value Engineering Change Proposal (VECP), perform a load rating of the altered bridge design and submit the load rating report to the District Construction Engineer (DCE) with the Final VECP submission. The DCE will supply this information to the District Bridge Engineer.

## 926 LOAD RATING OF EXISTING BRIDGES

### 926.1 APPLICABILITY OF AASHTO DESIGN SPECIFICATIONS

This Section is consistent with the current AASHTO LRFD Bridge Design Specifications and Standard Specifications for Highway Bridges (14th edition). Where this Section is silent, the current AASHTO LRFD Bridge Design Specifications or Standard Specifications for Highway Bridges shall govern for LRFR and LFR methods respectively.

### 926.2 LOADS TO BE USED FOR LOAD RATING

Existing bridges, starting preliminary design, as defined in BDM Section 905, **after October 1, 2010**, may be load rated at inventory and operating rating by either LFR or LRFR method with the prior approval of the bridge owner. When LFR method is used the load for inventory and operating rating shall be AASHTO HS20-44 [MS 18]. When LRFR method is used the load for inventory and operating rating shall be AASHTO HL-93.

All bridges shall also be load rated for four Ohio Legal Loads (2F1, 3F1, 4F1, and 5C1) at operating level using the same method of analysis as used for inventory and operating ratings above. The four Ohio legal loads (2F1, 3F1, 4F1 and 5C1) are given in Figure 903.

All legal loads used for analysis shall have transverse spacing, between centerline of wheels or wheel groups, of 6 ft. [1.830 m].

For long span bridges as defined in BDM Section 905, use the special load configurations given in BDM Section 917.

The inventory and operating ratings for the HL-93 or HS20-44 loading shall be expressed in terms of rating factors, rounded off to the nearest two decimal points. The operating ratings for each of the Ohio Legal Loads shall also be expressed in terms of rating factors of respective legal load, rounded off to the nearest two decimal points. The summary rating for all of the Ohio Legal Loads shall be the smallest rating factor of the four legal loads expressed as a percentage rounded off to the nearest 5 (i.e. multiplied by 100).

The owner may also require load rating to be done for special loads in addition to those specified here. The owner shall provide full configurations of the special load, including axle weights and spacing, number of tires on each axle, tire gauges, overall dimensions of the load and the desired method of load rating (LRFR or LFR). All special loads to be analyzed as per BDM Section 916, unless specified otherwise by the owner.

## 926.3 LOAD RATING OF BRIDGES TO BE REHABILITATED

### 926.3.1 HOW THE LOAD RATING SHALL BE DONE

The designer shall analyze and load rate all spans which are designed to carry vehicular traffic.

The load rating analysis shall be based on the final design plans. At the inventory level, the load rating shall be equal to or greater than the design loading.

All members shall have actual net section and current conditions incorporated into the member's analysis. Any known section losses, defects or damage to the existing structural members shall be considered in the rating analysis.

Bridge members designed as non-composite with the deck slab should be analyzed as non-composite.

Structures to be rehabilitated shall be analyzed using the original design plans, the actual field conditions, and all major changes in the final rehabilitation plans.

A complete review of all the available inspection information as well as a thorough site inspection of the existing bridge must be performed to establish the current conditions prior to proceeding with the analysis.

Future wearing surface dead loads shall not be applied, unless directed otherwise.

Total thickness of the composite concrete slab shall be used in load rating for the calculations of section properties. Do not subtract for the monolithic wearing surface.

Live load distribution factors, in accordance with the governing AASHTO specifications, shall be used.

For existing bridges, the rater should review the original design plans as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the design plans, ODOT Construction and Material Specifications (CMS) applicable at the time of the bridge construction shall be reviewed. This may require investigations into old ASTM or AASHTO Material Specifications active at the time of construction.

Ultimate or yield strengths of materials shall be as specified on the original design plans, unless it is required in the scope of services to conduct specific tests to determine the material strengths.

Figures 906 and 907 provide general information about Allowable Stresses in bending and shear and material strengths based on the year of construction. Any material stresses and strengths specified on the design plans shall supersede the values given in Figures 906 and 907.

The rater is cautioned to pay extra attention to the design plans and the year of construction, when determining material strengths for structures built during transition years of Figures 906 and 907 (e.g., for member type SS, years 1964-68, or 1988-93, etc.), as materials may have been substituted.

### 926.3.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

The load rating of bridges to be rehabilitated shall be done as per following:

#### 926.3.2.1 BRIDGES DESIGNED UNDER MAJOR OR MINOR PLAN DEVELOPMENT PROCESS

For bridges designed under the Major or Minor Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

#### 926.3.2.2 BRIDGES DESIGNED UNDER MINIMAL PLAN DEVELOPMENT PROCESS

For bridges designed under the Minimal Plan Development Process (PDP), perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3 and prior to contract sale, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

### 926.3.2.3 BRIDGES DESIGNED UNDER MINOR DESIGN-BUILD PROCESS

For bridges designed as part of a Minor Design-Build project, perform the load rating and include the load rating report in the Stage 2 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 2, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

### 926.3.2.4 BRIDGES DESIGNED UNDER MINIMAL DESIGN-BUILD PROCESS

For bridges designed as part of a Minimal Design-Build project, perform the load rating and include the load rating report in the Stage 3 Detail Design Submission. When design modifications that affect the previously submitted load rating analysis occur after Stage 3, revise and resubmit the load rating report to the District Project Manager. The District Project Manager will forward the final load rating report to the District Bridge Engineer.

### 926.3.2.5 BRIDGES DESIGNED UNDER VALUE ENGINEERING CHANGE PROPOSAL

For bridges re-designed under a Value Engineering Change Proposal (VECP), perform a load rating of the altered bridge design and submit the load rating report to the District Construction Engineer (DCE) with the Final VECP submission. The DCE will supply this information to the District Bridge Engineer.

### 926.3.3 LOAD RATING OF BURIED BRIDGES

### 926.3.3.1 CAST-IN-PLACE STRUCTURES

A. Cast-in-place bridges shall be load rated by the designer of the bridge.

B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, also see BDM Section 922.

### 926.3.3.2 PRECAST BOXES OF SPAN GREATER THAN 12-FT.

A. The load rating analysis will be performed by the OSE.

B. BRASS-Culvert program shall be used to load rate the structure. For the BRASS-Culvert Analysis, see BDM Section 922.

### 926.3.3.3 PRECAST BOXES OF SPAN EQUAL TO OR LESS THAN 12-FT

The load rating analysis will be performed by the OSE.

### 926.3.3.4 PRECAST FRAMES, ARCHES, AND CONSPANS & BEBO TYPE STRUCTURES

A. The load rating analysis for any new or replacement precast sections will be performed by the manufacturer; otherwise the load rating analysis will be performed as per the scope of services.

B. Load rating report shall be submitted along with the shop drawings before the placement of the units.

C. Use the design software to load rate the structure.

### 926.3.3.5 ANALYSIS OF CONCRETE BOX SECTIONS & FRAMES

Unless more accurate soil data exits, calculate the rating based on a lateral pressure as specified in AASHTO.

Apply live load surcharge according to AASHTO.

Effect of soil-structure interaction shall be taken into account according to AASHTO.

Assume hinged connections between the walls and the top and bottom slabs unless there is adequate reinforcing steel continuous between the slab and the walls at the joint. In that case continuity between the slab and the walls can be assumed.

### 926.3.4 LOAD RATING OF NON-BURIED STRUCTURES

All structures including flat slabs, arch structures, frames, box sections, etc., having a fill or pavement material of less than 2'-0" [600 mm] on top of the structures shall be load rated according to the provisions of BDM Sections 911 through 924 (as applicable).

## 926.4 LOAD RATING OF EXISTING BRIDGES WITH NO REPAIR PLANS

### 926.4.1 HOW THE LOAD RATING SHALL BE DONE

The rater shall analyze and load rate all spans which are designed to carry vehicular traffic.

Existing structures shall be analyzed using the information from the original design plans and the actual field conditions.

A complete review of all the available inspection information as well as a thorough site inspection of the existing bridge must be performed to establish the current conditions prior to proceeding with the analysis.

The bridges rated using design plans shall be noted as such in the load rating report.

Allowable stresses for the working stress and the ultimate or yield strengths of materials for Load Factor ratings shall be as specified on the original design plans, unless it is required in the scope of services to conduct specific tests to determine the material strengths.

For existing bridges, the rater should review the original design plans as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the design plans, ODOT Construction and Material Specifications (CMS) applicable at the time of the bridge construction shall be reviewed. This may require investigations into old ASTM or AASHTO Material Specifications active at the time of construction.

Total thickness of the composite concrete slab shall be used in load rating for the calculations of section properties. Do not subtract for the monolithic wearing surface.

Figures 906 and 907 provide general information about ODOT Allowable Stresses in bending and shear and material strengths based on the year of construction.

The rater is cautioned to pay extra attention to the design plans and the year of construction, when determining material strengths for structures built during transition years of Figures 906 and 907 (e.g., for member type SS, years 1964-68, or 1988-93, etc.), as materials may have been substituted.

Any material stresses and specifications specified on the design plans shall supersede the values given in Figures 906 and 907.

### 926.4.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

The load rating of existing bridges shall be done as per the Scope of Services.

### 926.4.3 LOAD RATING OF EXISTING BURIED BRIDGES

A. The load rating analysis will be performed as per the Scope of Services.
B. Unless specified otherwise, structures shall be load rated for the Loads as per BDM Section 926.3.3.

### 926.4.4 LOAD RATING OF NON-BURIED STRUCTURES

All structures including flat slabs, arch structures, frames, box sections, etc., having a fill or pavement material of less than 2’-0” [600 mm] on top of the structures shall be load rated according to the provisions of BDM Sections 911 through 924 (as applicable).

## 927 REFERENCES

A. AASHTO, 1978, “Guide Specifications for Fracture Critical Non-Redundant Steel Bridge

Members," and all subsequent Interims.

B. AASHTO, 1983, "Manual for Maintenance Inspection of Bridges."

C. AASHTO, 1989, "Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges."

D. AASHTO, 1990, "Guide Specifications for Fatigue Evaluation of Existing Steel Bridges," and all subsequent Interims.

E. BRASS-Culvert software developed by the Wyoming Department of Transportation (PO Box 1708, Cheyenne, WY 82003).

F. Duncan, J.M., 1979, "Design Studies For Aluminum Structural Plate Box Culverts," Kaiser Aluminum and Chemical Sales, Inc.

G. NCSPA, "Load Rating & Structural Evaluation of In-Service Corrugated Steel Structures," & Design Data Sheet No. 19, National Corrugated Steel Pipe Association (NCSPA, 202-452-1700).

H. AASHTO, 2003, "Manual for Condition Evaluation and Load Resistance Factor Rating (LRFR) of Bridges," and all subsequent Interims.

I. AASHTO, 2008, "The Manual for Bridge Evaluation," and all subsequent Interims.

J. AASHTO, 2010, "AASHTO LRFD Bridge Design Specifications", 5th Edition.

K. AASHTO, 2002, "Standard Specifications for Highway Bridges", 14th Edition, and all subsequent interims.

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# AASHTO HS20-44 LOADING

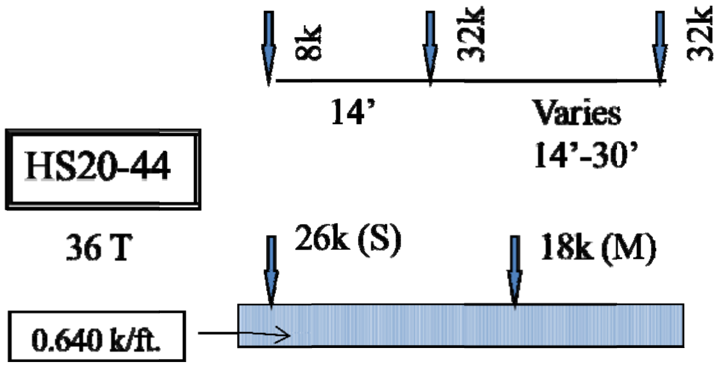



Figure 901

**AASHTO HL93 LOADING**

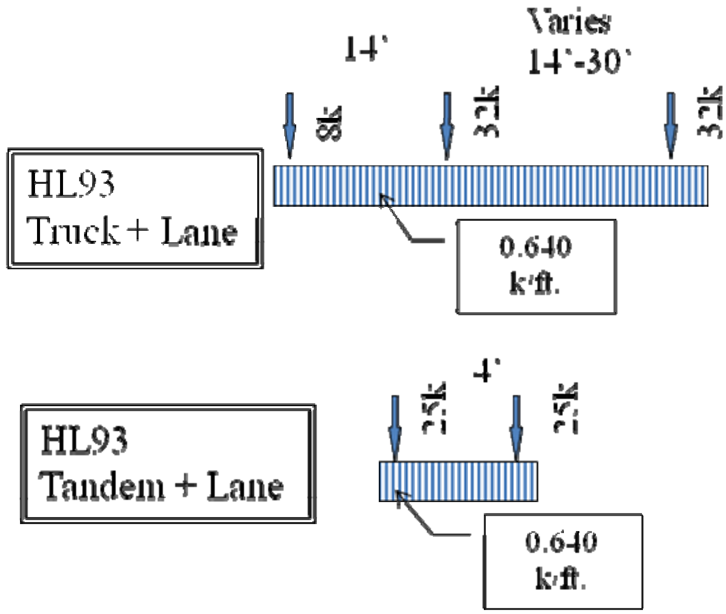



Figure 902

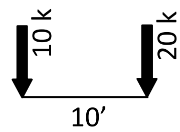
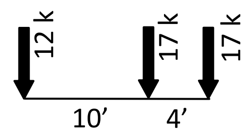
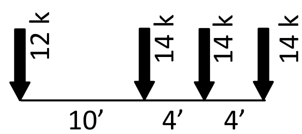
| OHIO LEGAL LOADS | | |
|---|---|---|
| **Load Designation** | **Load Configuration** | **Gross Weight** |
| 2F1 |   | 15 Tons |
| 3F1 |   | 23 Tons |
| 4F1 |   | 27 Tons |
| 5C1 |   | 40 Tons |

Figure 903

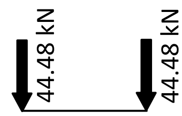
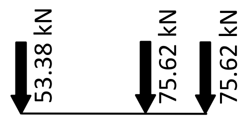
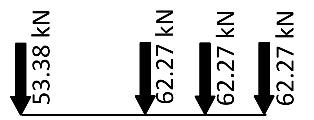
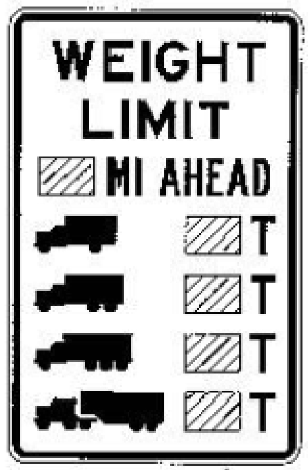
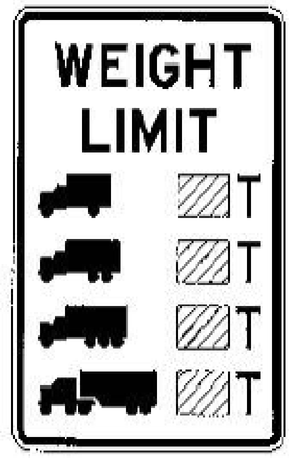
| OHIO LEGAL LOADS (METRIC) | | |
|---|---|---|
| **Load Designation** | **Load Configuration** | **Gross Weight** |
| 2F1 |  | 13.608 Metric Tons |
| 3F1 |  | 20.865 Metric Tons |
| 4F1 |  | 24.494 Metric Tons |
| 5C1 |  | 36.287 Metric Tons |

Figure 904




Bridge Ahead Sign (R-79)




Bridge Weight Limit Sign (R-78)

Figure 905

| CUSTOM ALLOWABLE STRESSES IN BENDING | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Type of Rating | | | | | | | |
| Material of Construction | Year of Construction | Fy / Fc' (ksi) | Fy / Fc' (MPa) | Inventory (ksi) | Inventory (MPa) | Operating (ksi) | Operating (MPa) | Posting (ksi) | Posting (MPa) |
| Structural Steel (SS),(CSC) | < 1900 | 26.00 | 179 | 14.00 | 97 | 19.00 | 131 | 19.00 | 131 |
| | 1901 To 1930 | 30.00 | 207 | 16.00 | 110 | 22.00 | 152 | 22.00 | 152 |
| | 1931 To 1965 | 33.00 | 228 | 18.00 | 124 | 25.00 | 172 | 25.00 | 172 |
| | 1966 To 1990 | 36.00 | 248 | 20.00 | 138 | 27.00 | 186 | 27.00 | 186 |
| | 1991 To Date | 50.00 | 345 | 27.00 | 186 | 37.50 | 259 | 37.50 | 259 |
| Reinforcing Steel (RC) | < 1935 | 32.00 | 221 | 16.00 | 110 | 24.00 | 165 | 24.00 | 165 |
| | 1936 To 1950 | 36.00 | 248 | 18.00 | 124 | 27.00 | 186 | 27.00 | 186 |
| | 1951 To 1983 | 40.00 | 276 | 20.00 | 138 | 30.00 | 207 | 30.00 | 207 |
| | 1984 To Date | 60.00 | 414 | 24.00 | 165 | 36.00 | 248 | 36.00 | 248 |
| Prestress. Strands (Fs') (CPS),(PSC) | All Years | 270.0 | 1862 | - | - | - | - | - | - |
| Cast-in-Place Reinf. Conc. (Compression in Bending) (RC),(CSC) | < 1930 | 2.00 | 14 | 0.70 | 5 | 1.30 | 9 | 1.30 | 9 |
| | 1931 To 1950 | 3.00 | 21 | 1.00 | 7 | 1.50 | 10 | 1.50 | 10 |
| | 1951 To 1980 | 4.00 | 28 | 1.30 | 9 | 2.00 | 14 | 2.00 | 14 |
| | 1981 To Date | 4.50 | 31 | 1.50 | 10 | 2.20 | 15 | 2.20 | 15 |
| Prestressed Concrete (Fc') (PSC),(CPS) | All Years | 5.50 | 38 | - | - | - | - | - | - |
| Cast-in-Place Comp. Slab for Prestress. Conc. (Fc') (CPS) | All Years | 4.00 | 28 | - | - | - | - | - | - |
| Timber (fb) (TMB) | All Years | | | 1.60 | 11 | 2.128 | 15 | 2.128 | 15 |
| | | | | | | | | | |
| Cast-in-Place Slab for Composite Reinforced Concrete | < 1930 | 2.00 | 14 | 0.70 | 5 | 1.30 | 9 | 1.30 | 9 |
| | 1931 To 1950 | 3.00 | 21 | 1.00 | 7 | 1.50 | 10 | 1.50 | 10 |
| | 1951 To 1980 | 4.00 | 28 | 1.30 | 9 | 2.00 | 14 | 2.00 | 14 |
| | 1981 To Date | 4.50 | 31 | 1.50 | 10 | 2.20 | 15 | 2.20 | 15 |

Figure 906

| CUSTOM ALLOWABLE STRESSES IN SHEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Type of Rating | | | | | | | |
| Material of Construction | Year of Construction | Fy / Fc' (ksi) | Fy / Fc' (MPa) | Inventory (ksi) | Inventory (MPa) | Operating (ksi) | Operating (MPa) | Posting (ksi) | Posting (MPa) |
| Structural Steel (SS),(CSC) | < 1900 | 26.00 | 179 | 8.50 | 59 | 11.50 | 79 | 11.50 | 79 |
| | 1901 To 1930 | 30.00 | 207 | 9.50 | 66 | 13.50 | 93 | 13.50 | 93 |
| | 1931 To 1965 | 33.00 | 228 | 11.00 | 76 | 15.00 | 103 | 15.00 | 103 |
| | 1966 To 1990 | 36.00 | 248 | 12.00 | 83 | 16.00 | 110 | 16.00 | 110 |
| | 1991 To Date | 50.00 | 345 | 17.00 | 117 | 22.50 | 155 | 22.50 | 155 |
| Reinforcing Steel (RC) | < 1935 | 32.00 | 221 | 16.00 | 110 | 24.00 | 165 | 24.00 | 165 |
| | 1936 To 1950 | 36.00 | 248 | 18.00 | 124 | 27.00 | 186 | 27.00 | 186 |
| | 1951 To 1983 | 40.00 | 276 | 20.00 | 138 | 30.00 | 207 | 30.00 | 207 |
| | 1984 To Date | 60.00 | 414 | 24.00 | 165 | 36.00 | 248 | 36.00 | 248 |
| Cast-in-Place Reinforced Conc. (RC),(CSC) | < 1930 | 2.00 | 14 | 0.70 | 5 | 1.30 | 9 | 1.30 | 9 |
| | 1931 To 1950 | 3.00 | 21 | 1.00 | 7 | 1.50 | 10 | 1.50 | 10 |
| | 1951 To 1980 | 4.00 | 28 | 1.30 | 9 | 2.00 | 14 | 2.00 | 14 |
| | 1981 To Date | 4.50 | 31 | 1.50 | 10 | 2.20 | 15 | 2.20 | 15 |
| Prestressed Concrete (Fc') (PSC),(CPS) | All Years | 5.50 | 38 | | | | | | |
| Timber (Horizontal Shear Stress) (fb) (TMB) | All Years | - | - | 0.09 | 1 | 0.12 | 1 | 0.12 | 1 |

Figure 907

## OHIO DEPARTMENT OF TRANSPORTATION
## OFFICE OF STRUCTURAL ENGINEERING
## BRIDGE LOAD RATING SUMMARY REPORT

| SFN | BRIDGE NUMBER | DISTRICT |
|---|---|---|
| | | |
| ORIGINAL CONSTRUCTION YEAR | REHABILITATION YEAR | OVERALL STRUCTURE LENGTH (FT) |
| | | |

| | |
|---|---|
| FEATURE INTERSECTED: | |
| SPECIAL ASSUMPTIONS & COMMENTS: | |

**RATING & ANALYSIS OPTION:** SELECT FROM LIST ON THE LEFT WHERE APPROPRIATE

| | |
|---|---|
| LOAD RATING PURPOSE: | |
| RATING SOFTWARE | |
| BASIS OF ANALYSIS: | |
| METHOD OF ANALYSIS: | |
| DESIGN LOADING (ORIGINAL): | |

STRUCTURE RATING SUMMARY

| LOADING & RATING TYPE | RATING FACTOR - RF (Rounded to 2 decimal points) | RATING LOAD |
|---|---|---|
| INVENTORY CURRENT DESIGN | | |
| OPERATING CURRENT DESIGN | | |
| OHIO LEGAL - 2F1 | | OHIO LEGAL LOADS OVERALL MINIMUM RATING FACTOR |
| OHIO LEGAL - 3F1 | | |
| OHIO LEGAL - 4F1 | | OHIO LEGAL LOADS OVERALL CONTROLLING TRUCK |
| OHIO LEGAL - 5C1 | | |

| RATED BY, PE# | REVIEWED BY, PE# | REPORT DATE |
|---|---|---|
| | | |
| AGENCY/FIRM | PHONE NUMBER | EMAIL |
| | | |

BR-100 (REV2010)

SFN: BRIDGE NO.:

Figure 908

| Plastic Moment Capacity of Aluminum Structural Plate with and without Stiffening Ribs | | | | | |
|---|---|---|---|---|---|
| Uncoated thickness in inches (cm) | Plastic Moment - Mp in kip.ft / ft (kN.m/m) | | | | |
| | Structural plate only | Structural plate with single rib @ 2' 3" (68.58 cm) | Structural plate with single rib @ 1' 6" (45.72 cm) | Structural plate with single rib @ 9" (22.86 cm) | Structural plate with double rib @ 2' 3" (68.58 cm) |
| 0.125 (0.3175) | 2.6 (11.565) | 6.2 (27.579) | 7.5 (33.362) | 10.3 (45.817) | 9.0 (40.034) |
| 0.150 (0.381) | 3.2 (14.234) | 7.2 (32.027) | 8.6 (38.255) | 12.0 (53.379) | 10.8 (48.041) |
| 0.175 (0.445) | 3.7 (16.458) | 7.9 (35.141) | 9.4 (41.813) | 12.9 (57.382) | 12.6 (56.048) |
| 0.200 (0.508) | 4.2 (18.683) | 8.6 (38.255) | 10.3 (45.817) | 14.0 (62.275) | 13.9 (61.830) |
| 0.225 (0.572) | 4.8 (21.351) | 9.2 (40.924) | 11.1 (49.375) | 14.9 (66.278) | 15.2 (67.613) |
| 0.250 (0.635) | 5.3 (23.576) | 9.8 (43.592) | 12.1 (53.823) | 16.0 (71.172) | 15.8 (70.282) |

Source: Duncan, J.M., 1979, “Design Studies For Aluminum Structural Plate Box Culverts,” A report on the study conducted under the sponsorship of Kaiser Aluminum and Chemical Sales, Inc., page 28.

Figure 909

| Plastic Moment Capacity of Aluminum Structural Plate with and without Stiffening Ribs | | | | | |
|---|---|---|---|---|---|
| Uncoated thickness in inches (cm) | Plastic Moment - Mp in kip.ft / ft (kN.m/m) | | | | |
| | Structural plate only | Structural plate with single rib @ 2' 3" (68.58 cm) | Structural plate with single rib @ 1' 6" (45.72 cm) | Structural plate with single rib @ 9" (22.86 cm) | Structural plate with double rib @ 2' 3" (68.58 cm) |
| 0.125 (0.3175) | 2.6 (11.565) | 6.2 (27.579) | 7.5 (33.362) | 10.3 (45.817) | 9.0 (40.034) |
| 0.150 (0.381) | 3.2 (14.234) | 7.2 (32.027) | 8.6 (38.255) | 12.0 (53.379) | 10.8 (48.041) |
| 0.175 (0.445) | 3.7 (16.458) | 7.9 (35.141) | 9.4 (41.813) | 12.9 (57.382) | 12.6 (56.048) |
| 0.200 (0.508) | 4.2 (18.683) | 8.6 (38.255) | 10.3 (45.817) | 14.0 (62.275) | 13.9 (61.830) |
| 0.225 (0.572) | 4.8 (21.351) | 9.2 (40.924) | 11.1 (49.375) | 14.9 (66.278) | 15.2 (67.613) |
| 0.250 (0.635) | 5.3 (23.576) | 9.8 (43.592) | 12.1 (53.823) | 16.0 (71.172) | 15.8 (70.282) |

Source: Duncan, J.M., 1979, “Design Studies For Aluminum Structural Plate Box Culverts,” A report on the study conducted under the sponsorship of Kaiser Aluminum and Chemical Sales, Inc., page 28.

Figure 909