OHIO DEPARTMENT OF TRANSPORTATION

CENTRAL OFFICE, 1980 W. BROAD ST., COLUMBUS, OHIO 43216-0899

July 20, 2012

To: Users of the Bridge Design Manual

From: Tim Keller, Administrator, Office of Structural Engineering

By: Sean Meddles, Bridge Standards Engineer

Re: 2012 Third 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 2 plan submission date after July 20, 2012. Implementation of some or all of these revisions for projects further along the development process should be considered on a project-by-project basis.

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
905	9-2 through 9-4	Definitions for ODOT's Bridge Number, Control Authority Program Manager, General Appraisal, GVW and Posting Load have been added.
906		Article 5577.042 from the Ohio Revised Code which expired 6/29/2011 was removed from the BDM.
918	9-17 through 9-20	The bridge posting policy and procedures have been modified.
926	9-32	The rating method for new timber bridges has been specified.
927	9-35	The rating method for existing timber bridges has been specified.
929	9-41	Load rating for culvert type bridges predesigned in nationally recognized ASTM specifications has been clarified.

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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 and bridge raters 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 conforming to 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 under the supervision of an Ohio registered professional engineer (i.e. the Load Rater) that will sign and stamp (seal) the final load rating report before submission to the bridge owner.

905 DEFINITIONS AND TERMINOLOGY

ASR: Allowable Stress Rating (also known as Working 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 Number: A combination of 3 letter county abbreviation-Route no.-straight line mileage & special designation (e.g., HAM-0071-1068 R)

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

Bridge Owner: A public or private entity that has jurisdiction over the bridge

Buried structure: A structure, including a flat slab, an arch, a frame, a box section, etc., that has 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 to as General Appraisal

Control Authority Program Manager (CAPM): Inspection Program Manager of the Control Authority; A person who is designated to be responsible to oversee FHWA's National Bridge Inspection Program in a public transportation entity.

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

General Appraisal (GA): See Condition Rating

GVW: Gross Vehicle Weight

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, etc.) 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 Rater: Individual responsible for the load rating of a bridge. The Load Rater shall be a professional engineer registered in the State of Ohio.

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

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

LRFD: Load and Resistance Factor Design

LRFR: Load and Resistance Factor Rating

MBE: AASHTO Manual for Bridge Evaluation

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

NBIS: 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.

NBIS 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 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.

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

Non-buried Structure: 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.

ODOT: Ohio Department of Transportation

ODOT Bridge: A bridge in which ODOT has jurisdiction

Operating Rating: Load ratings based on the operating rating level generally describe 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.

OPI: Organizational Performance Indices, A set of Indicators to measure the overall condition of bridges at the District or network level based on the several appraisal ratings

ORC: Ohio Revised Code (as amended and adopted)

OSE: ODOT Office of Structural Engineering

Pavement of A Roadway: The pavement of a roadway includes all the paved or unpaved portions of a roadway including graded shoulders that may support vehicular traffic

PDF: Portable Document Format, a type of industry standard, electronic file format developed by the Adobe Corporation

Posting: Signing a bridge for load restriction

Posting Load: Rating Factor (RF) times GVW of Ohio Legal Load

Preliminary Design Date: 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:

5577.042 [Effective 6/29/2011] Weight provisions for farm, log and coal trucks and farm machinery

(A) As used in this section:

(1) "Farm machinery" has the same meaning as in section 4501.01 of the Revised Code.

(2) "Farm commodities" includes livestock, bulk milk, corn, soybeans, tobacco, and wheat.

(3) "Farm truck" means a truck used in the transportation from a farm of farm commodities when the truck is operated in accordance with this section.

(4) "Log truck" means a truck used in the transportation of timber from the site of its cutting when the truck is operated in accordance with this section.

(5) "Coal truck" means a truck transporting coal from the site where it is mined when the truck is operated in accordance with this section.

(6) "Solid waste" has the same meaning as in section 3734.01 of the Revised Code.

(7) "Solid waste haul vehicle" means a vehicle hauling solid waste for which a bill of lading has not been issued.

(B)(1) Notwithstanding sections 5577.02 and 5577.04 of the Revised Code, the following vehicles under the described conditions may exceed by no more than seven and one-half per cent the weight provisions of sections 5577.01 to 5577.09 of the Revised Code and no penalty prescribed in section 5577.99 of the Revised Code shall be imposed:

(a) A coal truck transporting coal, from the place of production to the first point of delivery where title to the coal is transferred;

(b) A farm truck or farm machinery transporting farm commodities, from the place of production to the first point of delivery where the commodities are weighed and title to the commodities is transferred;

(c) A log truck transporting timber, from the site of its cutting to the first point of delivery where the timber is transferred;

(d) A solid waste haul vehicle hauling solid waste, from the place of production to the first point of delivery where the solid waste is disposed of or title to the solid waste is transferred.

(2) In addition, if any of the vehicles listed in division (B)(1) of this section and operated under the conditions described in that division does not exceed by more than seven and one-half per cent the gross vehicle weight provisions of sections 5577.01 to 5577.09 of the Revised Code, no wheel or axle-load limits shall apply and no penalty prescribed in section 5577.99 of the Revised Code for a wheel or axle overload shall be imposed.

(C) If any of the vehicles listed in division (B) (1) of this section and operated under the conditions described in that division exceeds by more than seven and one-half per cent the weight provisions of sections 5577.01 to 5577.09 of the Revised Code, both of the following apply without regard to the seven and one-half per cent allowance provided by division (B) of this section:

(1) The applicable penalty prescribed in section 5577.99 of the Revised Code;

(2) The civil liability imposed by section 5577.12 of the Revised Code.

(D) (1) Division (B) of this section does not apply to the operation of a farm truck, log truck, or farm machinery transporting farm commodities during the months of February and March.

(2) Regardless of when the operation occurs, division (B) of this section does not apply to the operation of a vehicle on either of the following:

(a) A highway that is part of the interstate system;

(b) A highway, road, or bridge that is subject to reduced maximum weights under section 4513.33, 5577.07, 5577.071, 5577.08, 5577.09, or 5591.42 of the Revised Code.

Amended by 129th General Assembly File No. 7, HB 114, § 101.01, eff. 6/29/2011.

Effective Date: 03-31-2003; 09-16-2004

This section is set out twice. See also § 5577.042, effective until 6/29/2011.

5577.043 [Effective 6/29/2011] Permissible weight variations for certain vehicles

(A) Notwithstanding sections 5577.02 and 5577.04 of the Revised Code, the following vehicles under the described conditions may exceed by no more than five per cent the weight provisions

of sections 5577.01 to 5577.09 of the Revised Code and no penalty prescribed in section 5577.99 of the Revised Code shall be imposed:

(1) A surface mining truck transporting minerals from the place where the minerals are loaded to any of the following:

(a) The construction site where the minerals are discharged;

(b) The place where title to the minerals is transferred;

(c) The place of processing.

(2) A vehicle transporting hot mix asphalt material from the place where the material is first mixed to the paving site where the material is discharged;

(3) A vehicle transporting concrete from the place where the material is first mixed to the site where the material is discharged;

(4) A vehicle transporting manure, turf, sod, or silage from the site where the material is first produced to the first place of delivery;

(5) A vehicle transporting chips, sawdust, mulch, bark, pulpwood, biomass, or firewood from the site where the product is first produced or harvested to first point where the product is transferred.

(B) In addition, if any of the vehicles listed in division (A) of this section and operated under the conditions described in that division does not exceed by more than five per cent the gross vehicle weight provisions of sections 5577.01 to 5577.09 of the Revised Code, no wheel or axle load limits shall apply and no penalty prescribed in section 5577.99 of the Revised Code for a wheel or axle overload shall be imposed.

(C) If any of the vehicles listed in division (A) of this section and operated under the conditions described in that division exceeds by more than five per cent the weight provisions of sections 5577.01 to 5577.09 of the Revised Code, both of the following apply without regard to the allowance provided by division (A) of this section:

(1) The applicable penalty prescribed in section 5577.99 of the Revised Code;

(2) The civil liability imposed by section 5577.12 of the Revised Code.

(D) Divisions (A) and (B) of this section do not apply to the operation of a vehicle listed in division (A) of this section on either of the following:

(1) A highway that is part of the interstate system;

(2) A highway, road, or bridge that is subject to reduced maximum weights under section 4513.33, 5577.07, 5577.071, 5577.08, 5577.09, or 5591.42 of the Revised Code.

Added by 129th General Assembly File No. 7, HB 114, § 101.01, eff. 6/29/2011.

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, and notices of project completion, telephone memos 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 load posting and rescinding actions taken for the bridge, including load capacity calculations, date of posting and description of signing used.

908 GENERAL

The provisions of BDM Section 900 apply to ODOT bridges. All provisions of BDM Section 900 may also be applied to Non-ODOT bridges at the discretion of the bridge owner. Refer to BDM Section 928.

For load rating of new bridges, BDM Sections 911 through 926 shall apply.

For load rating of existing bridges, BDM Sections 911 through 925 & 927 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 asphalt ..... 145 lb/ft^3 [22.8 kN/m^3]

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

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

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

E. Unit weight of steel ..... 490 lb/ft^3 [77.0 kN/m^3]

F. 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. Concrete pipes (circular, or elliptical)

C. Buried metal frames

D. Junction chambers

E. Manholes

F. Inlets and outlets

911 WHICH PORTION OF BRIDGES SHALL BE LOAD RATED

Any structural member of a bridge that would carry vehicular traffic shall be load rated. Typically, the structural members of only the bridge superstructure are load rated. Substructure elements such as pier caps and columns should be analyzed for their load carrying capacity in situations when they are either scoped to be analyzed or when the bridge owner or the rating engineer has reasons to believe that the capacity of a substructure element may control the capacity of the bridge.

912 PROCEDURE FOR RATING

The load ratings for each bridge shall be determined in the following manner:

A. Load rate new (proposed) bridges at the design stage per BDM Section 926.

B. Perform a careful field inspection of the existing bridge according to the ODOT Manual of Bridge Inspection 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.

C. If a field inspection of the bridge is not a part of the Scope of Services, as a minimum, review the most current inspection report (and inspection notes, if available).

D. Determine the yield stresses for the construction materials in older bridges, for which plan information is not available, using the date of construction.

E. For a load rating analysis request on an ODOT bridge, the District Bridge Engineer shall submit to the OSE, a complete inspection report (including comments), bridge photographs, field measurements and a copy of the previous rating calculation sheets or computer input data sheets. OSE will review the submitted material, analyze bridge and return a copy of the final calculations or computer output to the District Bridge Engineer, along with any recommendations concerning the proposed ratings.

F. The District Bridge Engineer/Bridge Owner shall keep the final calculations or computer output along with any recommendations concerning the proposed ratings on file.

G. Using pertinent current information & load rating analysis, the District Bridge Engineer/Bridge Owner shall determine and record the Inventory, Operating, and Ohio Legal Load 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 (GA) rating of the superstructure of a bridge 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.

When pedestrian load is present, the pedestrian load effect should be subtracted from the capacity of the member at the location being investigated while calculating the RF.

For bridges load rated according to the AASHTO Standard Specifications for Highway Bridges, AASHTO Table 3.22.1A applies. For bridges load rated according to the AASHTO LRFD Bridge Design Specifications, refer to BDM Section 925.2.

Pedestrian load shall not be considered when performing 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 Specifications.

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.

Apply the multiple presence factors of AASHTO Standard Specification for Highway Bridges - Section 3.12, or AASHTO LRFD Bridge Design Specification 3.6.1, accordingly.

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

917.1 WHEN THE LOAD RATING SHALL BE DONE

Perform the load rating of long span bridges according to BDM Sections 926.3.3, 927.3.2, or 927.4.2.

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.

Multilane loading factors shall be applied as per BDM Section 915.

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.

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.

D. Multilane loading factors shall be applied as per BDM Section 915.

917.2.3 OPERATING LEVEL RATING USING OHIO LEGAL LOADS

The provisions of BDM Sections 926 or 927 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.

Multilane loading factors shall be applied as per Section 915.

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.

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

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. 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.

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.

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

A. **When No Permit Load Is Present**:

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.

B. **When a Permit Load Is Present**:

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 or rescinding warnings of bridge strength deficiencies on ODOT bridges. Owners of non-ODOT bridges may modify and adapt the guidelines given in this section to post or rescind warnings of bridge strength deficiencies on their bridges.

918.2 REFERENCE

Ohio Revised Code, Section 5591.42:

918.3 PROCEDURE FOR BRIDGE POSTING

918.3.1 BRIDGE POSTING FOLLOWING LOAD RATING ANANLYSIS

A. A load rater performs the bridge load rating per the ODOT Bridge Design Manual (BDM)

B. For a bridge being designed, if the rating factor (RF) at inventory level (for design load) is less than 1.00, the design shall be revised to bring up the RF to 1.0 or higher.

C. For an existing or in-service bridge, the bridge shall be load rated based on current dead loads and the last field inspection report. The current operating status, inspection comments, photographs, and condition rating of structural elements shall be considered in the load rating.

D. Any structural deficiencies discovered during the most current field inspection, recorded on the Bridge Inspection Report (BIR) shall be considered during the load rating process. The Control Authority Program Manager (CAPM) shall contact the load rater to request to reanalyze a bridge in service.

E. If load rating is performed by load testing, the test load configuration shall be noted.

F. The Load Rating Report shall be signed, sealed and dated by an Ohio registered Professional Engineer. The load rating results shall be communicated to the CAPM who will enter/update the load rating results in the ODOT BMS.

G. Subsequent to load rating, if it is determined that the bridge needs to be posted for reduced loads (i.e., below Ohio Legal Loads), the CAPM shall mark in the BMS, “Bridge Posting Required” (available in 2013). The CAPM shall initiate the process to have the posting and early warning signs made and erected on the bridge no later than 90 days from the date of load rating.

H. It will be the responsibility of the CAPM to periodically verify that the posting signs are in place.

Table 918.3-1: ODOT Bridge Posting Policy (Effective July 1, 2011)

Controlling RF = Min. Calculated RF of Ohio Legal Loads % 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, 115, etc.)	NO
<100%	**Actual percentage rounded to the nearest 5 (i.e., 95%, 30%, etc.)**	**YES**

918.3.2 PROCEDURE FOR PLACING BRIDGE POSTING FOR ODOT DISTRICTS

A. The ODOT District Bridge Engineer shall submit a written bridge posting request according to BDM Section 918.6 to the OSE Bridge Rating Engineer.

B. After the Director signs the posting request:

   1. The OSE Bridge Rating Engineer shall send a copy to each of the following:
      a. District Bridge Engineer
      b. Manager, ODOT Special Hauling Permits
      c. Superintendent of State Highway Patrol
      d. Executive Director Ohio Trucking Association
      e. Board of County Commissioners
      f. Respective County Engineer's Office
   2. The District Roadway Services Manager shall prepare, erect and maintain all necessary signs according to BDM Section 918.3.C until the bridge is either strengthened or replaced.
   3. The District Bridge Engineer shall update all Bridge Inventory and Inspection records to show the latest official posted capacity.

C. Where posting of a bridge is determined necessary and no unusual or special circumstance at the bridge dictates otherwise, Ohio standard regulatory signs (as per the Ohio Manual of

Uniform Traffic Control Devices) 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. 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 bridge.

D. When the RF for a Legal Load falls below 0.30, that load configuration shall not be allowed on the bridge. A bridge must be closed to all traffic when the RF for each Ohio Legal Load falls below 0.30, until the bridge is rehabilitated or replaced. Bridges that are determined not capable of carrying 3 tons shall be closed.

918.4 PROCEDURE FOR RESCINDING BRIDGE POSTING FOR ODOT DISTRICTS

A. When a posted bridge has been strengthened or replaced and no longer needs posting, the District Bridge Engineer shall forward to the Bridge 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 Bridge 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 Bridge Rating Engineer shall distribute copies of the rescind notice as described in Section 918.3.2.B.1.

918.5 PROCEDURE FOR CHANGING BRIDGE POSTING FOR ODOT DISTRICTS

When the rated capacity of posted bridge changes, so as to require a revised posting level, the procedures in BDM Section 918.3 apply. Additionally, the existing posting must be rescinded as set forth in BDM Section 918.4. A new inspection report (BR86) is required to post a bridge, and change or rescind a load posting.

918.6 REQUIRED INFORMATION FOR POST, RESCIND AND CHANGE REQUESTS FROM ODOT DISTRICTS

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

A. Posting Request (Reduction in Load Limits)

1. Current Bridge Number
2. Structure File Number
3. Feature intersected (over or under bridge)

4. Posting Load for each Ohio Legal Load
5. Existing rating of bridge expressed as a percent of legal load or tons.
6. Explanation as to why posting is required
7. 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. Current Bridge Number
2. Structure File Number
3. Feature intersected (over or under bridge)
4. Existing posting (% reduction or weight limit currently in effect)
5. Date existing posting was effective
6. Explanation as to why posting restrictions can now be removed (include: contract project numbers or indicate force account or other work method used to correct problem)
7. New load rating for the rehabilitated or new structure

C. Change Request (Revision of Existing Posted Limits)

1. Current Bridge Number
2. Structure File Number
3. Feature intersected (over or under bridge)
4. Existing posting (weight limit currently in effect)
5. Revised posting request
6. Date of existing posting
7. 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. It is one of ODOT's preferred programs to do load rating.

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

B. Bentley LARS: LARS is bridge analysis software maintained and licensed by the Bentley Systems. It can load rate bridges by LRFR and LFR methods. It is one of ODOT's preferred programs to do load rating. (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 program is available from ODOT for a nominal charge of material and shipping. It is one of ODOT's preferred programs to do load rating.

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. It is one of ODOT's preferred programs to do load rating.

   (http://www.dot.state.wy.us/wydot/engineering_technical_programs/bridge/brass)

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).

F. DESCUS I: DESCUS I can perform analysis of horizontally curved flanged steel sections which act compositely or non-compositely with a concrete deck. The program can be run using Load Factor or Load and Resistance Factor method.

   (http://best.umd.edu/software/descus-i/)

G. MDX Software: MDX software can be used to design and load rate straight and curved steel bridges. The program can be run using Load Factor or Load and Resistance Factor method.

   (http://www.mdxsoftware.com/)

For the analysis of arches and other structures that cannot be modeled using any of the programs A through D above, contact the OSE for pre-approval of the software E through G before use.

The Department will not accept load rating performed using any software not pre-approved for a bridge.

920 LOAD RATING REPORT SUBMISSION

The load rating report shall be submitted to the ODOT project manager, ODOT District Bridge Engineer or the respective owner (in case of a non-ODOT bridge). The submission shall include:

A. Two printed copies of the Load Rating Report with the Summary sheet. The Load Rating Reports shall be signed, sealed and dated by an Ohio Registered Engineer.

B. One electronic copy of the Load Rating Report

C. One copy of all electronic input data files

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 summary 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 Bridge 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 incorporate any changes in the input files as a result of ODOT review.

921 LOAD RATING USING AASHTO VIRTIS PROGRAM

921.1 GENERAL

Virtis is a load rating program licensed from AASHTO. Virtis runs on Microsoft Windows and can load rate a variety of bridges by LFR as well as LRFR methods.

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 non-ODOT bridge owner. 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 Professional Engineer.

For an ODOT-bridge the District Bridge Engineer or Project Manager shall send a 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.

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 included as 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. To get the electronic copy of a bridge data file in Virtis, open the "Bridge Workspace," Export the bridge input file into an XML file and submit it electronically for review.

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 LARS PROGRAM

922.1 GENERAL

LARS (Load Analysis and Rating System) is a family of bridge load analysis and rating programs maintained and licensed by Bentley, Systems.

LARS can run on any Microsoft Windows compatible machine.

LARS can import BARS-PC files.

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

922.2 LARS CAPABILITIES

LARS program can analyze and rate single and multiple span bridges by Allowable Stress; Load Factor; and Load & Resistance Factor methods.

922.3 LARS 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.

In addition to the electronic input data file, the rater may submit hard (printed) copies of the computer input and output files.

923 LOAD ANALYSIS USING BRASS-CULVERT PROGRAM

923.1 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.

923.2 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.

923.3 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, the rater may submit hard (printed) copies of the computer input and output files.

924 LOAD RATING ANALYSIS USING BARS-PC

924.1 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 Standard Specifications for Highway Bridges.

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.

924.2 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.

924.3 BARS-PC LOAD RATING REPORT SUBMISSION

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

924.4 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

925 LOAD RATING OF BRIDGES USING LRFR SPECIFICATIONS

925.1 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.

925.2 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]:

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

For Strength Limit States:

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

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.

PL = Pedestrian Load effect only to be applied when a sidewalk is present

RF = Rating Factor

R_n = Nominal member resistance

γ_{DC} = Load factor for DC load

γ_{DW} = Load factor for DW load

γ_p = Load factor for P load = 1.0

γ_{LL} = Evaluation live load factor

γ_{PL} = Load factor for Sidewalk load = 1.0

φ_c = Condition factor

φ_s = System factor

φ = LRFD Resistance factor

For Limit States and factors see BDM Section 925.3.

925.3 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 925.3-1: LRFR Design Load Limit States and Load Factors [MBE 6A.4.2.2-1]

Bridge Type	Limit State	Dead Load γ_{DC}	Dead Load γ_{DW}	HL-93 Loading	
				Inventory γ_{LL}	Operating γ_{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 925.3-2: Legal Loads Limit States and Load Factors [MBE 6A.4.4.2.3a-1]

Bridge Type	Limit State	Dead Load γ_{DC}	Dead Load γ_{DW}	Ohio Legal Loads γ_{LL}
Steel	Strength I	1.25	1.50	1.40
	Service II	1.00	1.00	1.30
Reinforced Concrete	Strength I	1.25	1.50	1.40
	Service I	1.00	1.00	------
Prestressed Concrete	Strength I	1.25	1.50	1.40
	Service III	1.00	1.00	1.00
Wood	Strength I	1.25	1.50	1.40

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

Table 925.3-3: Permit Load Limit States and Load Factors [MBE 6A.4.5.4.2a-1]

Bridge Type	Limit State	Dead Load γDC	Dead Load γDW	Permit or Special Loads γ_{LL}
Steel	Strength II	1.25	1.50	1.35
	Service II	1.00	1.00	1.00
Reinforced Concrete	Strength II	1.25	1.50	1.35
	Service I	1.00	1.00	1.00
Prestressed Concrete	Strength II	1.25	1.50	1.35
	Service I	1.00	1.00	1.00
Wood	Strength II	1.25	1.50	1.35

925.4 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) ≥ 0% ..... [AASHTO 3.6.2.2-1]

Where:

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

925.5 CONDITION FACTOR (φ_c)

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

Table 925.5-1: Condition Factors [MBE 6A.4.2.3]

Structural Condition of a member	NBI General Appraisal	Condition Factor φ_c
Good or Satisfactory	6 or higher	1.00
Fair	5	0.95
Poor	4 or lower	0.85

925.6 SYSTEM FACTOR (φ_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 925.6-1: System Factors [MBE 6A.4.2.4]

Superstructure Type	φ_S
Welded members in two-girder/truss/arch bridges	0.85
Riveted members in two-girder/truss/arch bridges	0.90
Multiple eye bar 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

925.7 RESISTANCE FACTOR (φ)

Resistance factor (φ) 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 925.7-1: 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**

925.8 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).

926 LOAD RATING OF NEW BRIDGES

926.1 LOADS TO BE USED FOR LOAD RATING

All new and replacement bridges whose preliminary design is started **after October 1, 2010**, and requiring load rating, shall be load rated 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 given in Figure 903) using LRFR method of rating.

Newly designed timber bridges shall be load rated using LRFR method.

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

Long span bridges shall 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 second decimal point. 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 second decimal point. The Ohio Legal Loads Rating shall be the smallest rating factor of the four legal loads expressed as a percentage rounded off to the nearest 5 (i.e. smallest RF multiplied by 100).

The owner may also require load rating to be done for special loads in addition to those specified above. 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.

926.2 LOAD RATING OF NEW BURIED BRIDGES

926.2.1 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 923.

926.2.2 PRECAST CONCRETE BOXES

926.2.2.1 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 923.

926.2.2.2 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.

926.2.3 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 bridge.

926.2.4 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.

926.3 LOAD RATING OF NON-BURIED STRUCTURES

926.3.1 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.

926.3.2 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.

926.3.3 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

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

926.3.3.1 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.

926.3.3.2 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.

926.3.3.3 BRIDGES DESIGNED UNDER DESIGN-BUILD PROCESS

Unless otherwise indicated in the project scope, include the load rating report for bridges designed as part of a Design Build project with 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.

926.3.3.4 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.

927 LOAD RATING OF EXISTING BRIDGES

927.1 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.

927.2 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.

Existing timber bridges shall be load rated using ASR method.

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

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 Ohio Legal Loads Rating shall be the

smallest rating factor of the four legal loads expressed as a percentage rounded off to the nearest 5 (i.e. smallest RF 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.

927.3 LOAD RATING OF BRIDGES TO BE REHABILITATED

927.3.1 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 or as-built plans.

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 in load rating calculations, 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.

927.3.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

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

927.3.2.1 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.

927.3.2.2 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.

927.3.2.3 BRIDGES DESIGNED UNDER DESIGN-BUILD PROCESS

Unless otherwise indicated in the project scope, include the load rating report for bridges designed as part of a Design Build project with 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.

927.3.2.4 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.

927.3.3 LOAD RATING OF BURIED BRIDGES

927.3.3.1 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 923.

927.3.3.2 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 923.

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

The load rating analysis will be performed by the OSE.

927.3.3.4 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 bridge.

927.3.3.5 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.

927.3.4 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 925 (as applicable).

927.4 LOAD RATING OF EXISTING BRIDGES WITH NO REPAIR PLANS

927.4.1 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 bridges 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.

927.4.2 WHEN THE BRIDGE LOAD RATING SHALL BE DONE

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

927.4.3 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 927.3.3.

927.4.4 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 925 (as applicable).

928 LOAD RATING OF NON-ODOT BRIDGES

Provisions of BDM Section 900 may also be applied to load rating of Non-ODOT buried and non-buried bridges at the discretion of the respective bridge owners.

The load rating files and report of a Non-ODOT bridge shall be submitted to the respective bridge owner. The bridge owner shall keep the bridge load rating report in bridge file for future reference and use.

Based on the field conditions and the load rating calculations, if the rating engineer determines a bridge should be posted for reduced load capacity, the engineer shall forward the recommendation to the respective bridge owner. Applicable portions of BDM Section 918, Bridge Posting for Reduced Load Limits may be followed.

It is the responsibility of the respective bridge owner (or designated consultant/rating engineer) to ensure that the load rating information is finally updated in the ODOT BMS.

929 CULVERT TYPE BRIDGES DESIGNED USING ASTM C1577 (LRFD), C1433 (LFD), C789 (LFD) AND C850 (LFD)

When all of the following conditions apply:

A. A structure is designed by an AASHTO method using any of the above referred ASTM Specifications;

B. The ASTM Specifications are referenced via pay item in the design plans and the structure was built in accordance with the ASTM Specifications.

C. No changes to loading conditions or the structure conditions have occurred that could reduce the load rating below the design load level;

D. A field evaluation has been completed and the structure has not developed excessive cracks, deflections or signs of deterioration.

E. The design plans and the relevant ASTM Specification are accessible and referenced or included in the individual bridge records to form a basis for assigned load rating under FHWA 23 CFR 650.309(c);

F. The main structural members of the bridge have not been damaged or repaired since the structure was originally built;

G. During the last inspection, the General Appraisal (GA) was not less than 5 and the bridge was neither posted nor closed.

Appropriate load rating factors may be assigned to the structure, as follows:

- Inventory Rating Factor for HL93 loading = 1.00
- Operating Rating Factor for HL93 loading = 1.30
- Ohio Legal Loads Rating Factor = 1.50 (150%)
- Method of Rating = Assigned Load & Resistance Factor Rating (LRFR) using HL93 loadings OR

- Inventory Rating Factor for HS20 loading = 1.00
- Operating Rating Factor for HS20 loading = 1.30
- Ohio Legal Loads Rating Factor = 1.50 (150%)
- Method of Rating = Assigned Load Factor Rating (LFR) using HS20 loadings

A summary of the assigned load rating, which demonstrates above conditions are met, is to be included in the bridge records. An Ohio PE shall sign, seal and date the Load Rating Summary sheet.

If any of the above conditions (A through G) cannot be met for a bridge at any point during its service life, load ratings cannot be assigned and must be determined by the methods defined in BDM Section 900.

930 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, 2011, "The Manual for Bridge Evaluation," 2nd Edition and all subsequent Interims.

J. AASHTO, 2012, "AASHTO LRFD Bridge Design Specifications", 6th Edition.

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

AASHTO HS20-44 LOADING

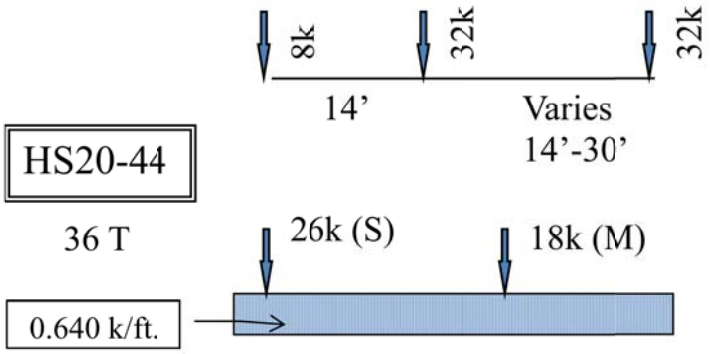


Figure 901

AASHTO HL93 LOADING

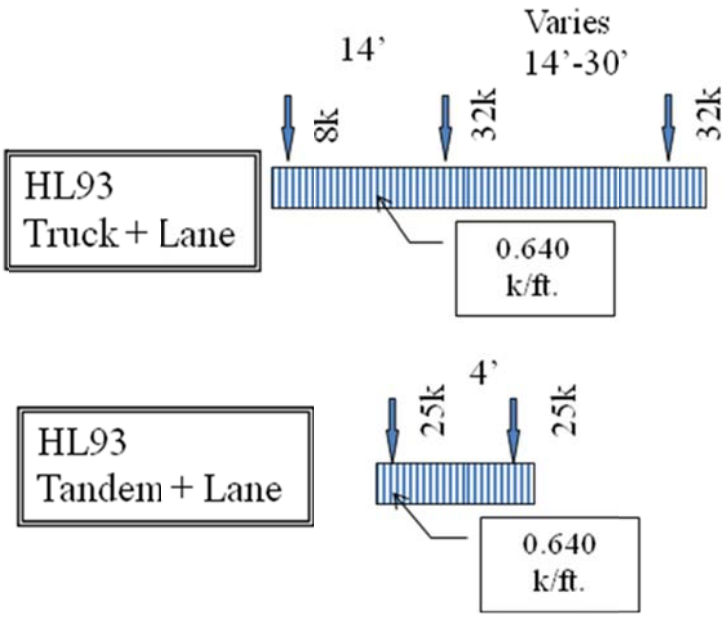


Figure 902

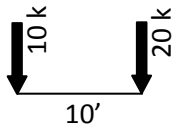
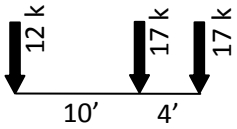
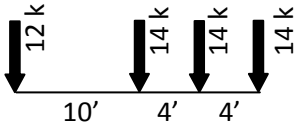
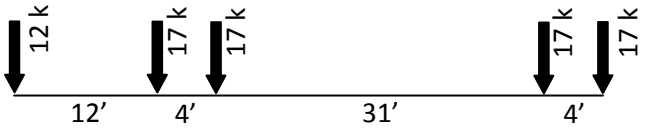
OHIO LEGAL LOADS		
Load Designation	**Load Configuration**	**Gross Vehicle Weight**
2F1		15 Tons
3F1		23 Tons
4F1		27 Tons
5C1		40 Tons

Figure 903

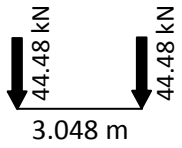
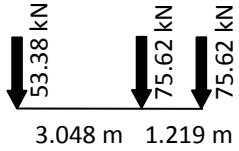
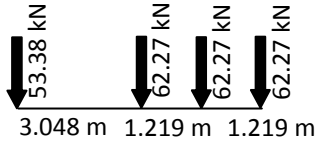
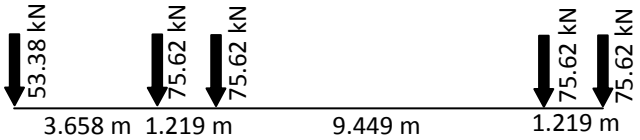
OHIO LEGAL LOADS (METRIC)		
Load Designation	**Load Configuration**	**Gross Vehicle Weight**
2F1		13.608 Metric Tons
3F1		20.865 Metric Tons
4F1		24.494 Metric Tons
5C1		36.287 Metric Tons

Figure 904

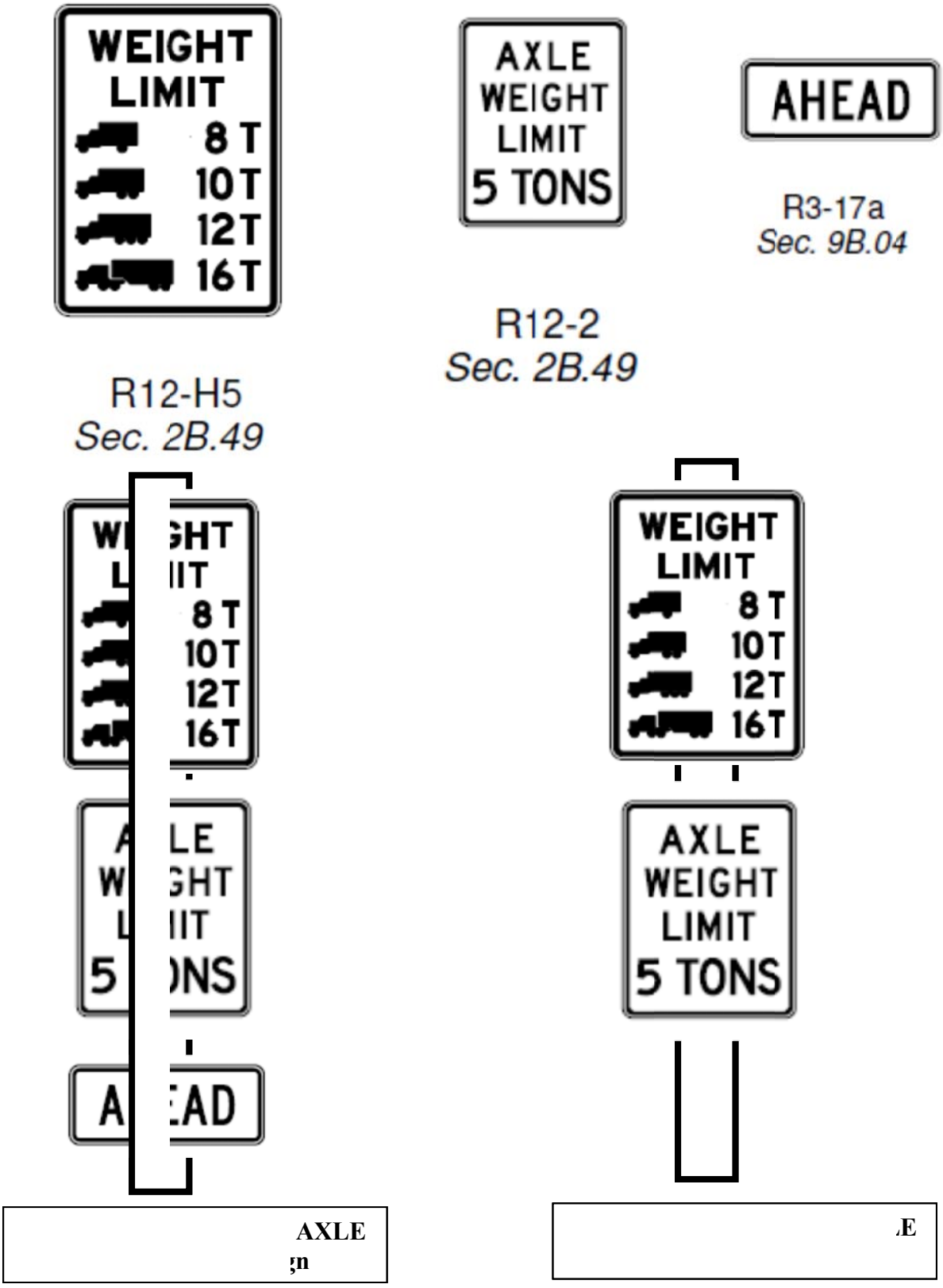

WEIGHT
LIMIT
8 T
10T
12T
16T
R12-H5
Sec. 2B.49
AXLE
WEIGHT
LIMIT
5 TONS
R12-2
Sec. 2B.49
AHEAD
R3-17a
Sec. 9B.04
WEIGHT
LIMIT
8 T
10T
12T
16T
AXLE
WEIGHT
LIMIT
5 TONS

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')	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

BRIDGE LOAD RATING SUMMARY REPORT

PROGRAM RESPONSIBLILITY	OHIO DEPARTMENT OF TRANSPORTATION	
MAINTENANCE RESPONSIBLILITY	OHIO DEPARTMENT OF TRANSPORTATION	

SFN	BRIDGE NUMBER	DISTRICT
1402390	CLI-73-1170	8
ORIGINAL CONSTRUCTION YEAR	**REHABILITATION YEAR**	**OVERALL STRUCTURE LENGTH (FT. xxxx.xx)**
2006		13.25

FIPS	FEATURE INTERSECTED:	FACILITY CARRIED
	LITTLE INDIAN CREEK	SR 73

SPECIAL ASSUMPTIONS & COMMENTS:	Using construction drawings dated March 2005; 3 span concrete slab (38.0' - 47.5' - 38.0'); skew = 30°; f'c = 4.5 ksi; fy = 60 ksi; slab thickness = 23".
	PLEASE SELECT ON RIGHT, WHERE APPROPRIATE, BY USING UP-DOWN ARROW BUTTONS
LOAD RATING PURPOSE:	1- Initial Load Rating
LOAD RATING SOFTWARE:	7 - Combination
RATING SOURCE:	1 - Plan information available for load rating analysis (Default)
METHOD OF RATING:	D - Assigned Load Factor Rating (LFR) using HS20 loadings
ORIGINAL DESIGN LOADING:	6 - HS20-44 & Alternate Military Loading

STRUCTURE RATING SUMMARY

LOADING TYPE	GVW (TONS)	RATING FACTOR - RF (x.xxx)	SAFE GVW (TONS)	Current Design Loading
INVENTORY RATING		1.000		2 - HS20 Loading
OPERATING RATING		1.250		2 - HS20 Loading
OHIO LEGAL - 2F1	15	1.500	23	OHIO LEGAL LOADS OVERALL MINIMUM RATING FACTOR
OHIO LEGAL - 3F1	23	1.500	35	*150%*
OHIO LEGAL - 4F1	27	1.500	41	OHIO LEGAL LOADS OVERALL CONTROLLING TRUCK
OHIO LEGAL - 5C1	40	1.500	60	*OHIO LEGAL - 2F1*

LOAD RESTRICTIONS RECOMMENDATION	NO ACTION IS NEEDED

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

BR-100 (REV 4/2012)

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