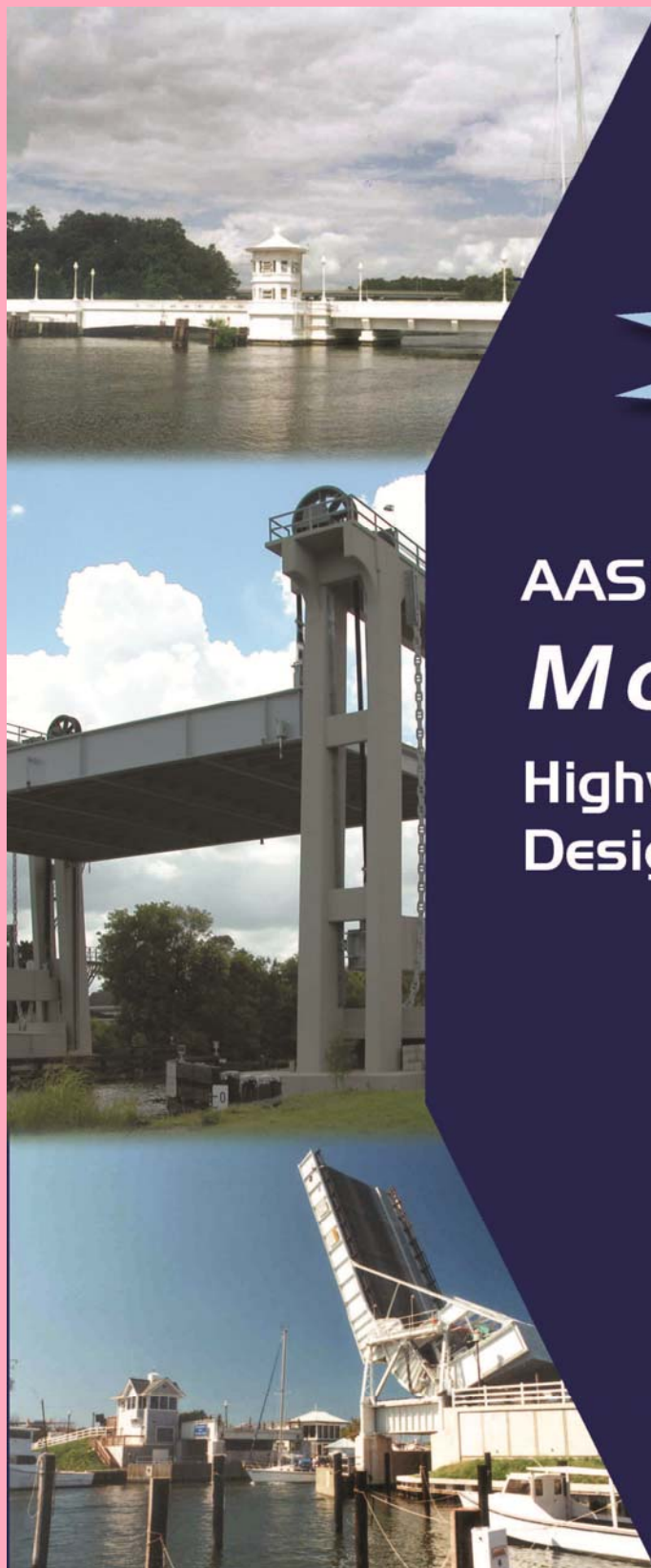




2018 Interim
Revisions

AASHTO LRFD
Movable
Highway Bridge
Design Specifications

2nd Edition
2007

AASHTO

ISBN: 978-1-56051-686-6 Pub Code: LRFDMOV-2-17



Documents

Document Sharing Hub

© 2017 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

Full document details: AASHTO LRFDMOV-2-2007 17-2018



American Association of State Highway and Transportation Officials
444 North Capitol Street, NW, Suite 249
Washington, DC 20001
202-624-5800 phone/202-624-5806 fax
www.transportation.org

© 2017 by the American Association of State Highway and Transportation Officials. All rights reserved. Duplication is a violation of applicable law.

ISBN: 978-1-56051-686-6

© 2017 by the American Association of State Highway and Transportation Officials.
All rights reserved. Duplication is a violation of applicable law.

Full document details: [AASHTO LRFD MOV-2-2007](#) 17-2018

INSTRUCTIONS AND INFORMATION

General

AASHTO has issued proposed interim revisions to the *AASHTO LRFD Movable Highway Bridge Design Specifications*, Second Edition (2007). This packet contains the revised pages. They are designed to replace the corresponding pages in the book.

Affected Articles

Underlined text indicates revisions that were approved in 2017 by the AASHTO Highways Subcommittee on Bridges and Structures. ~~Strikethrough text~~ indicates any deletions that were likewise approved by the Subcommittee. A list of affected articles is included below.

All interim pages are displayed on a pink background to make the changes stand out when inserted in the second edition binder. They also have a page header displaying the interim publication year. Please note that these pages may also contain nontechnical (i.e., editorial) changes made by AASHTO publications staff; any changes of this type will not be marked in any way so as not to distract the reader from the technical changes.

2018 Changed Articles

SECTION 2: STRUCTURAL DESIGN

2.4.1.2.5

C2.4.1.2.5

SECTION 6: MECHANICAL DESIGN

6.8.1.5.1

C6.8.1.5.1

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 2: STRUCTURAL DESIGN

TABLE OF CONTENTS

2.1 SCOPE.....	2-1
2.1.1 Specifications.....	2-1
2.1.2 Bridge Types.....	2-1
2.1.2.1 General	2-1
2.1.2.2 Contract Documents	2-1
2.2 DEFINITIONS.....	2-1
2.3 NOTATION.....	2-3
2.4 LOADS, LOAD FACTORS, AND COMBINATIONS	2-3
2.4.1 General Provisions and Limit States	2-3
2.4.1.1 Live Load and Dead Load	2-3
2.4.1.2 Dynamic Load Allowance	2-4
2.4.1.2.1 Live Load Dynamic Load Allowance (<i>IM</i>)	2-4
2.4.1.2.2 Dead Load Dynamic Load Allowance (<i>DAD</i>).....	2-4
2.4.1.2.3 Force Effects Due to Operation of Machinery (<i>DAM</i>)	2-4
2.4.1.2.4 End Floorbeams	2-4
2.4.1.2.5 Span Locks	2-4
2.4.1.3 Wind Loads.....	2-4
2.4.1.3.1 General	2-4
2.4.1.3.2 Movable Span Closed	2-5
2.4.1.3.3 Movable Span Open	2-5
2.4.1.4 Seismic Loads.....	2-6
2.4.1.5 Fatigue Limit State	2-6
2.4.1.6 Settlement	2-7
2.4.1.7 Vessel Collision and Pier Protection	2-7
2.4.1.8 Hydraulic Cylinder Structural Connections.....	2-7
2.4.1.9 Strength and Rigidity of Structural Machinery Supports.....	2-7
2.4.1.10 Ice Accretion.....	2-7
2.4.2 Bridge-Type Specific Provisions	2-8
2.4.2.1 Movable Bridge Load Combinations.....	2-8
2.4.2.2 Application of Fixed Bridge Load Combinations.....	2-8
2.4.2.3 Movable Bridge-Specific Load Combinations—Strength Limit State	2-8
2.5 MOVABLE BRIDGE DESIGN FEATURES AND REQUIREMENTS	2-10
2.5.1 Movable Bridge Specific Design Features and Requirements	2-10
2.5.1.1 Bascule Span Bridges	2-10
2.5.1.1.1 Types	2-10
2.5.1.1.2 Support Conditions	2-10
2.5.1.1.3 Segmental and Track Girders	2-10
2.5.1.1.4 Floors and Floor Fastenings.....	2-12
2.5.1.2 Swing Span Bridges.....	2-12
2.5.1.2.1 Center Bearing.....	2-12
2.5.1.2.2 Rim Bearing.....	2-12
2.5.1.2.3 Combined Bearing.....	2-12

2.5.1.2.4 Rim Girders	2-12
2.5.1.2.5 Shear Over Center.....	2-13
2.5.1.2.6 Reaction Due to Temperature	2-13
2.5.1.3 Vertical Lift Bridges	2-13
2.5.1.3.1 Tower and Tower Spans	2-13
2.5.1.3.2 Anchorage for Cantilevered Floors.....	2-13
2.5.1.3.3 Wind on Vertical Lift Spans	2-13
REFERENCE.....	2-14

STRUCTURAL DESIGN

2.1 SCOPE

2.1.1 Specifications

The structural design of movable bridges shall conform to the requirements of the latest edition of the *AASHTO LRFD Bridge Design Specifications* including all applicable interim changes, except as modified or supplemented herein.

2.1.2 Bridge Types

2.1.2.1 General

Movable bridges shall be of the following types, unless otherwise specified by the Engineer:

- bascule span bridges,
- swing span bridges, or
- vertical lift bridges.

2.1.2.2 Contract Documents

The contract documents shall specify, or the Engineer shall determine the following:

- the type of movable bridge,
- for bascule span bridges, the type of bascule,
- for swing span bridges, the type of center. Swing span bridges should be the center bearing type, unless there is a compelling reason otherwise.
- for vertical lift bridges, the type of tower, location of the prime mover(s) and provisions for keeping the moving span level, and
- the system of emergency operation, if any, and the standby power system, if any.

2.1.2.3 Prohibited Structure Types

Pin-connected trusses shall not be used for movable spans.

2.2 DEFINITIONS

Center Bearing Swing Bridge—Movable bridge which opens by rotating about a vertical axis, and whose span weight is supported on a thrust bearing, positioned at the movable span's center of gravity and rotation.

Design Life—Period of time upon which the statistical derivation of transient loads is based, 75 years.

Double-Leaf Bascule Bridge—Movable bridge which opens by rotating two cantilever spans, each about their own horizontal axis, and where the radius of both span's travel are tangent at the center of the channel.

Dynamic Load Allowance—An increase in the applied static force effects to account for the dynamic interaction between the bridge and moving loads.

Fatigue Limit States—Limit states relating to the initiation and/or propagation of cracks due to a repeated variation of normal stress with a tensile component.

Fixed Bridge—A bridge with a fixed vehicular or navigational clearance.

Force Effects—A deformation, stress or stress resultant, i.e., thrust, shear, torque or moment, caused by applied loads, imposed deformations or volumetric changes.

Heel-Trunnion Bascule Bridge—Movable bridge which opens by rotating a single cantilever span about a horizontal axis. The counterweight is mounted on a frame (not in the plane of the movable span) and counters the weight of the span through linkages.

Limit State—A condition beyond which the bridge or component ceases to fulfill the function for which it was designed.

Load Factor—A factor accounting primarily for the variability of loads, the lack of accuracy in analysis, and the probability of simultaneous occurrence of different loads, but also related to the statistics of the resistance through the calibration process.

Movable Bridge—A bridge with a variable vehicular or navigational clearance.

Rim Bearing Swing Bridge—Movable bridge which opens by rotating about a vertical axis, and whose span weight is supported by a ring of rollers located at a radius of usually one-half the width of the movable span from the center of rotation.

Rim Girder—A structural girder that distributes the weight of the rim-bearing swing bridge's movable span to the rollers.

Rolling-Lift Bascule Bridge—Movable bridge which opens by rotating a single cantilever span about a moving horizontal axis. The counterweight and movable span are attached to a vertically curved girder that rotates the center of rotation away from the channel.

Segmental Girders—The vertical curved girder that supports the weight of a rolling-lift bascule bridge, and rotates with the movable span as the center of rotation moves away from the channel.

Service Life—The period of time that the bridge is expected to be in operation.

Single-Leaf Bascule Bridge—Movable bridge which opens by rotating a single cantilever span about a horizontal axis.

Strength Limit States—Limit states relating to strength and stability.

Stress Range—The algebraic difference between extreme stresses resulting from the passage of a load and/or the opening of a span.

Track Girders—The fixed horizontal flat girder that supports and aligns the movement of the segmental girder of a rolling-lift bascule bridge.

Transfer Span—A bridge structure used for loading or off loading vehicles, pedestrians or cargo from a floating vessel in tidal or nontidal conditions under the direction of a qualified attendant. A transfer span is connected on the shore end to a pier, trestle, wharf or dock and the offshore end is directly supported or resting on a floating vessel or supported from a fixed or floating structure with a short apron to transition from bridge to vessel.

Trunnion Bascule Bridge—Movable bridge which opens by rotating a single cantilever span about a horizontal axis. The counterweight is located behind the movable span and counters the weight of the span.

Vertical Lift Bridge—Movable bridge which opens by vertically raising one movable span.

2.3 NOTATION

ADO	=	estimated average daily number of openings (2.4.1.5)
D	=	diameter of the segment (in.) (2.5.1.1.3)
DAD	=	operating impact specified in Article 2.4.1.2.2 applied to the maximum dead load effect in all members that are in motion, and the load effect on a stationary member caused by the moving dead load (dim) (2.4.1.2.2)
DAM	=	force effects from operation of machinery including 100 percent dynamic allowance (lb. or lb.-in.) (2.4.1.2.3)
D_{cw}	=	dead load, bridge closed, counterweight supported for repairs (lb.) (2.4.2.1)
D_o	=	dead load, bridge open in any position or closed with ends just touching (lb.) (2.4.2.1)
F_y	=	specified minimum yield strength of the material in tension (psi) (2.5.1.1.3)
L_c	=	live load on a swing bridge including dynamic load allowance, IM, bridge closed with ends just touching, with bridge considered as a continuous structure, reactions at both ends to be positive (lb.) (2.4.2.1)
L_{cw}	=	live load including dynamic load allowance, IM, bridge closed, counterweight supported for repairs (lb.) (2.4.2.1)
L_s	=	live load on a swing bridge including dynamic load allowance, IM, on one arm as a simple span, bridge closed with ends just touching (lb.) (2.4.2.1)
M_o	=	maximum forces on structural parts, including parts of the structure that support the counterweight assembly, caused by the operation of machinery, increased for machinery impact, DAM, as specified in Article 2.4.1.2.3 (lb. or lb.-in.) (2.4.2.1)
N_o	=	number of operational open and closed cycles in 75 years (2.4.1.5)
n_o	=	number of stress cycles per operation (2.4.1.5)
P_{LB}	=	allowable load for line bearing between segmental girder and track girder (lb./in.) (2.5.1.1.3)
W_o	=	wind load, bridge open in any position, or closed with ends just touching (lb.) (2.4.2.1)

2.4 LOADS, LOAD FACTORS, AND COMBINATIONS

2.4.1 General Provisions and Limit States

The loads specified in this Article are applicable to all types of movable bridges. Loads, load factors and load combinations specific to a particular type of movable bridge shall be taken as specified in Article 2.4.2. The provisions for bascule span bridges shall also apply to rolling lift bridges.

2.4.1.1 Live Load and Dead Load

The dead load and live load shall be as specified in Section 3 of the *AASHTO LRFD Bridge Design Specifications* under the designations DC, DW, EL, EH, ES, EV, LL, IM, BR, CE, PL, and LS. The D_o and D_{cw} dead loads shall be applied as appropriate to the condition of the bridge at the time these dead loads are considered. The specific loads are defined as follows:

D_o	=	the sum of DC and DW appropriate when the bridge is open in any position or closed with the ends just touching
D_{cw}	=	the sum of DC and DW appropriate when the bridge is closed with the counterweight supported for repairs

2.4.1.2 Dynamic Load Allowance*2.4.1.2.1 Live Load Dynamic Load Allowance (IM)*

The dynamic load allowance for live load shall be as specified in the current *AASHTO LRFD Bridge Design Specifications*.

2.4.1.2.2 Dead Load Dynamic Load Allowance (DAD)

Structural parts in which the force effect varies with the movement of the span, or in parts which move or support moving parts shall be designed for a load taken as 20 percent of D_o to allow for dynamic load allowance or vibratory effect. This dynamic load allowance shall not be combined with live load.

2.4.1.2.3 Force Effects Due to Operation of Machinery (DAM)

Structural components supporting forces caused by machinery during operation of the span shall be designed for the calculated machinery forces, increased 100 percent as a dynamic load allowance.

The machinery forces transferred to the structural system shall be taken as those specified for the service limit state for machinery design in Articles 5.7 and 7.4, augmented by the dynamic load allowance specified above, and factored for the strength limit state structural design as specified in Table 2.4.2.3-1.

2.4.1.2.4 End Floorbeams

The end floorbeams of the moving span shall be proportioned for full factored live load plus twice the normal dynamic load allowance specified in Article 3.6.2 of the *AASHTO LRFD Bridge Design Specifications*.

2.4.1.2.5 Span Locks

The span locks of double-leaf bascule bridges (center locks) shall be proportioned for full live load plus twice the normal dynamic load allowance, specified in Article 3.6.2 of the *AASHTO LRFD Bridge Design Specifications*.

C2.4.1.2.2

An example of situations in which dead load force effect varies with the movement of the span is a bascule bridge. Examples of parts which move or support moving parts include swing span trusses, vertical lift bridge trusses and towers, and supports for bascule trunnions.

C2.4.1.2.5

The use of twice the normal dynamic load allowance for span locks applies to Strength, Service and Fatigue Limit States.

2.4.1.3 Wind Loads*2.4.1.3.1 General*

In proportioning members and determining the stability of swing, bascule, and vertical lift spans, and their towers, wind loads shall be assumed acting either transversely, longitudinally, or diagonally as specified in Article 3.8.1.2.2 of the *AASHTO LRFD Bridge Design Specifications*.

C2.4.1.3.1

In past editions of these Specifications, only longitudinal, transverse, and 45° diagonal wind were considered.

Exposed areas for transverse wind loads on the spans shall be determined as provided in the current *AASHTO LRFD Bridge Design Specifications*, supplemented and modified as follows:

- Exposed areas for longitudinal wind load on the spans shall be taken as one-half those for transverse wind, except for bascule spans when open where they shall be modified as specified herein for loads acting normal to the floor.
- Exposed areas for transverse and longitudinal wind loads on houses and counterweights shall be their vertical projections.
- Exposed areas for transverse and longitudinal wind loads on towers and their bracing shall be the vertical projections of all columns and bracing not shielded by the counterweights and houses.
- Exposed areas of open-deck grid floor bridges subjected to ice and to wind acting normal to the floor shall be taken as 85 percent of the area of a quadrilateral using actual width and whose length is that of the span.
- For bridges with solid floors, or with sidewalks, the actual exposed floor surface shall be used.

2.4.1.3.2 Movable Span Closed

The structure shall be designed as a fixed span in accordance with the *AASHTO LRFD Bridge Design Specifications*.

2.4.1.3.3 Movable Span Open

The provisions of the *AASHTO LRFD Bridge Design Specifications* shall apply and shall be augmented as specified herein.

Force effects from loads specified below shall be evaluated at the strength limit state using Load Combination Strength III specified in Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications* and Table 2.4.2.3-1 herein.

When the movable span is normally left in the open position, the open position shall be investigated for the full wind pressures specified in Article 3.8 of the *AASHTO LRFD Bridge Design Specifications*, combined with dead load and other applicable loads in the load combinations which include wind. For swing bridges, provision shall also be made for 50 psf on one arm and 35 psf on the other arm. Wind loading shall be applied to both arms and shall be considered as blowing in a single direction even when wind pressure varies between arms.

When the movable span is normally left in the closed position, the open position shall also be investigated for a load combination 60 percent of the wind pressures, specified in Article 3.8 of the *AASHTO LRFD Bridge Design Specifications* applied to the structure combined with dead load and impact on dead load, as specified in Articles 2.4.1.1 and 2.4.1.2.2, and any other applicable loads. For swing bridges, provision shall also be made for 30 psf on one arm and 20 psf on the other arm. Wind loading shall be applied to both arms and shall be considered as blowing in a single direction even when wind pressure varies between arms.

2.4.1.4 Seismic Loads

Seismic loads, limit states, and load combinations shall be as specified in the *AASHTO LRFD Bridge Design Specifications* and Section 3 of these Specifications.

2.4.1.5 Fatigue Limit State

The fatigue provisions of the *AASHTO LRFD Bridge Design Specifications* shall apply as augmented herein.

In addition to the fixed-span bridge fatigue design check of the *AASHTO LRFD Bridge Design Specifications*, which is based upon the number of trucks to cross the bridge during its 75-year design life, fatigue shall be checked for movable bridges based upon the number of times the bridge is opened. The stress range arising from the operation of the span from fully closed to full open position, and return, including the effect of wind and the passage of the last truck before opening and the first truck after closing, shall be less than the allowable stress range specified in Article 6.6.1 of the *AASHTO LRFD Bridge Design Specifications*, based upon the estimated number of cycles taken as the number of times the bridge is expected to be opened in its 75-year design life.

For this case, the value of “ N ” in Eq. 6.6.1.2.5-2 from the *AASHTO LRFD Bridge Design Specifications* should be replaced with “ N_o ,” the number of operational open and close cycles for which,

$$N_o = (365)(75)n_o(ADO)$$

where:

n_o = number of stress range cycles per operation, as estimated by the structural designer with respect to the bridge type

ADO = estimated average daily number of openings

C2.4.1.5

The stress range arising from the operation of the span is primarily due to the change in the dead load stresses from opening and closing the bridge. If the bridge is kept open for a significant amount of time and thus subject to potentially significant wind, this wind load can contribute to this stress range also. Finally, the last truck before opening and the first truck after closing will also contribute to the stress range.

Since the number of openings of even the most frequently opened movable bridges will typically be much less than the number of trucks to cross the bridge during the 75-year design life, the stress range due to opening the bridge needs to be much greater than that due to the passage of the fatigue truck for this fatigue check to govern.

The weight of the last and first trucks before and after the operation of the span, respectively, is indeterminate. It is conservative to consider the trucks to be the maximum fatigue truck, or a 110,000-lb. truck. If this is too conservative (i.e. the fatigue check does not work), the 55,000-lb. fatigue truck may be considered appropriate if the number of openings of the bridge is a significant number and truly random.

2.4.1.6 Settlement

Special precaution shall be taken to control settlement or other movements of the piers to not exceed criteria established for the particular bridge. Where piles are used, consideration shall be given to the use of batter piles to resist torsional and horizontal forces produced by movement of the span.

2.4.1.7 Vessel Collision and Pier Protection

Vessel collision loads and limit states shall be taken as specified in the *AASHTO LRFD Bridge Design Specifications* and Section 4 of these Specifications.

2.4.1.8 Hydraulic Cylinder Structural Connections

Force effects on structural connections to cylinders shall be based on a cylinder pressure as specified in Article 7.4.3. These connections and their supporting members shall be designed for the overload limit state, specified in Article 1.3.2.1.

2.4.1.9 Strength and Rigidity of Structural Machinery Supports

Structural components directly supporting machinery design loads shall also be designed for the overload limit state specified in Article 1.3.2.4. The resistance factor, ϕ , for use with structural, not mechanical, design under this limit state shall be taken as 0.75.

The overload limit state shall be taken as specified in Articles 5.7 and 7.4.

In the design of structural parts subject to force effects from machinery or from forces applied for moving or stopping the span, consideration shall be given to providing adequate stiffness and rigidity consistent with the operating tolerance of applicable machinery components and the avoidance of resonance. Deflections shall be investigated sufficiently to insure that they will not interfere with proper machinery operation.

2.4.1.10 Ice Accretion

Except as modified herein, the provisions of Article 3.9.6 of the *AASHTO LRFD Bridge Design Specifications* shall apply to the superstructure design.

The effect of ice loads on structural supports for machinery shall be accounted for in machinery loads transmitted to machinery structural support systems through the power requirements specified in Article 5.4.

C2.4.1.8

See Article 7.6.2.

C2.4.1.9

Forces from operating equipment, for the overload limit state, must be carried by the supporting structure. Service limit state design for these overloads would be too conservative, while strength limit state design would be unconservative. The resistance factor, $\phi = 0.75$, provides the same reliability for the structure as is provided for the machinery.

Machinery support requirements for structural rigidity can be quite demanding in comparison to normal tolerated deflections. Design of structural machinery supports should be closely coordinated with the machinery design, for both static and dynamic machinery conditions.

C2.4.1.10

See Article C5.4.1.

2.4.2 Bridge-Type Specific Provisions

2.4.2.1 Movable Bridge Load Combinations

The load combinations identified in Table 2.4.2.3-1 and comprised of loads defined in Article 2.3 shall be considered in the design of movable bridges.

2.4.2.2 Application of Fixed Bridge Load Combinations

The load combinations, specified in Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications* for all applicable limit states shall apply to movable bridges, as follows, using the resistance factors specified therein:

- Where a bascule span is not in operating mode and the counterweight is not temporarily supported for repairs.
- Where a swing span is in the closed position, the bridge ends are lifted to give the positive reaction specified in the contract documents, factored as a dead load of component, DC, as specified in Table 3.4.1-2 of the *AASHTO LRFD Bridge Design Specifications*.
- When a vertical lift bridge is not in operating mode and the counterweight is not temporarily supported for repairs.

The additional strength limit state load combinations specified in Article 2.4.2.3 shall also apply.

2.4.2.3 Movable Bridge-Specific Load Combinations—Strength Limit State

The following movable bridge-specific load combinations—defined below and specified in Table 1—shall be considered as appropriate. Definitions of loads and load factors shall be as defined in Articles 2.3 and 2.4.1.

Load combinations for bascule and vertical lift bridge structures:

- **Strength BV-I**—Load combination related to structure in the open or closed position and dynamic effects of operating machinery.
- **Strength BV-II**—Load combination related to structure in any open position, dynamic effects of operating machinery, and wind.
- **Strength BV-III**—Load combination related to structure in the closed position, with live load and the counterweight independently supported.

C2.4.2.2

The positive reaction at the ends of a swing span is typically equal to 150 percent of the maximum negative reaction due to live load and dynamic load allowance. Table 3.4.1-2 of the *AASHTO LRFD Bridge Design Specifications* contains maximum load factors and minimum load factors. In this context, the minimum load factor is seen as addressing wear of the locking mechanism.

C2.4.2.3

Table 1 contains additional load cases to be investigated beyond those required in Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications*. These additional cases apply to the structural design of the movable bridge. The Table contains a set of design cases for bascule and vertical bridges and another set for swing bridges.

With respect to the load combinations required for bascule and vertical lift bridges, Load Case BV-I deals with the structure in the open position, including the dynamic effects resulting from the acceleration of the span for stopping or starting. This case has load factors similar to the strength design case for dead load components of fixed bridge cases as required in Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications*. Load Case BV-II deals with dead load and dynamic effects in combination with the wind loads specified in these Specifications for movable bridges in the open condition. Load Case BV-III deals with the situation where the

Load combinations for swing bridge structures:

- **Strength S-I**—Load combination related to structure in any open or closed position and dynamic effects of operating machinery.
- **Strength S-II**—Load combination related to live load on a simple span configuration.
- **Strength S-III**—Load combination related to live load on a continuous span configuration.
- **Strength S-IV**—Load combination related to structure in the open position, dynamic effects of operating machinery, and wind.
- **Strength S-V**—Load combination related to live load on a simple span configuration and wind.
- **Strength S-VI**—Load combination related to live load on a continuous span configuration and wind.

bridge is in the closed position and the counterweight is supported independent to the bridge as may be appropriate for certain maintenance or rehabilitation conditions, and the structure is available for traffic. Since this is a temporary condition, the load factors required are similar to those applicable to permit loads in Load Combination Strength II of Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications*.

In the case of swing bridges, Load Case S-I is similar to BV-I, requiring the analysis of the same loads using the same load factors as required for bascule and vertical lift bridges. Consideration of Load Cases S-I through S-VI will show that a pattern of factors appears in the Table relating to whether the structure supports dead load only, live load on one portion of the swing bridge treated as a simple span, or live load on the full bridge treated as a continuous structure. There is a further separation of these load cases, depending on whether or not wind is applied in combination with the live load. It can be seen that the pattern of factors is similar to comparable load cases in Table 3.4.1-1 of the fixed bridge specifications. Swing bridges must be designed with adequate end lift in the bridge closed position so that no live load condition, as specified in Table 1 herein or in Table 3.4.1-1 of the *AASHTO LRFD Bridge Design Specifications*, results in a negative reaction, i.e., uplift at the live load supports. Consideration of two special live load conditions is required to account for the possibility that the ends of the bridge might touch the supports, but the end wedges, or equivalent devices, do not lift the ends of the bridge properly before traffic is permitted on the bridge. Under such a situation, the component force effects from the permanent loads would be different from the intended, i.e., wedged condition.

Table 2.4.2.3-1—Movable Bridge-Specific Load Combinations

Load Combination	D_O	D_{CW}	L_S	L_C	L_{CW}	W_O	DAD	M_O
Bascule and Vertical Lift Bridges								
Strength BV-I	1.55	0	N/A	N/A	0	0	1.55	1.55
Strength BV-II	1.25	0	N/A	N/A	0	1.25	1.25	1.25
Strength BV-III	0	1.25	N/A	N/A	1.40	0	0	0
Swing Bridges								
Strength S-I	1.55	N/A	0	0	N/A	0	1.55	1.55
Strength S-II	1.35	N/A	1.75	0	N/A	0	0	0
Strength S-III	1.35	N/A	0	1.75	N/A	0	0	0
Strength S-IV	1.25	N/A	0	0	N/A	1.25	1.25	1.25
Strength S-V	1.25	N/A	1.40	0	N/A	1.25	0	0
Strength S-VI	1.25	N/A	0	1.40	N/A	1.25	0	0

2.5 MOVABLE BRIDGE DESIGN FEATURES AND REQUIREMENTS

2.5.1 Movable Bridge Specific Design Features and Requirements

2.5.1.1 Bascule Span Bridges

2.5.1.1.1 Types

Whenever practical, bascule spans should be of the trunnion or rolling lift type.

2.5.1.1.2 Support Conditions

The forward ends of the single-leaf bascules shall be supported. The forward ends of double-leaf bascules shall be provided with effective locking mechanisms designed to transmit the shear necessary to produce equal deflections of the main girders or trusses under unbalanced live loads. Ordinarily, the center locks shall not be designed to carry moment.

2.5.1.1.3 Segmental and Track Girders

The flanges of the segmental and track girders of rolling lift bridges shall be symmetrical about the central planes of the webs. The central planes of the webs of the segmental girders shall coincide with the corresponding central planes of the webs of the track girders. The treads attached to the segmental girders and track girders shall be steel castings or rolled steel plates and shall not be considered as part of the flanges of these girders.

The allowable load for line bearing P_{LB} (lb./in.) between treads of segments having a diameter of 10 ft or more shall not exceed:

$$P_{LB} = (12,000 + 80D) \left(\frac{F_y - 13,000}{20,000} \right) \quad (2.5.1.1.3-1)$$

where:

D = diameter of the segment (in.)

F_y = specified minimum yield strength of the material in tension (psi)

The thickness t (in.) of sole plates and of the flanges of flange-and-web castings shall not be less than $t = 3.00 + 0.004 D$. Tread plates may be flange-and-web castings. The edge thickness of the rolling flange shall not be less than 3 in., and the flange thickness at any horizontal section of the web of the casting shall be such that the unit bearing on the web of the casting shall not exceed one-half of the yield strength of the material in tension, with the length of the bearing taken as twice the depth from the rolling face to the plane under consideration.

The effective length of the line bearing for each web shall not exceed the thickness of the web of the segmental or track girder, including the effective thickness of the side plates, plus 1.6 times the least depth of the tread. The edge of the web shall be machined so as to bear continuously upon the tread. The thickness of the web shall be such that the quotient obtained by dividing the load by the area of a portion of the edge of the web whose length equals twice the thickness of the tread, shall not exceed one-half of the minimum yield strength of the material in tension.

Flange angles shall not be considered as transmitting any load from the web to the treads. The bearing value of side plates shall not exceed the resistance of those fasteners or welds connecting them to the web, which are included between diverging lines, in the plane of the web, that intersect at the line contact between the treads and track. These lines make an angle whose tangent is 0.8 with the normal to the rolling surface. The load, as used in this Article, shall be the weight of the structure, no addition being made for rolling impact.

Solid tread plates on segmental girders shall have a radius slightly smaller than the segmental girders in order to facilitate the securing of tight contact with the girders throughout their length when drawn up with the attaching bolts.

When not otherwise stipulated in the contract documents, all tread plates shall be made as long as practical. When tread plates are made in segments, the faces of the tread plates at the joints between the segments shall be in planes at right angles to the rolling surface and preferably at an angle of 45° to 60° with the longitudinal centerline of the tread plate.