A Review of Two Codes For The Design of Pedestrian Bridges

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Bridge Engineering is international, but while the laws of equilibrium do not change from country to country, the practices to ensure that bridges satisfy those laws can vary widely, reflecting the position taken by the members of code writing committees.

In preparing this review, the objective has not been to provide a summary of design practices but to provide a basis for the preparation of a common document by signaling the areas of agreement and, more importantly, the areas of disagreement, at the level of the basic engineering, for future code writing bodies.

Pedestrian Load

CAN/CSA S6-19 [1]	AASHTO Pedestrian Bridges – 2009 [2]
CSA S6 – Cl. 3.8.9	AASHTO Pedestrian Bridges – Cl. 3.1, 3.6
p = 5 – s/30 (kPa) Min. 1.6 kPa (35 psf) Max. 4 kPa (85 psf) s = total loaded length of walkway (m)	90 psf (4.24 kPa) Load pattern to produce maximum load effects. No dynamic load allowance with this loading.

Other Live Loads

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – Cl. 3.8.10	AASHTO Pedestrian Bridges – Cl. 3.3
Maintenance access loads Ultimate limit states of 359 lb (1.6 kN) over a rectangular surface of 3.28 ft x 1.64 ft (1 m x 0.5 m)	Equestrian loads (if applicable) 1,000 lb (4.46kN) over square area 4 in x 4 in (0.1 m x 0.1 m) 1 kN = 225 lb

[1] Canada : Canadian Highway Bridge Design Code
The CAN/CSA S6-19 code also includes the Design of Pedestrian Bridges.

[2] USA : LRFD Guide Specification for the Design of Pedestrian Bridges
The AASHTO Pedestrian Code – 2009 also refers to:
- LRFD Bridge Design Specifications: The Pedestrian Bridge Guide refers to the 4th edition of the AASHTO LRFD Bridge Design Specification (2009), but the most recent version is actually the 9th edition (2020). We refer to the most recent version in this document.
- Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

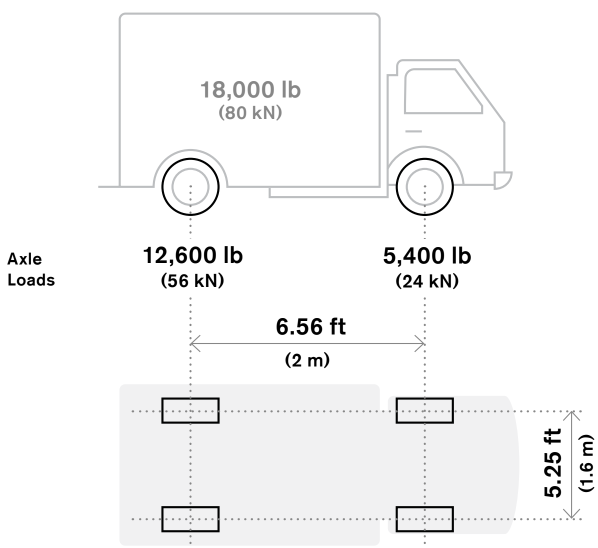
Maintenance Vehicule Load

CAN/CSA S6-06	AASHTO Pedestrian Bridges – 2009
CSA S6 – Art. 3.8.11	AASHTO Pedestrian bridges – Art. 3.2

CAN/CSA S6-06

When vehicular access is not physically prevented or specified by the client.

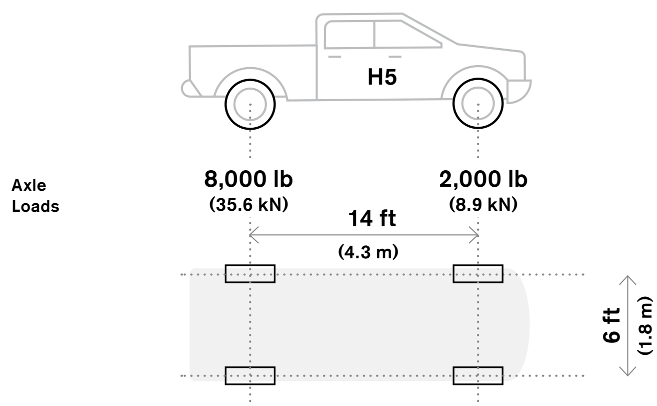
Clear deck width greater than 10 ft (3 m):
18,000 lb (80 kN) truck load



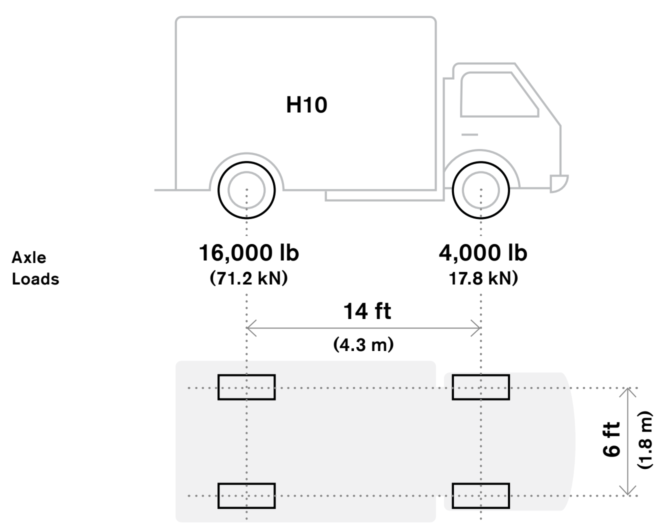
AASHTO Pedestrian Bridges – 2009

When vehicular access is not physically prevented or specifed by client.

1– Clear deck width from 7 to 10 ft (2.1 to 3 m):
10,000 lb (44.5 kN) truck load – H-5 Truck



2– Clear deck width over 10 ft (3 m):
20,000 lb (89.2 kN) truck load – H-10 Truck



Vehicle impact allowance is not required

Horizontal Wind Load

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – Cl. 3.10	AASHTO Pedestrian Bridges – Cl. 3.4 AASHTO Signs – Cl. 3.8, 3.9
The wind pressure q [Pa] is for a return period of 50 years for bridge structures with a span shorter than 125 m. Horizontal wind load per unit exposed frontal area of the structure: $Fh = q \cdot Cg \cdot Ce \cdot Ch$ [Pa] In the case of truss spans, this load shall be taken to act on the windward truss and an identical force shall be simultaneously applied to the leeward truss unless a recognized method is used to calculate the shielding effect of the windward truss.	Pedestrian bridges shall be designed for wind loads as specified in AASHTO Signs, Articles 3.8 and 3.9. Wind pressure calculated according to speed: - with a return period of 50 years, for the “STRENGTH III” limit state - 70 mph (31.3 m/s) for the limit state “SERVICE I”

Vertical Wind Load Overturning

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – Cl. 3.10	AASHTO Pedestrian Bridges – Cl. 3.4 AASHTO Signs – Cl. 3.8, 3.9 AASHTO Bridge Design Specification – Cl. 3.8.2
Vertical wind load per unit exposed plan area of the structure: $Fv = q \cdot Cg \cdot Ce \cdot Cv$ [Pa] The vertical load shall be taken to act either upwards or downwards. In addition to the application of Fv as a uniformly distributed load over the whole plan area, the effect of possible eccentricity in the application of the load shall be considered. For this purpose, the same total load shall be applied as an equivalent vertical line load at the windward quarter point of the transverse superstructure width.	A vertical upward wind force of 20 psf times the width of the deck shall be considered as a longitudinal line load. This lineal force shall be applied at the windward quarter-point of the deck width in conjunction with the horizontal wind loads.

Load Factors And Combinations

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – Cl. 3.5	LRFD 2020 – Cl. 3.4.1
Load combination ultimate limit states ULS 1: 1.10·D + 1.70·L ULS 3: 1.10·D + 1.40·L + 0.45·W ULS 4: 1.10·D + 1.4·W ULS 4: 0.95·D + 1.4·W (Overturning) ULS 7: 1.10·D + 0.75·W + 1.3·A ULS 9: 1.35·D **Serviceability limit states** SLS Combination 1: 1.00·D + 0.90·L (Deflection) L = live load (dynamic load allowance, when applicable) D = dead load W = wind load on structure A = ice accretion load	**Load combination limit state** STRENGTH I: 1.25 (DC) + 1.75 (PL) + 0 (WS) STRENGTH III: 1.25 (DC) + 0 (PL) + 1.0 (WS) SERVICE I: 1.00 (DC) + 1.00 (PL) + 1.0 (WS) DC = dead load of structural components PL = pedestrian live load WS* = wind load on structure * The WS load varies depending on the limit state. Refer to the section on wind loads, page 5.

Pedestrian And Bicycle Railings

CAN/CSA S6-19

CSA S6 – Cl. 12.4.4, 3.8.8.2

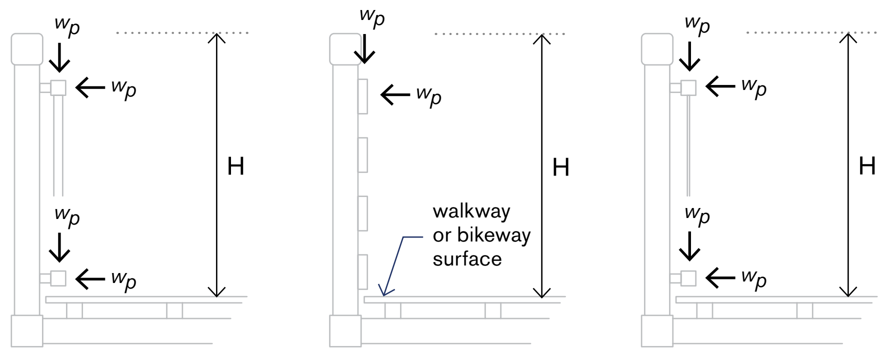
The load on railings

wp = 82 lb/ft (1.20 kN/m) applied laterally and vertically simultaneously.

Only one railing shall be loaded at a time when posts of post-and-railing barriers are being designed.

Each member must also resist at a point load of 112 lb (0.5 kN).

wp = 185 lb/ft (2.7 kN/m) on bridges likely to be used as assembly places.



Vertical bar **Horizontal railings** **Chain link mesh**

Minimum height (H)

Pedestrians: 42 in (1.05 m)
Bikes: 54 in (1.37 m) – can be reduced to 47 in (1.2 m) with owner approval

Openings in barriers

Pedestrians and bikes

Openings in pedestrian barriers shall not exceed 4 in (100 mm) in the least direction or shall be covered with chain link mesh. Openings in chain link mesh shall not be larger than 2 x 2 in (50 x 50 mm). The wires making up the mesh shall have a minimum diameter of 9/64 in (3.5 mm).

Bikes

The maximum space of 4 in (100 mm) applies to the first 42 in (1,050 mm).

Pedestrian And Bicycle Railings

AASHTO Pedestrian Bridges – 2009

AASHTO Bridge Design Specification – Cl. 13.8, 13.9

The load on railings

w = 50 lb/ft (0.73 kN/m) applied laterally and vertically simultaneously.

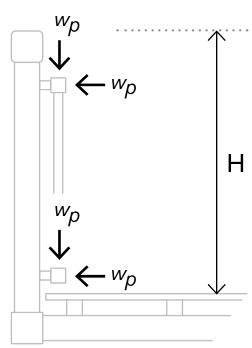
In addition, each longitudinal element will be designed for a concentrated load of 200 lb (0.89 kN), which shall act simultaneously with the above loads at any point and in any direction at the top of the longitudinal element.

The posts of pedestrian railings shall be designed for a concentrated design live load applied transversely at the center of gravity of the upper longitudinal element or, for railings with a total height greater than 54 in (1,370 mm), at a point 54 in (1,370 mm) above the top surface of the decking.

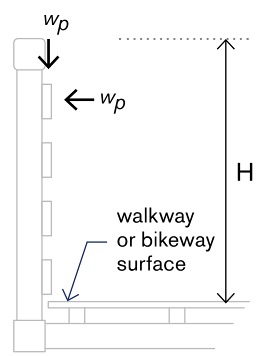
The value of the concentrated design live load for posts, PLL, in N, shall be taken as:

$P_{LL} =$ 200 + 50 L (lb, L in feet)

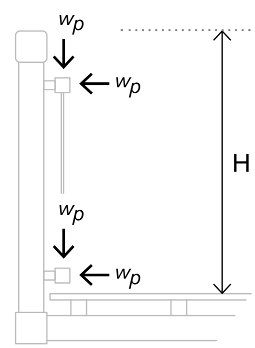
$P_{LL} =$ 0.89 + 0.73 L (kN, L in meters)



Vertical bar



Horizontal railings



Chain link mesh

The minimum height (H)

Pedestrians : 42 in (1070 mm)
Bikes : 42 in (1070 mm)

Openings in barriers

Pedestrians and bikes

A pedestrian rail may be composed of horizontaland/or vertical elements. The clear opening between elements shall be such that a 6 in (150 mm) diameter sphere shall not pass through.

When both horizontal and vertical elements are used, the 6 in (150 mm) clear opening shall apply to the lower 27 in (685 mm) of the railing, and the spacing in the upper portion shall be such that a 8 in (200 mm) diameter sphere shall not pass through.

A safety toe rail or curb should be provided. Rails should project beyond the face of posts and/or pickets.

Fatigue Load

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – N/A	AASHTO Pedestrian Bridges – Cl. 3.5
Not applicable unless specified by the Engineer	The fatigue loading used for fatigue and fracture limit state (Fatigue 1) shall be as specified in Section 11 of AASHTO Signs. The Natural Wind Gust specified in Article 11.7.3 and the Truck-Induced Gust specified in Article 11.7.4 of that section need only be considered, as appropriate.

Maximum Deflection

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – Cl. 3.4.4	AASHTO Pedestrian Bridges – Cl. 5
Cl. 3.4.4 et Figure 3.1 Deflection limits for highway bridge superstructure vibration.	Deflections should be investigated at the service limit state using load combination “SERVICE I”. For spans other than cantilever arms, the deflection of the bridge due to the unfactored pedestrian live loading shall not exceed 1/360 of the span length. Deflection in cantilever arms due to pedestrian live loading shall not exceed 1/220 of the cantilever length. Horizontal deflections under unfactored wind loading shall not exceed 1/360 of the span length.

Vibrations

CAN/CSA S6-19	AASHTO Pedestrian Bridges – 2009
CSA S6 – Cl. 3.4.4	AASHTO Pedestrian Bridges – Cl. 6
Cl. 3.4.4 et Figure 3.1 Deflection limits for highway bridge superstructure vibration.	Deflections should be investigated at the service limit state using load combination “SERVICE I”. The fundamental frequency in a vertical mode of the pedestrian bridge without live load shall be greater than 3.0 hertz (Hz) to avoid the first harmonic. In the lateral direction, the fundamental frequency of the pedestrian bridge shall be greater than 1.3 Hz. If the fundamental frequency cannot satisfy these limitations or if the second harmonic is a concern, an evaluation of the dynamic performance shall be made. Other considerations must be taken into account in Cl. 6. Alternatively, the minimum natural frequency can be calculated using the following equation: $f \geq 2.86 \ln(180/w)$ w = structure self-weight in kips (0.225 kips = 1 kN)

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