

Bridge Formula Weights

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Note

The Federal Highway Administration (FHWA) revises its guidance pamphlet Federal Bridge Formula Weights (May 2015). Previous editions of this guidance pamphlet are superseded and no longer valid. This guidance paraphrases provisions of 23 U.S.C. § 127 and 23 C.F.R. § 658 for purposes of illustration only. In the event of a dispute, the statute and regulation take precedence with respect to maximum allowable Federal Bridge Formula weights.

Bridge Formula Weights

With a few exceptions noted in this pamphlet, the Bridge Formula establishes the maximum weight any set of axles on a motor vehicle may carry on the Interstate highway system. This pamphlet describes the Bridge Formula, why it was established, and how it is used.

What Is It?

Congress enacted the Bridge Formula in 1975 to limit the weight-to-length ratio of a vehicle crossing a bridge. This is accomplished either by spreading weight over additional axles or by increasing the distance between axles.

Compliance with Bridge Formula weight limits is determined by using the following formula:

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$

W = the overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds.

L = the distance in feet between the outer axles of any group of two or more consecutive axles.

N = the number of axles in the group under consideration.

In addition to Bridge Formula weight limits, Federal law states that single axles are limited to 20,000 pounds, and axles spaced more than 40 inches and not more than 96 inches apart (tandem axles) are limited to 34,000 pounds (23 U.S.C. 127).

Is the Formula Necessary?

Bridges on the Interstate System highways are designed to support a wide variety of vehicles and their expected loads. As trucks grew heavier in the 1950s and 1960, something had to be done to protect bridges. The solution was to link allowable weights to the number and spacing of axles.

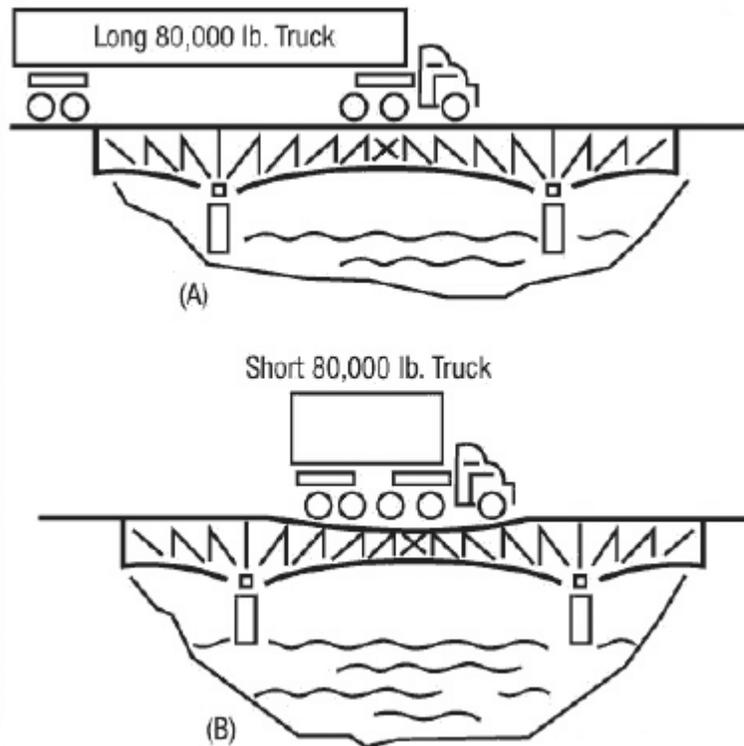


Figure 1

Axle spacing is as important as axle weight in designing bridges. In Figure 1A, the stress on bridge members as a longer truck rolls across is much less than that caused by a short vehicle as shown in Figure 1B, even though both trucks have the same total weight and individual axle weights. The weight of the longer vehicle is spread out, while the shorter vehicle is concentrated on a smaller area.

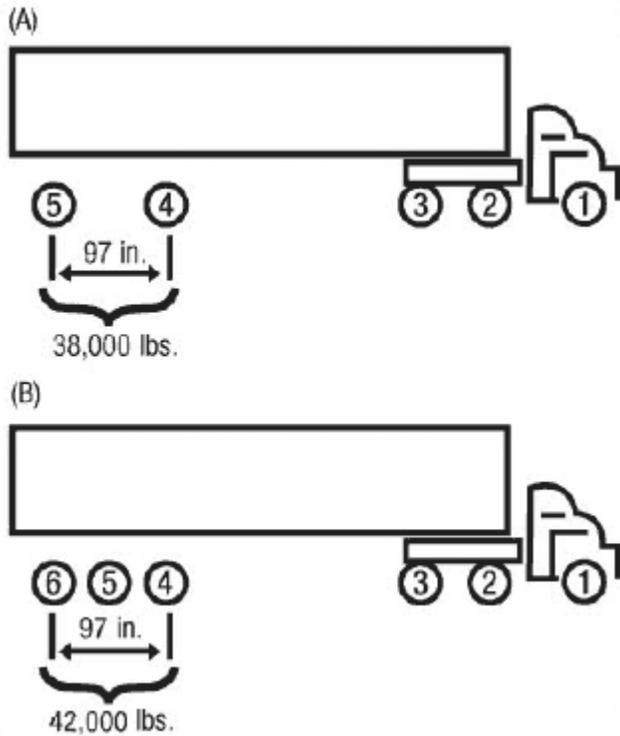
How Is the Formula Used?

The weight on various axle configurations must be checked to determine compliance with the Bridge Formula. Three definitions are needed to use the Bridge Formula correctly.

- **Gross Weight**—The weight of a vehicle or vehicle combination and any load thereon. The Federal gross weight limit on the Interstate System is 80,000 pounds unless the Bridge Formula dictates a lower weight limit.
- **Single-Axle Weight**—The total weight on one or more axles whose centers are spaced not more than 40 inches apart. The Federal single-axle weight limit on the Interstate System is 20,000 pounds.
- **Tandem-Axle Weight**—The total weight on two or more consecutive axles whose centers are spaced more than 40 inches apart but not more than 96 inches apart. The Federal tandem-axle weight limit on the Interstate System is 34,000 pounds.

Interstate System weight limits in some States may be higher than the figures noted above due to "grandfather" rights. When the Interstate System axle and gross weight limits were adopted in 1956, and amended in 1975, States were allowed to keep or "grandfather" weight limits that were higher.

Bridge Formula calculations yield a series of weights (Bridge Table, pages 5-6). It is important to note that the single-axle weight limit replaces the Bridge Formula weight limit on axles not more than 40 inches apart, and the tandem-axle weight limit replaces the Bridge Formula weight limit for axles over 40 but not more than 96 inches apart. At 97 inches apart, for example, two axles may carry 38,000 pounds (Figure 2A) and three axles may carry 42,000 pounds, as shown in Figure 2B.

**Figure 2**

Federal law states that any two or more consecutive axles may not exceed the weight computed by the Bridge Formula even though single axles, tandem axles, and gross weight are within legal limits. As a result, the axle group that includes the entire truck—sometimes called the "outer bridge" group—must comply with the Bridge Formula. However, interior combinations of axles, such as the "tractor bridge" (axles 1, 2, and 3) and "trailer bridge" (axles 2, 3, 4, and 5), must also comply with weights computed by the Bridge Formula (Figure 3).

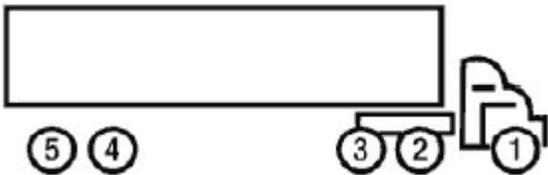
**Figure 3**

Figure 3 shows the most common vehicle checked for compliance with weight limit requirements. Although the Bridge Formula applies to each combination of two or more axles, experience shows that axle combinations 1 through 3, 1 through 5, and 2 through 5 are critical and must be checked. If these combinations are found to be satisfactory, then all of the others on this type of vehicle normally will be satisfactory.

The vehicle with weights and axle dimensions shown in Figure 4 is used to illustrate a Bridge Formula check.

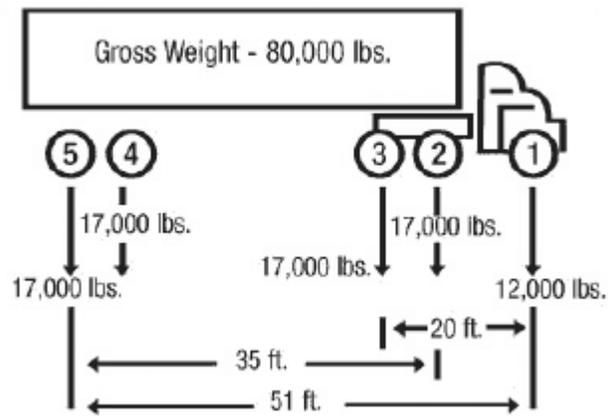


Figure 4

Permissible Gross Loads for Vehicles in Regular Operation¹

		Based on weight formula				$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$				
Distance in feet (L) between the extremes of any group of 2 or more consecutive axles		Maximum load in pounds carried on any group of 2 or more consecutive axles ²								
	L	N=	2 AXLES	3 AXLES	4 AXLES	5 AXLES	6 AXLES	7 AXLES	8 AXLES	9 AXLES
Tandem Axle Weight (see pages 3 & 4)	4		34,000							
	5		34,000							
	6		34,000							
	7		34,000							
	8		34,000	34,000						
	More than 8/less than 9		38,000	42,000						
	9		39,000	42,500						
	10		40,000	43,500						
	11			44,000						
	12			45,000	50,000					
13			45,500	50,500						
14			46,500	51,500						
15			47,000	52,000						
16			48,000*	52,500	58,000					
17			48,500	53,500	58,500					
18			49,500	54,000	59,000					
19	Example		50,000	54,500	60,000					
20	(see page 7)		51,000	55,500	60,500	68,000				
21			51,500	56,000	61,000	68,500				
22			52,500	56,500	61,500	67,000				
23			53,000	57,500	62,500	68,000				
24			54,000	58,000	63,000	68,500	74,000			
25			54,500	58,500	63,500	69,000	74,500			
26			55,500	59,500	64,000	69,500	75,000			
27			56,000	60,000	65,000	70,000	75,500			
28			57,000	60,500	65,500	71,000	76,500	82,000		
29			57,500	61,500	66,000	71,500	77,000	82,500		
30			58,500	62,000	66,500	72,000	77,500	83,000		
31			59,000	62,500	67,500	72,500	78,000	83,500		
32			60,000	63,500	68,000	73,000	78,500	84,500	90,000	
33				64,000	68,500	74,000	79,000	85,000	90,500	
34				64,500	69,000	74,500	80,000	85,500	91,000	
35				65,500	70,000	75,000	80,500	86,000	91,500	
36				66,500	71,000	75,500	81,000	86,500	92,000	
37				67,500	71,500	76,000	81,500	87,000	93,000	
38				68,000	72,000	77,000	82,000	87,500	93,500	
39				68,500	73,000	77,500	82,500	88,500	94,000	
40				69,500	73,500	78,000	83,500	89,000	94,500	
41				70,000	74,000	78,500	84,000	89,500	95,000	
42				70,500	75,000	79,000	84,500	90,000	95,500	
43				71,500	75,500	80,000	85,000	90,500	96,000	
44				72,000	76,000	81,000	86,000	91,500	96,500	
45				72,500	76,500	81,500	87,000	92,500	98,000	
46				73,500	77,500	82,000	87,500	93,000	98,500	
47				74,000	78,000	83,000	88,000	93,500	99,000	
48				74,500	78,500	83,500	88,500	94,000	99,500	
49				75,500	79,000	84,000	89,000	94,500	100,000	
50				76,000	80,000	84,500	89,500	95,000	100,500	
51				76,500	80,500	85,000	90,500	95,500	101,000	
52				77,500	81,000	86,000	91,000	96,500	101,500	
53				78,000	81,500	86,500	91,500	97,000	102,000	
54				78,500	82,500	87,000	92,000	97,500	102,500	
55				79,500	83,000	87,500	92,500	98,000	103,000	
56				80,000	83,500	88,000	93,000	98,500	104,000	
57				84,000	84,000	89,000	94,000	99,000	104,500	
58				85,000	85,000	89,500	94,500	99,500	105,000	
59				85,500	85,500	90,000	95,000	100,500	105,500	
60										

The values in this table reflect FHWA's policy of rounding down when calculated weights fall exactly halfway between 500-pound increments. Because the Bridge Formula is designed to protect highway infrastructure, FHWA determined that this conservative policy is consistent with the statutory mandate.

Ft. 2 The Federal Highway Administration (FHWA) revises its guidance pamphlet *Bridge Formula Weights* (August 2006). Specifically, footnote 2 on page 6 of the guidance is superseded and replaced with the following: "Pursuant to 23 CFR 650.3 13, all bridges must be inspected, rated to safe load-carrying capacity, and if required, posted or restricted with respect to the maximum allowable weight."

Permissible Gross Loads for Vehicles in Regular Operation¹

Before checking for compliance with the Bridge Formula, a vehicle's single-axle, tandem-axle, and gross weight should be checked. Here the single axle (number 1) does not exceed 20,000 pounds, tandems 2-3 and 4-5 do not exceed 34,000 pounds each, and the gross weight does not exceed 80,000 pounds. Thus, these preliminary requirements are satisfied. The first Bridge Formula combination is checked as follows:

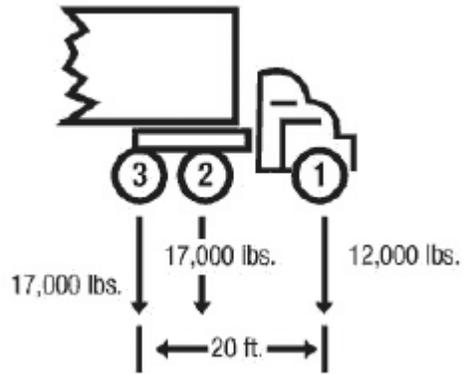


Figure 5

Check axles 1 through 3 (Figure 5)

Actual weight = 12,000 + 17,000 + 17,000 = 46,000 pounds.

N = 3 axles

L = 20 feet

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$

$$W = 500 \left[\frac{(20 \times 3)}{(3 - 1)} + (12 \times 3) + 36 \right] = 51,000 \text{ lbs.}$$

Maximum weight (W) = 51,000 pounds, which is more than the actual weight of 46,000 pounds. Thus, the Bridge Formula requirement is satisfied.

Example From the Bridge Table (pages 5 & 6)

This same number (51,000 pounds) could have been obtained from the Bridge Table by reading down the left side to L = 20 and across to the right where N = 3.

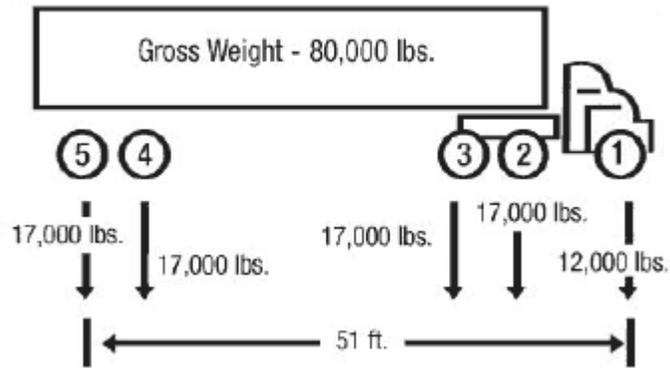


Figure 6

Now check axles 1 through 5 (Figure 6)

Actual weight = 12,000 + 17,000 + 17,000 + 17,000 + 17,000 = 80,000 pounds.

Maximum weight (W) = 80,000 pounds (Bridge Table for "L" of 51 feet and "N" of 5 axles).

Therefore, this axle spacing is satisfactory.

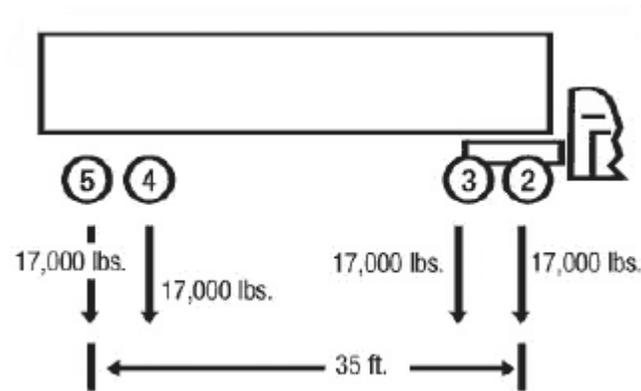


Figure 7

Now check axles 2 through 5 (Figure 7)

Actual weight = 17,000 + 17,000 + 17,000 + 17,000 = 68,000 pounds.

Maximum weight (W) = 65,500 pounds (Bridge Table for "L" of 35 feet and "N" of 4 axles).

This is a violation because the actual weight exceeds the weight allowed by the Bridge Formula. To correct the situation, some load must be removed from the vehicle or the axle spacing (35 feet) must be increased.

Exception to Formula and Bridge Table

In addition to the grandfather rights notes on page 3, Federal law (23 U.S.C. 127) includes one other exception to the Bridge Formula and the Bridge Table—two consecutive sets of tandem axles may carry 34,000 pounds each if the overall distance between the first and last axles of these tandems is 36 feet or more. For example, a five-axle tractor-semitrailer combination may carry 34,000 pounds both on the tractor tandem (axles 2 and 3) and the trailer tandem (axles 4 and 5), provided axles 2 and 5 are spaced at least 36 feet apart. Without this exception, the Bridge Formula would allow an actual weight of only 66,000 to 67,500 pounds on tandems spaced 36 to 38 feet apart.

Bridge Formula Application to Single-Unit Trucks

The procedure described above could be used to check any axle combinations, but several closely spaced axles usually produce the most critical situation.

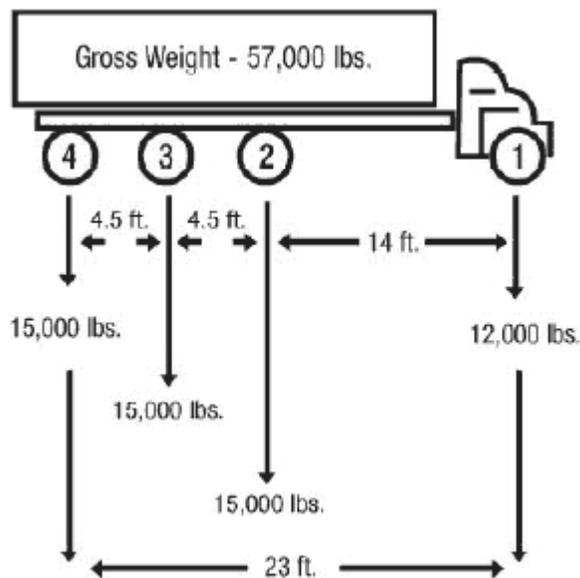


Figure 8

The truck shown in Figure 8 satisfies the single-axle weight limit (12,000 pounds are less than 20,000 pounds), the tandem-axle limit (30,000 pounds are less than 34,000 pounds) and the gross-weight limit (57,000 pounds are less than 80,000 pounds). With these restrictions satisfied, a check is done for Bridge Formula requirements, axles 1 through 4.

Actual weight = 12,000 + 15,000 + 15,000 + 15,000 = 57,000 pounds.

Maximum weight (W) = 57,500 pounds (Bridge Table for "L" of 23 feet and "N" of 4 axles).

Since axles 1 through 4 are satisfactory, check axles 2 through 4:

Actual weight = 15,000 + 15,000 + 15,000 = 45,000 pounds.

Maximum weight (W) = 42,500 pounds (Bridge Table for "L" of 9 feet and "N" of 3 axles).

This is a violation because the actual weight exceeds the weight allowed by the Bridge Formula. The load must either be reduced, axles added, or spacing increased to comply with the Bridge Formula.

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