

APPENDIX D

Bridge Classification Card*

GTA 5-7-7

MAY 1969

(THIS GTA, TOGETHER WITH GTA 5-7-6, OCT. 1968, SUPERSEDES GTA 5-7-5, JULY 1965)

BRIDGE CLASSIFICATION CARD

Bridges and vehicles are classified to prevent bridge failures due to overloading. If a vehicle class number is less than or equal to the bridge class number, the vehicle may cross without restrictions. Standard vehicles are assigned class numbers in FM 5-36. Refer to TM 5-312, *Military Fixed Bridges*, for a complete discussion of bridge classification procedures. The purpose of this card is to provide an expedient method of estimating the capacity of bridges in the field.

NOTATIONS

A—Area (in²)
 b—width of stringer (in)
 d—total depth of stringer (in)
 kip—1000 lbs
 L—span length (ft)
 L_e—effective span length (ft)
 L_m—maximum span length (ft)
 M_{D.L.}—dead load bending moment for entire span (kip-ft)
 M_{L.L.}—live load bending moment per lane (kip-ft)
 m—total bending moment per stringer (kip-ft)
 m_{D.L.}—dead load bending moment per stringer (kip-ft)
 m_{L.L.}—live load bending moment per stringer (kip-ft)

N_s—number of stringers
 N_{1,2}—effective number of stringers
 S₁—maximum spacing of bracing (ft)
 S_c—center-to-center spacing for given stringer (ft)
 V_{D.L.}—dead load shear for entire span (kips)
 V_{L.L.}—live load shear per lane (kips)
 v—total live load shear per stringer (kips)
 v_{L.L.}—live load shear per stringer (kips)
 v_{D.L.}—dead load shear per stringer (kips)
 W_R—width of roadway from inside curb to inside curb (ft)
 W_s—width of concrete slab (ft)

A. BRIDGE SIGNS

Class number signs are required on all classified vehicles and bridges in the theater of operations. Bridge signs are circular with a yellow background and black inscriptions. Signs are a minimum of 16 inches in diameter for one-lane bridges and a minimum of 20 inches in diameter for two-lane bridges. A two-lane bridge has two numbers on the bridge sign. The number on the left is the class of the bridge if two-lanes are used simultaneously. The number on the right (fig. 1) indicates the class if the bridge is used for one-way traffic and the vehicles proceed along the centerline of the bridge. For a bridge with separate classifications for wheeled and tracked vehicles (dual classification), a special circular sign which indicates both classifications is used (fig. 2). Dual classification may be used for bridges greater than class 30. A separate rectangular sign is used if necessary to show bridge width limitations.

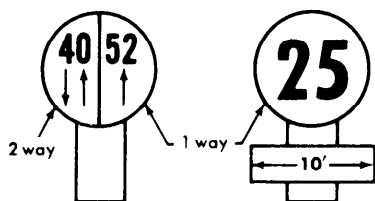


FIGURE 1

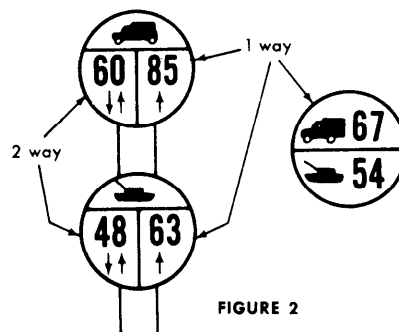


FIGURE 2

B. WIDTH AND HEIGHT REQUIREMENTS

Width and height requirements for bridges are listed in Table I. If a one-lane bridge does not meet the width requirement listed, post a rectangular warning sign under the class sign showing the actual clear width. For a two-lane bridge, downgrade the two way classification to the highest class for which it does qualify. The one-way class is not affected. If a bridge does not meet the minimum overhead clearance requirement, a telltale is used (fig. 3).

Bridge Class	WIDTH REQUIREMENTS				MINIMUM OVERHEAD CLEARANCE		
	4-12	13-30	31-60	61-100	CLASS	4-70	71-Over
One-Lane	9'-0"	11'-0"	13'-2"	14'-9"	HEIGHT	14'-0"	15'-6"
Two-Lane	18'-0"	18'-0"	24'-0"	27'-0"			

C. HIGHWAY BRIDGE CLASSIFICATION, TIMBER STRINGERS

Classify the weakest span to obtain the bridge classification. If the weakest span is unknown use the following procedure for each span.

①

*A sample GTA 5-7-7, Bridge Classification Card, has been reproduced here, in its entirety, for your convenience.

1. Measure width and depth of stringers (measure diameter of stringer if circular), span length, and width of roadway. Count total number of stringers in the span. If overhead obstruction exists determine the amount of overhead clearance to the roadway.
 2. Obtain total bending moment per stringer (m) from table II. Use the formula in figure 4 to obtain (m) for a concrete T-beam.
 3. Read dead load per foot of bridge (w_{DL}) from figure 5, then divide by the total number of stringers to obtain w_{DL} .
 4. Knowing w_{DL} and the span length determine the moment per stringer (m_{DL}) due to the dead load, from figure 7.
 5. Calculate the total moment per stringer (m_{LL}) due to live load: $m_{LL} = m - m_{DL}$.
- NOTE: Check maximum span length (L_m) of stringer. If L_m obtained from table II is greater than span length (L) proceed to step 6. If the maximum span length (L_m) of the stringer is less than span length (L) reduce m_{LL} by the ratio L_m/L and proceed to step 6.
6. Compute stringer spacing (S_s).

$$S_s = \frac{W_R}{N_s - 1}$$

Read the effective number of stringers (N_1) for one-way traffic from figure 6. Compute effective number of stringers for two-way traffic (N_2).

$$N_2 = \frac{3}{8} N_s$$

where N_s equals the total number of stringers in the span. Compare N_1 and N_2 . If N_2 is greater than N_1 , the one- and two-way class will be the same and the value of N_1 is used to determine the class. If N_2 is less than N_1 , N_2 will be used to determine the two-way class and N_1 will be used to determine the one-way class.

7. Determine the live load moment per lane (M_{LL}) by entering figure 8 with the value of m_{LL} obtained from step 5 and either N_1 or N_2 as obtained in step 6.
8. Determine the classification of the bridge based on bending moment by entering figure 10 (moment graph) with M_{LL} as obtained from step 7 and the span length as measured.
9. Obtain total shear per stringer (v) from table II. (See figure 4 for concrete T-beam section.)
10. Knowing w_{DL} from step 3 and the span length, determine dead load shear per stringer (v_{DL}) from figure 7.
11. Knowing the total shear per stringer (v) from step 9 and the dead load shear per stringer (v_{DL}) from step 10, calculate the live load shear per stringer (v_{LL}) from: $v_{LL} = v - v_{DL}$.
12. Determine the live load shear per lane (V_{LL}) by entering figure 9 with v_{LL} and either N_1 or N_2 as determined in step 6.
13. Determine the bridge classification based on shear by entering the shear graph (fig. 11) with the value for V_{LL} obtained in step 12 and the measured span length.
14. Compare the classifications obtained in step 8 for bending moment and in step 13 for shear. The lower of the two classifications obtained will govern.
15. Check the width and clearance restrictions (table I) and downgrade the two-way class or post a width restriction sign for one-way class.
16. Check chart (fig. 12) based on deck thickness and stringer spacing. Downgrade the classification if the deck thickness controls.
17. Check lateral bracing. Lateral braces are required as indicated in table II. If necessary add bracing as required before posting bridge classification.

EXAMPLE 1

Given: Two lane timber stringer bridge having no overhead obstructions. Span 20 feet; 10 stringers, each 10" x 18" actual dimensions; roadway width (W_R) 24 feet; timber decking 5 inches thick; no lateral braces.

1. Make field measurements to determine above information.
2. $m = 108.0$ kip-ft.

$$3. w_{DL} = \frac{1.12 \text{ kips}}{10} = 0.112 \text{ kips per foot of span.}$$

$$4. m_{DL} = 6.0 \text{ kip-ft.}$$

$$5. m_{LL} = 108.0 - 6.0 = 102 \text{ kip-ft.}$$

$$L_v \text{ for } 10 \times 18 = 21.5 \text{ ft.} > 20 \text{ ft.} \therefore \text{OK.}$$

$$6. \text{Stringer spacing } (S_s) = \frac{W_R}{N_s - 1} = \frac{24}{10 - 1} = 2.67 \text{ ft.}$$

$$N_1 = 2.9; N_2 = \frac{3}{8}(10) = 3.75$$

N_2 is greater than N_1 , therefore one- and two-way class will be the same. Use N_1 to determine both one- and two-way class.

$$7. M_{LL} = 290 \text{ kip-ft.}$$

8. Class based on moment from figure 10 is:

Wheel - 60

Track - 40

$$9. v = 18 \text{ kips (from table II).}$$

$$10. v_{DL} = 1.1 \text{ kips (from fig. 7).}$$

$$11. v_{LL} = 18.0 - 1.1 = 16.9 \text{ kips.}$$

$$12. V_{LL} = 63 \text{ kips from fig. 9.}$$

(2)

13. Class based on shear from fig. 11 is:
Wheel - 60
Track - 48
14. Comparing classifications obtained from moment and shear (steps 8 and 13) one- and two-way
Classification is:
Wheel - 60
Track - 40
15. There are no width or height (clearance) restrictions.
16. Deck thickness is 5 inches with stringer spacing of 32 inches yields class 40 from fig. 12, so deck thickness controls and classification is:
Wheel - 40
Track - 40
17. No lateral bracing is required.

D. HIGHWAY BRIDGE CLASSIFICATION WITH STEEL STRINGERS

Classify the weakest span to obtain bridge classification. If weakest span is unknown use the following procedure for each span.

1. Measure stringer dimensions to obtain information required by tables III and measure span length and width of roadway. Count total number of stringers in one span. If overhead obstruction is present, measure the overhead clearance.
2. Same as step C-2 for timber bridges except use table III.
3. Same as step C-3 for timber bridges.
4. Same as step C-4 for timber bridges.
5. Calculate the total live load moment per stringer ($m_{L.L.}$) knowing m from step 2 and $m_{D.L.}$ from step 4.

$$m_{L.L.} = \frac{m - m_{D.L.}}{1.15}$$

NOTE: Check L_u as in step 5 for timber stringers.

6. Same as step C-6 for timber bridges.
7. Same as step C-7 for timber bridges.
8. Same as step C-8 for timber bridges.
9. Same as step C-9 for timber bridges except use table III.
10. Same as step C-10 for timber bridges.
11. Same as step C-11 for timber bridges.
12. Determine live load shear per lane, ($V_{L.L.}$): $V_{L.L.} = \frac{2 v_{L.L.}}{1.15}$
13. Same as C-13 for timber bridges.
14. Same as C-14 for timber bridges.
15. Same as C-15 for timber bridges.
16. Same as C-16 for timber bridges.
17. Same as C-17 for timber bridges except use $N_b = \frac{L}{S_b} + 1$ to calculate number of lateral braces. S_b is the maximum bracing spacing for a given steel stringer and is found in table III.

EXAMPLE 2

Given: 10-10WF25 stringers, 5-inch timber deck span length is 20 ft., $W_R = 24$ feet. There are no overhead obstructions and no lateral braces.

1. The given data shown is usually obtained by field measurements.
2. $m = 59$ kip-ft for 10WF25 beam from table III.
3. $W_{D.L.} = 1.05$ kip-ft. from fig. 5 for 20 ft. span.

$$w_{D.L.} = \frac{W_{D.L.}}{N_s} = \frac{1.05}{10} = 0.105 \text{ kip/ft.}$$

4. $m_{D.L.} = 5.3$ kip-ft from fig. 7.

$$5. m_{L.L.} = \frac{m - m_{D.L.}}{1.15} = \frac{59 - 5.3}{1.15} = 46.7 \text{ kip-ft.}$$

$$L_u = 25 \text{ (from table III)} > 20 \therefore \text{OK}$$

$$6. S_s = \frac{W_R}{N_s - 1} = \frac{24}{10 - 1} = 2.67 \text{ ft.}$$

$$N_1 = 2.9 \text{ ft. from fig. 6.}$$

$$N_2 = \frac{3}{8} N_s = \frac{3}{8} \times 10 = 3.75$$

Since N_2 is larger than N_1 one- and two-way class will be the same. Use N_1 to obtain both one- and two-way class.

$$7. M_{L.L.} = 140 \text{ kip-ft.}$$

8. Class based on moment from fig. 10 is:

Class 18 for both wheel and track vehicles.

9. $v = 38$ kips from table III for 10WF25 beam.

$$10. v_{D.L.} = 1.1 \text{ kips.}$$

$$11. v_{L.L.} = v - v_{D.L.} = 38 - 1.1 = 36.9 \text{ kips.}$$

$$12. V_{L.L.} = \frac{2 v_{L.L.}}{1.15} = \frac{(2)(36.9)}{1.15} = 64.2 \text{ kips.}$$

③

13. Class based on shear from fig. 11 is: Wheel = 58 Track = 46
14. Class 18 obtained from bending moment (step 8) will govern.
15. No width or clearance restrictions.
16. Deck thickness of 5 inches with stringer spacing of 32 inches yields class 40 from fig. 12.
17. Class of bridge must be based on class of the weakest span. Therefore, the moment class of the steel stringer span governs and the bridge classification is: 18.
18. Number of braces, $N_b = \frac{L}{S_b} + 1 = \frac{20}{8} + 1 = 3.5$ $\therefore$ 4 braces must be added.

E. REINFORCED CONCRETE BRIDGE

Due to wide variations in design criteria, it is not possible to calculate the exact capacity of a reinforced concrete bridge based only on the measureable external dimensions. Therefore, when information is available pertaining to the design loading or civil load rating for the bridge (from a local agency or from intelligence reports), the class will be obtained by correlation if charts are available relating civilian design load to the military class for various span lengths. Such charts are available in TM 5-312 for many United States and foreign civilian design loads, or they may be developed within certain army areas. When the necessary information is not available for classification by correlation, the expedient methods shown below may be used.

SLAB BRIDGES: Measure the span length from center-to-center of supports in feet, the roadway width (W_R) in feet, the slab width (W_s) in feet, and the depth (D) of the concrete slab, (fig. 13) exclusive of any wearing surface or fill, in inches. Enter fig. 14 with the span length, drawing a vertical line until it intersects the curve representing the depth (D) of the slab, estimating when necessary where this point should be. From this intersection draw a horizontal line to read the value of $M_{1,1}$ on the left hand axis. Depending on one or two way classification, use one or both of the following formulas to determine the effective roadway width:

$$\text{One-way} \quad W_1 = \frac{3}{4} + \frac{L}{W_s} \quad \text{Two-way} \quad W_2 = \frac{1}{4} + \frac{2L}{W_s}$$

Find M for one-way or two-way traffic using W_1 or W_2 respectively:

$$M_{1,2} = W_{1,2} m_{1,1}$$

Enter fig. 10 with this value of $M_{1,2}$ and the span length to obtain the class of the bridge. Check width and height restrictions for the class bridge obtained.

EXAMPLE 3

Given: Two-lane concrete slab bridge; span length = 20'; $D = 14$ "; roadway width (W_R) = 28'; slab width (W_s) = 31'. To find Bridge Class:—Enter fig. 14 with span length on the horizontal scale and move vertically until it intersects curve for $D = 14$ " and read across to 20 kip-ft. on the vertical scale.

$$(1) \text{ One-way class: } W_1 = \frac{3}{4} + \frac{L}{W_s} = \frac{3}{4} + \frac{20}{31} = 14.3'$$

$$(2) \text{ Two-way class: } W_2 = \frac{1}{4} + \frac{2L}{W_s} = \frac{1}{4} + \frac{40}{31} = 13.0'$$

$$(3) M_1 = 20 (14.3) = 286 \text{ kip-ft. yields class 60 wheel, 40 track from moment graph (fig. 10).}$$

$$(4) M_2 = 20 (13.0) = 260 \text{ kip-ft. yields class 52 wheel, 34 track.}$$

$$(5) \text{ Bridge Class is: } \begin{array}{cc} \text{One-way} & \text{Two-way} \\ \text{a. wheel} & 60 & 52 \\ \text{b. track} & 40 & 34 \end{array}$$

T-BEAM BRIDGES: Make the necessary measurements as shown in fig. 15, and find L , the span length from center-to-center of supports. All dimensions are in inches except L and W , which are in feet. Calculate "M" by the formula:

$$M = N [(158 + D(1.07T + 0.34L + 0.027S + 0.77b - 24.1)) + 0.08L^2]$$

Enter the graph on fig. 10 with this value of "M" and the span length to obtain the class of the bridge.

EXAMPLE 4.

Given: Two-lane concrete T-Beam bridge; 32' span length; 7 T-Beams, $S = 48$ ", $D = 30$ ", $b = 12$ ", $T = 6$ "; 24' roadway.

To find Bridge Class: Roadway width limits two-way classes 4 to 60. Number of stringers per lane = 3.5

$$M = 3.5 [158 + 30(1.07(6) + 0.34(32) + 0.027(48) + 0.77(12) - 24.1)) + 0.08(32)^2]$$

$$M = 3.5 [158 + 30(6.42 + 10.88 + 1.30 + 9.24 - 24.1)) + 82]$$

$$M = 3.5 [158 + 30(3.74)] + 82 = 3.5(158 + 112.2) + 82 = 1028$$

With this value of "M" and the span length, obtain the class from the moment graph (fig. 10).

Two-way Class: Bridge is class 60 wheeled as limited by roadway width and class 50 tracked.

One-way Class:

$$\begin{aligned} \text{Effective No. of Str.} &= \frac{15}{\text{roadway width in feet}} \times \text{No. of Str.} \\ &= \frac{15}{24} \times 7 = 4.375 \end{aligned}$$

$$M = 4.375 [158 + 112.2] + 82 = 1264$$

Bridge is class 95 wheeled and class 63 tracked.

④

TABLE II
PROPERTIES OF TIMBER STRINGERS

Actual size (bxd) (in)	(a) Moment capacity m (kip-ft)	(b) Shear capacity v (kips)	(c) Maximum span Length (L _{max}) (ft)	Actual size (bxd) (in)	(a) Moment capacity m (kip-ft)	(b) Shear capacity v (kips)	(c) Maximum span Length (L _{max}) (ft)
4x8	8.53	3.2	9.5	12x20	160.0	24.0	23.8
*4x10	13.33	4.0	11.9	12x22	193.6	26.4	26.2
*4x12	19.20	4.8	14.3	12x24	230	28.8	28.6
6x8	12.80	4.8	79.5	14x14	91.5	19.6	16.7
6x10	20.0	6.0	11.9	14x16	119.5	22.4	19.1
6x12	28.8	7.2	14.3	14x18	151.2	25.2	21.5
*6x14	39.2	8.4	16.7	14x20	186.7	28.0	23.8
*6x16	51.2	9.6	19.1	14x22	226	30.8	26.2
*6x18	64.8	10.8	21.5	14x24	269	33.6	28.6
8x8	17.07	6.4	79.5	16x16	136.5	25.6	19.1
8x10	26.7	8.0	11.9	16x18	172.8	28.8	21.5
8x12	38.4	9.6	14.3	16x20	213	32.0	23.8
8x14	52.3	11.2	16.7	16x22	258	35.2	26.2
8x16	68.3	12.8	19.1	16x24	307	38.4	28.6
*8x18	86.4	14.4	21.5	18x18	194.4	32.4	21.5
*8x20	106.7	16.4	23.8	18x20	240	36.0	23.8
*8x22	129.1	17.6	26.2	18x22	290	39.6	26.2
*8x24	153.6	19.2	28.6	18x24	346	43.2	28.6
10x10	33.3	10.0	11.9	8φ	10.05	5.7	9.5
10x12	48.0	12.0	14.3	9φ	14.31	7.2	10.7
10x14	65.3	14.0	16.7	10φ	19.63	8.8	11.9
10x16	85.3	16.0	19.1	11φ	26.1	10.6	13.1
10x18	108.0	18.0	21.5	12φ	33.9	12.7	14.3
10x20	133.3	20.0	23.8	13φ	43.1	15.0	15.5
*10x22	161.3	22.0	26.2	14φ	53.9	17.4	16.7
*10x24	192.0	24.0	28.6	16φ	80.4	22.6	19.1
12x12	57.6	14.4	14.3	18φ	114.5	28.6	21.5
12x24	78.4	16.8	16.7	20φ	157.1	35.4	23.8
12x16	102.4	19.2	19.1	22φ	209	42.7	26.2
12x18	129.6	21.6	21.5	24φ	271	50.8	28.6

Key to symbols:

φ Diameter

* Lateral bracing required at mid-point and ends of span. (b) For rectangular stringer not listed, $v = \frac{bd}{10}$ (a) For rectangular stringer not listed, $m = \frac{bd^2}{30}$ For a round stringer not listed, $v = .09d^2$ For a round stringer not listed, $m = .02d^2$ (c) For stringer not listed, $L_{max} = 1.19d$

TABLE III
PROPERTIES OF STEEL STRINGERS

Nominal size	Actual depth (d) (in)	Actual width (b) (in)	Flange thickness (t _f) (in)	Web thickness (t _w) (in)	Moment capacity m (kip-ft)	Shear capacity v (kips)	Max Span Length (L _s) (ft)	Max Bracing Spacing (S _b) (ft)
51BU278	51-1/4	14	1-5/8	3/4	3067	594	133	15
*39WF211	39-1/4	11-3/4	1-7/16	3/4	1770	450	100	15
*37WF206	37-1/4	11-3/4	1-7/16	3/4	1656	425	95	15
36WF300	36-3/4	16-5/8	1-11/16	15/16	2486	520	94	25.5
36WF194	36-1/2	12-1/8	1-1/4	13/16	1492	431	93	14
36WF182	36-3/8	12-1/8	1-3/16	3/4	1397	406	93	13
36WF170	36-1/8	12	1-1/8	1-1/16	1302	381	92	12
36WF160	36	12	1	11/16	1217	365	92	11.5
36WF230	35-7/8	16-1/2	1-1/4	3/4	1879	421	91	19.5
36WF150	35-7/8	12	15/16	5/8	1131	350	91	10.5
*36WF201	35-3/8	11-3/4	1-7/16	3/4	1545	402	90	16
*33WF196	33-3/8	11-3/4	1-7/16	3/4	1433	377	85	17
33WF220	33-1/4	15-3/4	1-1/4	13/16	1661	392	85	20

(5)

TABLE III
PROPERTIES OF STEEL STRINGERS (Cont'd)

Nominal size	Actual depth (d) (in)	Actual width (b) (in)	Flange thickness (t _f) (in)	Web thickness (t _w) (in)	Moment capacity M (kip-ft)	Shear capacity V (kips)	Max Span Length (L _{max}) (ft)	Max Bracing Spacing (S _b) (ft)
33WF141	33-1/4	11-1/2	15/16	5/8	1005	313	85	11
33WF130	33-1/8	11-1/2	7/8	9/16	911	300	85	10
33WF200	33	15-3/4	1-1/8	3/4	1506	362	84	18.5
*31WF180	31-1/2	11-3/4	1-5/16	11/16	1327	327	80	16.5
30WF124	30-1/8	10-1/2	15/16	5/8	797	273	77	11
30WF116	30	10-1/2	7/8	9/16	738	263	76	10
30WF108	29-7/8	10-1/2	3/4	9/16	672	255	76	9
*30WF175	29-1/2	11-3/4	1-5/16	11/16	1156	304	75	17.5
*27WF171	27-1/2	11-3/4	1-5/16	11/16	1059	282	70	18.5
27WF102	27-1/8	10	13/16	1/2	599	217	69	10
27WF94	26-7/8	10	3/4	1/2	546	205	68	9
*26WF157	25-1/2	11-3/4	1-1/4	5/8	915	237	65	19
24WF94	24-1/4	9	7/8	1/2	497	191	62	11
24WF84	24-1/8	9	3/4	1/2	442	174	61	9.5
24WF100	24	12	3/4	1/2	560	173	61	13
24I120	24	8	1-1/8	1-3/16	564	286	61	12.5
24I106	24	7-7/8	1-1/8	5/8	527	224	61	12
24I80	24	7	7/8	1/2	391	183	61	8.5
24WF76	23-7/8	9	11/16	7/16	394	163	61	8.5
*24WF153	23-5/8	11-3/4	1-1/4	5/8	828	217	60	20.5
*24I134	23-5/8	8-1/2	1-1/4	13/16	634	283	60	15
*22I75	22	7	13/16	1/2	308	168	56	8.5
*21WF139	21-5/8	11-3/4	1-3/16	5/8	699	198	55	24.5
*21I112	21-5/8	7-7/8	1-3/16	3/4	495	238	55	14.5
21WF73	21-1/4	8-1/4	3/4	1/2	338	148	54	9.5
21WF68	21-1/8	8-1/4	11/16	7/16	315	140	54	9
21WF62	21	8-1/4	5/8	3/8	284	130	53	8
20I85	20	7-1/8	15/16	11/16	337	195	51	11
*20I65	20	6-1/2	13/16	7/16	245	132	51	9
*20WF134	19-5/8	11-3/4	1-3/16	5/8	621	177	50	23.5
18WF60	18-1/4	7-1/2	11/16	7/16	243	115	46	9.5
*18I88	18-1/4	7	1	11/16	326	184	46	13
18WF55	18-1/8	7-1/2	5/8	3/8	220	108	46	8.5
*18I80	18	8	15/16	1/2	292	133	46	14
18WF50	18	7-1/2	9/16	3/8	200	99	46	8
18I55	18	6	11/16	1/2	199	126	46	7.5
*18WF122	17-3/4	11-3/4	1-1/16	9/16	648	145	45	23.5
*18I62	17-3/4	6-7/8	3/4	3/8	238	100	45	9.5
*18I77	17-3/4	6-5/8	15/16	5/8	281	163	45	11.5
16WF112	16-3/4	11-3/4	1	9/16	450	136	42	23.5
*16I70	16-3/4	6-1/2	15/16	5/8	238	146	42	12
16WF50	16-1/4	7-1/8	5/8	3/8	181	94	41	9
16WF45	16-1/8	7	9/16	3/8	163	85	41	8
16WF64	16	8-1/2	11/16	7/16	234	106	40	12.5
16WF40	16	7	1/2	5/16	145	75	40	7.5
*16I50	16	6	11/16	7/16	155	105	40	8.5
16WF36	15-7/8	7	7/16	5/16	127	74	40	6.5
*16WF110	15-3/4	11-3/4	1	9/16	345	127	40	25
*16I62	15-3/4	6-1/8	7/8	9/16	200	129	40	11.5
*16I45	15-3/4	5-5/8	5/8	7/16	150	104	40	7.5
*15WF103	15	11-3/4	15/16	9/16	369	121	38	24.5
15I56	15	5-7/8	13/16	1/2	173	110	38	10.5
15I43	15	5-1/2	5/8	7/16	132	93	38	7.5
*14WP101	14-1/4	11-3/4	15/16	9/16	344	114	36	26
*14I40	14-1/4	5-3/8	3/8	3/8	119	83	36	8
14I51	14-1/8	5-5/8	3/4	1/2	150	104	36	10
14I70	14	8	15/16	7/16	204	87	35	18
*14I57	14	6	7/8	1/2	153	101	35	12.5
*14I40	14	5-1/2	5/8	3/8	121	78	35	8
14WF34	14	6-3/4	7/16	5/16	109	61	35	7.5
14WF30	13-7/8	6-3/4	3/8	1/4	94	58	35	6

TABLE III
PROPERTIES OF STEEL STRINGERS (Cont'd)

Nominal size	Actual depth (d) (in)	Actual width (b) (in)	Flange thickness (t _f) (in)	Web thickness (t _w) (in)	Moment capacity m (kip-ft)	Shear capacity v (kips)	Max Span Length (L _{max}) (ft)	Max Bracing Spacing (S _{max}) (ft)
*14WF92	13-3/8	11-3/4	7/8	1/2	297	96	34	25.5
*14I46	13-3/8	5-3/8	11/16	1/2	126	99	34	9
*13I35	13	5	5/8	3/8	85	72	33	8
*13I41	12-5/8	5-1/8	11/16	9/16	108	104	32	9.5
12WF36	12-1/4	6-5/8	9/16	5/16	103	56	31	9.5
*12I65	12	8	15/16	7/16	182	73	30	21
12WF27	12	6-1/2	3/8	1/4	76	44	30	7
12I50	12	5-1/2	11/16	11/16	113	120	30	10
12I32	12	5	9/16	3/8	81	62	30	7.5
*12I34	11-1/4	4-3/4	5/8	7/16	81	72	28	8.5
*11WF76	11	11	13/16	1/2	202	77	28	27
*10I29	10-5/8	4-3/4	9/16	5/16	67	48	27	8.5
10WF25	10-1/8	5-3/4	7/16	1/4	59	38	25	8
*10I40	10	6	11/16	3/8	92	53	25	14
10I35	10	5	1/2	5/8	65	88	25	8
10I25	10	4-5/8	1/2	5/16	55	46	25	7.5
10WF21	9-7/8	5-3/4	5/16	1/4	48	36	25	6.5
*10WF59	9-1/4	9-1/2	11/16	7/16	132	56	23	23
*9I25	9-1/2	4-1/2	1/2	5/16	51	43	24	8
*9I50	9	7	13/16	3/8	103	45	23	21
*8I35	8	6	5/8	5/16	65	34	20	15.5
*8I28	8	5	9/16	5/16	49	35	20	11.5
8WF31	8	8	7/16	5/16	61	33	20	14.5
*8WF44	7-7/8	7-7/8	5/8	3/8	81	40	20	21
*7WF35	7-1/8	7-1/8	9/16	3/8	58	37	18	18.5
*6WF31	6-1/4	6-1/4	9/16	3/8	45	31	16	18.5

* These nominal sizes have no U.S. equivalent.

(a) For a stringer not listed $m = d (bt_f + \frac{d^2 t_w}{6}) (2.25)$.

(b) For a stringer not listed, $v = 16.5 (d \times t_w)$.

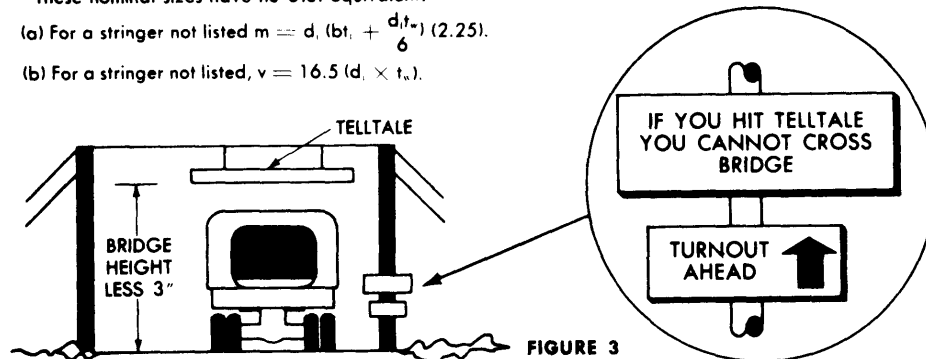


FIGURE 3

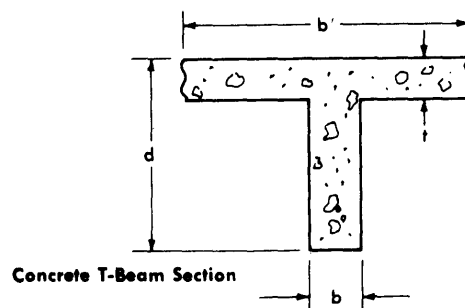


FIGURE 4

$$m = 0.585 b' t d$$

b' in inches

t in inches

d in feet

m in kip ft

NOTE: Shear is not critical in Concrete T-Beams

⑦

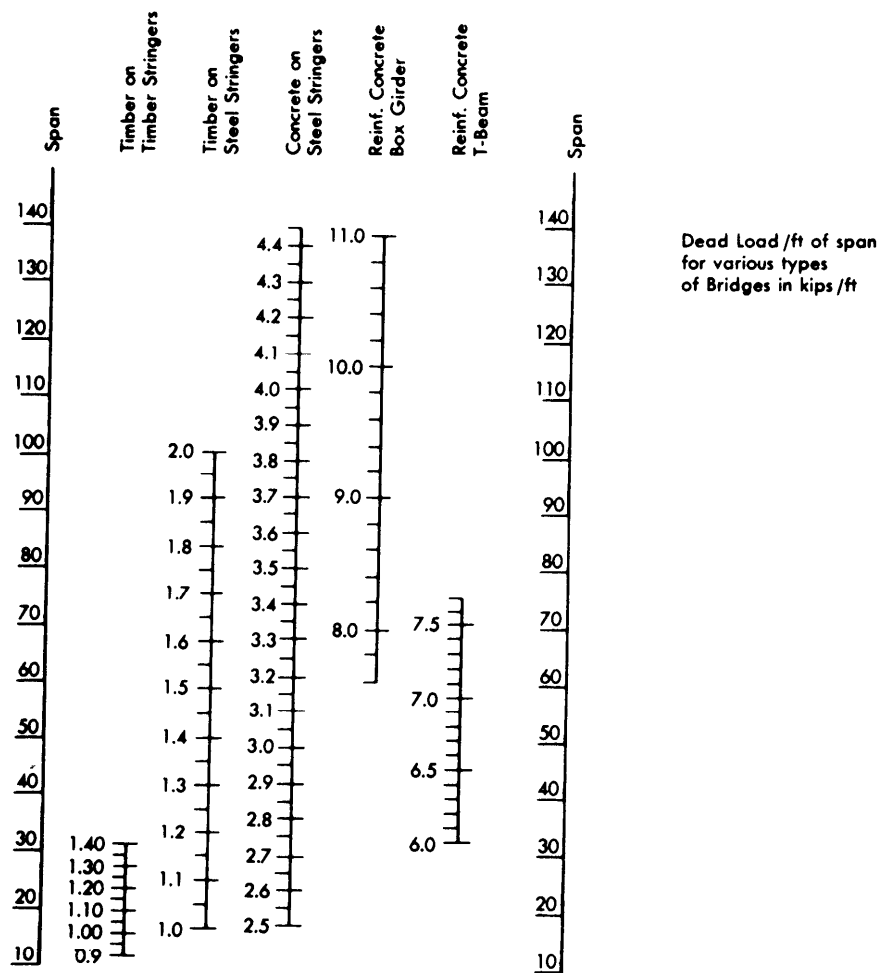
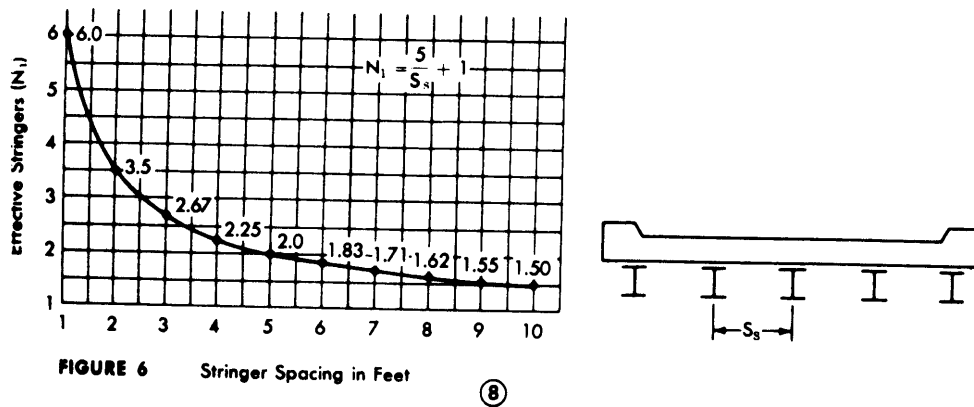


FIGURE 5 Notes: 1. Span is center to center of supports in feet.
2. All dead load weights are in kips/ft of bridge.
3. Weights are for a 24' roadway. If roadway width is different multiply by, $\frac{x}{24}$, where x is actual roadway width.



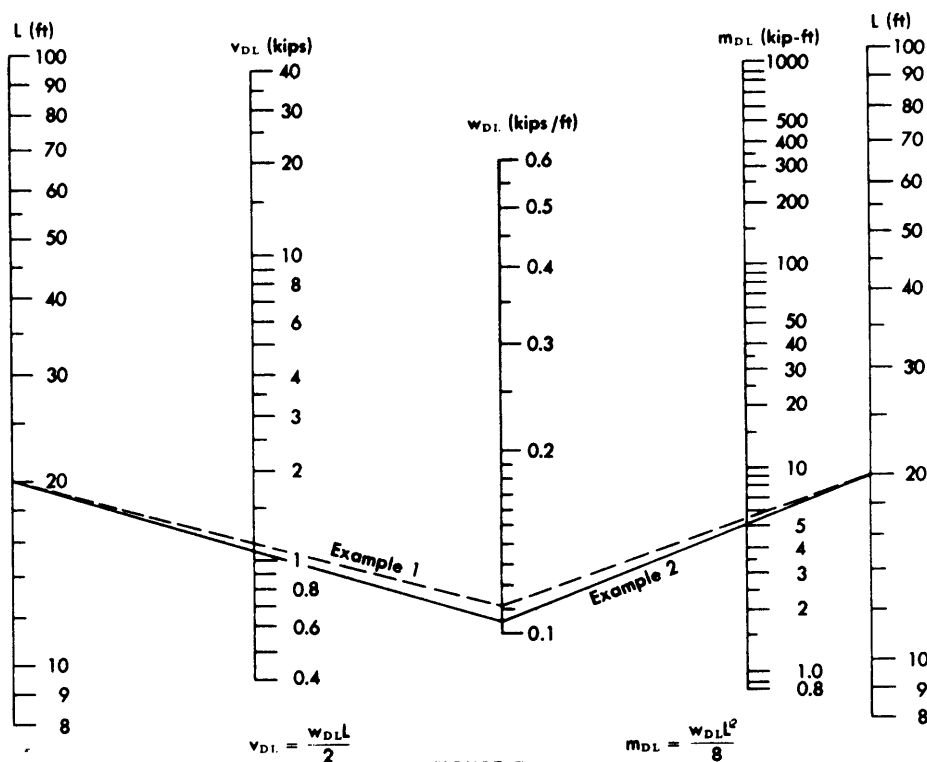


FIGURE 7

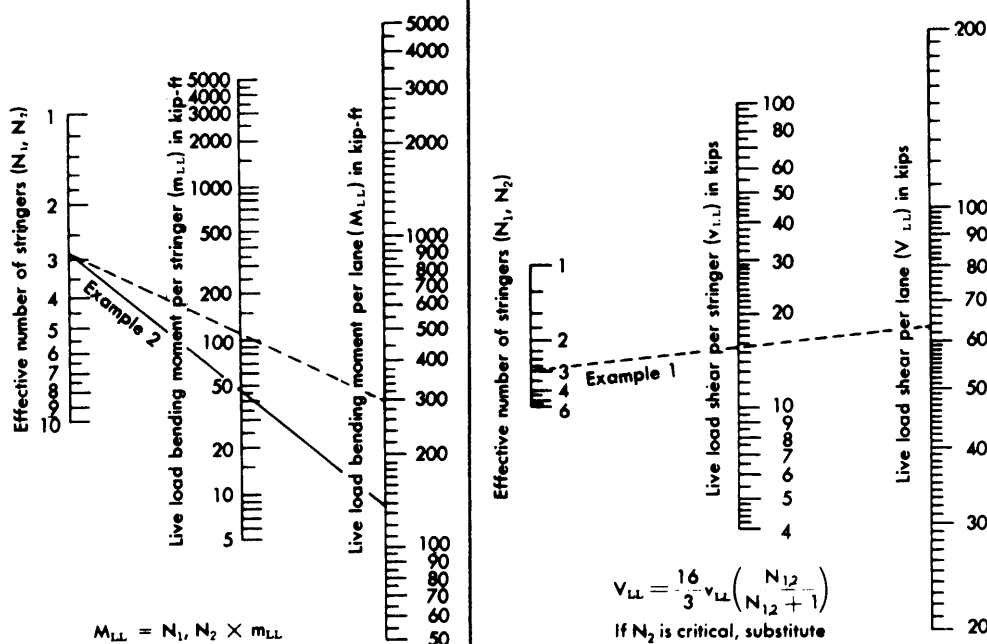


FIGURE 8

FIGURE 9

9

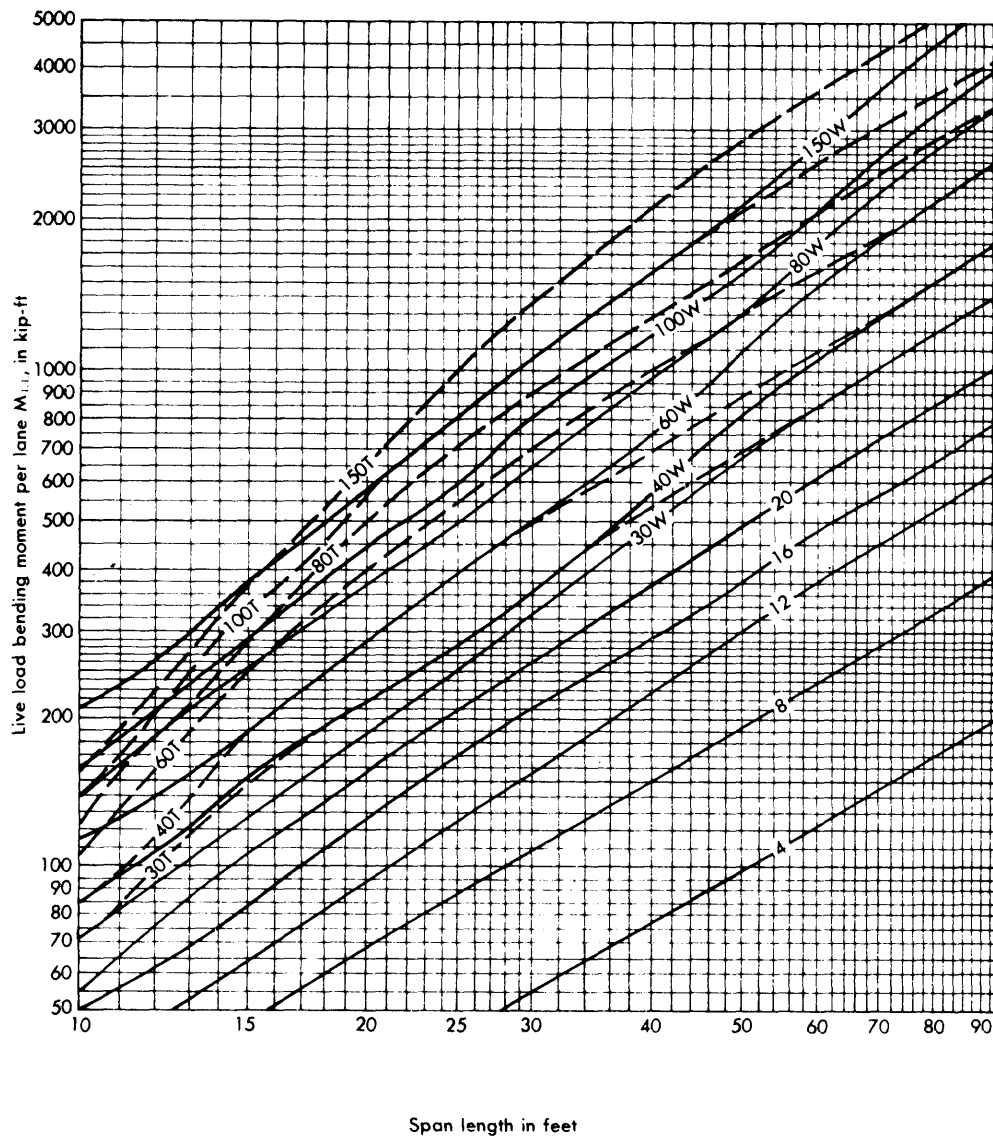


FIGURE 10. MOMENT GRAPH

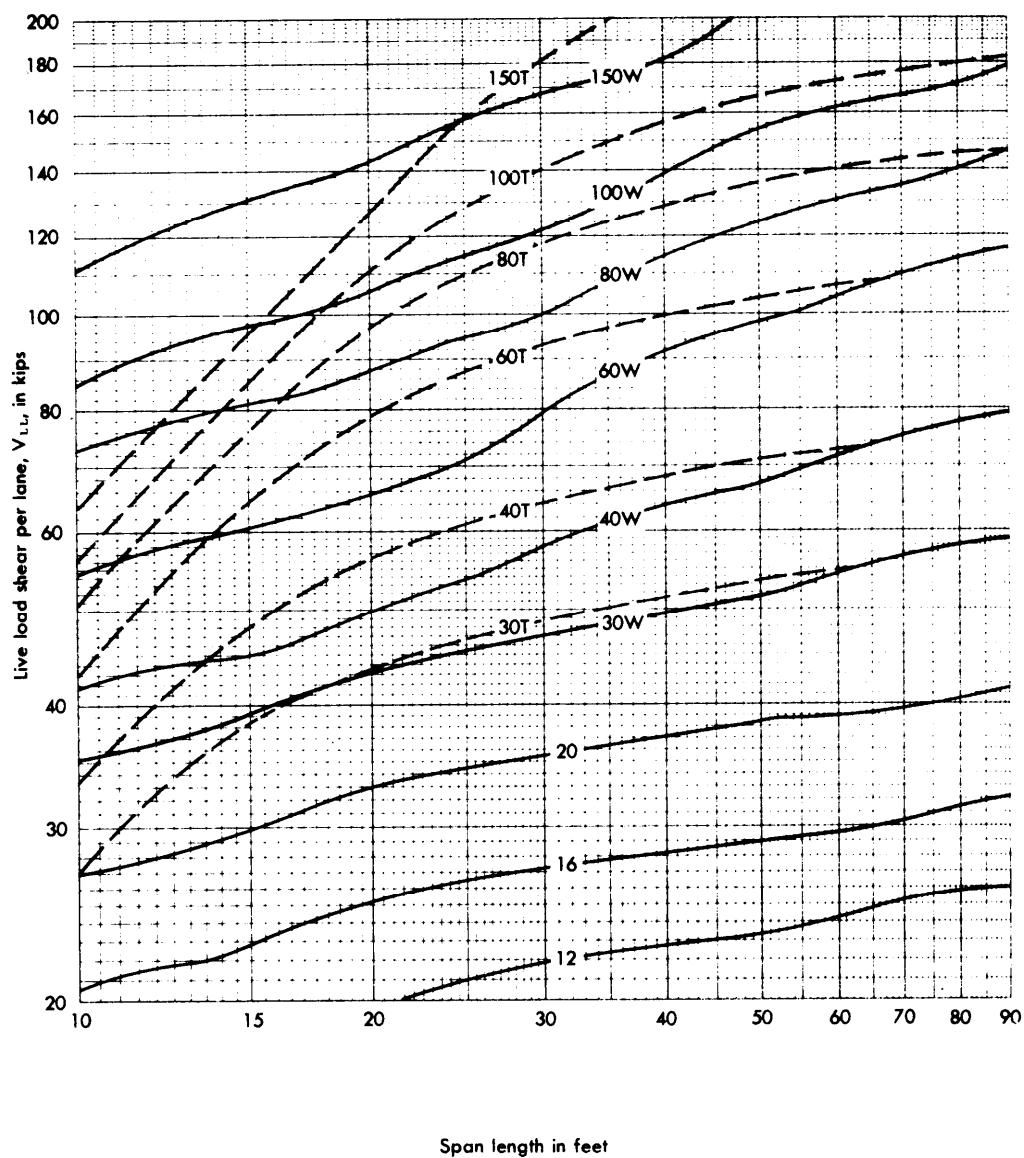


FIGURE 11. SHEAR GRAPH

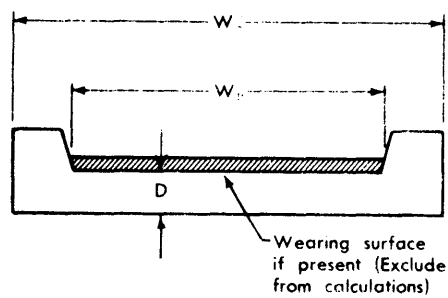
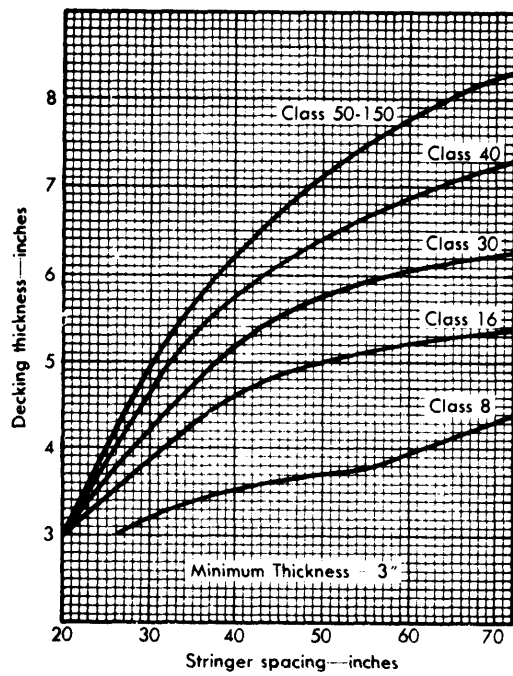


FIGURE 13. CONCRETE SLAB BRIDGE

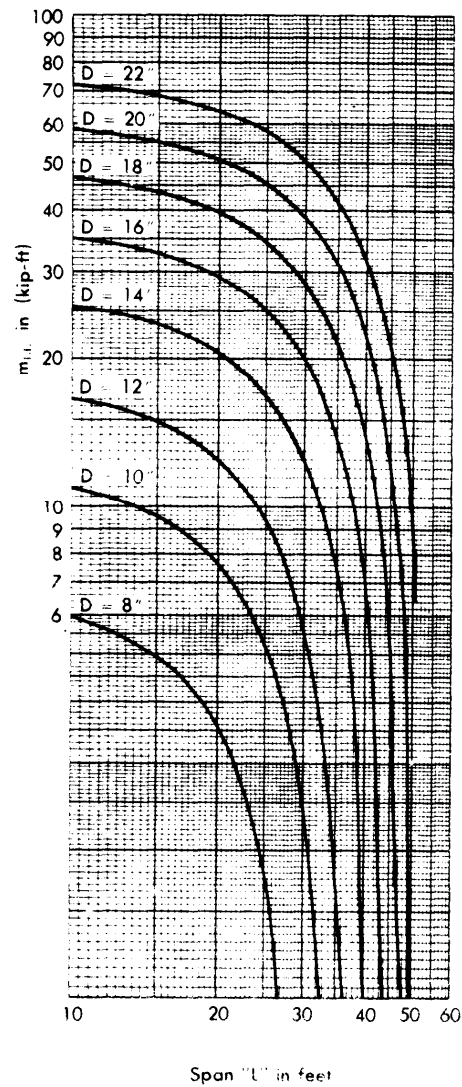


FIGURE 14. LIVE LOAD MOMENT FOR A 12 INCH STRIP OF REINFORCED CONCRETE.

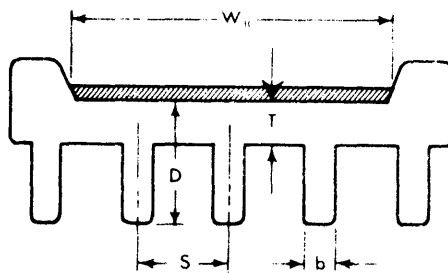


FIGURE 15. CONCRETE T-BEAM BRIDGE

(12)

F. MASONRY ARCH BRIDGE CLASSIFICATION

To obtain the bridge classification number for a masonry arch bridge, a provisional class number based on the crown thickness and span length is determined, this provisional class number is then adjusted by applying factors based on the materials and the condition of the bridge.

PROVISIONAL CLASS NUMBER

1. Mark span length (S in fig. 16) on Col. A of chart 1.
2. Mark total crown thickness (t - D in fig. 16) on Col. B of chart 1.
3. Draw a straight line through the points marked in steps 1 and 2 and where this line intersects Col. C, read the provisional class number.

PROFILE FACTOR

4. Divide span length (S in fig. 16) by the rise (R in fig. 16) and mark the result at the bottom of chart 2. If the result is 4 or less, profile factor is 1. Otherwise
5. Draw a vertical line from the mark made in step 4 and mark the point where it intersects the curved line.
6. Draw a horizontal line from the mark made in step 5 to the left edge of chart 2 and read the profile factor at this point.

OTHER FACTORS (See table IV)

7. Select the material, joint, deformation, crack, abutment size, and abutment fault factors from the table. Use only those factors which apply.

ACTUAL CLASS NUMBER

8. Multiply the provisional class number by each of the various factors found above. The result is the bridge classification number.

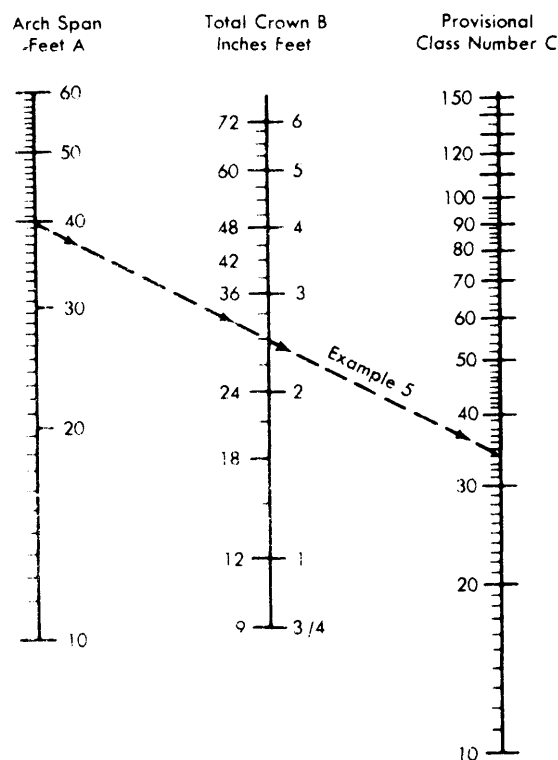


CHART 1
CHART FOR DETERMINING PROVISIONAL
LOAD CLASS OF ARCH BRIDGES

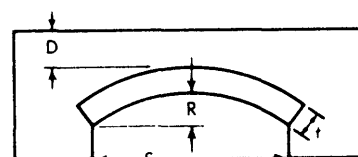


FIGURE 16 MASONRY ARCH BRIDGE

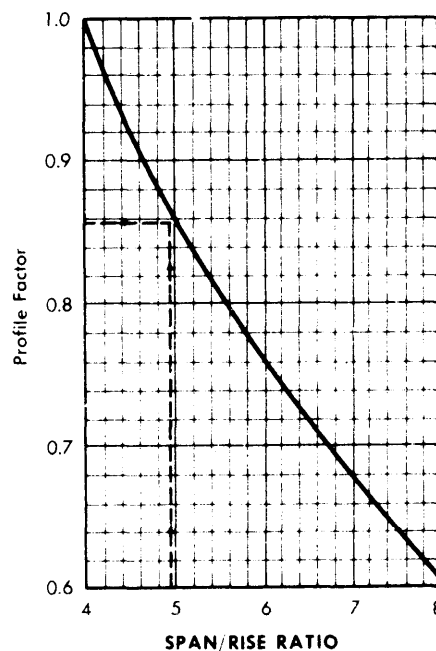


CHART 2
PROFILE FACTORS FOR ARCH BRIDGES

(13)

EXAMPLE 5

GIVEN: Masonry arch bridge; span (S) 40 ft; rise (R) 8 ft, arch ring thickness (t) 18 in; depth of fill at crown (D) 12 in; roadway width 15 ft; material—limestone in good condition; joints—mortar, some deterioration, small voids, close joints; cracks—large longitudinal crack in arch under one parapet wall; abutments—one approach up a narrow embankment.

Find Bridge Class—Solution: Roadway width limits bridge to one lane. Total crown thickness ($t + D$, see fig.16) = 18 in + 12 in = 2.5 ft. Using chart 1 line up straight edge at span of 40 ft (Col. A) and total crown thickness of 2.5 ft (Col. B). At the intersection of straight edge and Col. C, read provisional class number, 34.

Determine the profile factor. Span/rise ratio = $S/R = 40/8 = 5$. Enter the bottom of chart 2 with the span-rise ratio and draw a vertical line. At the intersection of this vertical line and the curved line on the chart, pivot (going horizontally) to the left edge of the chart. Read the profile factor as 0.86.

Material factor for limestone in good condition is 1.0. Joint factor is between 0.80 and 0.70, say 0.75. Crack factor for one crack at the edge of the ring is 0.90. Abutment factor for one unsatisfactory abutment is 0.95.

Determine actual class number by multiplying provisional class number by factors found above.

Actual Class Number = $34 \times 0.86 \times 1.0 \times 0.75 \times 0.90 \times 0.95 = \text{Class } 19$.

GENERAL NOTES

1. Bridge classification using this card is based on the class of the superstructure only, since this is considered to be the controlling feature in bridge classification. The theoretical substructure design for the given superstructure can be determined using the Bridge Design Card (GTA 5-7-6) and then compared with the substructure in place as a basis of determining whether or not the bridge classification should be lowered.

2. The condition of both Superstructure and Substructure components should be examined closely for damage or deterioration and the probable effect on the bridge classification.

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WG: State AG (3); Units - Same as Active Army except allowance is one (1) copy for each unit.

USAR: Same as Active Army except allowance is one (1) copy for each unit.

For explanation of abbreviations used, see AR 320-50.

TABLE IV Arch Factors**MATERIAL FACTOR**

- | | |
|--|------------|
| 1. Granite, whistone and built-in-course masonry | 1.5 |
| 2. Concrete or blue engineering bricks | 1.2 |
| 3. Good limestone masonry and building bricks | 1.0 |
| 4. Poor masonry or brickwood (of any kind) | 0.7 to 0.5 |

JOINT FACTORS

- | | |
|--|------|
| 1. Thin joints, 1/10" or less in width | 1.25 |
| 2. Normal joints, with width up to 1/4" | 1.00 |
| 3. Ditto, but with mortar unpainted | 0.90 |
| 4. Joint over 1/4" wide, irregular good mortar | 0.80 |
| 5. Ditto, but with mortar containing voids deeper than one-tenth of the ring thickness | 0.70 |
| 6. Joints 1/2" or more wide, poor mortar | 0.50 |

DEFORMATION FACTORS

- | | |
|---|--|
| 1. The rise over the affected portion is always positive. | — Apply span-rise ratio of affected portion to the whole arch. |
| 2. Flat section of profile. | — Maximum: 12 |
| 3. A portion of the ring is sagging. | — Maximum class: 5; if fill at crown exceeds 18" |

CRACK FACTORS

- | | |
|---|------------|
| 1. Small transverse cracks within 2 ft. of the edge | 1.0 |
| 2. Large transverse cracks within 2 ft. of the edge | 1.0 |
| 3. Longitudinal cracks in center third of bridge | 0.9 to 0.7 |
| One small crack | 1.0 |
| One large crack or several narrow cracks | 0.5 |
| 4. Small lateral and diagonal cracks | 1.0 |
| 5. Large lateral and diagonal cracks—Maximum Class: 12; or the figure derived by using the other factors. | |
| 6. Cracks between the arch ring and parapet wall due to lateral spread of the fill | 0.9 |
| 7. Cracks between the ring and spandrel, due to a dropped ring—Reclassify from the nomograph, on the assumption that the crown thickness is that of the ring alone. | |

ABUTMENT SIZE FACTORS

- | | |
|--|------|
| 1. Both abutments satisfactory | 1.00 |
| 2. One unsatisfactory abutment | 0.95 |
| 3. Both abutments unsatisfactory | 0.90 |
| 4. Both abutments massive, clay fill suspected | 0.70 |
| 5. Arch supported on one abutment and one pier | 0.90 |
| 6. Arch supported on two piers | 0.80 |

ABUTMENT FAULT FACTORS

- | | |
|--|--------------|
| 1. Inward movement of one abutment | 0.75 to 0.50 |
| 2. Outward spread of abutments | 1.00 to 0.50 |
| 3. Vertical settlement of one abutment | 0.90 to 0.50 |