

APPENDIX I – SAMPLE CALCULATIONS, RECOMMENDED SIMPLIFIED METHOD

Introduction

This appendix contains worked sample problems using the recommended distribution factor method. A summary of the bridge types and geometries is presented, and followed by the examples. These are actual bridges from the Tennessee Tech bridge set.

Steel I-Beam Bridges

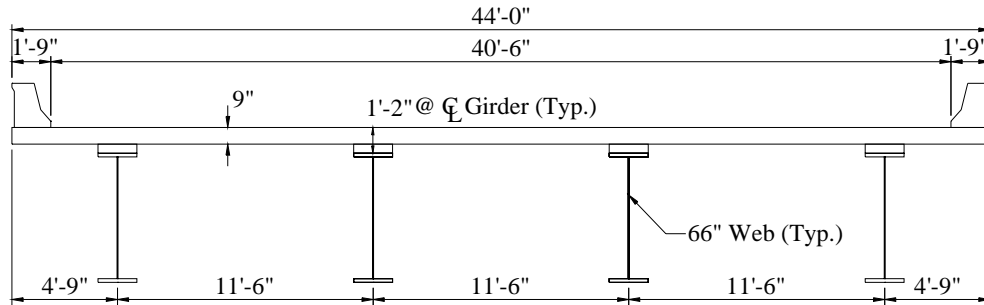


Figure I-1: Typical Cross Section (Bridge #18)

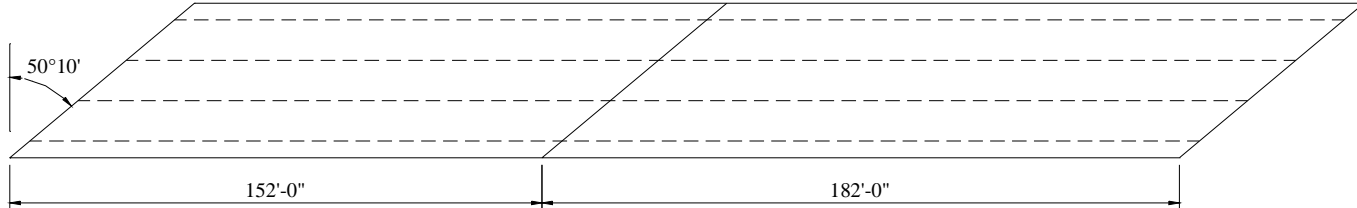


Figure I-2: Plan View (Bridge #18)

Table I-1: Steel I-Beam Bridge Information

Bridge No.	Number of Spans	Span Length 1 (ft)	Span Length 2 (ft)	Span Length 3 (ft)	Span Length 4 (ft)	Number of Girders	Girder Spacing (ft)	Slab Thickness (in)	Beam f_y (psi)	Slab f_c (psi)	Skew Angle (deg)	Overhang (ft)	Curb/Barrier Width (ft)
16	4	123.75	158.00	158.00	123.75	5	9.50	8.00	36,000	3,000	0.00	4.00	1.75
17	2	131.00	143.00	-	-	3	9.33	8.25	50,000	3,000	19.40	4.67	1.75
18	2	152.00	182.00	-	-	4	11.50	9.00	50,000	4,000	50.16	4.75	1.75
19	2	150.00	150.00	-	-	9	11.00	9.00	50,000	3,000	26.66	3.00	1.75

Table I-2: Steel I-Beam Dimensions (At Midspan)

Bridge No.	Web Depth (in)	Web Thickness (in)	Top Flange Width (in)	Top Flange Thickness (in)	Bottom Flange Width (in)	Bottom Flange Thickness (in)
16	66	0.5625	16.0	0.750	16.0	0.875
17	48	0.5000	16.0	0.875	16.0	1.375
18	66	0.5000	21.0	1.000	21.0	1.750
19	54	0.4375	18.0	1.000	18.0	1.625

Precast Concrete Spread Box Beam Bridges

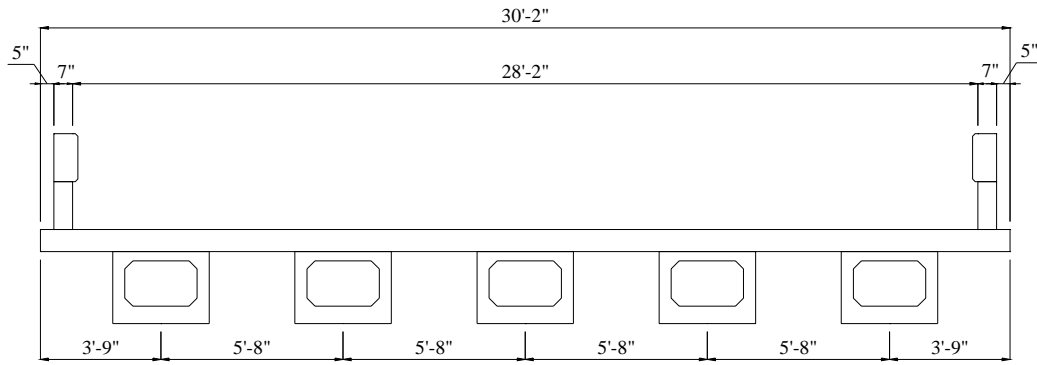


Figure I-3: Typical Cross Section (Bridge #4)

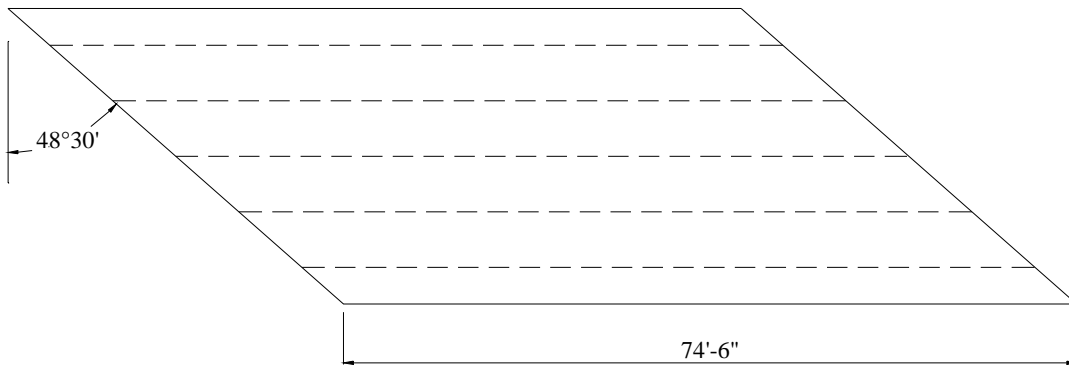


Figure I-4: Plan View (Bridge #4)

Table I-3: Precast Concrete Spread Box Beam Bridge Information

Bridge No.	Number of Spans	Span Length 1 (ft)	Span Length 2 (ft)	Span Length 3 (ft)	Span Length 4 (ft)	Span Length 5 (ft)	Span Length 6 (ft)	Number of Girders	Girder Spacing (ft)	Slab Thickness (in)	Beam f_c (psi)	Slab f_c (psi)	Skew Angle (deg)	Overhang (ft)	Curb/Barrier Width (ft)
1	3	60.88	60.25	60.88	-	-	-	3	10.58	8.00	6,000	3,000	15.00	4.42	1.75
2	3	44.38	43.75	44.38	-	-	-	2	13.75	8.75	6,000	3,000	0	6.29	1.17
3	6	81.46	80.75	80.75	80.75	80.75	81.46	4	11.25	7.75	5,000	3,000	0	5.13	1.75
4	1	74.50	-	-	-	-	-	5	5.67	8.25	5,500	4,000	48.49	3.75	1.17

Table I-4: Precast Concrete Spread Box Beam Dimensions

Bridge No.	Box Depth (in)	Box Width (in)	Top Slab Thickness (in)	Web Thickness (in)	Bottom Slab Thickness (in)
1	30	36	3.5	4.5	6.5
2	24	48	3.5	4.5	6.5
3	45	36	5.0	4.5	6.0
4	27	36	3.5	4.5	6.5

Cast-in-Place Concrete Multicell Box Beam Bridges

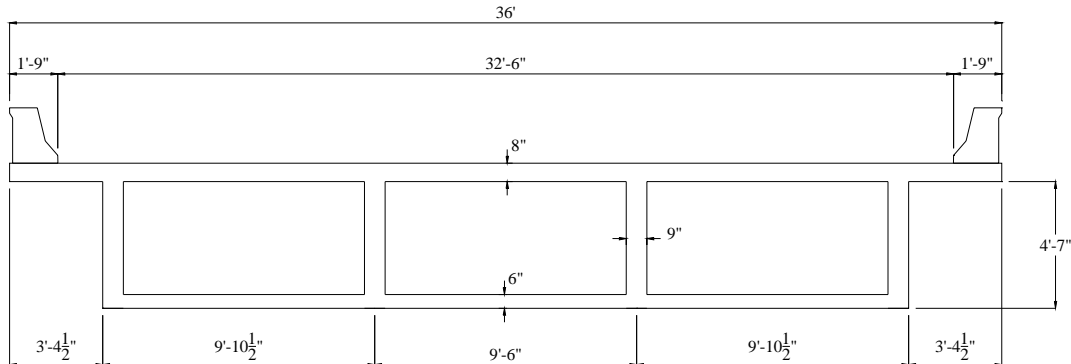


Figure I-5: Typical Cross Section (Bridge #15)

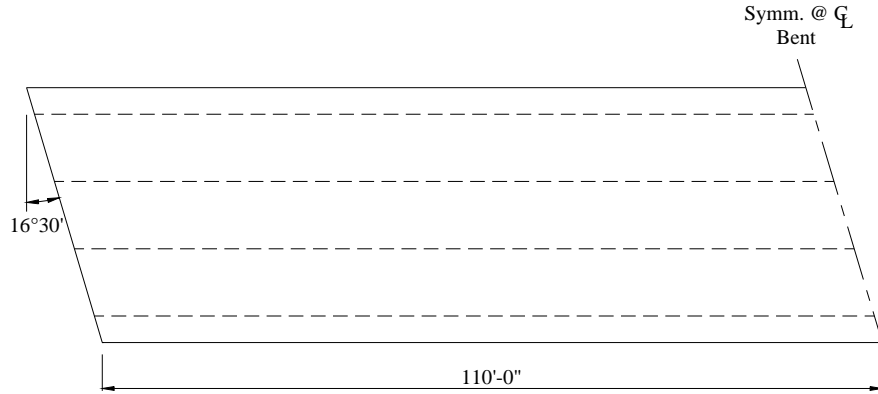


Figure I-6: Plan View (Bridge #15)

Table I-5: Cast-in-Place Concrete Multicell Box Beam Bridge Information

Bridge No.	Number of Spans	Span Length 1 (ft)	Span Length 2 (ft)	Span Length 3 (ft)	Number of Cells	Slab Thickness (in)	Beam f'_c (psi)	Slab f'_c (psi)	Skew Angle (deg)	Overhang (ft)	Curb/Barrier Width (ft)
12	2	128.08	133.83	-	4	0.00	3,000	-	0.00	3.50	1.75
13	2	98.75	98.75	-	4	0.00	3,000	-	0.00	4.00	1.75
14	3	91.00	119.00	140.00	4	0.00	3,000	-	26.23	4.33	1.75
15	2	110.00	110.00	-	3	0.00	3,000	-	16.5	3.75	1.75

Table I-6: Cast-in-Place Concrete Multicell Box Beam Dimensions (At Midspan)

Bridge No.	Box Depth (in)	Box Width (in)	Top Slab Thickness (in)	Web Thickness (in)	Bottom Slab Thickness (in)
12	66	111	8.00	12.00	6.00
13	63	108	8.25	12.00	7.00
14	84	124	9.25	12.00	7.00
15	60	114	8.00	9.00	6.00

Cast-in-Place Concrete Tee Beam Bridges

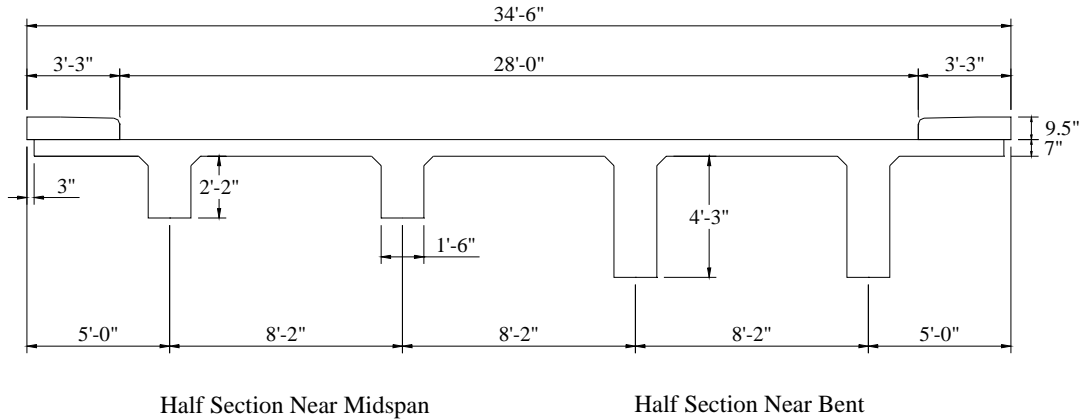


Figure I-7: Typical Cross Section (Bridge #11)

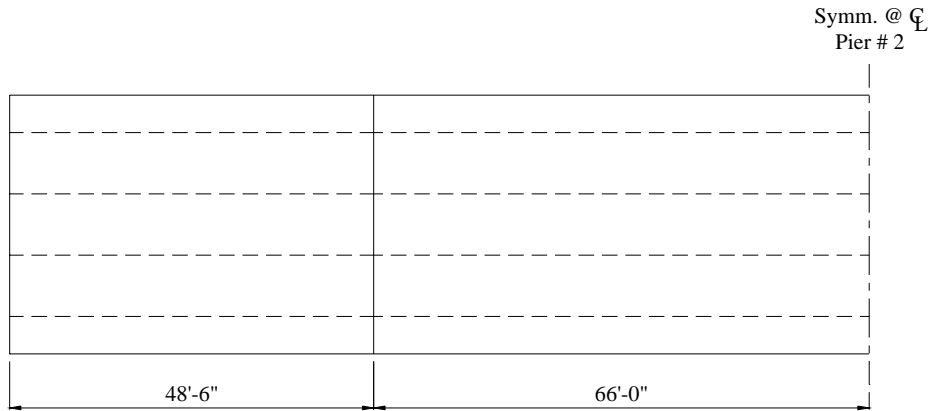


Figure I-8: Plan View (Bridge #11)

Table I-7: Cast-in-Place Concrete Tee Beam Bridge Information

Bridge No.	Number of Spans	Span Length 1 (ft)	Span Length 2 (ft)	Span Length 3 (ft)	Span Length 4 (ft)	Span Length 5 (ft)	Number of Girders	Girder Spacing (ft)	Slab Thickness (in)	Beam f'_c (psi)	Slab f'_c (psi)	Skew Angle (deg)	Overhang (ft)	Curb/Barrier Width (ft)
9	4	35.45	88.50	88.50	51.42	-	3	11.17	7.50	3,000	3,000	31.56	5.00	1.92
10	5	40.00	77.00	96.00	96.00	50.00	3	12.58	9.00	3,000	3,000	9.83	4.67	1.75
11	4	48.50	66.00	66.00	45.50	-	4	8.17	7.00	3,000	3,000	0.00	5.00	3.25

Table I-8: Cast-in-Place Concrete Tee Beam Dimensions (At Midspan)

Bridge No.	Web Depth (in)	Web Thickness (in)	Top Flange Width (in)	Top Flange Thickness (in)	Bottom Flange Width (in)	Bottom Flange Thickness (in)
9	28.50	26.00	134.00	7.50	-	-
10	36.00	26.00	151.00	9.00	-	-
11	26.00	18.00	98.00	7.00	-	-

Precast Concrete I-Beam Bridges

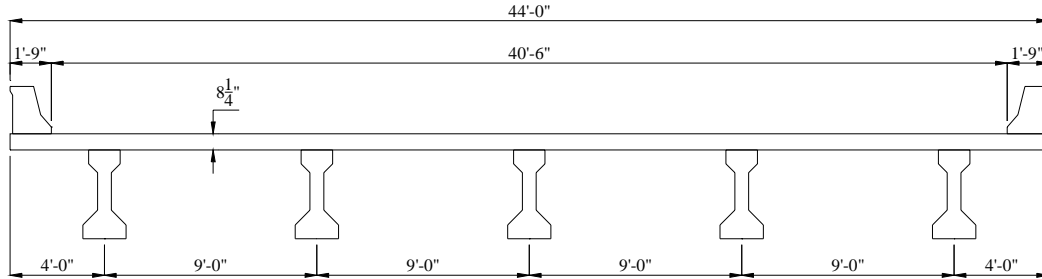


Figure I-9: Typical Cross Section (Bridge #7)

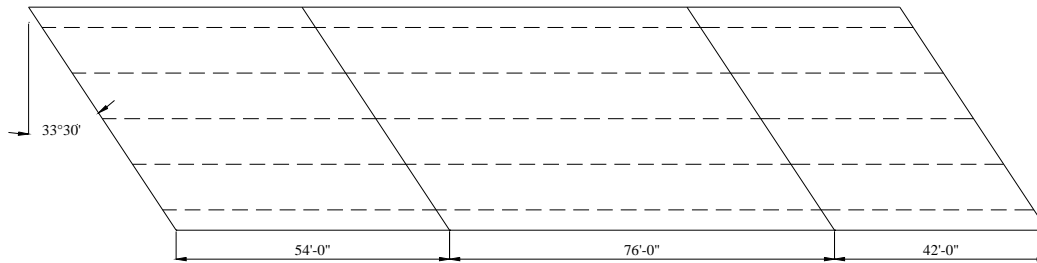


Figure I-10: Plan View (Bridge #7)

Table I-9: Precast Concrete I-Beam Bridge Information

Bridge No.	Number of Spans	Span Length 1 (ft)	Span Length 2 (ft)	Span Length 3 (ft)	Span Length 4 (ft)	Span Length 5 (ft)	AASHTO Beam Type	Number of Girders	Girder Spacing (ft)	Slab Thickness (in)	Beam f'_c (psi)	Slab f'_c (psi)	Skew Angle (deg)	Overhang (ft)	Curb/Barrier Width (ft)
6	3	47.25	67.58	39.25	-	-	III	5	9.00	8.25	5,000	3,000	21.33	4.50	1.75
7	3	54.00	76.00	42.00	-	-	III	5	9.00	8.25	5,500	4,000	33.50	4.00	1.75
24	5	75.00	75.00	75.00	75.00	75.00	III	5	10.50	8.75	10,000	3,000	74.33	4.50	1.75

Precast Concrete Bulb-Tee Beam Bridges

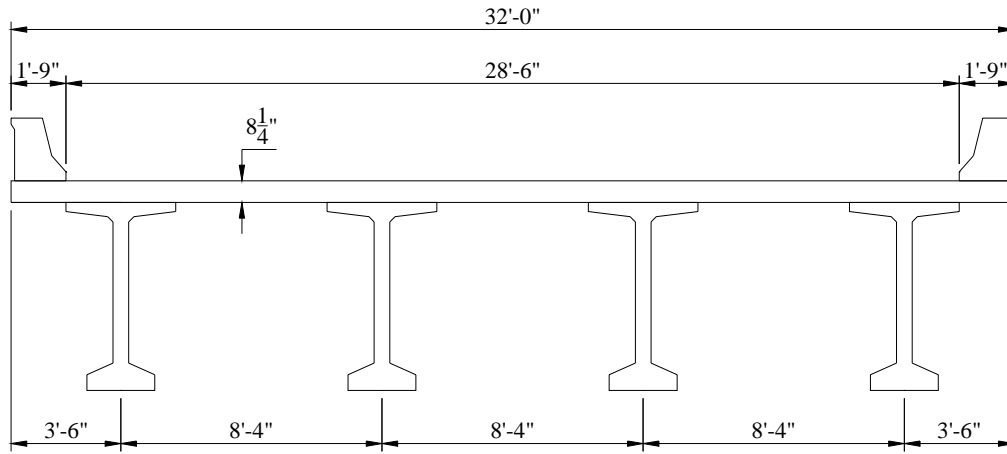


Figure I-11: Typical Cross Section (Bridge #22)

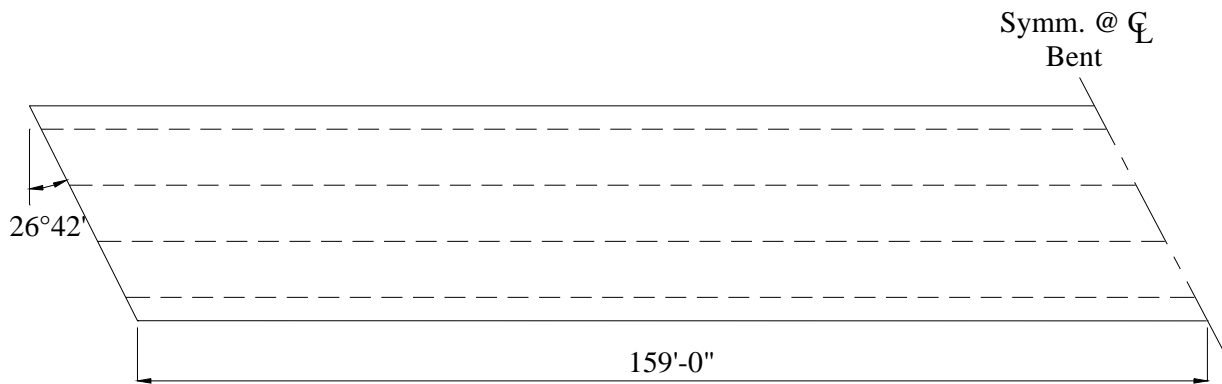
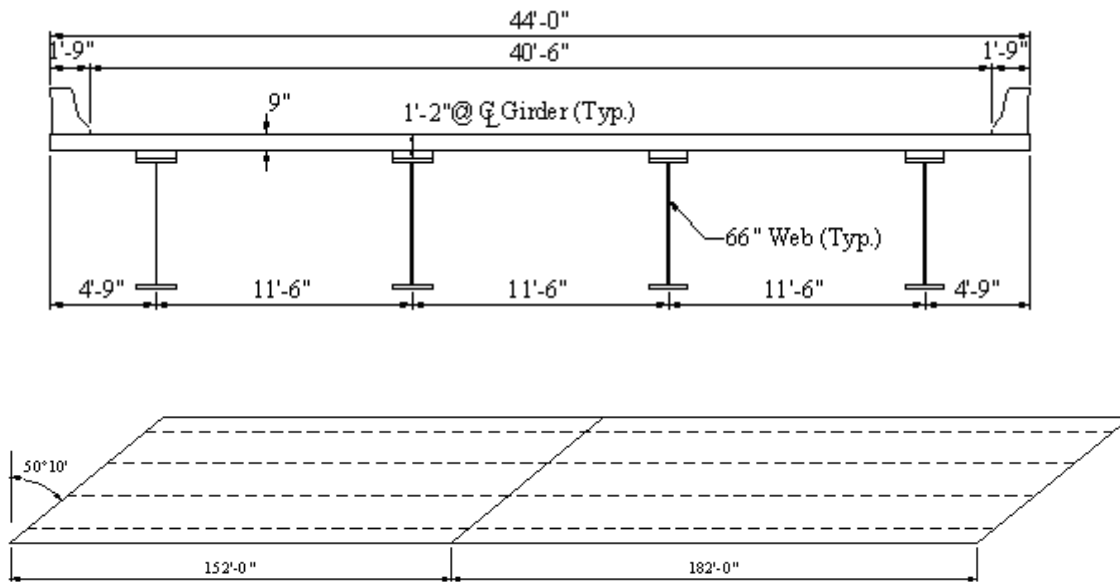


Figure I-12: Plan View (Bridge #22)

Table I-10: Precast Concrete Bulb-Tee Beam Bridge Information

Bridge No.	Number of Spans	Span Length 1 (ft)	Span Length 2 (ft)	Span Length 3 (ft)	Span Length 4 (ft)	Span Length 5 (ft)	Span Length 6 (ft)	AASHTO Beam Type	Number of Girders	Girder Spacing (ft)	Slab Thickness (in)	Beam f'_c (psi)	Slab f'_c (psi)	Skew Angle (deg)	Overhang (ft)	Curb/Barrier Width (ft)
5	4	124.33	124.00	124.00	124.33	-	-	BT-72	5	8.75	8.25	6,000	3,000	15.00	4.50	1.75
8	6	85.63	114.83	115.49	115.49	115.49	85.63	BT-72	8	10.29	8.25	9,000	4,000	0.00	4.35	1.75
22	2	159.00	159.00	-	-	-	-	BT-72	4	8.33	8.25	10,000	3,000	26.70	3.50	1.75
23	2	139.33	151.33	-	-	-	-	BT-72	4	8.33	8.25	10,000	3,000	17.50	3.50	1.75

Steel I-Beam Bridge #1



$S_g := 11.5\text{ft}$	girder spacing
$L_1 := 152\text{ft}$	span length
$L_2 := 182\text{ft}$	span length
$t_s := 9.0\text{in}$	slab thickness
$N_g := 4$	number of girders
$d_e := 1.0\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 40.5\text{ft}$	clear roadway width
$\theta := 50.16$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.97$$

Table 4.6.2.2.2b-2

$$b_m := -0.24$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.11$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B 4-1

$$g_{m1i} = 0.529$$

$$m_1 \cdot g_{m1i} = 0.635$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.250$$

$$m_1 \cdot g_{m1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.17$$

Table 4.6.2.2.2b-2

$$b_m := -0.08$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.149$$

$$m_3 \cdot g_{mi} = 0.976$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.750$$

$$m_3 \cdot g_{mi_lb} = 0.638$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.976$

Shear:

One Lane Loaded

$$N_{L_v} := 1$$

$$a_v := 1.04$$

Table 4.6.2.2.2a-1

$$b_v := -0.12$$

$$m_{L_v} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_s1i} \cdot \left[a_v \cdot \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.662$$

$$m_1 \cdot g_{s1i} = 0.794$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.250$$

$$m_1 \cdot g_{s1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.99$$

Table 4.6.2.2.2a-1

$$b_w := 0.01$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_si} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_si} \cdot \left[a_w \cdot \left(2 - \frac{10\text{ft}}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.174$$

$$m_2 \cdot g_{si} = 1.174$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.500$$

$$m_2 \cdot g_{si_lb} = 0.500$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{s1i}, m_1 \cdot g_{s1i_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.174$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.240$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.456$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.53$$

Table 4.6.2.2.2b-2

$$b_m := 0.19$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.653$$

$$m_1 \cdot g_{m1e} = 0.784$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.250$$

$$m_1 \cdot g_{m1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-2

$$b_m := -0.12$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.07$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_{m2e}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m2e} = 1.107$$

$$m_3 \cdot g_{me} = 0.941$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.750$$

$$m_3 \cdot g_{me_lb} = 0.638$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.941$

Shear:

One Lane Loaded

$$N_{L1} := 1$$

$$a_w := 0.70$$

Table 4.6.2.2.2a-1

$$b_w := 0.13$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_w \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.722$$

$$m_1 \cdot g_{s1e} = 0.867$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.250$$

$$m_1 \cdot g_{s1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_{Lx} := 2$$

$$a_{vv} := 0.83$$

Table 4.6.2.2.2a-1

$$b_{vv} := 0.11$$

$$m_{2v} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_{vv} \left(\frac{3}{2} + \frac{3 \cdot d_e}{2 \cdot S} - \frac{8ft}{S} \right) + b_{vv} \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.904$$

$$m_2 \cdot g_{se} = 0.904$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.500$$

$$m_2 \cdot g_{se_lb} = 0.500$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.904$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.240$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 1.120$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.976$$

Shear:

$$m_{g_{si}} = 1.456$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.941$$

Shear:

$$m_{g_{se}} = 1.120$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior
Girders:
Moment

:
One Lane Loaded

$$N_g := 1$$

$$S := 11.5\text{ft}$$

girder spacing

$$L := 152\text{ft}$$

shortest span length

$$\text{Exp1} := 0.40$$

Table
4C-1

$$\text{Exp2} := 0.18$$

$$\text{Exp3} := 0.00$$

$$D := 42.3$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.373$$

$$a_m := 1.53$$

Table
4C-2

$$b_m := -0.17$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.04$$

Table 4C-3

$$g_{a_{m1i}} := \gamma_{a_{m1i}} \cdot (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{a_{m1i}} = 0.417$$

$$m_1 \cdot g_{a_{m1i}} = 0.500$$

Lower Bound Distribution Factor

$$g_{a_{m1i_lb}} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{a_{m1i_lb}} = 0.250$$

$$m_1 \cdot g_{a_{m1i_lb}} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.17$$

Table
4C-2

$$b_m := -0.08$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2i}} := 1.04$$

Table 4C-3

$$g_{a_{mi}} := \gamma_{a_{mi}} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{a_{mi}} = 1.149$$

$$m_3 \cdot g_{a_{mi}} = 0.976$$

Lower Bound Distribution Factor

$$g_{a_{mi_lb}} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{a_{mi_lb}} = 0.750$$

$$m_3 \cdot g_{a_{mi_lb}} = 0.638$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$m g_{ami_max} = 0.976$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{L1} := 1$$

$$a_{m1} := 0.53$$

Table 4C-2

$$b_{m1} := 0.19$$

$$m_{1L} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \cdot a_{m1} \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_{m1}$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.653$$

$$m_1 \cdot g_{am1e} = 0.784$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.250$$

$$m_1 \cdot g_{am1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_{L2} := 2$$

$$a_{m2} := 0.71$$

Table 4C-2

$$b_{m2} := 0.23$$

$$m_{2L} := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.06$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \left[a_m \left(\frac{2}{3} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.320$$

$$m_2 \cdot g_{ame} = 0.320$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.500$$

$$m_2 \cdot g_{ame_lb} = 0.500$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$$mg_{ame_max} = 0.784$$

Summary:

Interior Girder

Moment:

$$mg_{ami} := mg_{ami_max}$$

$$mg_{ami} = 0.976$$

Exterior Girder

Moment:

$$mg_{ame} := mg_{ame_max}$$

$$mg_{ame} = 0.784$$

Steel I-Beam Bridge #2

$S_g := 9.5\text{ft}$	girder spacing
$L_1 := 123.75\text{ft}$	span length
$L_2 := 158\text{ft}$	span length
$L_3 := 158\text{ft}$	span length
$L_4 := 123.75\text{ft}$	span length
$t_s := 8.0\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.25\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 42.5\text{ft}$	clear roadway width
$\theta := 0$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.97$$

Table 4.6.2.2.2b-2

$$b_m := -0.24$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.11$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.470$$

$$m_1 \cdot g_{m1i} = 0.564$$

Lower Bound Distribution Factor

$$g_{m1_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1_lb} = 0.200$$

$$m_1 \cdot g_{m1_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.17$$

Table 4.6.2.2.2b-2

$$b_m := -0.08$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.951$$

$$m_3 \cdot g_{mi} = 0.808$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.808$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.04 \quad \text{Table 4.6.2.2.2a-1}$$

$$b_v := -0.12$$

$$m_w := 1.2 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_s1i} := 1.02 \quad \text{Table 4.6.2.2.1-2}$$

$$g_{s1i} := \gamma_{a_s1i} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right] \quad \begin{array}{l} \text{Eq. 4.6.2.2.2a-1} \\ \text{Table B4-1} \end{array}$$

$$g_{s1i} = 0.603$$

$$m_1 \cdot g_{s1i} = 0.724$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_w := 2$$

$$a_w := 0.99 \quad \text{Table 4.6.2.2.2a-1}$$

$$b_w := 0.01$$

$$m_2 := 1.0 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_si} := 1.04 \quad \text{Table 4.6.2.2.1-2}$$

$$g_{si} := \gamma_{a_si} \left[a_w \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right) + b_w \right] \quad \begin{array}{l} \text{Eq. 4.6.2.2.2a-1} \\ \text{Table B4-1} \end{array}$$

$$g_{si} = 1.013$$

$$m_2 \cdot g_{si} = 1.013$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.013$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$mg_{si} = 1.013$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{L1} := 1$$

$$a_{m1} := 0.53$$

Table 4.6.2.2.2b-2

$$b_{m1} := 0.19$$

$$m_{L1} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_{m1} \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_{m1} \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.589$$

$$m_1 \cdot g_{m1e} = 0.707$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-2

$$b_m := -0.12$$

$$m_a := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.07$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.908$$

$$m_3 \cdot g_{me} = 0.772$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.772$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.70$$

Table 4.6.2.2.2a-1

$$b_w := 0.13$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.640$$

$$m_1 \cdot g_{s1e} = 0.768$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.11$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.714$$

$$m_2 \cdot g_{se} = 0.714$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $m_{g_{se_max}} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$m_{g_{se_max}} = 0.768$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

$SCF = 1.000$

$m_{g_{se}} := m_{g_{se_max}} \cdot SCF$

$m_{g_{se}} = 0.768$

Summary:

Interior Girder

Moment:

$m_{g_{mi}} := m_{g_{mi_max}}$

$m_{g_{mi}} = 0.808$

Shear:

$m_{g_{si}} = 1.013$

Exterior Girder

Moment:

$m_{g_{me}} := m_{g_{me_max}}$

$m_{g_{me}} = 0.772$

Shear:

$m_{g_{se}} = 0.768$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$N_L := 1$

$S := 9.5\text{ft}$

girder spacing

$L := 123.75\text{ft}$

shortest span length

Exp1 := 0.40

Table
4C-1

Exp2 := 0.18

Exp3 := 0.00

D := 42.3

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$g_{PF} = 0.347$

$a_m := 1.53$

Table
4C-2

$b_m := -0.17$

$m_1 := 1.2$

Table 3.6.1.1.2-1

$\gamma_{a_{m1i}} := 1.04$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$g_{am1i} = 0.375$

$m_1 \cdot g_{am1i} = 0.450$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$g_{am1i_lb} = 0.200$

$m_1 \cdot g_{am1i_lb} = 0.240$

Two or More Lanes Loaded

$N_L := 3$

$a_m := 1.17$

Table
4C-2

$b_m := -0.08$

$m_2 := 0.85$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.951$$

$$m_3 \cdot g_{ami} = 0.808$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.600$$

$$m_3 \cdot g_{ami_lb} = 0.510$$

Controlling Distribution Factor: $m_{g_{ami_max}} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$m_{g_{ami_max}} = 0.808$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{L1} := 1$$

$$a_{m1} := 0.53$$

Table 4C-2

$$b_{m1} := 0.19$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.589$$

$$m_1 \cdot g_{am1e} = 0.707$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_{L_{max}} := 3$$

$$a_{mm} := 0.71 \quad \text{Table 4C-2}$$

$$b_{mm} := 0.23$$

$$m_2 := 1.00 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_{me}} := 1.06 \quad \text{Table 4C-3}$$

$$g_{ame} := \gamma_{a_{me}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3 \cdot \text{ft}}{S} \right) + b_m \right] \quad \begin{array}{l} \text{Eq. 4C-1} \\ \text{Table 4C-1} \\ \text{Table B4-2} \end{array}$$

$$g_{ame} = 0.779$$

$$m_2 \cdot g_{ame} = 0.779$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.600$$

$$m_2 \cdot g_{ame_lb} = 0.600$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.779$

Summary:

Interior Girder

Moment:

$$m_{gami} := m_{gami_max}$$

$$m_{gami} = 0.808$$

Exterior Girder

Moment:

$$m_{game} := m_{game_max}$$

$$m_{game} = 0.779$$

Steel I-Beam Bridge #3

$S_g := 9.33\text{ft}$	girder spacing
$L_1 := 131\text{ft}$	span length
$L_2 := 143\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 3$	number of girders
$d_e := 0.92\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 24.5\text{ft}$	clear roadway width
$\theta := 19.4$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.97$$

Table 4.6.2.2.2b-2

$$b_m := -0.24$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.11$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.464$$

$$m_1 \cdot g_{m1i} = 0.557$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.333$$

$$m_1 \cdot g_{m1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.17$$

Table 4.6.2.2.2b-2

$$b_m := -0.08$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.911$$

$$m_2 \cdot g_{mi} = 0.911$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.667$$

$$m_2 \cdot g_{mi_lb} = 0.667$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.911$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.04$$

Table 4.6.2.2.2a-1

$$b_v := -0.12$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \cdot \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.597$$

$$m_1 \cdot g_{s1i} = 0.717$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{s1i_lb} = 0.333$$

$$m_1 \cdot g_{s1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.99$$

Table 4.6.2.2.2a-1

$$b_w := 0.01$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_v \cdot \left(\frac{3}{2} - \frac{5ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.003$$

$$m_2 \cdot g_{si} = 1.003$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.667$$

$$m_2 \cdot g_{si_lb} = 0.667$$

Controlling Distribution Factor: $m_{g_{si_max}} := \max(m_1 \cdot g_{s_{li}}, m_1 \cdot g_{s_{li_lb}}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$m_{g_{si_max}} = 1.003$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.070$$

$$m_{g_{si}} := m_{g_{si_max}} \cdot SCF$$

$m_{g_{si}} = 1.074$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.53$$

Table 4.6.2.2.2b-2

$$b_m := 0.19$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.626$$

$$m_1 \cdot g_{m1e} = 0.751$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.333$$

$$m_1 \cdot g_{m1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-2

$$b_m := -0.12$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{me}} := 1.07$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_{me}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.868$$

$$m_2 \cdot g_{me} = 0.868$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.667$$

$$m_2 \cdot g_{me_lb} = 0.667$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$mg_{me_max} = 0.868$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.70$$

Table 4.6.2.2.2a-1

$$b_w := 0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1e}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \left[a_w \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.687$$

$$m_1 \cdot g_{s1e} = 0.825$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.333$$

$$m_1 \cdot g_{s1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{wv} := 0.83$$

Table 4.6.2.2.2a-1

$$b_{wv} := 0.11$$

$$m_{2v} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \cdot \left[a_{v'} \cdot \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_{v'} \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.781$$

$$m_2 \cdot g_{se} = 0.781$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.667$$

$$m_2 \cdot g_{se_lb} = 0.667$$

$$\text{Controlling Distribution Factor: } mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$$

$$mg_{se_max} = 0.825$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

$SCF = 1.070$

$mg_{se} := mg_{se_max} \cdot SCF$

$mg_{se} = 0.883$

Summary:

Interior Girder

Moment:

$mg_{mi} := mg_{mi_max}$

$mg_{mi} = 0.911$

Shear:

$mg_{si} = 1.074$

Exterior Girder

Moment:

$mg_{me} := mg_{me_max}$

$mg_{me} = 0.868$

Shear:

$mg_{se} = 0.883$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$N_L := 1$

$S_v := 9.33\text{ft}$

$L_v := 131\text{ft}$

girder spacing

shortest span length

Exp1 := 0.40

Table
4C-1

Exp2 := 0.18

Exp3 := 0.00

D := 42.3

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$g_{PF} = 0.340$

$a_m := 1.53$

Table
4C-2

$b_m := -0.17$

$m_1 := 1.2$

Table 3.6.1.1.2-1

$\gamma_{a_m b_m} := 1.04$

Table 4C-3

$$g_{amli} := \gamma_{a_m b_m} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$g_{amli} = 0.363$

$m_1 \cdot g_{amli} = 0.436$

Lower Bound Distribution Factor

$$g_{amli_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$g_{amli_lb} = 0.333$

$m_1 \cdot g_{amli_lb} = 0.400$

Two or More Lanes Loaded

$N_L := 2$

$a_m := 1.17$

Table
4C-2

$b_m := -0.08$

$m_2 := 1.00$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.911$$

$$m_2 \cdot g_{ami} = 0.911$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.667$$

$$m_2 \cdot g_{ami_lb} = 0.667$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$$mg_{ami_max} = 0.911$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.53$$

Table 4C-2

$$b_m := 0.19$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.626$$

$$m_1 \cdot g_{am1e} = 0.751$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.333$$

$$m_1 \cdot g_{am1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_{Lm} := 1$$

$$a_{m1} := 0.71 \quad \text{Table 4C-2}$$

$$b_{m1} := 0.23$$

$$m_2 := 1.00 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_me} := 1.06 \quad \text{Table 4C-3}$$

$$g_{ame} := \gamma_{a_me} \left[a_{m1} \left(\frac{2}{3} + \frac{3d_e}{2S} - \frac{8 \cdot \text{ft}}{S} \right) + b_{m1} \right] \quad \begin{array}{l} \text{Eq. 4C-1} \\ \text{Table 4C-1} \\ \text{Table B4-2} \end{array}$$

$$g_{ame} = 0.212$$

$$m_2 \cdot g_{ame} = 0.212$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.333$$

$$m_2 \cdot g_{ame_lb} = 0.333$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.751$

Summary:

Interior Girder

Moment:

$$m_{gami} := m_{gami_max}$$

$$m_{gami} = 0.911$$

Exterior Girder

Moment:

$$m_{game} := m_{game_max}$$

$$m_{game} = 0.751$$

Steel I-Beam Bridge #4

$S_g := 11.0\text{ft}$	girder spacing
$L_1 := 150\text{ft}$	span length
$L_2 := 150\text{ft}$	span length
$t_s := 9\text{in}$	slab thickness
$N_g := 9$	number of girders
$d_e := -0.75\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 90.5\text{ft}$	clear roadway width
$\theta := 26.$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.97$$

Table 4.6.2.2.2b-2

$$b_m := -0.24$$

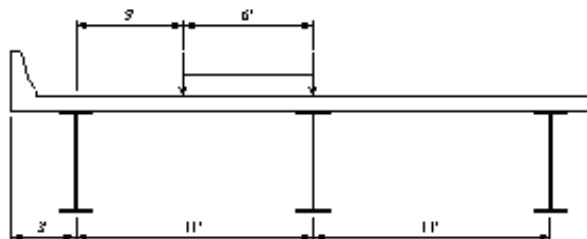
$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.11$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{m1i} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6ft)}{S} \quad \text{or} \quad g_{m1i} := \left(1 - \frac{3ft}{S}\right)$$

$$g_{m1i} := \gamma_{a_{m1i}} \left[a_{m1i} \left(1 - \frac{3ft}{S}\right) + b_{m1i} \right]$$

$$g_{m1i} = 0.517$$

$$m_1 \cdot g_{m1i} = 0.620$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.111$$

$$m_1 \cdot g_{m1i_lb} = 0.133$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_{m1i} := 1.17$$

Table 4.6.2.2.2b-2

$$b_{m1i} := -0.08$$

$$m_4 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_{mi}} \left[a_{mi} \left(\frac{W_c}{10ft N_g} \right) + b_{mi} \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.140$$

$$m_4 \cdot g_{mi} = 0.969$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.333$$

$$m_4 \cdot g_{mi_lb} = 0.283$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_4 \cdot g_{mi}, m_4 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.969$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.04$$

Table 4.6.2.2.2a-1

$$b_v := -0.12$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.02$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)

$$g_{s1i} := \gamma_{a_s1i} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

$$g_{s1i} = 0.649$$

$$m_1 \cdot g_{s1i} = 0.779$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{s1i_lb} = 0.111$$

$$m_1 \cdot g_{s1i_lb} = 0.133$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.99$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.01$$

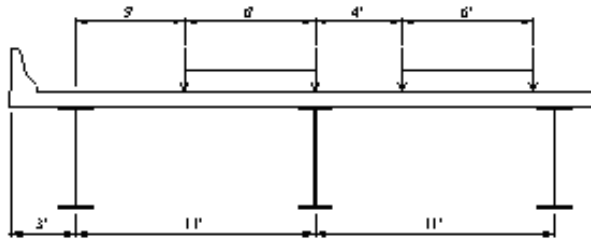
$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{si} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6 \cdot \text{ft}) + \frac{1}{2} \cdot (S - 10 \cdot \text{ft}) + \frac{1}{2} \cdot (S - 4 \cdot \text{ft})}{S} \quad \text{or} \quad g_{si} := \left(2 - 10 \frac{\text{ft}}{S} \right)$$

$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(2 - \frac{10 \cdot \text{ft}}{S} \right) + b_v \right]$$

$$g_{si} = 1.134$$

$$m_2 \cdot g_{si} = 1.134$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.222$$

$$m_2 \cdot g_{si_lb} = 0.222$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.134$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.098$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.244$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.53$$

Table 4.6.2.2.2b-1

$$b_m := 0.19$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.561$$

$$m_1 \cdot g_{m1e} = 0.673$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.111$$

$$m_1 \cdot g_{m1e_lb} = 0.133$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-1

$$b_m := -0.12$$

$$m_1 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.07$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_{m1e}} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 1.098$$

$$m_4 \cdot g_{me} = 0.933$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.333$$

$$m_4 \cdot g_{me_lb} = 0.283$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_4 \cdot g_{me}, m_4 \cdot g_{me_lb})$

$mg_{me_max} = 0.933$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.70$$

Table 4.6.2.2.2a-1

$$b_w := 0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.603$$

$$m_1 \cdot g_{s1e} = 0.724$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{s1e_lb} = 0.111$$

$$m_1 \cdot g_{s1e_lb} = 0.133$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{ww} := 0.83$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.11$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.680$$

$$m_2 \cdot g_{se} = 0.680$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{se_lb} = 0.222$$

$$m_2 \cdot g_{se_lb} = 0.222$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.724$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

$$SCF = 1.098$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.794$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 0.969$$

Shear:

$$m_{g_{si}} = 1.244$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.933$$

Shear:

$$m_{g_{se}} = 0.794$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$$N_L := 1$$

$$S_w := 11.0\text{ft}$$

girder spacing

$$L_w := 150\text{ft}$$

span length

$$\text{Exp1} := 0.40$$

Table
4C-1

$$\text{Exp2} := 0.18$$

$$\text{Exp3} := 0.00$$

$$D := 42.3$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$$g_{PF} = 0.365$$

$$a_m := 1.53$$

Table
4C-2

$$b_m := -0.17$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.04$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.403$$

$$m_1 \cdot g_{am1i} = 0.484$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.111$$

$$m_1 \cdot g_{am1i_lb} = 0.133$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.17$$

Table
4C-2

$$b_m := -0.08$$

$$m_1 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{m1i}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 1.140$$

$$m_4 \cdot g_{ami} = 0.969$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ami_lb} = 0.333$$

$$m_4 \cdot g_{ami_lb} = 0.283$$

Controlling Distribution Factor: $m_{gami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_4 \cdot g_{ami}, m_4 \cdot g_{ami_lb})$

$m_{gami_max} = 0.969$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.53 \quad \text{Table 4C-2}$$

$$b_m := 0.19$$

$$m_1 := 1.2 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_m1e} := 1.04 \quad \text{Table 4C-3}$$

$$g_{am1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.561$$

$$m_1 \cdot g_{am1e} = 0.673$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.111$$

$$m_1 \cdot g_{am1e_lb} = 0.133$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.71$$

Table 4C-2

$$b_m := 0.23$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.06$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \cdot \left[a_m \cdot \left(\frac{2}{3} + \frac{3d_e}{2S} - \frac{8 \cdot \text{ft}}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.121$$

$$m_2 \cdot g_{ame} = 0.121$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.222$$

$$m_2 \cdot g_{ame_lb} = 0.222$$

Controlling Distribution Factor: $m_{game_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$m_{game_max} = 0.673$

Summary:

Interior Girder

Moment:

$$m_{gami} := m_{gami_max}$$

$$m_{gami} = 0.969$$

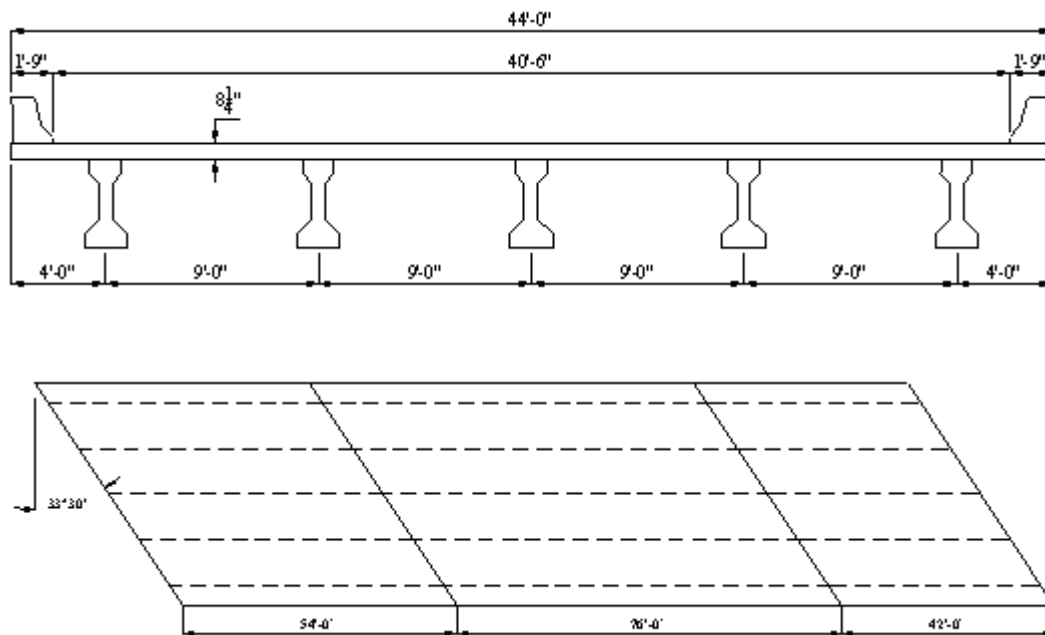
Exterior Girder

Moment:

$$m_{game} := m_{game_max}$$

$$m_{game} = 0.673$$

Precast Concrete I-Beam Bridge #1



$S_g := 9.0\text{ft}$	girder spacing
$L_1 := 54.0\text{ft}$	span length
$L_2 := 76.0\text{ft}$	span length
$L_3 := 42.0\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.25\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 40.5\text{ft}$	clear roadway width
$\theta := 33.5$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.33$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_{m1i}} \left[a_m \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.515$$

$$m_1 \cdot g_{m1i} = 0.618$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_{mi}} \left[a_m \left(\frac{W_c}{10\text{ft} N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.973$$

$$m_3 \cdot g_{mi} = 0.827$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.827$

Shear:

One Lane Loaded

$$N_{LW} := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_{LW} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_s1i} \cdot \left[a_v \cdot \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.602$$

$$m_1 \cdot g_{s1i} = 0.722$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.94$$

Table 4.6.2.2.2a-1

$$b_v := 0.03$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.954$$

$$m_2 \cdot g_{si} = 0.954$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.954$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

$$SCF = 1.060$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.011$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m1e} = 0.637$$

$$m_1 \cdot g_{m1e} = 0.764$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.25$$

Table 4.6.2.2.2b-2

$$b_m := -0.20$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.10$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_{m2e}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.894$$

$$m_3 \cdot g_{me} = 0.760$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.764$

Shear:

One Lane Loaded

$$N_{L1} := 1$$

$$a_v := 0.83$$

Table 4.6.2.2.2a-1

$$b_v := 0.07$$

$$m_{L1} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.666$$

$$m_1 \cdot g_{s1e} = 0.799$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.92$$

Table 4.6.2.2.2a-1

$$b_v := 0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.713$$

$$m_2 \cdot g_{se} = 0.713$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.799$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.060$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.847$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 0.827$$

Shear:

$$m_{g_{si}} = 1.011$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.764$$

Shear:

$$m_{g_{se}} = 0.847$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$$N_L := 1$$

$$S_w := 9.00\text{ft}$$

girder spacing

$$L_w := 42\text{ft}$$

shortest span length

$$\text{Exp1} := 0.34$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$$g_{PF} = 0.478$$

$$a_m := 1.17$$

Table
4C-2

$$b_m := -0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.519$$

$$m_1 \cdot g_{am1i} = 0.622$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.200$$

$$m_1 \cdot g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

Table
4C-2

$$b_m := -0.19$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2i}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{m2i}} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.973$$

$$m_3 \cdot g_{ami} = 0.827$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ami_lb} = 0.600$$

$$m_3 \cdot g_{ami_lb} = 0.510$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$mg_{ami_max} = 0.827$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68 \quad \text{Table 4C-2}$$

$$b_m := 0.14$$

$$m_1 := 1.2 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_m1e} := 1.04 \quad \text{Table 4C-3}$$

$$g_{am1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.637$$

$$m_1 \cdot g_{am1e} = 0.764$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.85$$

Table 4C-2

$$b_m := 0.15$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.777$$

$$m_2 \cdot g_{ame} = 0.777$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.400$$

$$m_2 \cdot g_{ame_lb} = 0.400$$

Controlling Distribution Factor: $m_{game_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$m_{game_max} = 0.777$

Summary:

Interior Girder

Moment:

$$m_{gami} := m_{gami_max}$$

$m_{gami} = 0.827$

Exterior Girder

Moment:

$$m_{game} := m_{game_max}$$

$m_{game} = 0.777$

Precast Concrete I-Beam Bridge #2

$S_w := 9.0\text{ft}$	girder spacing
$L_1 := 47.25\text{ft}$	span length
$L_2 := 67.58\text{ft}$	span length
$L_3 := 39.25\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.75\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 41.5\text{ft}$	clear roadway width
$\theta := 21.33$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.33$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.515$$

$$m_1 \cdot g_{m1i} = 0.618$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.002$$

$$m_3 \cdot g_{mi} = 0.852$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.852$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.602$$

$$m_1 \cdot g_{s1i} = 0.722$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_w := 2$$

$$a_w := 0.94$$

Table 4.6.2.2.2a-1

$$b_w := 0.03$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_v \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.954$$

$$m_2 \cdot g_{si} = 0.954$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $m_{g_{si_max}} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$m_{g_{si_max}} = 0.954$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.035$$

$$m_{g_{si}} := m_{g_{si_max}} \cdot SCF$$

$$m_{g_{si}} = 0.988$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-1

$$b_m := 0.14$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.676$$

$$m_1 \cdot g_{m1e} = 0.811$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_{Lm} := 3$$

$$a_{mm} := 1.25$$

Table 4.6.2.2.2b-2

$$b_{mv} := -0.20$$

$$m_{3v} := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.10$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.921$$

$$m_3 \cdot g_{me} = 0.783$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.811$

Shear:

One Lane Loaded

$$N_{Lm} := 1$$

$$a_{mv} := 0.83$$

Table 4.6.2.2.2a-1

$$b_{mv} := 0.07$$

$$m_{1v} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \left[a_v \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.713$$

$$m_1 \cdot g_{s1e} = 0.856$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.92$$

Table 4.6.2.2.2a-1

$$b_v := 0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.765$$

$$m_2 \cdot g_{se} = 0.765$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.856$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

$SCF = 1.035$

$mg_{se} := mg_{se_max} \cdot SCF$

$mg_{se} = 0.886$

Summary:

Interior Girder

Moment:

$mg_{mi} := mg_{mi_max}$

$mg_{mi} = 0.852$

Shear:

$mg_{si} = 0.988$

Exterior Girder

Moment:

$mg_{me} := mg_{me_max}$

$mg_{me} = 0.811$

Shear:

$mg_{se} = 0.886$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders: Moment

:

One Lane Loaded

$N_L := 1$

$S_w := 9.00\text{ft}$

girder spacing

$L_w := 39.25\text{ft}$

shortest span length

$$\text{Exp1} := 0.34$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.486$$

$$a_{m1} := 1.17$$

Table
4C-2

$$b_{m1} := -0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_{m1} g_{PF} + b_{m1})$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.529$$

$$m_1 \cdot g_{am1i} = 0.635$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.200$$

$$m_1 \cdot g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_{m1} := 1.39$$

Table
4C-2

$$b_{m1} := -0.19$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 1.002$$

$$m_3 \cdot g_{ami} = 0.852$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.600$$

$$m_3 \cdot g_{ami_lb} = 0.510$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$$mg_{ami_max} = 0.852$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4C-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.676$$

$$m_1 \cdot g_{am1e} = 0.811$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_{L_{max}} := 3$$

$$a_{mm} := 0.85$$

Table 4C-2

$$b_{mm} := 0.15$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{me}} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_{me}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.827$$

$$m_2 \cdot g_{ame} = 0.827$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.600$$

$$m_2 \cdot g_{ame_lb} = 0.600$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.827$

Summary:

Interior Girder

Moment:

$$m_{gami} := m_{gami_max}$$

$$m_{gami} = 0.852$$

Exterior Girder

Moment:

$$m_{game} := m_{game_max}$$

$$m_{game} = 0.827$$

Precast Concrete I-Beam Bridge #3

$S_g := 10.5\text{ft}$	girder spacing
$L_1 := 75.0\text{ft}$	span length
$L_2 := 75.0\text{ft}$	span length
$L_3 := 75.0\text{ft}$	span length
$L_4 := 75.0\text{ft}$	span length
$L_5 := 75.0\text{ft}$	span length
$t_s := 8.75\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.75\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 47.5\text{ft}$	clear roadway width
$\theta := 74.33$	skew angle

NOTE: Since $\theta > 60$, a rigorous analysis is required. However, for purpose of calculations, θ will be limited to 60.

Use $\theta := 60$

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.33$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.583$$

$$m_1 \cdot g_{m1i} = 0.700$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.176$$

$$m_3 \cdot g_{mi} = 0.999$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$$mg_{mi_max} = 0.999$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.654$$

$$m_1 \cdot g_{s1i} = 0.785$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.94$$

Table 4.6.2.2.2a-1

$$b_w := 0.03$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_w \left(2 - \frac{10\text{ft}}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.055$$

$$m_2 \cdot g_{si} = 1.055$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.055$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.156$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.220$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.701$$

$$m_1 \cdot g_{m1e} = 0.842$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.25$$

Table 4.6.2.2.2b-2

$$b_m := -0.20$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.10$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 1.086$$

$$m_3 \cdot g_{me} = 0.923$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.923$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.07$$

$$m_{1w} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1e}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.744$$

$$m_1 \cdot g_{s1e} = 0.893$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_{Lw} := 2$$

$$a_{ww} := 0.92$$

Table 4.6.2.2.2a-2

$$b_{ww} := 0.06$$

$$m_{2w} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.854$$

$$m_2 \cdot g_{se} = 0.854$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.893$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.156$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 1.032$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.999$$

Shear:

$$mg_{si} = 1.220$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 0.923$$

Shear:

$$mg_{se} = 1.032$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

**Interior
Girders:
Moment**

:

One Lane Loaded

$$N_L := 1$$

$$S := 10.5\text{ft}$$

girder spacing

$$L := 75.00\text{ft}$$

span length

$$\text{Exp1} := 0.34$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.451$$

$$a_m := 1.17$$

Table
4C-2

$$b_m := -0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_m1i} \cdot (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.485$$

$$m_1 \cdot g_{am1i} = 0.582$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.200$$

$$m_1 \cdot g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

$$b_m := -0.19$$

$$m_2 := 0.85$$

$$\gamma_{a_mi} := 1.04$$

$$g_{ami} := \gamma_{a_mi} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

$$g_{ami} = 1.176$$

$$m_3 \cdot g_{ami} = 0.999$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

$$g_{ami_lb} = 0.600$$

$$m_3 \cdot g_{ami_lb} = 0.510$$

Table
4C-2

Table 3.6.1.1.2-1

Table 4C-3

Eq. 4C-1
Eq. 4C-2
Table 4C-1

Eq. 4C-1

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$m g_{ami_max} = 0.999$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_{m1} := 0.68$$

Table 4C-2

$$b_{m1} := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \left[a_{m1} \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_{m1} \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.701$$

$$m_1 \cdot g_{am1e} = 0.842$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_{L2} := 2$$

$$a_{m2} := 0.85$$

Table 4C-2

$$b_{m2} := 0.15$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_{m2e}} \left[a_{m2} \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_{m2} \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.912$$

$$m_2 \cdot g_{ame} = 0.912$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.400$$

$$m_2 \cdot g_{ame_lb} = 0.400$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$$mg_{ame_max} = 0.912$$

Summary:

Interior Girder

Moment:

$$mg_{ami} := mg_{ami_max}$$

$$mg_{ami} = 0.999$$

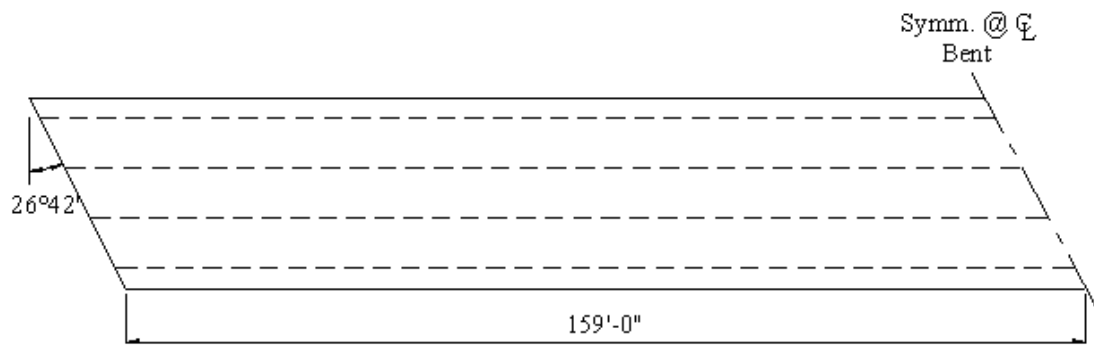
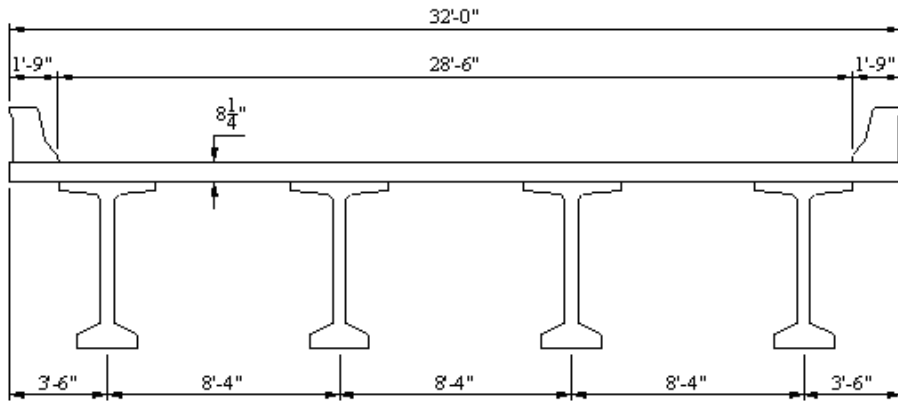
Exterior Girder

Moment:

$$mg_{ame} := mg_{ame_max}$$

$$mg_{ame} = 0.912$$

Precast Concrete Bulb Tee Beam Bridge #1



- $S_g := 8.33\text{ft}$ girder spacing
- $L_1 := 159\text{ft}$ span length
- $L_2 := 159\text{ft}$ span length
- $t_s := 8.25\text{in}$ slab thickness
- $N_g := 4$ number of girders
- $d_e := -0.25\text{ft}$ distance from center of the exterior girder to the location of the outer most wheel load
- $W_c := 28.5\text{ft}$ clear roadway width
- $\theta := 26.7$ skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.33$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

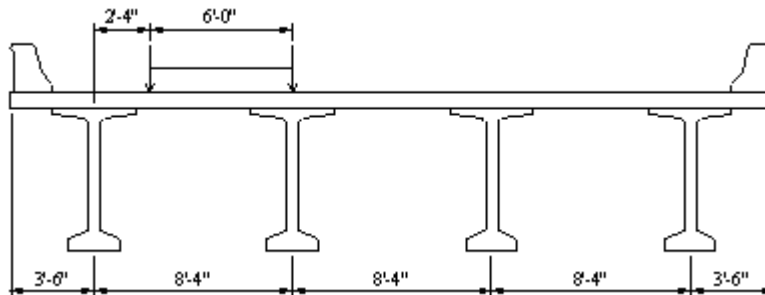
$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_mli} := 1.08$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{mli} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6ft)}{S} \quad \text{or} \quad g_{mli} := \left(1 - \frac{3ft}{S}\right)$$

$$g_{mli} := \gamma_{a_mli} \left[a_m \cdot \left(1 - \frac{3ft}{S}\right) + b_m \right]$$

$$g_{mli} = 0.476$$

$$m_1 \cdot g_{mli} = 0.572$$

Lower Bound Distribution Factor

$$g_{mli_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{mli_lb} = 0.250$$

$$m_1 \cdot g_{mli_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_{mi}} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.832$$

$$m_2 \cdot g_{mi} = 0.832$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.500$$

$$m_2 \cdot g_{mi_lb} = 0.500$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.832$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_sli} := 1.02$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)

$$g_{sli} := \gamma_{a_sli} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

$$g_{sli} = 0.572$$

$$m_1 \cdot g_{sli} = 0.687$$

Lower Bound Distribution Factor

$$g_{sli_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{sli_lb} = 0.250$$

$$m_1 \cdot g_{sli_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.94$$

Table 4.6.2.2.2a-1

$$b_v := 0.03$$

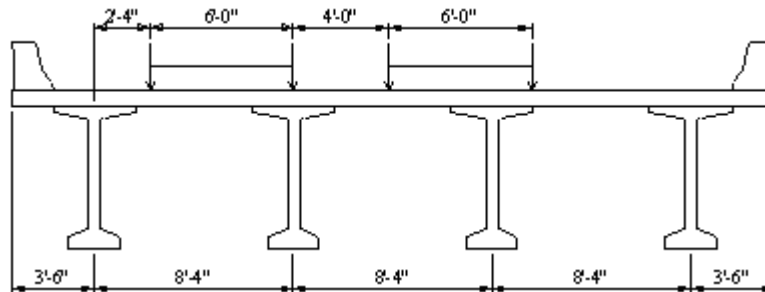
$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_si} := 1.04$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{si} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6\text{-ft}) - \frac{1}{2} \cdot (S - 4\text{-ft})}{S} \quad \text{or} \quad g_{si} := \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right)$$

$$g_{si} := \gamma_{a_si} \cdot \left[a_v \cdot \left(\frac{3}{2} - \frac{5ft}{S} \right) + b_v \right]$$

$$g_{si} = 0.911$$

$$m_2 \cdot g_{si} = 0.911$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.500$$

$$m_2 \cdot g_{si_lb} = 0.500$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.911$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.045$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 0.952$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.577$$

$$m_1 \cdot g_{m1e} = 0.692$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.250$$

$$m_1 \cdot g_{m1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.25$$

Table 4.6.2.2.2b-2

$$b_m := -0.20$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.10$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.760$$

$$m_2 \cdot g_{me} = 0.760$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.500$$

$$m_2 \cdot g_{me_lb} = 0.500$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$$mg_{me_max} = 0.760$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 0.83$$

Table 4.6.2.2.2a-1

$$b_v := 0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.593$$

$$m_1 \cdot g_{s1e} = 0.712$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.250$$

$$m_1 \cdot g_{s1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.92$$

Table 4.6.2.2.2a-1

$$b_v := 0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Table 4.6.2.2.2a-1

$$g_{se} = 0.633$$

$$m_2 \cdot g_{se} = 0.633$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.500$$

$$m_2 \cdot g_{se_lb} = 0.500$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.712$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.045$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.744$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.832$$

Shear:

$$mg_{si} = 0.952$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 0.760$$

Shear:

$$m_{g_{se}} = 0.744$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders: Moment

:

One Lane Loaded

$$N_g := 1$$

$$L := 159\text{ft}$$

span length

$$\text{Exp1} := 0.34$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.323$$

$$a_m := 1.17$$

Table
4C-2

$$b_m := -0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.326$$

$$m_1 \cdot g_{am1i} = 0.391$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1i_lb} = 0.250$$

$$m_1 \cdot g_{am1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.39$$

Table
4C-2

$$b_m := -0.19$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_mi} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.832$$

$$m_2 \cdot g_{ami} = 0.832$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.500$$

$$m_2 \cdot g_{ami_lb} = 0.500$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$m g_{ami_max} = 0.832$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{L1} := 1$$

$$a_{m1} := 0.68$$

Table 4C-2

$$b_{m1} := 0.14$$

$$m_{1v} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \left[a_{m1} \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_{m1} \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.577$$

$$m_1 \cdot g_{am1e} = 0.692$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.250$$

$$m_1 \cdot g_{am1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_{L2} := 1$$

$$a_{m2} := 0.85$$

Table 4C-2

$$b_{m2} := 0.15$$

$$m_{2v} := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_{m2e}} \left[a_{m2} \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_{m2} \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.702$$

$$m_2 \cdot g_{ame} = 0.702$$

Lower Bound Distribution Factor

$$g_{\text{ame_lb}} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{\text{ame_lb}} = 0.250$$

$$m_2 \cdot g_{\text{ame_lb}} = 0.250$$

Controlling Distribution Factor: $m_{\text{game_max}} := \max(m_1 \cdot g_{\text{ame}}, m_1 \cdot g_{\text{ame_lb}}, m_2 \cdot g_{\text{ame}}, m_2 \cdot g_{\text{ame_lb}})$

$$m_{\text{game_max}} = 0.702$$

Summary:

Interior Girder

Moment:

$$m_{\text{gami}} := m_{\text{gami_max}}$$

$$m_{\text{gami}} = 0.832$$

Exterior Girder

Moment:

$$m_{\text{game}} := m_{\text{game_max}}$$

$$m_{\text{game}} = 0.702$$

Precast Concrete Bulb Tee Beam Bridge #2

$S_g := 8.75\text{ft}$	girder spacing
$L_1 := 124.33\text{ft}$	span length
$L_2 := 124.0\text{ft}$	span length
$L_3 := 124.0\text{ft}$	span length
$L_4 := 124.33\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.75\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 40.5\text{ft}$	clear roadway width
$\theta := 15.0$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.33$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_{m1i}} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.501$$

$$m_1 \cdot g_{m1i} = 0.601$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{mi} = 0.973$$

$$m_3 \cdot g_{mi} = 0.827$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.827$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.591$$

$$m_1 \cdot g_{s1i} = 0.710$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.94$$

Table 4.6.2.2.2a-1

$$b_w := 0.03$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_w \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.939$$

$$m_2 \cdot g_{si} = 0.939$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.939$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.024$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 0.962$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.671$$

$$m_1 \cdot g_{m1e} = 0.805$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.25$$

Table 4.6.2.2.2b-2

$$b_m := -0.20$$

$$m_a := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.10$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.894$$

$$m_3 \cdot g_{me} = 0.760$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.805$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.707$$

$$m_1 \cdot g_{s1e} = 0.849$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.92$$

Table 4.6.2.2.2a-2

$$b_w := 0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.758$$

$$m_2 \cdot g_{se} = 0.758$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.849$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.024$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.869$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.827$$

Shear:

$$mg_{si} = 0.962$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 0.805$$

Shear:

$$mg_{se} = 0.869$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior

Girders:

Moment

:

One Lane Loaded

$$N_{\text{L}} := 1$$

$$S := 8.75\text{ft}$$

$$L := 124.00\text{ft}$$

$$\text{Exp1} := 0.34$$

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{\text{PF}} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_{\text{g}}}\right)^{\text{Exp3}}$$

$$g_{\text{PF}} = 0.355$$

$$a_{\text{m}} := 1.17$$

$$b_{\text{m}} := -0.07$$

$$m_{\text{L}} := 1.2$$

$$\gamma_{\text{a}_{\text{m}}\text{m}_{\text{L}}} := 1.06$$

$$g_{\text{amLi}} := \gamma_{\text{a}_{\text{m}}\text{m}_{\text{L}}} (a_{\text{m}} \cdot g_{\text{PF}} + b_{\text{m}})$$

$$g_{\text{amLi}} = 0.366$$

$$m_{\text{L}} \cdot g_{\text{amLi}} = 0.439$$

Lower Bound Distribution Factor

$$g_{\text{amLi_lb}} := \left(\frac{N_{\text{L}}}{N_{\text{g}}}\right)$$

$$g_{\text{amLi_lb}} = 0.200$$

$$m_{\text{L}} \cdot g_{\text{amLi_lb}} = 0.240$$

Two or More Lanes Loaded

$$N_{\text{L}} := 1$$

girder spacing

shortest span length

Table
4C-1

Eq. 4C-3

Table
4C-2

Table 3.6.1.1.2-1

Table 4C-3

Eq. 4C-1
Table 4C-1

Eq. 4C-1

$$a_{mi} := 1.39$$

Table
4C-2

$$b_{mi} := -0.19$$

$$m_{2v} := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} \left[a_{mi} \left(\frac{W_c}{10ft N_g} \right) + b_{mi} \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.973$$

$$m_3 \cdot g_{ami} = 0.827$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.200$$

$$m_3 \cdot g_{ami_lb} = 0.170$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$$mg_{ami_max} = 0.827$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_{mi} := 0.68$$

Table 4C-2

$$b_{mi} := 0.14$$

$$m_{1v} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_m1e} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.671$$

$$m_1 \cdot g_{am1e} = 0.805$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 1$$

$$a_m := 0.85$$

Table 4C-2

$$b_m := 0.15$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.821$$

$$m_2 \cdot g_{ame} = 0.821$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.200$$

$$m_2 \cdot g_{ame_lb} = 0.200$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$$m_{g_{ame_max}} = 0.821$$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$$m_{g_{ami}} = 0.827$$

Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$$m_{g_{ame}} = 0.821$$

Precast Concrete Bulb Tee Beam Bridge #3

$S_g := 10.29\text{ft}$	girder spacing
$L_1 := 85.63\text{ft}$	span length
$L_2 := 114.83\text{ft}$	span length
$L_3 := 115.49\text{ft}$	span length
$L_4 := 115.49\text{ft}$	span length
$L_5 := 115.49\text{ft}$	span length
$L_6 := 85.63\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 8$	number of girders
$d_e := 0.60\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 77.23\text{ft}$	clear roadway width
$\theta := 0$	skew angle

Interior Girders: Moment

:
One Lane Loaded

$N_L := 1$	
$a_m := 1.33$	Table 4.6.2.2.2b-2
$b_m := -0.41$	
$m_1 := 1.2$	Table 3.6.1.1.2-1
$\gamma_{a_m1i} := 1.08$	Table 4.6.2.2.1-2
$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$	Table 4.6.2.2.2b-1 Table B4-1
$g_{m1i} = 0.575$	
$m_1 \cdot g_{m1i} = 0.690$	

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.125$$

$$m_1 \cdot g_{m1i_lb} = 0.150$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_4 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.198$$

$$m_4 \cdot g_{mi} = 1.018$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.375$$

$$m_4 \cdot g_{mi_lb} = 0.319$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_4 \cdot g_{mi}, m_4 \cdot g_{mi_lb})$

$mg_{mi_max} = 1.018$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.648$$

$$m_1 \cdot g_{s1i} = 0.777$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.125$$

$$m_1 \cdot g_{s1i_lb} = 0.150$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.94$$

Table 4.6.2.2.2a-1

$$b_w := 0.03$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_w \left(2 - \frac{10ft}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.036$$

$$m_2 \cdot g_{si} = 1.036$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.250$$

$$m_2 \cdot g_{si_lb} = 0.250$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.036$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$mg_{si} = 1.036$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.688$$

$$m_1 \cdot g_{m1e} = 0.825$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.125$$

$$m_1 \cdot g_{m1e_lb} = 0.150$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.25$$

Table 4.6.2.2.2b-2

$$b_m := -0.20$$

$$m_M := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.10$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 1.107$$

$$m_4 \cdot g_{me} = 0.941$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.375$$

$$m_4 \cdot g_{me_lb} = 0.319$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_4 \cdot g_{me}, m_4 \cdot g_{me_lb})$

$mg_{me_max} = 0.941$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1e}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.728$$

$$m_1 \cdot g_{s1e} = 0.873$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.125$$

$$m_1 \cdot g_{s1e_lb} = 0.150$$

Two or More Lanes Loaded

$$N_L := 1$$

$$a_{wv} := 0.92$$

Table 4.6.2.2.2a-1

$$b_{wv} := 0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \cdot \left[a_v \cdot \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.821$$

$$m_2 \cdot g_{se} = 0.821$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.125$$

$$m_2 \cdot g_{se_lb} = 0.125$$

Controlling Distribution Factor: $m_{g_{se_max}} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$m_{g_{se_max}} = 0.873$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$m_{g_{se}} := m_{g_{se_max}} \cdot SCF$$

$$m_{g_{se}} = 0.873$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 1.018$$

Shear:

$$m_{g_{si}} = 1.036$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.941$$

Shear:

$$m_{g_{se}} = 0.873$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

**Interior
Girders:
Moment**

:
One Lane Loaded

$$N_L := 1$$

$$S := 10.29\text{ft}$$

girder spacing

$$L := 85.63\text{ft}$$

shortest span length

$$\text{Exp1} := 0.34$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.430$$

$$a_m := 1.17$$

Table
4C-2

$$b_m := -0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_m1i} \cdot (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.460$$

$$m_1 \cdot g_{am1i} = 0.551$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.125$$

$$m_1 \cdot g_{am1i_lb} = 0.150$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.39$$

$$b_m := -0.19$$

$$m_A := 0.85$$

$$\gamma_{a_mi} := 1.04$$

$$g_{ami} := \gamma_{a_mi} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

$$g_{ami} = 1.198$$

$$m_4 \cdot g_{ami} = 1.018$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

$$g_{ami_lb} = 0.375$$

$$m_4 \cdot g_{ami_lb} = 0.319$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_4 \cdot g_{ami}, m_4 \cdot g_{ami_lb})$

$mg_{ami_max} = 1.018$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_{mv} := 0.68$$

Table 4C-2

$$b_{mv} := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.688$$

$$m_1 \cdot g_{am1e} = 0.825$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.125$$

$$m_1 \cdot g_{am1e_lb} = 0.150$$

Two or More Lanes Loaded

$$N_{L2} := 1$$

$$a_{mv} := 0.85$$

Table 4C-2

$$b_{mv} := 0.15$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_{m2e}} \left[a_m \left(\frac{2}{3} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.137$$

$$m_2 \cdot g_{ame} = 0.137$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.125$$

$$m_2 \cdot g_{\text{ame_lb}} = 0.125$$

Controlling Distribution Factor: $mg_{\text{ame_max}} := \max(m_1 \cdot g_{\text{am1e}}, m_1 \cdot g_{\text{am1e_lb}}, m_2 \cdot g_{\text{ame}}, m_2 \cdot g_{\text{ame_lb}})$

$$mg_{\text{ame_max}} = 0.825$$

Summary:

Interior Girder

Moment:

$$mg_{\text{ami}} := mg_{\text{ami_max}}$$

$$mg_{\text{ami}} = 1.018$$

Exterior Girder

Moment:

$$mg_{\text{ame}} := mg_{\text{ame_max}}$$

$$mg_{\text{ame}} = 0.825$$

Precast Concrete Bulb Tee Beam Bridge #4

$S_w := 8.33\text{ft}$	girder spacing
$L_1 := 139.33\text{ft}$	span length
$L_2 := 151.33\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 4$	number of girders
$d_e := -0.25\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 28.5\text{ft}$	clear roadway width
$\theta := 17.50$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.33$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

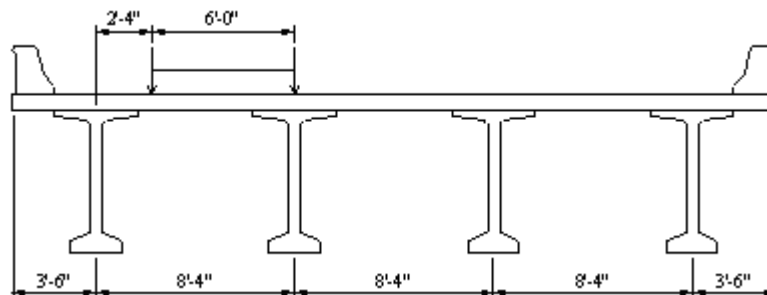
$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.08$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{m1i} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6ft)}{S} \quad \text{or} \quad g_{m1i} := \left(1 - \frac{3ft}{S}\right)$$

$$g_{m1i} := \gamma_{a_{m1i}} \left[a_m \cdot \left(1 - \frac{3ft}{S}\right) + b_m \right]$$

$$g_{m1i} = 0.476$$

$$m_1 \cdot g_{m1i} = 0.572$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.250$$

$$m_1 \cdot g_{m1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.39$$

Table 4.6.2.2.2b-2

$$b_m := -0.19$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_{mi}} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.832$$

$$m_2 \cdot g_{mi} = 0.832$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.500$$

$$m_2 \cdot g_{mi_lb} = 0.500$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.832$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.08$$

Table 4.6.2.2.2a-1

$$b_v := -0.13$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.02$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)

$$g_{s1i} := \gamma_{a_s1i} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

$$g_{s1i} = 0.572$$

$$m_1 \cdot g_{s1i} = 0.687$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.250$$

$$m_1 \cdot g_{s1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.94$$

Table 4.6.2.2.2a-1

$$b_w := 0.03$$

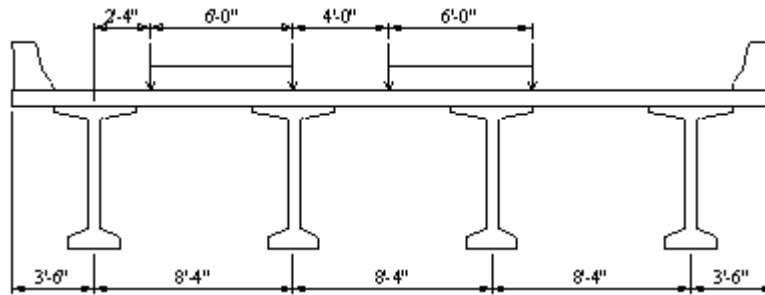
$$m_{2v} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.04$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{si} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6 \cdot \text{ft}) - \frac{1}{2} \cdot (S - 4 \cdot \text{ft})}{S} \quad \text{or} \quad g_{si} := \left(\frac{3}{2} - \frac{5 \cdot \text{ft}}{S} \right)$$

$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(\frac{3}{2} - \frac{5 \cdot \text{ft}}{S} \right) + b_v \right]$$

$$g_{si} = 0.911$$

$$m_2 \cdot g_{si} = 0.911$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.500$$

$$m_2 \cdot g_{si_lb} = 0.500$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.911$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.028$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 0.937$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68$$

Table 4.6.2.2.2b-2

$$b_m := 0.14$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.577$$

$$m_1 \cdot g_{m1e} = 0.692$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.250$$

$$m_1 \cdot g_{m1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.25$$

Table 4.6.2.2.2b-2

$$b_m := -0.20$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.10$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_{m2e}} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.760$$

$$m_2 \cdot g_{me} = 0.760$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.500$$

$$m_2 \cdot g_{me_lb} = 0.500$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$mg_{me_max} = 0.760$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B-2

$$g_{s1e} = 0.593$$

$$m_1 \cdot g_{s1e} = 0.712$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.250$$

$$m_1 \cdot g_{s1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{ww} := 0.92$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Table 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.633$$

$$m_2 \cdot g_{se} = 0.633$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.500$$

$$m_2 \cdot g_{se_lb} = 0.500$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.712$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.09 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.028$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.732$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$m_{g_{mi}} = 0.832$$

Shear:

$$m_{g_{si}} = 0.937$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.760$$

Shear:

$$m_{g_{se}} = 0.732$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior
Girders:
Moment

:

One Lane Loaded

$$N_L := 1$$

$$S_w := 8.33\text{ft}$$

girder spacing

$$L_w := 139.33\text{ft}$$

shortest span length

$$\text{Exp1} := 0.34$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.00$$

$$D := 24.30$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.334$$

$$a_m := 1.17$$

Table
4C-2

$$b_{mv} := -0.07$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} \cdot (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.340$$

$$m_1 \cdot g_{am1i} = 0.408$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.250$$

$$m_1 \cdot g_{am1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{mv} := 1.39$$

Table
4C-2

$$b_{mv} := -0.19$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2i}} := 1.04$$

Table 4C-3

$$g_{ami} := \gamma_{a_{m2i}} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.832$$

$$m_2 \cdot g_{ami} = 0.832$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ami_lb} = 0.500$$

$$m_2 \cdot g_{ami_lb} = 0.500$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$m g_{ami_max} = 0.832$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.68 \quad \text{Table 4C-2}$$

$$b_m := 0.14$$

$$m_1 := 1.2 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_m1e} := 1.04 \quad \text{Table 4C-3}$$

$$g_{am1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.577$$

$$m_1 \cdot g_{am1e} = 0.692$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.250$$

$$m_1 \cdot g_{am1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.85$$

Table 4C-2

$$b_m := 0.15$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a-me} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a-me} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.702$$

$$m_2 \cdot g_{ame} = 0.702$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.750$$

$$m_2 \cdot g_{ame_lb} = 0.750$$

Controlling Distribution Factor: $m_{game_max} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$$m_{game_max} = 0.750$$

Summary:

Interior Girder

Moment:

$$m_{gami} := m_{gami_max}$$

$$m_{gami} = 0.832$$

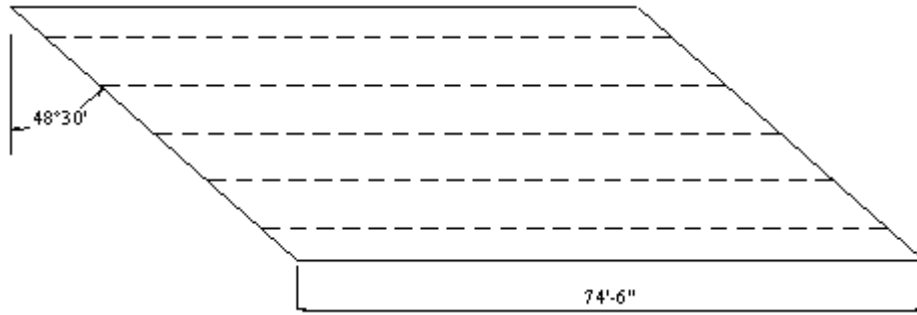
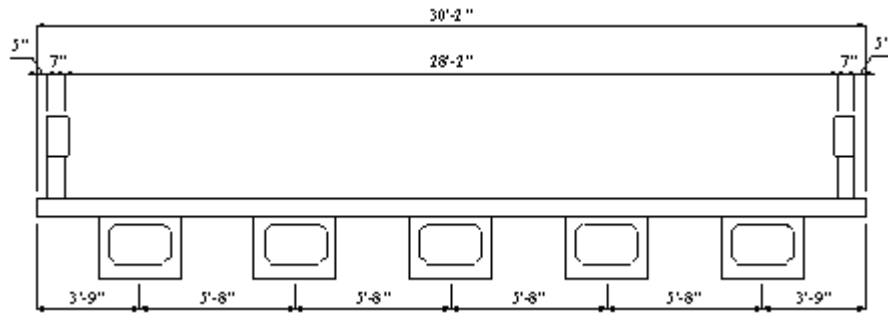
Exterior Girder

Moment:

$$m_{game} := m_{game_max}$$

$$m_{game} = 0.750$$

Precast Concrete Spread Box Beam Bridge #1



$S_g := 5.67\text{ft}$	girder spacing
$L_1 := 74.5\text{ft}$	span length
$t_s := 8.25\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.58\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 27.83\text{ft}$	clear roadway width
$\theta := 48.49$	skew angle
$d := 27\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.77$$

Table 4.6.2.2.2b-2

$$b_m := -0.17$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_{m1i}} \left[a_m \cdot \left(\frac{1}{2} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.232$$

$$m_1 \cdot g_{m1i} = 0.279$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.90$$

Table 4.6.2.2.2b-1

$$b_m := 0.00$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.07$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_{mi}} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.536$$

$$m_2 \cdot g_{mi} = 0.536$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.400$$

$$m_2 \cdot g_{mi_lb} = 0.400$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.536$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.00$$

Table 4.6.2.2.2a-1

$$b_v := -0.11$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_s1i} \left[a_v \cdot \left(\frac{1}{2} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.402$$

$$m_1 \cdot g_{s1i} = 0.482$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(1 - \frac{2ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.625$$

$$m_2 \cdot g_{si} = 0.625$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.625$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{in}{ft}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.430$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 0.894$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.62$$

Table 4.6.2.2.2b-2

$$b_m := -0.08$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.14$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.314$$

$$m_1 \cdot g_{m1e} = 0.377$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.00$$

Table 4.6.2.2.2b-2

$$b_m := -0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_{m2e}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m2e} = 0.516$$

$$m_2 \cdot g_{me} = 0.516$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.400$$

$$m_2 \cdot g_{me_lb} = 0.400$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$mg_{me_max} = 0.516$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.61$$

Table 4.6.2.2.2a-1

$$b_w := 0.15$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.510$$

$$m_1 \cdot g_{s1e} = 0.612$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.78$$

Table 4.6.2.2.2a-1

$$b_v := 0.12$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.584$$

$$m_2 \cdot g_{se} = 0.584$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.612$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{in}{ft}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.430$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.875$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 0.536$$

Shear:

$$m_{g_{si}} = 0.894$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.516$$

Shear:

$$m_{g_{se}} = 0.875$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$$N_L := 1$$

$$S := 5.67\text{ft}$$

girder distance

$$L := 74.5\text{ft}$$

span length

$$\text{Exp1} := 0.00$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.316$$

$$a_m := 1.85$$

Table
4C-2

$$b_m := -0.30$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.11$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.316$$

$$m_1 \cdot g_{am1i} = 0.379$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.200$$

$$m_1 \cdot g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.90$$

Table
4C-2

$$b_m := 0.00$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2i}} := 1.07$$

Table 4C-3

$$g_{ami} := \gamma_{a_{m2i}} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.536$$

$$m_2 \cdot g_{ami} = 0.536$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ami_lb} = 0.400$$

$$m_2 \cdot g_{ami_lb} = 0.400$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$m g_{ami_max} = 0.536$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$Exp1 := 0.00$$

Table
4C-1

$$Exp2 := 0.26$$

$$Exp3 := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot ft} \right)^{Exp1} \left(\frac{S}{L} \right)^{Exp2} \left(\frac{1}{N_g} \right)^{Exp3}$$

Eq. 4C-3

$$g_{PF} = 0.316$$

$$a_m := 2.26$$

Table
4C-2

$$b_m := -0.35$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.10$$

Table 4C-3

$$g_{am1e} := \gamma_{a_m1e} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.400$$

$$m_1 \cdot g_{am1e} = 0.480$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.54 \quad \text{Table 4C-2}$$

$$b_m := 0.19$$

$$m_2 := 1.00 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_me} := 1.07 \quad \text{Table 4C-3}$$

$$g_{ame} := \gamma_{a_me} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right] \quad \begin{array}{l} \text{Eq. 4C-1} \\ \text{Table 4C-1} \\ \text{Table B4-2} \end{array}$$

$$g_{ame} = 0.534$$

$$m_2 \cdot g_{ame} = 0.534$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.400$$

$$m_2 \cdot g_{ame_lb} = 0.400$$

Controlling Distribution Factor: $m_{g_{ame_max}} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$m_{g_{ame_max}} = 0.534$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$$m_{g_{ami}} = 0.536$$

Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$$m_{g_{ame}} = 0.534$$

Precast Concrete Spread Box Beam Bridge #2

$S_g := 10.58\text{ft}$	girder spacing
$L_1 := 60.88\text{ft}$	span length
$L_2 := 60.25\text{ft}$	span length
$L_3 := 60.88\text{ft}$	span length
$t_s := 8\text{in}$	slab thickness
$N_g := 3$	number of girders
$d_e := 0.67\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 26.5\text{ft}$	clear roadway width
$\theta := 15.0$	skew angle
$d := 30\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.77$$

Table 4.6.2.2.2b-2

$$b_m := -0.17$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.412$$

$$m_1 \cdot g_{m1i} = 0.495$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.333$$

$$m_1 \cdot g_{m1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.90$$

Table 4.6.2.2.2b-2

$$b_m := 0.00$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.07$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.851$$

$$m_2 \cdot g_{mi} = 0.851$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.667$$

$$m_2 \cdot g_{mi_lb} = 0.667$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.851$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.00$$

Table 4.6.2.2.2a-1

$$b_v := -0.11$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_s1i} \left[a_v \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.625$$

$$m_1 \cdot g_{s1i} = 0.750$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.333$$

$$m_1 \cdot g_{s1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_si} := 1.03$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_si} \left[a_w \cdot \left(2 - \frac{10\text{ft}}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.974$$

$$m_2 \cdot g_{si} = 0.974$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.667$$

$$m_2 \cdot g_{si_lb} = 0.667$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{s1i}, m_1 \cdot g_{s1i_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.974$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{\text{in}}{\text{ft}}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.052$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.025$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.62$$

Table 4.6.2.2.2b-2

$$b_m := -0.08$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.14$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.460$$

$$m_1 \cdot g_{m1e} = 0.552$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.333$$

$$m_1 \cdot g_{m1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.00$$

Table 4.6.2.2.2b-2

$$b_m := -0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.04$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.856$$

$$m_2 \cdot g_{me} = 0.856$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.667$$

$$m_2 \cdot g_{me_lb} = 0.667$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$$mg_{me_max} = 0.856$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_{ww} := 0.61$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.15$$

$$m_{1w} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1e}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.638$$

$$m_1 \cdot g_{s1e} = 0.766$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.333$$

$$m_1 \cdot g_{s1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_{1w} := 2$$

$$a_{ww} := 0.78$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.12$$

$$m_{2w} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \cdot a_v \cdot \left[\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.798$$

$$m_2 \cdot g_{se} = 0.798$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.667$$

$$m_2 \cdot g_{se_lb} = 0.667$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.798$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{\text{in}}{\text{ft}}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.052$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.839$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.851$$

Shear:

$$mg_{si} = 1.025$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 0.856$$

Shear:

$$mg_{se} = 0.839$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$S := 10.58\text{ft}$$

girder distance

$$L := 60.25\text{ft}$$

shortest span length

$$\text{Exp1} := 0.00$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.458$$

$$a_m := 1.85$$

Table
4C-2

$$b_m := -0.30$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m m_1} := 1.11$$

Table 4C-3

$$g_{am1i} := \gamma_{a_m m_1} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.607$$

$$m_1 \cdot g_{am1i} = 0.728$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{ami_lb} = 0.333$$

$$m_1 \cdot g_{ami_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.90$$

$$b_m := 0.00$$

$$m_2 := 1.00$$

$$\gamma_{a_mi} := 1.07$$

$$g_{ami} := \gamma_{a_mi} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

$$g_{ami} = 0.851$$

$$m_2 \cdot g_{ami} = 0.851$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

$$g_{ami_lb} = 0.667$$

$$m_2 \cdot g_{ami_lb} = 0.667$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$$mg_{ami_max} = 0.851$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$Exp1 := 0.00$$

Table
4C-2

Table 3.6.1.1.2-1

Table 4C-3

Eq. 4C-1
Eq. 4C-2
Table 4C-1

Eq. 4C-1

Table
4C-1

$$Exp2 := 0.26$$

$$Exp3 := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$$g_{PF} = 0.458$$

$$a_m := 2.26$$

Table
4C-2

$$b_m := -0.35$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.10$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.752$$

$$m_1 \cdot g_{am1e} = 0.903$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.333$$

$$m_1 \cdot g_{am1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.54$$

Table 4C-2

$$b_m := 0.19$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.07$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \left[a_m \left(\frac{2}{3} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.206$$

$$m_2 \cdot g_{ame} = 0.206$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.667$$

$$m_2 \cdot g_{ame_lb} = 0.667$$

Controlling Distribution Factor: $m_{g_{ame_max}} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$$m_{g_{ame_max}} = 0.903$$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$$m_{g_{ami}} = 0.851$$

Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$$m_{g_{ame}} = 0.903$$

Precast Concrete Spread Box Beam Bridge #3

$S_g := 13.75\text{ft}$	girder spacing
$L_1 := 44.38\text{ft}$	span length
$L_2 := 43.75\text{ft}$	span length
$L_3 := 44.38\text{ft}$	span length
$t_s := 8.75\text{in}$	slab thickness
$N_g := 2$	number of girders
$d_e := 3.12\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 24\text{ft}$	clear roadway width
$\theta := 0$	skew angle
$d := 24\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.77$$

Table 4.6.2.2.2b-2

$$b_m := -0.17$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.467$$

$$m_1 \cdot g_{m1i} = 0.560$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.500$$

$$m_1 \cdot g_{m1i_lb} = 0.600$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.90$$

Table 4.6.2.2.2b-2

$$b_m := 0.00$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.07$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.156$$

$$m_2 \cdot g_{mi} = 1.156$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 1.000$$

$$m_2 \cdot g_{mi_lb} = 1.000$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 1.156$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.00$$

Table 4.6.2.2.2a-1

$$b_v := -0.11$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.692$$

$$m_1 \cdot g_{s1i} = 0.830$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.500$$

$$m_1 \cdot g_{s1i_lb} = 0.600$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_w \left(2 - \frac{10ft}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.160$$

$$m_2 \cdot g_{si} = 1.160$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 1.000$$

$$m_2 \cdot g_{si_lb} = 1.000$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{s1i}, m_1 \cdot g_{s1i_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.160$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{\text{in}}{\text{ft}}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.160$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.62$$

Table 4.6.2.2.2b-1

$$b_m := -0.08$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.14$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.622$$

$$m_1 \cdot g_{m1e} = 0.746$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.500$$

$$m_1 \cdot g_{m1e_lb} = 0.600$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.00$$

Table 4.6.2.2.2b-2

$$b_m := -0.06$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.04$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 1.186$$

$$m_2 \cdot g_{me} = 1.186$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 1.000$$

$$m_2 \cdot g_{me_lb} = 1.000$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$$mg_{me_max} = 1.186$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_{ww} := 0.61$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.15$$

$$m_{1w} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1e}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.781$$

$$m_1 \cdot g_{s1e} = 0.937$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.500$$

$$m_1 \cdot g_{s1e_lb} = 0.600$$

Two or More Lanes Loaded

$$N_{Lw} := 2$$

$$a_{ww} := 0.78$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.12$$

$$m_{2w} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \cdot a_v \cdot \left[2 + \frac{d_e}{S} - \frac{16ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.978$$

$$m_2 \cdot g_{se} = 0.978$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 1.000$$

$$m_2 \cdot g_{se_lb} = 1.000$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 1.000$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{\text{in}}{\text{ft}}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 1.000$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 1.156$$

Shear:

$$mg_{si} = 1.160$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 1.186$$

Shear:

$$mg_{se} = 1.000$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

**Interior
Girders:
Moment**

:
One Lane Loaded

$$N_L := 1$$

$$S := 13.75\text{ft}$$

girder distance

$$L := 43.75\text{ft}$$

shortest span length

$$\text{Exp1} := 0.00$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.601$$

$$a_m := 1.85$$

Table
4C-2

$$b_m := -0.30$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m b_m} := 1.11$$

Table 4C-3

$$g_{amli} := \gamma_{a_m b_m} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{amli} = 0.901$$

$$m_1 \cdot g_{amli} = 1.082$$

Lower Bound Distribution Factor

$$g_{amli_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{ami_lb} = 0.500$$

$$m_1 \cdot g_{ami_lb} = 0.600$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.90$$

$$b_m := 0.00$$

$$m_2 := 1.00$$

$$\gamma_{a_{mi}} := 1.07$$

$$g_{ami} := \gamma_{a_{mi}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

$$g_{ami} = 1.156$$

$$m_2 \cdot g_{ami} = 1.156$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

$$g_{ami_lb} = 1.000$$

$$m_2 \cdot g_{ami_lb} = 1.000$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$$mg_{ami_max} = 1.156$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$Exp_1 := 0.00$$

Table
4C-2

Table 3.6.1.1.2-1

Table 4C-3

Eq. 4C-1
Eq. 4C-2
Table 4C-1

Eq. 4C-1

Table
4C-1

$$Exp2 := 0.26$$

$$Exp3 := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$$g_{PF} = 0.601$$

$$a_m := 2.26$$

Table
4C-2

$$b_m := -0.35$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.10$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 1.110$$

$$m_1 \cdot g_{am1e} = 1.331$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.500$$

$$m_1 \cdot g_{am1e_lb} = 0.600$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.54$$

Table 4C-2

$$b_m := 0.19$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.07$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \left[a_m \left(2 + \frac{2d_e}{S} - \frac{16ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.949$$

$$m_2 \cdot g_{ame} = 0.949$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 1.000$$

$$m_2 \cdot g_{ame_lb} = 1.000$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 1.331$

Summary:

Interior Girder

Moment:

$$mg_{ami} := mg_{ami_max}$$

$mg_{ami} = 1.156$

Exterior Girder

Moment:

$$mg_{ame} := mg_{ame_max}$$

$mg_{ame} = 1.331$

Precast Concrete Spread Box Beam Bridge #4

$S_g := 11.25\text{ft}$	girder spacing
$L_1 := 81.46\text{ft}$	span length
$L_2 := 80.75\text{ft}$	span length
$L_3 := 80.75\text{ft}$	span length
$L_4 := 80.75\text{ft}$	span length
$L_5 := 80.75\text{ft}$	span length
$L_6 := 81.46\text{ft}$	span length
$t_s := 7.75\text{in}$	slab thickness
$N_g := 4$	number of girders
$d_e := 1.38\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 40.5\text{ft}$	clear roadway width
$\theta := 0$	skew angle
$d := 45\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.77$$

Table 4.6.2.2.2b-2

$$b_m := -0.17$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.08$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.426$$

$$m_1 \cdot g_{m1i} = 0.511$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.250$$

$$m_1 \cdot g_{m1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.90$$

Table 4.6.2.2.2b-2

$$b_m := 0.00$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.07$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.975$$

$$m_3 \cdot g_{mi} = 0.829$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.750$$

$$m_3 \cdot g_{mi_lb} = 0.638$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$$mg_{mi_max} = 0.829$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.00$$

Table 4.6.2.2.2a-1

$$b_v := -0.11$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.642$$

$$m_1 \cdot g_{s1i} = 0.770$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.250$$

$$m_1 \cdot g_{s1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.83$$

Table 4.6.2.2.2a-1

$$b_w := 0.07$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_w \left(2 - \frac{10\text{ft}}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.022$$

$$m_2 \cdot g_{si} = 1.022$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.500$$

$$m_2 \cdot g_{si_lb} = 0.500$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.022$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{\text{in}}{\text{ft}}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.022$$

Exterior Girders

Moment

: *One Lane Loaded*

$$N_L := 1$$

$$a_m := 0.62$$

Table 4.6.2.2.2b-2

$$b_m := -0.08$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.14$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.514$$

$$m_1 \cdot g_{m1e} = 0.617$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.250$$

$$m_1 \cdot g_{m1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 1.00$$

Table 4.6.2.2.2b-2

$$b_m := -0.06$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.04$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.991$$

$$m_3 \cdot g_{me} = 0.842$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.750$$

$$m_3 \cdot g_{me_lb} = 0.638$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.842$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_{ww} := 0.61$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.15$$

$$m_{1w} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1e}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.686$$

$$m_1 \cdot g_{s1e} = 0.823$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.250$$

$$m_1 \cdot g_{s1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_{Lw} := 2$$

$$a_{ww} := 0.78$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.12$$

$$m_{2w} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.905$$

$$m_2 \cdot g_{se} = 0.905$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.500$$

$$m_2 \cdot g_{se_lb} = 0.500$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.905$$

Skew Correction Factor (SCF): $SCF := 1.0 + \sqrt{\frac{L_1 \cdot d}{12 \frac{\text{in}}{\text{ft}}}} \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.905$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.829$$

Shear:

$$mg_{si} = 1.022$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 0.842$$

Shear:

$$mg_{se} = 0.905$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$S := 11.25\text{ft}$$

girder distance

$$L := 80.75\text{ft}$$

shortest span length

$$\text{Exp1} := 0.00$$

Table
4C-1

$$\text{Exp2} := 0.26$$

$$\text{Exp3} := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.395$$

$$a_m := 1.85$$

Table
4C-2

$$b_m := -0.30$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m m_1} := 1.11$$

Table 4C-3

$$g_{am1i} := \gamma_{a_m m_1} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.479$$

$$m_1 \cdot g_{am1i} = 0.574$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.250$$

$$m_1 \cdot g_{am1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.90$$

Table
4C-2

$$b_m := 0.00$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.07$$

Table 4C-3

$$g_{ami} := \gamma_{a_mi} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-2
Table 4C-1

$$g_{ami} = 0.975$$

$$m_3 \cdot g_{ami} = 0.829$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.750$$

$$m_3 \cdot g_{ami_lb} = 0.638$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_3 \cdot g_{ami}, m_3 \cdot g_{ami_lb})$

$mg_{ami_max} = 0.829$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$Exp1 := 0.00$$

Table
4C-1

$$Exp2 := 0.26$$

$$Exp3 := 0.30$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{Exp1} \left(\frac{S}{L}\right)^{Exp2} \left(\frac{1}{N_g}\right)^{Exp3}$$

Eq. 4C-3

$$g_{PF} = 0.395$$

$$a_m := 2.26$$

Table
4C-2

$$b_m := -0.35$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.10$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.597$$

$$m_1 \cdot g_{am1e} = 0.717$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.250$$

$$m_1 \cdot g_{am1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.54$$

Table 4C-2

$$b_m := 0.19$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.07$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \left[a_m \left(\frac{2}{3} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.284$$

$$m_2 \cdot g_{ame} = 0.284$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.750$$

$$m_2 \cdot g_{ame_lb} = 0.750$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$$mg_{ame_max} = 0.750$$

Summary:

Interior Girder

Moment:

$$mg_{ami} := mg_{ami_max}$$

$$mg_{ami} = 0.829$$

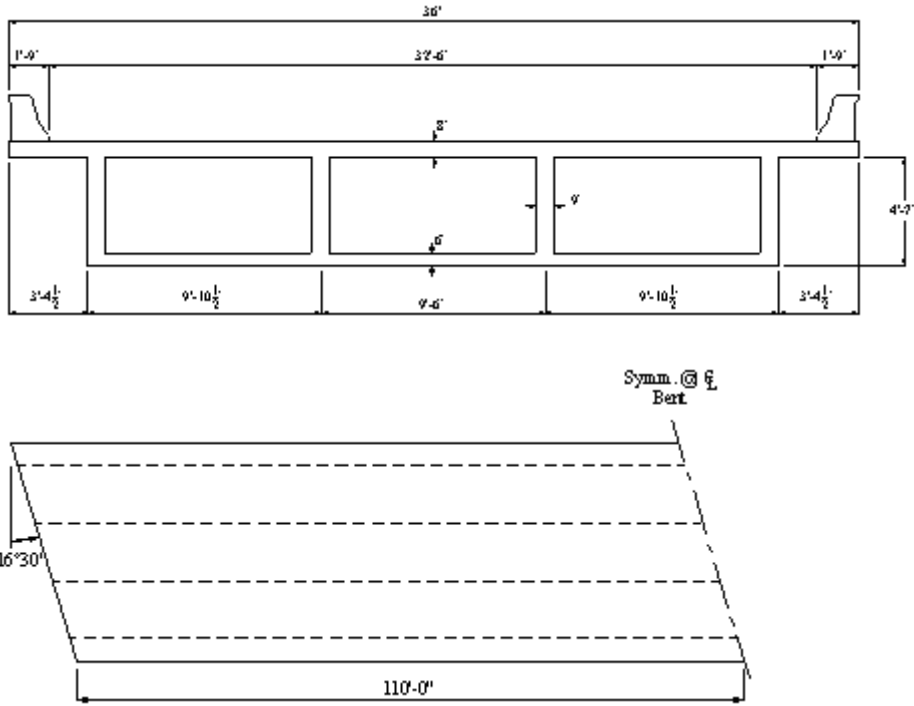
Exterior Girder

Moment:

$$mg_{ame} := mg_{ame_max}$$

$$mg_{ame} = 0.750$$

Cast-In-Place Concrete Multicell Box Beam Bridge #1



- $S_g := 9.5\text{ft}$ girder spacing
- $L_1 := 110\text{ft}$ span length
- $L_2 := 110\text{ft}$ span length
- $t_s := 8\text{in}$ slab thickness
- $N_g := 4$ number of girders
- $d_e := 0\text{ft}$ distance from center of the exterior girder to the location of the outer most wheel load
- $W_c := 32.5\text{ft}$ clear roadway width
- $\theta := 16.5$ skew angle
- $d := 60\text{in}$ box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.71$$

Table 4.6.2.2.2b-2

$$b_m := -0.82$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.18$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_{m1i}} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.413$$

$$m_1 \cdot g_{m1i} = 0.496$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.250$$

$$m_1 \cdot g_{m1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.93$$

Table 4.6.2.2.2b-1

$$b_m := -0.10$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.06$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_{mi}} \left[a_m \cdot \left(\frac{W_c}{10\text{ft}N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.695$$

$$m_2 \cdot g_{mi} = 0.695$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.500$$

$$m_2 \cdot g_{mi_lb} = 0.500$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.695$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.19$$

Table 4.6.2.2.2a-1

$$b_v := -0.20$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1i} := 1.04$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_s1i} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.639$$

$$m_1 \cdot g_{s1i} = 0.767$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.250$$

$$m_1 \cdot g_{s1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.71$$

Table 4.6.2.2.2a-1

$$b_w := 0.23$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.949$$

$$m_2 \cdot g_{si} = 0.949$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.500$$

$$m_2 \cdot g_{si_lb} = 0.500$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.949$$

Skew Correction Factor (SCF): $SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{\text{in}}{\text{ft}} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan \left(\frac{\pi}{180} \cdot \theta \right)$

$$SCF = 1.167$$

Table 4.6.1.3-1

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.108$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.54$$

Table 4.6.2.2.2b-2

$$b_m := -0.09$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.17$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.327$$

$$m_1 \cdot g_{m1e} = 0.392$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.250$$

$$m_1 \cdot g_{m1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.65$$

Table 4.6.2.2.2b-1

$$b_m := -0.07$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_{m2e}} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.476$$

$$m_2 \cdot g_{me} = 0.476$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.500$$

$$m_2 \cdot g_{me_lb} = 0.500$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$mg_{me_max} = 0.500$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.85$$

Table 4.6.2.2.2a-1

$$b_w := 0.00$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.05$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.611$$

$$m_1 \cdot g_{s1e} = 0.733$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.250$$

$$m_1 \cdot g_{s1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{ww} := 0.82$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.613$$

$$m_2 \cdot g_{se} = 0.613$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.500$$

$$m_2 \cdot g_{se_lb} = 0.500$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.733$$

Skew Correction Factor (SCF): $SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{in}{ft} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan \left(\frac{\pi}{180} \cdot \theta \right)$

$$SCF = 1.167$$

Table 4.6.1.3-1

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.855$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 0.695$$

Shear:

$$m_{g_{si}} = 1.108$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.500$$

Shear:

$$m_{g_{se}} = 0.855$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$$N_L := 1$$

$$S := 9.5\text{ft}$$

girder distance

$$L := 110\text{ft}$$

span length

$$\text{Exp1} := 0.00$$

Table
4C-1

$$\text{Exp2} := 0.35$$

$$\text{Exp3} := 0.32$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.272$$

$$a_m := 1.13$$

Table
4C-2

$$b_m := -0.04$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.284$$

$$m_1 \cdot g_{am1i} = 0.341$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.250$$

$$m_1 \cdot g_{am1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 1$$

$$a_m := 2.03$$

Table
4C-2

$$b_m := -0.05$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2i}} := 1.03$$

Table 4C-3

$$g_{ami} := \gamma_{a_{m2i}} [a_m (g_{PF}) + b_m]$$

Eq. 4C-1
Table 4C-1

$$g_{ami} = 0.518$$

$$m_2 \cdot g_{ami} = 0.518$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ami_lb} = 0.250$$

$$m_2 \cdot g_{ami_lb} = 0.250$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$$m g_{ami_max} = 0.518$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.25$$

Table
4C-2

$$b_m := -0.12$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.07$$

Table 4C-3

$$g_{am1e} := \gamma_{a_m1e} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.236$$

$$m_1 \cdot g_{am1e} = 0.283$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.250$$

$$m_1 \cdot g_{am1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.80$$

Table 4C-2

$$b_m := -0.12$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a-me} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a-me} \cdot [a_m \cdot (g_{PF}) + b_m]$$

Eq. 4C-1
Table 4C-1

$$g_{ame} = 0.389$$

$$m_2 \cdot g_{ame} = 0.389$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.500$$

$$m_2 \cdot g_{ame_lb} = 0.500$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.500$

Summary:

Interior Girder

Moment:

$$mg_{ami} := mg_{ami_max}$$

$mg_{ami} = 0.518$

Exterior Girder

Moment:

$$mg_{ame} := mg_{ame_max}$$

$mg_{ame} = 0.500$

Cast-In-Place Concrete Multicell Box Beam Bridge #2

$S_g := 9.25\text{ft}$	girder spacing
$L_1 := 128.08\text{ft}$	span length
$L_2 := 133.83\text{ft}$	span length
$t_s := 8\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := -0.25\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 40.5\text{ft}$	clear roadway width
$\theta := 0$	skew angle
$d := 66\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.71$$

Table 4.6.2.2.2b-2

$$b_m := -0.82$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.18$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m1i} = 0.396$$

$$m_1 \cdot g_{m1i} = 0.475$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.93$$

Table 4.6.2.2.2b-1

$$b_m := -0.10$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.06$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.692$$

$$m_3 \cdot g_{mi} = 0.589$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$$mg_{mi_max} = 0.589$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.19 \quad \text{Table 4.6.2.2.2a-1}$$

$$b_v := -0.20$$

$$m_1 := 1.2 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_{s1i}} := 1.04 \quad \text{Table 4.6.2.2.1-2}$$

$d_e < 0$ (Position loads manually)

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right] \quad \text{Eq. 4.6.2.2.2a-1}$$

$$g_{s1i} = 0.628$$

$$m_1 \cdot g_{s1i} = 0.754$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

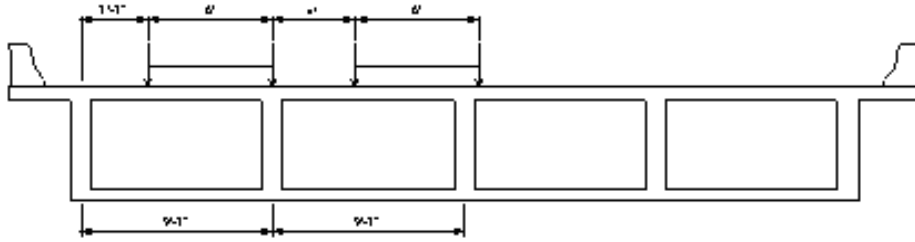
$$a_w := 0.71 \quad \text{Table 4.6.2.2.2a-1}$$

$$b_w := 0.23$$

$$m_2 := 1.0 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_{si}} := 1.03 \quad \text{Table 4.6.2.2.1-2}$$

$d_e < 0$ (Cannot use lever rule formula - position loads manually)



$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(\frac{3}{2} - \frac{5ft}{S} \right) + b_v \right] \quad \text{Eq. 4.6.2.2.2a-1}$$

$$g_{si} = 0.939$$

$$m_2 \cdot g_{si} = 0.939$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.939$$

Skew Correction Factor (SCF): $SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{\text{in}}{\text{ft}} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan \left(\frac{\pi}{180} \cdot \theta \right)$

$$SCF = 1.000$$

Table 4.6.1.3-1

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 0.939$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.54$$

Table 4.6.2.2.2b-2

$$b_m := -0.09$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.17$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_{m1e}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m1e} = 0.305$$

$$m_1 \cdot g_{m1e} = 0.365$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.65$$

Table 4.6.2.2.2b-2

$$b_m := -0.07$$

$$m_2 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_{m2e}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m2e} = 0.475$$

$$m_3 \cdot g_{me} = 0.404$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.510$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.85$$

Table 4.6.2.2.2a-1

$$b_w := 0.00$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.05$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1

$$g_{s1e} = 0.579$$

$$m_1 \cdot g_{s1e} = 0.695$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.82$$

Table 4.6.2.2.2a-1

$$b_v := 0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \cdot a_v \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_v$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.583$$

$$m_2 \cdot g_{se} = 0.583$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.695$$

Skew Correction Factor (SCF): $SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{in}{ft} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan \left(\frac{\pi}{180} \cdot \theta \right)$

$$SCF = 1.000$$

Table 4.6.1.3-1

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.695$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 0.589$$

Shear:

$$m_{g_{si}} = 0.939$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.510$$

Shear:

$$m_{g_{se}} = 0.695$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$$N_g := 1$$

$$S := 9.25\text{ft}$$

$$L := 128.08\text{ft}$$

$$\text{Exp1} := 0.00$$

$$\text{Exp2} := 0.35$$

$$\text{Exp3} := 0.32$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}} \right)^{\text{Exp1}} \left(\frac{S}{L} \right)^{\text{Exp2}} \left(\frac{1}{N_g} \right)^{\text{Exp3}}$$

girder distance

shortest span length

Table
4C-1

Eq. 4C-3

$$g_{PF} = 0.238$$

$$a_{m1} := 1.13$$

Table
4C-2

$$b_{m1} := -0.04$$

$$m_{1v} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_{m1} g_{PF} + b_{m1})$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.243$$

$$m_1 g_{am1i} = 0.291$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.200$$

$$m_1 g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_{1v} := 2$$

$$a_{m2} := 2.03$$

Table
4C-2

$$b_{m2} := -0.05$$

$$m_{2v} := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2i}} := 1.03$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} [a_{m2} (g_{PF}) + b_{m2}]$$

Eq. 4C-1
Table 4C-1

$$g_{ami} = 0.446$$

$$m_2 g_{ami} = 0.446$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ami_lb} = 0.400$$

$$m_2 \cdot g_{ami_lb} = 0.400$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$mg_{ami_max} = 0.446$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{m1} := 1$$

$$a_{m1} := 1.25$$

Table
4C-2

$$b_{m1} := -0.12$$

$$m_{1w} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.07$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \cdot (a_{m1} \cdot g_{PF} + b_{m1})$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.190$$

$$m_1 \cdot g_{am1e} = 0.228$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.80$$

Table 4C-2

$$b_m := -0.12$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{me}} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_{me}} [a_m (g_{PF}) + b_m]$$

Eq. 4C-1
Table 4C-1

$$g_{ame} = 0.324$$

$$m_2 \cdot g_{ame} = 0.324$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.400$$

$$m_2 \cdot g_{ame_lb} = 0.400$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.400$

Summary:

Interior Girder

Moment:

$$mg_{ami} := mg_{ami_max}$$

$mg_{ami} = 0.446$

Exterior Girder

Moment:

$$mg_{ame} := mg_{ame_max}$$

$mg_{ame} = 0.400$

Cast-In-Place Concrete Multicell Box Beam Bridge #3

$S_w := 9.0\text{ft}$	girder spacing
$L_1 := 98.75\text{ft}$	span length
$L_2 := 98.75\text{ft}$	span length
$t_s := 8\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.25\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 40.5\text{ft}$	clear roadway width
$\theta := 0$	skew angle
$d := 63\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.71$$

Table 4.6.2.2.2b-2

$$b_m := -0.82$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.18$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.378$$

$$m_1 \cdot g_{m1i} = 0.453$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.93$$

Table 4.6.2.2.2b-2

$$b_m := -0.10$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.06$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.692$$

$$m_3 \cdot g_{mi} = 0.589$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.589$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.19$$

Table 4.6.2.2.2a-1

$$b_v := -0.20$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.04$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.617$$

$$m_1 \cdot g_{s1i} = 0.740$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.200$$

$$m_1 \cdot g_{s1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{ww} := 0.71$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.23$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.03$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_v \cdot \left(\frac{3}{2} - \frac{5\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 0.928$$

$$m_2 \cdot g_{si} = 0.928$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.400$$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $m_{g_{si_max}} := \max(m_1 \cdot g_{s_{l1}}, m_1 \cdot g_{s_{l1_lb}}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$m_{g_{si_max}} = 0.928$$

Skew Correction Factor (SCF): $SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{\text{in}}{\text{ft}} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

$$SCF = 1.000$$

Table 4.6.1.3-1

$$m_{g_{si}} := m_{g_{si_max}} \cdot SCF$$

$$m_{g_{si}} = 0.928$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.54$$

Table 4.6.2.2.2b-2

$$b_m := -0.09$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.17$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.333$$

$$m_1 \cdot g_{m1e} = 0.400$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.200$$

$$m_1 \cdot g_{m1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.65$$

Table 4.6.2.2.2b-2

$$b_m := -0.07$$

Table 3.6.1.1.2-1

$$m_a := 0.85$$

$$\gamma_{a_me} := 1.04$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.475$$

$$m_3 \cdot g_{me} = 0.404$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.510$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.85$$

Table 4.6.2.2.2a-1

$$b_w := 0.00$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.05$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.620$$

$$m_1 \cdot g_{s1e} = 0.744$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{ww} := 0.82$$

Table 4.6.2.2.2a-1

$$b_{ww} := 0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{se} = 0.622$$

$$m_2 \cdot g_{se} = 0.622$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.744$$

Skew Correction Factor (SCF):
$$SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{\text{in}}{\text{ft}} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan \left(\frac{\pi}{180} \cdot \theta \right)$$

SCF = 1.000

Table 4.6.1.3-1

$mg_{se} := mg_{se_max} \cdot SCF$

$mg_{se} = 0.744$

Summary:

Interior Girder

Moment:

$mg_{mi} := mg_{mi_max}$

$mg_{mi} = 0.589$

Shear:

$mg_{si} = 0.928$

Exterior Girder

Moment:

$mg_{me} := mg_{me_max}$

$mg_{me} = 0.510$

Shear:

$mg_{se} = 0.744$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders:

Moment

:

One Lane Loaded

$N_L := 1$

$S_v := 9.00\text{ft}$

girder distance

$L_v := 98.75\text{ft}$

span length

$$\text{Exp1} := 0.00$$

Table
4C-1

$$\text{Exp2} := 0.35$$

$$\text{Exp3} := 0.32$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.258$$

$$a_m := 1.13$$

Table
4C-2

$$b_m := -0.04$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.06$$

Table 4C-3

$$g_{am1i} := \gamma_{a_{m1i}} (a_m g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.267$$

$$m_1 \cdot g_{am1i} = 0.320$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{am1i_lb} = 0.200$$

$$m_1 \cdot g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 2.03$$

Table
4C-2

$$b_m := -0.05$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.03$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} \left[a_m (g_{PF}) + b_m \right]$$

Eq. 4C-1
Table 4C-1

$$g_{ami} = 0.489$$

$$m_2 \cdot g_{ami} = 0.489$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.400$$

$$m_2 \cdot g_{ami_lb} = 0.400$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$m g_{ami_max} = 0.489$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.25$$

Table
4C-2

$$b_m := -0.12$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.07$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} (a_m g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.217$$

$$m_1 \cdot g_{am1e} = 0.261$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.80 \quad \text{Table 4C-2}$$

$$b_m := -0.12$$

$$m_2 := 1.00 \quad \text{Table 3.6.1.1.2-1}$$

$$\gamma_{a_me} := 1.05 \quad \text{Table 4C-3}$$

$$g_{ame} := \gamma_{a_me} \cdot [a_m \cdot (g_{PF}) + b_m] \quad \begin{array}{l} \text{Eq. 4C-1} \\ \text{Table 4C-1} \end{array}$$

$$g_{ame} = 0.362$$

$$m_2 \cdot g_{ame} = 0.362$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.400$$

$$m_2 \cdot g_{ame_lb} = 0.400$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.400$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$$m_{g_{ami}} = 0.489$$

Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$$m_{g_{ame}} = 0.400$$

Cast-In-Place Concrete Multicell Box Beam Bridge #4

$S_w := 10.33\text{ft}$	girder spacing
$L_1 := 91\text{ft}$	span length
$L_2 := 119\text{ft}$	span length
$L_3 := 140\text{ft}$	span length
$t_s := 8\text{in}$	slab thickness
$N_g := 5$	number of girders
$d_e := 0.58\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 46.5\text{ft}$	clear roadway width
$\theta := 26.23$	skew angle
$d := 84\text{in}$	box beam depth

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.71$$

Table 4.6.2.2.2b-2

$$b_m := -0.82$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.18$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.464$$

$$m_1 \cdot g_{m1i} = 0.557$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.200$$

$$m_1 \cdot g_{m1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.93$$

Table 4.6.2.2.2b-2

$$b_m := -0.10$$

$$m_3 := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.06$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.811$$

$$m_3 \cdot g_{mi} = 0.689$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.600$$

$$m_3 \cdot g_{mi_lb} = 0.510$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_3 \cdot g_{mi}, m_3 \cdot g_{mi_lb})$

$$mg_{mi_max} = 0.689$$

Shear:

One Lane Loaded

$$N_L := 1$$

$a_v := 1.19$ Table 4.6.2.2.2a-1

$b_v := -0.20$

$m_1 := 1.2$ Table 3.6.1.1.2-1

$\gamma_{a_{s1i}} := 1.04$ Table 4.6.2.2.1-2

$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$ Eq. 4.6.2.2.2a-1
Table B4-1

$g_{s1i} = 0.670$

$m_1 \cdot g_{s1i} = 0.804$

Lower Bound Distribution Factor

$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$

$g_{s1i_lb} = 0.200$

$m_1 \cdot g_{s1i_lb} = 0.240$

Two or More Lanes Loaded

$N_{L2} := 2$

$a_v := 0.71$ Table 4.6.2.2.2a-1

$b_v := 0.23$

$m_2 := 1.0$ Table 3.6.1.1.2-1

$\gamma_{a_{si}} := 1.03$ Table 4.6.2.2.1-2

$g_{si} := \gamma_{a_{si}} \left[a_v \left(2 - \frac{10\text{ft}}{S} \right) + b_v \right]$ Eq. 4.6.2.2.2a-1
Table B4-1

$g_{si} = 0.992$

$m_2 \cdot g_{si} = 0.992$

Lower Bound Distribution Factor

$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$

$g_{si_lb} = 0.400$

$$m_2 \cdot g_{si_lb} = 0.400$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.992$$

Skew Correction Factor (SCF): $SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{\text{in}}{\text{ft}} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

$$SCF = 1.215$$

Table 4.6.1.3-1

$$mg_{si} := mg_{si_max} \cdot SCF$$

$mg_{si} = 1.204$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.54$$

Table 4.6.2.2.2b-2

$$b_m := -0.09$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_mle} := 1.17$$

Table 4.6.2.2.1-2

$$g_{mle} := \gamma_{a_mle} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{mle} = 0.378$$

$$m_1 \cdot g_{mle} = 0.454$$

Lower Bound Distribution Factor

$$g_{mle_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{mle_lb} = 0.200$$

$$m_1 \cdot g_{mle_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 3$$

$$a_m := 0.65$$

Table 4.6.2.2.2b-2

$$b_m := -0.07$$

$$m_a := 0.85$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.04$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.556$$

$$m_3 \cdot g_{me} = 0.472$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.600$$

$$m_3 \cdot g_{me_lb} = 0.510$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_3 \cdot g_{me}, m_3 \cdot g_{me_lb})$

$mg_{me_max} = 0.510$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_w := 0.85$$

Table 4.6.2.2.2a-1

$$b_w := 0.00$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.05$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_{s1e}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.683$$

$$m_1 \cdot g_{s1e} = 0.820$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.200$$

$$m_1 \cdot g_{s1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.82$$

Table 4.6.2.2.2a-1

$$b_w := 0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{se}} := 1.02$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.718$$

$$m_2 \cdot g_{se} = 0.718$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.400$$

$$m_2 \cdot g_{se_lb} = 0.400$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$m_{g_{se_max}} = 0.820$$

Skew Correction Factor (SCF):
$$SCF := 1.0 + \left[0.25 + \left(\frac{12.0 \frac{\text{in}}{\text{ft}} \cdot L_1}{70 \cdot d} \right) \right] \cdot \tan \left(\frac{\pi}{180} \cdot \theta \right)$$

$$SCF = 1.215$$

Table 4.6.1.3-1

$$m_{g_{se}} := m_{g_{se_max}} \cdot SCF$$

$$m_{g_{se}} = 0.996$$

Summary:

Interior Girder

Moment:

$$m_{g_{mi}} := m_{g_{mi_max}}$$

$$m_{g_{mi}} = 0.689$$

Shear:

$$m_{g_{si}} = 1.204$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.510$$

Shear:

$$m_{g_{se}} = 0.996$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior

Girders:

Moment

:

One Lane Loaded

$$N_g := 1$$

$$S := 10.33\text{ft}$$

$$L := 91\text{ft}$$

$$\text{Exp1} := 0.00$$

$$\text{Exp2} := 0.35$$

$$\text{Exp3} := 0.32$$

$$D := 1.00$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

$$g_{PF} = 0.279$$

$$a_m := 1.13$$

$$b_m := -0.04$$

$$m_1 := 1.2$$

$$\gamma_{a_m b_m} := 1.06$$

$$g_{am1i} := \gamma_{a_m b_m} (a_m \cdot g_{PF} + b_m)$$

$$g_{am1i} = 0.292$$

$$m_1 \cdot g_{am1i} = 0.350$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g}\right)$$

$$g_{am1i_lb} = 0.200$$

$$m_1 \cdot g_{am1i_lb} = 0.240$$

Two or More Lanes Loaded

$$N_g := 2$$

girder distance

shortest span length

Table
4C-1

Eq. 4C-3

Table
4C-2

Table 3.6.1.1.2-1

Table 4C-3

Eq. 4C-1
Table 4C-1

Eq. 4C-1

$$a_{mi} := 2.03$$

Table
4C-2

$$b_{mi} := -0.05$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{ami} := 1.03$$

Table 4C-3

$$g_{ami} := \gamma_{ami} [a_{mi}(g_{PF}) + b_{mi}]$$

Eq. 4C-1
Eq. 4C-3

$$g_{ami} = 0.532$$

$$m_2 \cdot g_{ami} = 0.532$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.400$$

$$m_2 \cdot g_{ami_lb} = 0.400$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$$mg_{ami_max} = 0.532$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{L1} := 1$$

$$a_{m1} := 1.25$$

Table
4C-2

$$b_{m1} := -0.12$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{am1e} := 1.07$$

Table 4C-3

$$g_{am1e} := \gamma_{am1e} (a_{m1} g_{PF} + b_{m1})$$

Eq. 4C-1
Table 4C-1

$$g_{am1e} = 0.245$$

$$m_1 \cdot g_{am1e} = 0.294$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.200$$

$$m_1 \cdot g_{am1e_lb} = 0.240$$

Two or More Lanes Loaded

$$N_m := 2$$

$$a_m := 1.80$$

Table 4C-2

$$b_m := -0.12$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.05$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \left[a_m (g_{PF}) + b_m \right]$$

Eq. 4C-1
Table 4C-1

$$g_{ame} = 0.401$$

$$m_2 \cdot g_{ame} = 0.401$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.400$$

$$m_2 \cdot g_{ame_lb} = 0.400$$

Controlling Distribution Factor: $m_{g_{ame_max}} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$m_{g_{ame_max}} = 0.401$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$$m_{g_{ami}} = 0.532$$

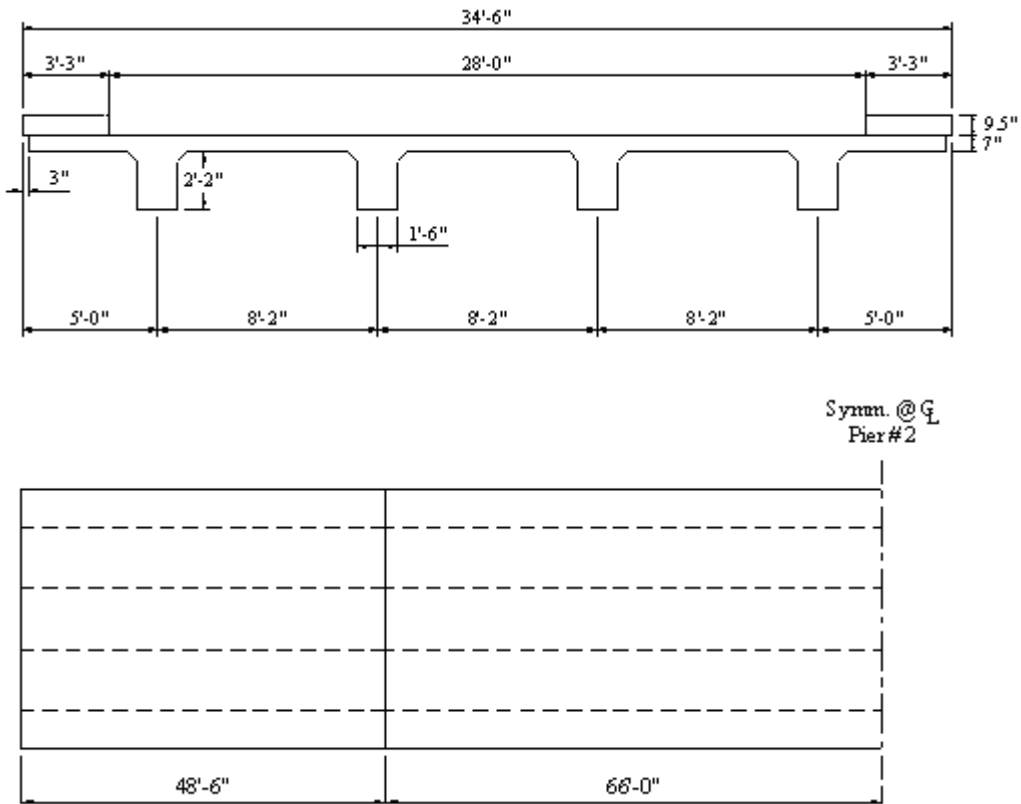
Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$$m_{g_{ame}} = 0.401$$

Cast-In-Place Concrete Tee Beam Bridge #1



- $S_g := 8.17\text{ft}$ girder spacing
- $L_1 := 48.5\text{ft}$ span length
- $L_2 := 66\text{ft}$ span length
- $L_3 := 66\text{ft}$ span length
- $L_4 := 45.5\text{ft}$ span length
- $t_s := 7\text{in}$ slab thickness
- $N_g := 4$ number of girders
- $d_e := -0.25\text{ft}$ distance from center of the exterior girder to the location of the outer most wheel load
- $W_c := 28\text{ft}$ clear roadway width
- $\theta := 0$ skew angle

**Interior
Girders:
Moment**

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.40$$

Table 4.6.2.2b-2

$$b_m := -0.41$$

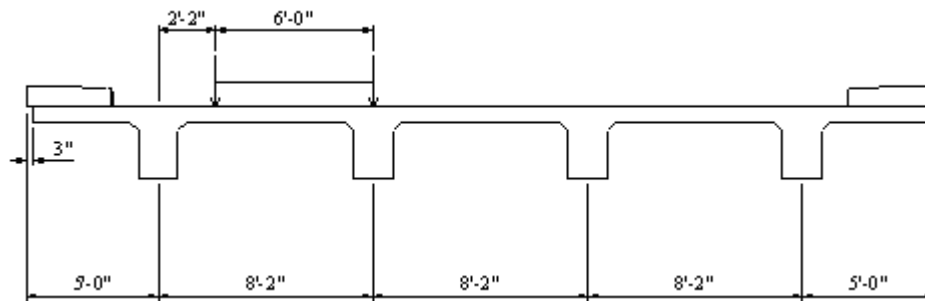
$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.13$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{m1i} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6ft)}{S} \quad \text{or} \quad g_{m1i} := \left(1 - \frac{3ft}{S}\right)$$

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3ft}{S}\right) + b_m \right]$$

$$g_{m1i} = 0.538$$

$$m_1 \cdot g_{m1i} = 0.645$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2b-1

$$g_{m1i_lb} = 0.250$$

$$m_1 \cdot g_{m1_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-1

$$b_m := -0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.05$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 0.796$$

$$m_2 \cdot g_{mi} = 0.796$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.500$$

$$m_2 \cdot g_{mi_lb} = 0.500$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 0.796$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.24$$

Table 4.6.2.2.2a-1

$$b_v := -0.22$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{sli}} := 1.05$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)

$$g_{sli} := \gamma_{a_{sli}} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

$$g_{sli} = 0.593$$

$$m_1 \cdot g_{sli} = 0.711$$

Lower Bound Distribution Factor

$$g_{sli_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{sli_lb} = 0.250$$

$$m_1 \cdot g_{sli_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 1.21$$

Table 4.6.2.2.2a-1

$$b_w := -0.17$$

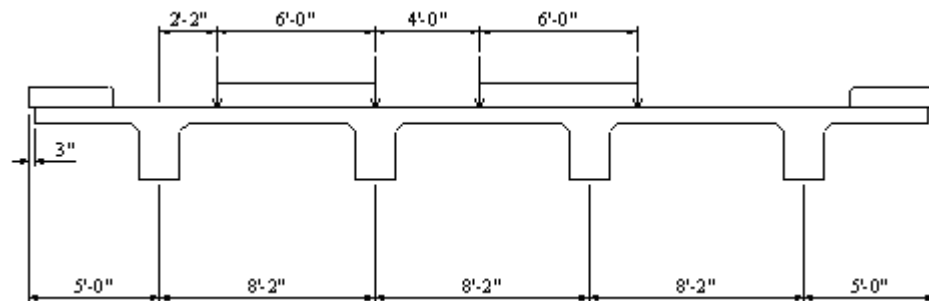
$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.08$$

Table 4.6.2.2.1-2

$d_e < 0$ (Position loads manually)



$$g_{si} := \frac{\frac{1}{2} \cdot S + \frac{1}{2} \cdot (S - 6 \cdot \text{ft}) - \frac{1}{2} \cdot (S - 4 \cdot \text{ft})}{S} \quad \text{or} \quad g_{si} := \left(\frac{3}{2} - \frac{5 \text{ft}}{S} \right)$$

$$g_{si} := \gamma_{a_{si}} \cdot \left[a_v \cdot \left(\frac{3}{2} - \frac{5 \text{ft}}{S} \right) + b_v \right]$$

$$g_{si} = 0.977$$

$$m_2 \cdot g_{si} = 0.977$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.500$$

$$m_2 \cdot g_{si_lb} = 0.500$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{si}, m_1 \cdot g_{si_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 0.977$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 0.977$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_{L1} := 1$$

$$a_{m1} := 0.65$$

Table 4.6.2.2.2b-2

$$b_{m1} := 0.15$$

$$m_{L1} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.02$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.552$$

$$m_1 \cdot g_{m1e} = 0.663$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.250$$

$$m_1 \cdot g_{m1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_{L2} := 2$$

$$a_{m2} := 1.11$$

Table 4.6.2.2.2b-2

$$b_{m2} := -0.14$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_m2e} := 1.05$$

Table 4.6.2.2.1-2

$$g_{m2e} := \gamma_{a_m2e} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{m2e} = 0.669$$

$$m_2 \cdot g_{m2e} = 0.669$$

Lower Bound Distribution Factor

$$g_{m2e_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{m2e_lb} = 0.500$$

$$m_2 \cdot g_{m2e_lb} = 0.500$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{m2e}, m_2 \cdot g_{m2e_lb})$

$$mg_{me_max} = 0.669$$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 0.79$$

Table 4.6.2.2.2a-1

$$b_v := 0.09$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.583$$

$$m_1 \cdot g_{s1e} = 0.699$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.250$$

$$m_1 \cdot g_{s1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.94$$

Table 4.6.2.2.2a-1

$$b_v := 0.05$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_{se}} \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.635$$

$$m_2 \cdot g_{se} = 0.635$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.500$$

$$m_2 \cdot g_{se_lb} = 0.500$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.699$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

$$SCF = 1.000$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 0.699$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 0.796$$

Shear:

$$mg_{si} = 0.977$$

Exterior Girder

Moment:

$$m_{g_{me}} := m_{g_{me_max}}$$

$$m_{g_{me}} = 0.669$$

Shear:

$$m_{g_{se}} = 0.699$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior
Girders:
Moment

:

One Lane Loaded

$$N_g := 1$$

$$S := 8.17 \text{ ft}$$

girder distance

$$L := 45.5 \text{ ft}$$

shortest span length

$$\text{Exp1} := 0.20$$

Table
4C-1

$$\text{Exp2} := 0.30$$

$$\text{Exp3} := 0.00$$

$$D := 44.60$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}} \right)^{\text{Exp1}} \left(\frac{S}{L} \right)^{\text{Exp2}} \left(\frac{1}{N_g} \right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.425$$

$$a_m := 2.44$$

Table
4C-2

$$b_m := -0.58$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1i}} := 1.13$$

Table 4C-3

$$g_{a_{m1i}} := \gamma_{a_{m1i}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{a_{m1i}} = 0.518$$

$$m_1 \cdot g_{a_{m1i}} = 0.621$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1i_lb} = 0.250$$

$$m_1 \cdot g_{am1i_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.14$$

Table
4C-2

$$b_m := -0.04$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.05$$

Table 4C-3

$$g_{ami} := \gamma_{a_mi} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-3
Table 4C-1

$$g_{ami} = 0.796$$

$$m_2 \cdot g_{ami} = 0.796$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.500$$

$$m_2 \cdot g_{ami_lb} = 0.500$$

Controlling Distribution Factor: $mg_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$mg_{ami_max} = 0.796$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.65$$

Table
4C-2

$$b_m := 0.15$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m b_m} := 1.02$$

Table 4C-3

$$g_{am1e} := \gamma_{a_m b_m} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.552$$

$$m_1 \cdot g_{am1e} = 0.663$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.250$$

$$m_1 \cdot g_{am1e_lb} = 0.300$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.84$$

Table 4C-2

$$b_m := 0.13$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_m b_m} := 1.03$$

Table 4C-3

$$g_{ame} := \gamma_{a_me} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.655$$

$$m_2 \cdot g_{ame} = 0.655$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ame_lb} = 0.500$$

$$m_2 \cdot g_{ame_lb} = 0.500$$

Controlling Distribution Factor: $m_{g_{ame_max}} := \max(m_1 \cdot g_{ame}, m_1 \cdot g_{ame_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$m_{g_{ame_max}} = 0.663$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$m_{g_{ami}} = 0.796$

Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$m_{g_{ame}} = 0.663$

Cast-In-Place Concrete Tee Beam Bridge #2

$S_g := 11.17\text{ft}$	girder spacing
$L_1 := 35.45\text{ft}$	span length
$L_2 := 88.50\text{ft}$	span length
$L_3 := 88.50\text{ft}$	span length
$L_4 := 51.42\text{ft}$	span length
$t_s := 7.50\text{in}$	slab thickness
$N_g := 3$	number of girders
$d_e := 1.08\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 28.5\text{ft}$	clear roadway width
$\theta := 31.56$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.40$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.13$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-1

$$g_{m1i} = 0.694$$

$$m_1 \cdot g_{m1i} = 0.833$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.333$$

$$m_1 \cdot g_{m1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-1

$$b_m := -0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.05$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.095$$

$$m_2 \cdot g_{mi} = 1.095$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.667$$

$$m_2 \cdot g_{mi_lb} = 0.667$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 1.095$

Shear:

One Lane Loaded

$$a_v := 1.24$$

Table 4.6.2.2.2a-1

$$b_v := -0.22$$

$$m_{1v} := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.05$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.721$$

$$m_1 \cdot g_{s1i} = 0.866$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.667$$

$$m_1 \cdot g_{s1i_lb} = 0.800$$

Two or More Lanes Loaded

$$a_{2v} := 1.21$$

Table 4.6.2.2.2a-1

$$b_{2v} := -0.17$$

$$m_{2v} := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s2i}} := 1.08$$

Table 4.6.2.2.1-2

$$g_{s2i} := \gamma_{a_{s2i}} \left[a_v \left(2 - \frac{10\text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s2i} = 1.260$$

$$m_2 \cdot g_{s2i} = 1.260$$

Lower Bound Distribution Factor

$$g_{s2i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s2i_lb} = 0.667$$

$$m_2 \cdot g_{s2i_lb} = 0.667$$

Controlling Distribution Factor: $m_{g_{si_max}} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$m_{g_{si_max}} = 1.260$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.123$$

$$m_{g_{si}} := m_{g_{si_max}} \cdot SCF$$

$$m_{g_{si}} = 1.415$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.65$$

Table 4.6.2.2.2b-2

$$b_m := 0.15$$

$$m_w := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_mle} := 1.02$$

Table 4.6.2.2.1-2

$$g_{mle} := \gamma_{a_mle} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{mle} = 0.702$$

$$m_1 \cdot g_{mle} = 0.842$$

Lower Bound Distribution Factor

$$g_{mle_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{mle_lb} = 0.333$$

$$m_1 \cdot g_{mle_lb} = 0.400$$

Two or More Lanes Loaded

$$N_{Lm} := 2$$

$$a_{mm} := 1.11$$

Table 4.6.2.2.2b-2

$$b_{mv} := -0.14$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.05$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 0.960$$

$$m_2 \cdot g_{me} = 0.960$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.667$$

$$m_2 \cdot g_{me_lb} = 0.667$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$mg_{me_max} = 0.960$

Shear:

One Lane Loaded

$$N_{Lm} := 1$$

$$a_{mv} := 0.79$$

Table 4.6.2.2.2a-1

$$b_{mv} := 0.09$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \left[a_v \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Eq. B4-2

$$g_{s1e} = 0.767$$

$$m_1 \cdot g_{s1e} = 0.920$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.333$$

$$m_1 \cdot g_{s1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_v := 0.94$$

Table 4.6.2.2.2a-1

$$b_v := 0.05$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \left[a_v \cdot \left(\frac{3}{2} + \frac{3 \cdot d_e}{2 \cdot S} - \frac{8 \text{ft}}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.951$$

$$m_2 \cdot g_{se} = 0.951$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.667$$

$$m_2 \cdot g_{se_lb} = 0.667$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.951$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$

Table 4.6.1.3-1

SCF = 1.123

$mg_{se} := mg_{se_max} \cdot SCF$

$mg_{se} = 1.068$

Summary:

Interior Girder

Moment:

$mg_{mi} := mg_{mi_max}$

$mg_{mi} = 1.095$

Shear:

$mg_{si} = 1.415$

Exterior Girder

Moment:

$mg_{me} := mg_{me_max}$

$mg_{me} = 0.960$

Shear:

$mg_{se} = 1.068$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

Interior Girders: Moment

:
One Lane Loaded

$N_L := 1$

$S_w := 11.17\text{ft}$

$L_w := 35.45\text{ft}$

Exp1 := 0.20

girder distance

shortest span length

Table
4C-1

$$\text{Exp2} := 0.30$$

$$\text{Exp3} := 0.00$$

$$D := 44.60$$

$$g_{PF} := \left(\frac{S}{D \cdot ft}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_g}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.536$$

$$a_{mm} := 2.44$$

Table
4C-2

$$b_{mm} := -0.58$$

$$m_L := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mli}} := 1.13$$

Table 4C-3

$$g_{amli} := \gamma_{a_{mli}} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{amli} = 0.823$$

$$m_1 \cdot g_{amli} = 0.987$$

Lower Bound Distribution Factor

$$g_{amli_lb} := \left(\frac{N_L}{N_g}\right)$$

Eq. 4C-1

$$g_{amli_lb} = 0.333$$

$$m_1 \cdot g_{amli_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_{mm} := 1.14$$

Table
4C-2

$$b_{mm} := -0.04$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mi}} := 1.05$$

Table 4C-3

$$g_{ami} := \gamma_{a_{mi}} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-3
Table 4C-1

$$g_{ami} = 1.095$$

$$m_2 \cdot g_{ami} = 1.095$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.667$$

$$m_2 \cdot g_{ami_lb} = 0.667$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{ami}, m_1 \cdot g_{ami_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$m g_{ami_max} = 1.095$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.65$$

Table
4C-2

$$b_m := 0.15$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{mle}} := 1.02$$

Table 4C-3

$$g_{amle} := \gamma_{a_{mle}} \left[a_m \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{amle} = 0.702$$

$$m_1 \cdot g_{am1e} = 0.842$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1e_lb} = 0.333$$

$$m_1 \cdot g_{am1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_{Lm} := 2$$

$$a_{mm} := 0.84$$

$$b_{mm} := 0.13$$

$$m_2 := 1.00$$

$$\gamma_{a_{me}} := 1.03$$

$$g_{ame} := \gamma_{a_{me}} \left[a_m \left(\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right) + b_m \right]$$

$$g_{ame} = 0.938$$

$$m_2 \cdot g_{ame} = 0.938$$

Lower Bound Distribution Factor

$$g_{ame_lb} := \frac{N_L}{N_g} \quad \text{Eq. 4C-1}$$

$$g_{ame_lb} = 0.667$$

$$m_2 \cdot g_{ame_lb} = 0.667$$

Controlling Distribution Factor: $mg_{ame_max} := \max(m_1 \cdot g_{am1e}, m_1 \cdot g_{am1e_lb}, m_2 \cdot g_{ame}, m_2 \cdot g_{ame_lb})$

$mg_{ame_max} = 0.938$

Summary:

Interior Girder

Moment:

$$m_{g_{ami}} := m_{g_{ami_max}}$$

$$m_{g_{ami}} = 1.095$$

Exterior Girder

Moment:

$$m_{g_{ame}} := m_{g_{ame_max}}$$

$$m_{g_{ame}} = 0.938$$

Cast-In-Place Concrete Tee Beam Bridge #3

$S_g := 12.58\text{ft}$	girder spacing
$L_1 := 40.0\text{ft}$	span length
$L_2 := 77.0\text{ft}$	span length
$L_3 := 96.0\text{ft}$	span length
$L_4 := 96.0\text{ft}$	span length
$L_5 := 50.0\text{ft}$	span length
$t_s := 9.0\text{in}$	slab thickness
$N_g := 3$	number of girders
$d_e := 0.92\text{ft}$	distance from center of the exterior girder to the location of the outer most wheel load
$W_c := 31.0\text{ft}$	clear roadway width
$\theta := 9.83$	skew angle

Interior Girders: Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 1.40$$

Table 4.6.2.2.2b-2

$$b_m := -0.41$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1i} := 1.13$$

Table 4.6.2.2.1-2

$$g_{m1i} := \gamma_{a_m1i} \left[a_m \cdot \left(1 - \frac{3\text{ft}}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1.
Table B4-1

$$g_{m1i} = 0.741$$

$$m_1 \cdot g_{m1i} = 0.890$$

Lower Bound Distribution Factor

$$g_{m1i_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1i_lb} = 0.333$$

$$m_1 \cdot g_{m1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.14$$

Table 4.6.2.2.2b-1

$$b_m := -0.04$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.05$$

Table 4.6.2.2.1-2

$$g_{mi} := \gamma_{a_mi} \cdot \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{mi} = 1.195$$

$$m_2 \cdot g_{mi} = 1.195$$

Lower Bound Distribution Factor

$$g_{mi_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{mi_lb} = 0.667$$

$$m_2 \cdot g_{mi_lb} = 0.667$$

Controlling Distribution Factor: $mg_{mi_max} := \max(m_1 \cdot g_{m1i}, m_1 \cdot g_{m1i_lb}, m_2 \cdot g_{mi}, m_2 \cdot g_{mi_lb})$

$mg_{mi_max} = 1.195$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_v := 1.24$$

Table 4.6.2.2.2a-1

$$b_v := -0.22$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{s1i}} := 1.05$$

Table 4.6.2.2.1-2

$$g_{s1i} := \gamma_{a_{s1i}} \left[a_v \left(1 - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{s1i} = 0.761$$

$$m_1 \cdot g_{s1i} = 0.913$$

Lower Bound Distribution Factor

$$g_{s1i_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1i_lb} = 0.333$$

$$m_1 \cdot g_{s1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 1.21$$

Table 4.6.2.2.2a-1

$$b_w := -0.17$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_{si}} := 1.08$$

Table 4.6.2.2.1-2

$$g_{si} := \gamma_{a_{si}} \left[a_w \left(2 - \frac{10ft}{S} \right) + b_w \right]$$

Eq. 4.6.2.2.2a-1
Table B4-1

$$g_{si} = 1.391$$

$$m_2 \cdot g_{si} = 1.391$$

Lower Bound Distribution Factor

$$g_{si_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{si_lb} = 0.667$$

$$m_2 \cdot g_{si_lb} = 0.667$$

Controlling Distribution Factor: $mg_{si_max} := \max(m_1 \cdot g_{sli}, m_1 \cdot g_{sli_lb}, m_2 \cdot g_{si}, m_2 \cdot g_{si_lb})$

$$mg_{si_max} = 1.391$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.035$$

$$mg_{si} := mg_{si_max} \cdot SCF$$

$$mg_{si} = 1.439$$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.65$$

Table 4.6.2.2.2b-2

$$b_m := 0.15$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m1e} := 1.02$$

Table 4.6.2.2.1-2

$$g_{m1e} := \gamma_{a_m1e} \cdot \left[a_m \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_m \right]$$

Table 4.6.2.2.2b-1
Table B4-2

$$g_{m1e} = 0.706$$

$$m_1 \cdot g_{m1e} = 0.848$$

Lower Bound Distribution Factor

$$g_{m1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Table 4.6.2.2.2b-1

$$g_{m1e_lb} = 0.333$$

$$m_1 \cdot g_{m1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.11$$

Table 4.6.2.2.2b-2

$$b_m := -0.14$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_me} := 1.05$$

Table 4.6.2.2.1-2

$$g_{me} := \gamma_{a_me} \left[a_m \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Table 4.6.2.2.2b-1

$$g_{me} = 1.057$$

$$m_2 \cdot g_{me} = 1.057$$

Lower Bound Distribution Factor

$$g_{me_lb} := \frac{N_L}{N_g}$$

Table 4.6.2.2.2b-1

$$g_{me_lb} = 0.667$$

$$m_2 \cdot g_{me_lb} = 0.667$$

Controlling Distribution Factor: $mg_{me_max} := \max(m_1 \cdot g_{m1e}, m_1 \cdot g_{m1e_lb}, m_2 \cdot g_{me}, m_2 \cdot g_{me_lb})$

$mg_{me_max} = 1.057$

Shear:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.79$$

Table 4.6.2.2.2a-1

$$b_m := 0.09$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_s1e} := 1.03$$

Table 4.6.2.2.1-2

$$g_{s1e} := \gamma_{a_s1e} \cdot \left[a_v \cdot \left(1 + \frac{d_e}{S} - \frac{3ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{s1e} = 0.772$$

$$m_1 \cdot g_{s1e} = 0.926$$

Lower Bound Distribution Factor

$$g_{s1e_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{s1e_lb} = 0.333$$

$$m_1 \cdot g_{s1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_w := 0.94$$

Table 4.6.2.2.2a-1

$$b_w := 0.05$$

$$m_2 := 1.0$$

Table 3.6.1.1.2-1

$$\gamma_{a_se} := 1.03$$

Table 4.6.2.2.1-2

$$g_{se} := \gamma_{a_se} \cdot \left[a_v \cdot \left(\frac{3}{2} + \frac{3 \cdot d_e}{2 \cdot S} - \frac{8ft}{S} \right) + b_v \right]$$

Eq. 4.6.2.2.2a-1
Table B4-2

$$g_{se} = 0.994$$

$$m_2 \cdot g_{se} = 0.994$$

Lower Bound Distribution Factor

$$g_{se_lb} := \left(\frac{N_L}{N_g} \right)$$

$$g_{se_lb} = 0.667$$

$$m_2 \cdot g_{se_lb} = 0.667$$

Controlling Distribution Factor: $mg_{se_max} := \max(m_1 \cdot g_{s1e}, m_1 \cdot g_{s1e_lb}, m_2 \cdot g_{se}, m_2 \cdot g_{se_lb})$

$$mg_{se_max} = 0.994$$

Skew Correction Factor (SCF): $SCF := 1.0 + 0.2 \cdot \tan\left(\frac{\pi}{180} \cdot \theta\right)$ Table 4.6.1.3-1

$$SCF = 1.035$$

$$mg_{se} := mg_{se_max} \cdot SCF$$

$$mg_{se} = 1.029$$

Summary:

Interior Girder

Moment:

$$mg_{mi} := mg_{mi_max}$$

$$mg_{mi} = 1.195$$

Shear:

$$mg_{si} = 1.439$$

Exterior Girder

Moment:

$$mg_{me} := mg_{me_max}$$

$$mg_{me} = 1.057$$

Shear:

$$mg_{se} = 1.029$$

ALTERNATE MOMENT DISTRIBUTION FACTOR APPROACH:

**Interior
Girders:
Moment**

:

One Lane Loaded

$$N_L := 1$$

$$S := 12.58\text{ft}$$

girder distance

$$L := 40.00\text{ft}$$

shortest span length

$$\text{Exp1} := 0.20$$

Table
4C-1

$$\text{Exp2} := 0.30$$

$$\text{Exp3} := 0.00$$

$$D := 44.60$$

$$g_{PF} := \left(\frac{S}{D \cdot \text{ft}}\right)^{\text{Exp1}} \left(\frac{S}{L}\right)^{\text{Exp2}} \left(\frac{1}{N_L}\right)^{\text{Exp3}}$$

Eq. 4C-3

$$g_{PF} = 0.549$$

$$a_m := 2.44$$

Table
4C-2

$$b_m := -0.58$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_m m_1} := 1.13$$

Table 4C-3

$$g_{am1i} := \gamma_{a_m m_1} (a_m \cdot g_{PF} + b_m)$$

Eq. 4C-1
Table 4C-1

$$g_{am1i} = 0.858$$

$$m_1 \cdot g_{am1i} = 1.029$$

Lower Bound Distribution Factor

$$g_{am1i_lb} := \left(\frac{N_L}{N_g} \right) \quad \text{Eq. 4C-1}$$

$$g_{am1i_lb} = 0.333$$

$$m_1 \cdot g_{am1i_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 1.14$$

Table
4C-2

$$b_m := -0.04$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_mi} := 1.05$$

Table 4C-3

$$g_{ami} := \gamma_{a_mi} \left[a_m \cdot \left(\frac{W_c}{10ft N_g} \right) + b_m \right]$$

Eq. 4C-1
Eq. 4C-3
Table 4C-1

$$g_{ami} = 1.195$$

$$m_2 \cdot g_{ami} = 1.195$$

Lower Bound Distribution Factor

$$g_{ami_lb} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{ami_lb} = 0.667$$

$$m_2 \cdot g_{ami_lb} = 0.667$$

Controlling Distribution Factor: $m g_{ami_max} := \max(m_1 \cdot g_{am1i}, m_1 \cdot g_{am1i_lb}, m_2 \cdot g_{ami}, m_2 \cdot g_{ami_lb})$

$m g_{ami_max} = 1.195$

Exterior Girders

Moment

:

One Lane Loaded

$$N_L := 1$$

$$a_m := 0.65$$

Table
4C-2

$$b_m := 0.15$$

$$m_1 := 1.2$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m1e}} := 1.02$$

Table 4C-3

$$g_{am1e} := \gamma_{a_{m1e}} \cdot a_m \cdot \left[1 + \frac{d_e}{S} - \frac{3ft}{S} \right] + b_m$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{am1e} = 0.706$$

$$m_1 \cdot g_{am1e} = 0.848$$

Lower Bound Distribution Factor

$$g_{am1e_lb} := \left(\frac{N_L}{N_g} \right)$$

Eq. 4C-1

$$g_{am1e_lb} = 0.333$$

$$m_1 \cdot g_{am1e_lb} = 0.400$$

Two or More Lanes Loaded

$$N_L := 2$$

$$a_m := 0.84$$

Table 4C-2

$$b_m := 0.13$$

$$m_2 := 1.00$$

Table 3.6.1.1.2-1

$$\gamma_{a_{m2e}} := 1.03$$

Table 4C-3

$$g_{ame} := \gamma_{a_{m2e}} \cdot a_m \cdot \left[\frac{3}{2} + \frac{3d_e}{2S} - \frac{8ft}{S} \right] + b_m$$

Eq. 4C-1
Table 4C-1
Table B4-2

$$g_{ame} = 0.976$$

$$m_2 \cdot g_{ame} = 0.976$$

Lower Bound Distribution Factor

$$g_{\text{ame_lb}} := \frac{N_L}{N_g}$$

Eq. 4C-1

$$g_{\text{ame_lb}} = 0.667$$

$$m_2 \cdot g_{\text{ame_lb}} = 0.667$$

Controlling Distribution Factor: $m_{\text{game_max}} := \max(m_1 \cdot g_{\text{ame}}, m_1 \cdot g_{\text{ame_lb}}, m_2 \cdot g_{\text{ame}}, m_2 \cdot g_{\text{ame_lb}})$

$$m_{\text{game_max}} = 0.976$$

Summary:

Interior Girder

Moment:

$$m_{\text{gami}} := m_{\text{gami_max}}$$

$$m_{\text{gami}} = 1.195$$

Exterior Girder

Moment:

$$m_{\text{game}} := m_{\text{game_max}}$$

$$m_{\text{game}} = 0.976$$

