Prestress LRFD Excel Input
Example Bridge B-28-136
3 Span 72W" Prestress Girder
Last Updated by DVB – 12/29/2011

FIRST - - - ENABLE MACROS

Optional Library Data

Abutment Bearing Pad Width

Enter width of bearing pad on top of the abutment

= 8 in

Pier Bearing Pad Width

Enter width of bearing pad on top of the piers.

= 8 in

Beam Extension

Enter distance from centerline of bearing to the end of the beam.

= 6 in

Centerline of Pier to Centerline of Bearing

Enter distance from the centerline of pier to centerline of bearing.

= 7.5 in

Deck Transverse Bar Size

Enter rebar size of the transverse reinforcement in the deck.

= 5

Longitudinal Spacing

Enter spacing of top longitudinal slab reinforcement over the pier.

= 4 in

Bridge ID

Enter the bridge ID number in this format: B-xx-xxxx.

B-28-0136

Engineer

Enter initials of rater/designer

AMK

SPAN DATA

Span Lengths

Enter the length of the spans from the centerline to centerline of abutments/piers.

Span 1 = 128 ft
Span 2 = 141 ft

Girder Cross Section

Enter the standard I-Beam shape.

= 72W

Intermediate Diaphragm Type

Enter “1” for a concrete diaphragm; enter “2” for a steel diaphragm.

= 2 (Steel Diaphragm)

Skew Angle

Enter the skew angle from the bridge bearing line.

= 41.00 deg

Number of Beams

Enter the number of beams in cross section.

= 4

Number of Design Lanes

The number of lanes equals the clear roadway-width divided by 12, rounded down to the nearest integer.

= 34 ft ÷ 12 ft/lane = 2.83 lanes ➔ 2 lanes

Relative Humidity (%)

Enter the average annual ambient relative humidity. This value will usually be 72%.

= *72*

LLDF Design Moment (axles/lane) – Calculations shown at end of this document

Enter the live load distribution factor for design moment. Use controlling (largest) value from all spans. See 17.2.8 WisDOT LRFD Bridge Manual

LLDF Design Shear (axles/lane) - Calculations shown at end of this document

Enter the live load distribution factor for design shear. Use controlling (largest) value from all spans. See 17.2.8 WisDOT LRFD Bridge Manual

LLDF Fatigue Moment (axles/lane) - Calculations shown at end of this document

Enter the live load distribution factor for fatigue moment. Use controlling (largest) value from all spans. See 17.2.8 WisDOT LRFD Bridge Manual

LLDF Fatigue Shear (axles/lane) - Calculations shown at end of this document

Enter the live load distribution factor for fatigue shear. Use controlling (largest) value from all spans. See 17.2.8 WisDOT LRFD Bridge Manual

Deck Width

Enter the clear roadway-width.

= *34 ft*

Parapet Type

Enter the type of parapet (choose from drop down list). Note: This information is not used by the program for the calculation of the dead weight associated with the parapet type. The parapet weight still must be hand-calculated later on (see page 5 of this document).

= *LF*

GIRDER DATA

Identification

Enter a description of the span.

= 2 *span 72W"*

Stand Type

Enter "1" for stress relieved strands, enter "2" for low relaxation strands.

= 2 (low relaxation strands)

Fy Slab Steel

Enter the yield strength of the slab reinforcing steel.

= 60 ksi

Strand Diameter (Draped)

Enter the diameter of the draped prestressing strands.

= 0.6 in

Strand Area (Draped)

Enter the area of the draped prestressing strands. For a 0.5" strand, the area is 0.153in^2; for a 0.6" strand, the area is 0.217in^2.

= $0.2170\ in^2$

Strand Diameter (Undraped)

Enter the diameter of the undraped prestressing strands.

= 0.6 in

Strand Area (Undraped)

Enter the area of the undraped prestressing strands. For a 0.5" strand, the area is 0.153in^2; for a 0.6" strand, the area is 0.217in^2.

= $0.2170\ in^2$

Girder Spacing

Enter the center-to-center spacing of the girders.

= 10.25 ft

Uniform Dead Load of Slab Including Haunch

Enter the uniform dead load of the slab and the haunch, distributed to the girder.

*Slab Weight = [10.25 ft*0.75 ft*0.15 kip/ft*^{3}*] = 1.153 kip/ft*
*Haunch Weight = [4 ft*0.25 ft*0.15 kip/ft*^{3}*] = 0.15 kip/ft*
Total Weight = 1.303 kip/ft

Uniform Dead Load of Curb, Parapet, Sidewalk, and Median

Enter the uniform dead load from the curb, parapet, sidewalk, and median, distributed evenly to the girder.

*Parapet Weight = [2*0.387 kip/ft] ÷ 4 girders = 0.194 kip/ft*
*Screening Weight = [2*0.035 kip/ft] ÷ 4 girders = 0.018 kip/ft*
Total Weight = 0.212 kip/ft

F’c Girder

Enter the concrete strength for the prestressed girder.

= 8 ksi

Effective Slab Thickness

Enter the effective thickness of the slab, which is equal to the total thickness minus a ½” thick wearing surface.

= 9 in – 0.5 in = 8.5 in

Effective Slab Width

Enter the effective width of the slab. According to 19.3.3.8 of the WisDOT LRFD Bridge Manual, this value is equal to the tributary width (i.e. the center-to-center spacing) for an interior girder.

= 10.25 ft 12 in/ft = 123 in*

Haunch

Enter the distance from the top of the girder to the bottom of the slab. When the girder is embedded in the slab, this value is negative. This haunch value is used for section property calculations and is different than the average haunch used to compute dead load. This value is equal to the minimum haunch at the edge of the girder plus the additional haunch at the center of the girder due to the slope of the deck.

Minimum haunch thickness = 1.25 in
Width of top flange = 48 in
Slope of deck = 0.02
*Haunch height = 1.25in + [48 in ÷ 2]*0.02 = 1.73 in*

F'c Slab (ksi)

Enter the concrete strength of the slab.

= 4 ksi

Uniform Dead of Future Wearing Surface per Girder (k/ft)

Since no future overlay currently exists, this value should not be accounted for. A bridge should be rated for how it exits at the moment, not accounting for future overlays.

= 0 kip/ft

Uniform Dead Load of Overburden per Girder (k/ft)

Enter the total dead weight of the overburden equally distributed to all girders. This new bridge has no overburden.

=0 kip/ft

Uniform Dead Load of Utilities per Girder (k/ft)

Enter the dead weight of the utilities (water pipes, electrical conduits, etc.) attached to the bridge that are adding extra weight to the girder being rated. There are no utilities attached to this particular bridge.

= 0 kip/ft

ANALYSIS DATA

Number of Strands

Enter the number of strands of prestressing steel in each girder.

Span 1 = 36
Span 2 = 48

Initial P/S Force

Enter the initial prestressing force in of all strands in a girder prior to losses due to elastic shortening, shrinkage and creep of concrete, and relaxation of the prestressing steel.

Span 1 = 1582 kips
Span 2 = 2109 kips

“A” Distance

Enter the distance from the bottom of the girder to the center of gravity of the draped strands, measured at the end of the girder.

Span 1 = 66 in
Span 2 = 67 in

“B” Distance

Enter the distance from the bottom of the girder to the center of gravity of the draped strands, measured at ¼ of the span length. If a B_{max} and B_{min} are given, take the average of the two.

Girder 1 = [20.25 in+23.25 in] ÷ 2 = 21.75 in
Girder 2 = [20.5 in+23.5 in] ÷ 2 = 22.00 in

Debonded Row Number

Enter the row number that the pair of debonded strands is in. The row closest to the bottom of the girder is row one. It is possible to have multiple pairs of debonded strands in the same row. There are no debonded strands in this particular bridge.

Debonded Length

Enter the length into the girder that the strand is debonded. This can be found on the girder plans, if applicable. There are no debonded strands in this particular bridge.

Area of Non-Prestressed Slab Steel per Effective Deck Width at Tenth Points of the Span

Enter the area of steel (top mat only) in the concrete slab in a characteristic one-foot width of the bridge, multiplied by the girder spacing.

Span 1:

_0/10 pt: 0.00 ft = [#4 @ 8 in = 0.29 in^2/ft]*10.25 ft = 2.97 in^2_
_1/10 pt: 12.8 ft = 2.97 in^2_
_2/10 pt: 25.6 ft = 2.97 in^2_
_3/10 pt: 38.4 ft = 2.97 in^2_
_4/10 pt: 51.2 ft = 2.97 in^2_
_5/10 pt: 64.0 ft = 2.97 in^2_
_6/10 pt: 76.8 ft = 2.97 in^2_
_7/10 pt: 89.6 ft = [#4 @ 8 in+#8 @ 8" = 1.47 in^2/ft]*10.25 ft = 15.07 in^2_
_8/10 pt: 102.4 ft = [#8 @ 8 in + 33%(#8 @ 8 in) = 1.57 in^2/ft]*10.25 ft = 16.09 in^2_
_9/10 pt: 115.2 ft = [#8 @ 4 in = 2.36 in^2/ft]*10.25 ft = 24.19 in^2_
_10/10 pt: 128 ft = 24.19 in^2_

> _Note: At the 8th point, only 33% of the #8 bars are developed. To determine how much of a bar is developed, refer to Table 9.9-2 in the LRFD WisDOT Bridge Manual. Assume that the bar develops from 0-100% linearly._

Span 2:

_0/10 pt: 0.00 ft = [#8 @ 4 in = 2.36 in^2/ft]*10.25 ft = 24.19 in^2_
_1/10 pt: 14.1 ft = 24.19 in^2_
_2/10 pt: 28.2 ft = [#4 @ 8 in+#8 @ 8" = 1.47 in^2/ft]*10.25 ft = 15.07 in^2_
_3/10 pt: 42.3 ft = [#4 @ 8 in +40%(#8 @ 8 in) = 0.76 in^2/ft]*10.25 ft = 7.81 in^2_
_4/10 pt: 56.4 ft = [#4 @ 8 in = 0.29 in^2/ft]*10.25 ft = 2.97 in^2_
_5/10 pt: 70.5 ft = 2.97 in^2_
_6/10 pt: 84.6 ft = 2.97 in^2_
_7/10 pt: 98.7 ft = 2.97 in^2_
_8/10 pt: 112.8 ft = 2.97 in^2_
_9/10 pt: 126.9 ft = 2.97 in^2_
_10/10 pt: 141.0 ft = 2.97 in^2_

> _Note: At the 3rd point, only 40% of the #8 bars are developed. To determine how much of a bar is developed, refer to Table 9.9-2 in LRFD WisDOT Bridge Manual. Assume that the bar develops from 0-100% linearly._

Spacing of #4 Stirrup Reinforcement Steel at Tenth Points of Span (in)

Enter the spacing of #4 stirrup reinforcement. If the stirrups are not #4 bars, you must calculate the face area of the stirrups and convert this area into an equivalent #4 spacing.

Span 1

0/10 pt: 0.00 ft = 4.25 in
1/10 pt: 12.8 ft = 7 in
2/10 pt: 25.7 ft = 7 in
3/10 pt: 38.5 ft = 18 in
4/10 pt: 51.4 ft = 18 in
5/10 pt: 64.2 ft = 18 in
6/10 pt: 77.0 ft = 18 in
7/10 pt: 89.9 ft = 18 in
8/10 pt: 102.7 ft = 7 in
9/10 pt: 115.6 ft = 7 in
10/10 pt: 128.4 ft = 4.25 in

Spans 2

0/10 pt: 0.00 ft = 4.25 in
1/10 pt: 14.1 ft = 9 in
2/10 pt: 28.3 ft = 9 in
3/10 pt: 42.4 ft = 18 in
4/10 pt: 56.6 ft = 18 in
5/10 pt: 70.7 ft = 18 in
6/10 pt: 84.8 ft = 18 in
7/10 pt: 99.0 ft = 18 in
8/10 pt: 113.1 ft = 9 in
9/10 pt: 127.2 ft = 9 in
10/10 pt: 141.4 ft = 4.25 in

DISTRIBUTION FACTOR CALCULATIONS

$S_1 := 10.25$ $S_2 := 10.25$ $\theta := 41$ $L_1 := 128$ $L_2 := 141$ $t_s := 8.5$ $N_b := 4$

$f'c_{beam} := 8$ $f'c_{deck} := 4$ $I := 656426$ $y_t := 37.13$ $A := 915$

$E_b := 5500 \cdot \frac{\sqrt{f'c_{beam}}}{\sqrt{6}}$ $E_d := 4125 \cdot \frac{\sqrt{f'c_{deck}}}{\sqrt{4}}$ $n := \frac{E_b}{(E_d)}$ $n = 1.54$

$Haunch\_Height := 1.73$ $e_g := y_t + Haunch\_Height + \frac{t_s}{2}$ $e_g = 43.11$

$K_g := n \cdot \left(I + A \cdot e_g^{\,2}\right)$ $K_g = 3.629 \times 10^6$

Moment Calculations:

Single Lane Loaded:

$$Moment\_DF_{Single\_Lane\_1} := 0.06 + \left(\frac{S_1}{14}\right)^{0.4} \cdot \left(\frac{S_1}{L_1}\right)^{0.3} \cdot \left(\frac{K_g}{12 \cdot L_1 \cdot t_s^{\,3}}\right)^{0.1}$$ $Moment\_DF_{Single\_Lane\_1} = 0.534$

$$Moment\_DF_{Single\_Lane\_2} := 0.06 + \left(\frac{S_2}{14}\right)^{0.4} \cdot \left(\frac{S_2}{L_2}\right)^{0.3} \cdot \left(\frac{K_g}{12 \cdot L_2 \cdot t_s^{\,3}}\right)^{0.1}$$ $Moment\_DF_{Single\_Lane\_2} = 0.516$

Multi Lane Loaded:

$$Moment\_DF_{Multi\_Lane\_1} := 0.075 + \left(\frac{S_1}{9.5}\right)^{0.6} \cdot \left(\frac{S_1}{L_1}\right)^{0.2} \cdot \left(\frac{K_g}{12 \cdot L_1 \cdot t_s^{\,3}}\right)^{0.1}$$ $Moment\_DF_{Multi\_Lane\_1} = 0.798$

$$Moment\_DF_{Multi\_Lane\_2} := 0.075 + \left(\frac{S_2}{9.5}\right)^{0.6} \cdot \left(\frac{S_2}{L_2}\right)^{0.2} \cdot \left(\frac{K_g}{12 \cdot L_2 \cdot t_s^{\,3}}\right)^{0.1}$$ $Moment\_DF_{Multi\_Lane\_2} = 0.777$

$\boxed{LLDF\_Design\_Moment := 0.798}$

Shear Calculations:

Single Lane Loaded:

$$Shear\_DF_{Single\_Lane} := 0.36 + \left(\frac{S_1}{25}\right) \qquad Shear\_DF_{Single\_Lane} = 0.77$$

Multi Lane Loaded:

$$Shear\_DF_{Multi\_Lane} := 0.2 + \left(\frac{S_1}{12}\right) - \left(\frac{S_1}{35}\right)^2 \qquad Shear\_DF_{Multi\_Lane} = 0.968$$

Skew Correction Factor:

$$Skew\_Correction_1 := 1 + 0.2 \cdot \left(12 \cdot L_1 \cdot \frac{t_s^{\,3}}{K_g}\right)^{0.3} \cdot \tan(\theta) \qquad Skew\_Correction_1 = 1.021$$

$$Skew\_Correction_2 := 1 + 0.2 \cdot \left(12 \cdot L_2 \cdot \frac{t_s^{\,3}}{K_g}\right)^{0.3} \cdot \tan(\theta) \qquad Skew\_Correction_2 = 1.022$$

$$LLDF\_Design\_Shear := Shear\_DF_{Multi\_Lane} \cdot Skew\_Correction_2 \qquad \boxed{LLDF\_Design\_Shear = 0.99}$$

Fatigue Moment Calculation:

$$LLDF\_Fatigue\_Moment := \frac{Moment\_DF_{Single\_Lane\_1}}{1.2} \qquad \boxed{LLDF\_Fatigue\_Moment = 0.445}$$

Fatigue Shear Calculation:

$$LLDF\_Fatigue\_Shear := \frac{Shear\_DF_{Single\_Lane}}{1.2} \qquad \boxed{LLDF\_Fatigue\_Shear = 0.642}$$