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Calculation of connection of loads for the DSS

Loads on CPA beam

1) Calculations of support loads on CPA Bridge Beam 1
Inputs:

$Wcpa := 158 \cdot lbf$
$Wfc := 440 \cdot lbf$
$Wcf := Wcpa + 2 \cdot Wfc = (1.038 \cdot 10^3)\ lbf$
$Wew := 1400 \cdot lbf$
$Wbp := 100 \cdot lbf$
$Wapa := 900 \cdot lbf$
$wb := 18 \cdot \frac{lbf}{ft}$

$Laf := 3840 \cdot mm$
$Ld := Laf \cdot wb = 226.772\ lbf$
$La := Wew$
$Lc := Wcf$
$Le := Wcf$
$Lf := Wcf$
$AG := 3575 \cdot mm$
$BG := 3159 \cdot mm$
$CG := 2930 \cdot mm$
$DG := 1895 \cdot mm$
$EG := 1770 \cdot mm$
$FG := 610 \cdot mm$

$Rb1 := La \cdot \frac{AG}{BG} = (1.584 \cdot 10^3)\ lbf$

$Rb2 := Lc \cdot \frac{CG}{BG} = 962.754\ lbf$
$Rb3 := Ld \cdot \frac{DG}{BG} = 136.034\ lbf$
$Rb4 := Le \cdot \frac{EG}{BG} = 581.595\ lbf$
$Rb5 := Lf \cdot \frac{FG}{BG} = 200.437\ lbf$

$Rbc := Rb1 + Rb2 + Rb3 + Rb4 + Rb5 = (3.465 \cdot 10^3)\ lbf$

$\left(\frac{AG}{} \right)$

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$$Rg1 := La \cdot \left(1 - \frac{AG}{BG}\right) = -184.362\ lbf$$

$$Rg2 := Lc \cdot \left(1 - \frac{CG}{BG}\right) = 75.246\ lbf$$

$$Rg3 := Ld \cdot \left(1 - \frac{DG}{BG}\right) = 90.737\ lbf$$

$$Rg4 := Le \cdot \left(1 - \frac{EG}{BG}\right) = 456.405\ lbf$$

$$Rg5 := Lf \cdot \left(1 - \frac{FG}{BG}\right) = 837.563\ lbf$$

$$Rg := Rg1 + Rg2 + Rg3 + Rg4 + Rg5 = \left(1.276 \cdot 10^{3}\right)\ lbf$$

2) Calculations of loads on CPA bridge beam 2
Inputs:

$$GN := (3770 - 42) \cdot mm$$

$$Lk := GN \cdot wb = 220.157\ lbf$$

$$Li := Wcf$$

$$Lj := Wcf$$

$$Ll := Wcf$$

$$Ln := Wew$$

$$GM := 3171 \cdot mm$$

$$HM := 2669 \cdot mm$$

$$IM := 2621 \cdot mm$$

$$JM := 1461 \cdot mm$$

$$KM := 1307 \cdot mm$$

$$LM := 301 \cdot mm$$

$$MN := 344 \cdot mm$$

$$Rh1 := Rg \cdot \frac{GM}{HM} = \left(1.516 \cdot 10^{3}\right)\ lbf$$

$$Rm1 := Rg \cdot \left(1 - \frac{GM}{HM}\right) = -239.92\ lbf$$

$$Rh2 := Li \cdot \frac{IM}{HM} = \left(1.019 \cdot 10^{3}\right)\ lbf$$

$$Rm2 := Li \cdot \left(1 - \frac{IM}{HM}\right) = 18.668\ lbf$$

$$Rh3 := Lj \cdot \frac{JM}{HM} = 568.197\ lbf$$

$$Rm3 := Lj \cdot \left(1 - \frac{JM}{HM}\right) = 469.803\ lbf$$

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$$Rh4 := Lk \cdot \frac{KM}{HM} = 107.81\ lbf$$

$$Rm4 := Lk \cdot \left(1 - \frac{KM}{HM}\right) = 112.347\ lbf$$

$$Rh5 := Ll \cdot \frac{LM}{HM} = 117.062\ lbf$$

$$Rm5 := Ll \cdot \left(1 - \frac{LM}{HM}\right) = 920.938\ lbf$$

$$Rh6 := -Ln \cdot \frac{MN}{HM} = -180.442\ lbf$$

$$Rm6 := Ln \cdot \left(1 + \frac{MN}{HM}\right) = \left(1.58 \cdot 10^{3}\right)\ lbf$$

$$Rhc := Rh1 + Rh2 + Rh3 + Rh4 + Rh5 + Rh6 = \left(3.147 \cdot 10^{3}\right)\ lbf$$

$$Rmc := Rm1 + Rm2 + Rm3 + Rm4 + Rm5 + Rm6 = \left(2.862 \cdot 10^{3}\right)\ lbf$$

Loads on EW beam

1) Calculations of support loads on EW Bridge Beam 1
Inputs:

$$Wcpa := 0 \cdot lbf$$
$$Wfc := 0 \cdot lbf$$
$$Wcf := Wcpa + 2 \cdot Wfc = 0\ lbf$$
$$Wew := 0 \cdot lbf$$
$$Wbp := 100 \cdot lbf$$
$$Wapa := 0 \cdot lbf$$
$$wb := 18 \cdot \frac{lbf}{ft}$$

$$Laf := 3840 \cdot mm$$
$$Ld := Laf \cdot wb = 226.772\ lbf$$
$$La := Wew$$
$$Lc := Wcf$$
$$Le := Wcf$$
$$Lf := Wcf$$
$$AG := 3575 \cdot mm$$
$$BG := 3159 \cdot mm$$
$$CG := 2930 \cdot mm$$
$$DG := 1895 \cdot mm$$

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$EG := 1770 \cdot mm$

$FG := 610 \cdot mm$

$Rb1 := 0 \cdot lbf \cdot \frac{AG}{BG} = 0\ lbf$

$Rb2 := Lc \cdot \frac{CG}{BG} = 0\ lbf$

$Rb3 := Ld \cdot \frac{DG}{BG} = 136.034\ lbf$

$Rb4 := Le \cdot \frac{EG}{BG} = 0\ lbf$

$Rb5 := Lf \cdot \frac{FG}{BG} = 0\ lbf$

$Rbe := Rb1 + Rb2 + Rb3 + Rb4 + Rb5 = 136.034\ lbf$

$Rg1 := (0 \cdot lbf) \cdot \left(1 - \frac{AG}{BG}\right) = 0\ lbf$

$Rg2 := Lc \cdot \left(1 - \frac{CG}{BG}\right) = 0\ lbf$

$Rg3 := Ld \cdot \left(1 - \frac{DG}{BG}\right) = 90.737\ lbf$

$Rg4 := Le \cdot \left(1 - \frac{EG}{BG}\right) = 0\ lbf$

$Rg5 := Lf \cdot \left(1 - \frac{FG}{BG}\right) = 0\ lbf$

$Rg := Rg1 + Rg2 + Rg3 + Rg4 + Rg5 = 90.737\ lbf$

2) Calculations of loads on EW bridge beam 2
Inputs:

$Lgn := (3770 - 42) \cdot mm$

$Lk := Lgn \cdot wb = 220.157\ lbf$

$Li := Wcf$

$Lj := Wcf$

$Ll := Wcf$

$Ln := Wew$

$GM := 3171 \cdot mm$

$HM := 2669 \cdot mm$

$IM := 2621 \cdot mm$

$JM := 1461 \cdot mm$

$KM := 1307 \cdot mm$

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$LM := 301 \cdot mm$

$MN := 344 \cdot mm$

$Rh1 := Rg \cdot \frac{GM}{HM} = 107.804\ lbf$

$Rm1 := Rg \cdot \left(1 - \frac{GM}{HM}\right) = -17.066\ lbf$

$Rh2 := Li \cdot \frac{IM}{HM} = 0\ lbf$

$Rm2 := Li \cdot \left(1 - \frac{IM}{HM}\right) = 0\ lbf$

$Rh3 := Lj \cdot \frac{JM}{HM} = 0\ lbf$

$Rm3 := Lj \cdot \left(1 - \frac{JM}{HM}\right) = 0\ lbf$

$Rh4 := Lk \cdot \frac{KM}{HM} = 107.81\ lbf$

$Rm4 := Lk \cdot \left(1 - \frac{KM}{HM}\right) = 112.347\ lbf$

$Rh5 := Ll \cdot \frac{LM}{HM} = 0\ lbf$

$Rm5 := Ll \cdot \left(1 - \frac{LM}{HM}\right) = 0\ lbf$

$Rh6 := 0 \cdot lbf \cdot \frac{MN}{HM} = 0\ lbf$

$Rm6 := 0 \cdot lbf \cdot \left(1 + \frac{MN}{HM}\right) = 0\ lbf$

$Rhe := Rh1 + Rh2 + Rh3 + Rh4 + Rh5 + Rh6 + Wew = 215.614\ lbf$

$Rme := Rm1 + Rm2 + Rm3 + Rm4 + Rm5 + Rm6 = 95.281\ lbf$

Loads on APA beam

1) Calculations of support loads on APA Bridge Beam 1
Inputs:

$Vcpa := 0 \cdot lbf$

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$Wfc := 0 \cdot lbf$

$Wcf := Wcpa + 2 \cdot Wfc = 0\ lbf$

$Wew := 1400 \cdot lbf$

$Wbp := 0 \cdot lbf$

$Wapa := 450 \cdot lbf$

$wb := 18 \cdot \frac{lbf}{ft}$

$Laf := 3840 \cdot mm$

$Ld := Laf \cdot wb = 226.772\ lbf$

$La := Wew$

$Lc := Wapa$

$Le := Wapa$

$Lf := Wapa$

$AG := 3575 \cdot mm$

$BG := 3159 \cdot mm$

$CG := 2930 \cdot mm$

$DG := 1895 \cdot mm$

$EG := 1770 \cdot mm$

$FG := 610 \cdot mm$

$Rb1 := La \cdot \frac{AG}{BG} = \left(1.584 \cdot 10^3\right)\ lbf$

$Rb2 := Lc \cdot \frac{CG}{BG} = 417.379\ lbf$

$Rb3 := Ld \cdot \frac{DG}{BG} = 136.034\ lbf$

$Rb4 := Le \cdot \frac{EG}{BG} = 252.137\ lbf$

$Rb5 := Lf \cdot \frac{FG}{BG} = 86.895\ lbf$

$Rba := Rb1 + Rb2 + Rb3 + Rb4 + Rb5 = \left(2.477 \cdot 10^3\right)\ lbf$

$Rg1 := La \cdot \left(1 - \frac{AG}{BG}\right) = -184.362\ lbf$

$Rg2 := Lc \cdot \left(1 - \frac{CG}{BG}\right) = 32.621\ lbf$

$Rg3 := Ld \cdot \left(1 - \frac{DG}{BG}\right) = 90.737\ lbf$

$Rg4 := Le \cdot \left(1 - \frac{EG}{BG}\right) = 197.863\ lbf$

$Rg5 := Lf \cdot \left(1 - \frac{FG}{BG}\right) = 363.105\ lbf$

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$Rg := Rg1 + Rg2 + Rg3 + Rg4 + Rg5 = 499.965\ lbf$

2) Calculations of loads on APA bridge beam 2
Inputs:

$Lgn := (3770 - 42) \cdot mm$
$Lk := Lgn \cdot wb = 220.157\ lbf$
$Li := Wapa$
$Lj := Wapa$
$Ll := Wapa$
$Ln := Wew$
$GM := 3171 \cdot mm$
$HM := 2669 \cdot mm$
$IM := 2621 \cdot mm$
$JM := 1461 \cdot mm$
$KM := 1307 \cdot mm$
$LM := 301 \cdot mm$
$MN := 344 \cdot mm$

$Rh1 := Rg \cdot \frac{GM}{HM} = 594.001\ lbf$
$Rm1 := Rg \cdot \left(1 - \frac{GM}{HM}\right) = -94.036\ lbf$
$Rh2 := Li \cdot \frac{IM}{HM} = 441.907\ lbf$
$Rm2 := Li \cdot \left(1 - \frac{IM}{HM}\right) = 8.093\ lbf$
$Rh3 := Lj \cdot \frac{JM}{HM} = 246.328\ lbf$
$Rm3 := Lj \cdot \left(1 - \frac{JM}{HM}\right) = 203.672\ lbf$

$Rh4 := Lk \cdot \frac{KM}{HM} = 107.81\ lbf$
$Rm4 := Lk \cdot \left(1 - \frac{KM}{HM}\right) = 112.347\ lbf$
$Rh5 := Ll \cdot \frac{LM}{HM} = 50.749\ lbf$
$Rm5 := Ll \cdot \left(1 - \frac{LM}{HM}\right) = 399.251\ lbf$
$Rh6 := -Ln \cdot \frac{MN}{HM} = -180.442\ lbf$

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HM

$Rm6 := Ln \cdot \left(1 + \frac{MN}{HM}\right) = \left(1.58 \cdot 10^3\right)\ lbf$

$Rha := Rh1 + Rh2 + Rh3 + Rh4 + Rh5 + Rh6 = \left(1.26 \cdot 10^3\right)\ lbf$

$Rma := Rm1 + Rm2 + Rm3 + Rm4 + Rm5 + Rm6 = \left(2.21 \cdot 10^3\right)\ lbf$

3) Calculations on loads on rail beam b

Inputs:

$Lov := (3812) \cdot mm$

$Lu := Lov \cdot wb = 225.118\ lbf$

$Lo := Rba = \left(2.477 \cdot 10^3\right)\ lbf$

$Lt := Rbe = 136.034\ lbf$

$Lv := Rbc = \left(3.465 \cdot 10^3\right)\ lbf$

$OV := 3637 \cdot mm$

$PV := 3305 \cdot mm$

$TV := 1960 \cdot mm$

$UV := 1906 \cdot mm$

$Rp1 := Lo \cdot \frac{OV}{PV} = \left(2.726 \cdot 10^3\right)\ lbf$

$Rv1 := Lo \cdot \left(1 - \frac{OV}{PV}\right) = -248.805\ lbf$

$Rp2 := Lt \cdot \frac{TV}{PV} = 80.674\ lbf$

$Rv2 := Lt \cdot \left(1 - \frac{TV}{PV}\right) = 55.36\ lbf$

$Rp3 := Lu \cdot \frac{UV}{PV} = 129.826\ lbf$

$Rv3 := Lu \cdot \left(1 - \frac{UV}{PV}\right) = 95.292\ lbf$

$Rbp := Rp1 + Rp2 + Rh3 = \left(3.053 \cdot 10^3\right)\ lbf$

$Rbv := 2 \cdot (Rv1 + Rv2 + Rv3) + Lv = \left(3.269 \cdot 10^3\right)\ lbf$

3) Calculations on loads on rail beam h

Inputs:

$Lov := (3812) \cdot mm$

$Lu := Lov \cdot wb = 225.118\ lbf$

$Lo := Rha = \left(1.26 \cdot 10^3\right)\ lbf$

$Lt := Rhe = 215.614\ lbf$

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$Lv := Rhc = (3.147 \cdot 10^3)\ lbf$

$OV := 3637 \cdot mm$

$PV := 3305 \cdot mm$

$TV := 1960 \cdot mm$

$UV := 1906 \cdot mm$

$Rp1 := Lo \cdot \frac{OV}{PV} = (1.387 \cdot 10^3)\ lbf$

$Rv1 := Lo \cdot \left(1 - \frac{OV}{PV}\right) = -126.607\ lbf$

$Rp2 := Lt \cdot \frac{TV}{PV} = 127.868\ lbf$

$Rv2 := Lt \cdot \left(1 - \frac{TV}{PV}\right) = 87.746\ lbf$

$Rp3 := Lu \cdot \frac{UV}{PV} = 129.826\ lbf$

$Rv3 := Lu \cdot \left(1 - \frac{UV}{PV}\right) = 95.292\ lbf$

$Rhp := Rp1 + Rp2 + Rh3 = (1.761 \cdot 10^3)\ lbf$

$Rhv := 2 \cdot (Rv1 + Rv2 + Rv3) + Lv = (3.26 \cdot 10^3)\ lbf$

3) Calculations on loads on rail beam m

Inputs:

$OV := (3812) \cdot mm$

$Lu := OV \cdot wb = 225.118\ lbf$

$Lo := Rma = (2.21 \cdot 10^3)\ lbf$

$Lt := Rme = 95.281\ lbf$

$Lv := Rmc = (2.862 \cdot 10^3)\ lbf$

$OV := 3637 \cdot mm$

$PV := 3305 \cdot mm$

$TV := 1960 \cdot mm$

$UV := 1906 \cdot mm$

$Rp1 := Lo \cdot \frac{OV}{PV} = (2.432 \cdot 10^3)\ lbf$

$Rv1 := Lo \cdot \left(1 - \frac{OV}{PV}\right) = -221.98\ lbf$

$Rp2 := Lt \cdot \frac{TV}{PV} = 56.505\ lbf$

$Rv2 := Lt \cdot \left(1 - \frac{TV}{PV}\right) = 38.775\ lbf$

UV

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$$Rp3 := Lu \cdot \frac{UV}{PV} = 129.826\ lbf$$

$$Rv3 := Lu \cdot \left(1 - \frac{UV}{PV}\right) = 95.292\ lbf$$

$$Rmp := Rp1 + Rp2 + Rh3 = \left(2.735 \cdot 10^3\right)\ lbf$$

$$Rmv := 2 \cdot (Rv1 + Rv2 + Rv3) + Lv = \left(2.686 \cdot 10^3\right)\ lbf$$

Double check of loads - Comparison of total detector weight with weight on trolleys and weight on runway hangers

Total TPC+beam weight:

$$Wcpa := 158 \cdot lbf$$
$$Wfc := 440 \cdot lbf$$
$$Wcf := Wcpa + 2 \cdot Wfc = \left(1.038 \cdot 10^3\right)\ lbf$$
$$Wew := 1400 \cdot lbf$$
$$Wbp := 100 \cdot lbf$$
$$Wapa := 900 \cdot lbf$$
$$wb := 18 \cdot \frac{lbf}{ft}$$

$$Wtcpa := 6 \cdot Wcpa = 948\ lbf$$

$$Wtapa := 6 \cdot Wapa = \left(5.4 \cdot 10^3\right)\ lbf$$
$$Wtew := 4 \cdot Wew = \left(5.6 \cdot 10^3\right)\ lbf$$
$$Wtfc := Wfc \cdot 12 = \left(5.28 \cdot 10^3\right)\ lbf$$
$$Wtb := (((AG + GN) \cdot 5) + (6 \cdot OV)) \cdot wb = \left(3.445 \cdot 10^3\right)\ lbf$$
$$Wt := Wtcpa + Wtapa + Wtew + Wtfc + Wtb = \left(2.067 \cdot 10^4\right)\ lbf$$

Total weight on trolleys+beam weight

$$Rxa := 2 \cdot (Rba + Rha + Rma) = \left(1.189 \cdot 10^4\right)\ lbf$$
$$Rxe := 2 \cdot (Rbe + Rhe + Rme) = 893.858\ lbf$$
$$Rxc := Rbc + Rhc + Rmc = \left(9.475 \cdot 10^3\right)\ lbf$$
$$Wtrb := 6 \cdot OV \cdot wb = \left(1.289 \cdot 10^3\right)\ lbf$$

$$Rt := Rxa + Rxe + Rxc + Wtrb = \left(2.355 \cdot 10^4\right)\ lbf$$

$$Wtcpa + Wtfc = \left(6.228 \cdot 10^3\right)\ lbf$$

$$Wbr := (AG + GN) \cdot wb = 431.28\ lbf$$

$$Rxa - 2 \cdot Wbr = \left(1.103 \cdot 10^4\right)\ lbf$$

$$Rxe - 2 \cdot Wbr = 31.299\ lbf$$

$$Rxc - Wbr = \left(9.044 \cdot 10^3\right)\ lbf$$

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Total weight on support:

$Wsa := Rbp + Rhp + Rmp = (7.548 \cdot 10^3)\ lbf$

$Wsc := Rbv + Rhv + Rmv = (9.216 \cdot 10^3)\ lbf$

$Wst := 2 \cdot (Wsa + Wsc) - (Rbc + Rhc + Rmv) = (2.423 \cdot 10^4)\ lbf$

$Rba = (1.102 \cdot 10^4)\ N$	$Rba = (2.477 \cdot 10^3)\ lbf$
$Rbe = 605.111\ N$	$Rbe = 136.034\ lbf$
$Rbc = (1.541 \cdot 10^4)\ N$	$Rbc = (3.465 \cdot 10^3)\ lbf$
$Rha = (5.606 \cdot 10^3)\ N$	$Rha = (1.26 \cdot 10^3)\ lbf$
$Rhe = 959.099\ N$	$Rhe = 215.614\ lbf$
$Rhc = (1.4 \cdot 10^4)\ N$	$Rhc = (3.147 \cdot 10^3)\ lbf$
$Rma = (9.83 \cdot 10^3)\ N$	$Rma = (2.21 \cdot 10^3)\ lbf$
$Rme = 423.83\ N$	$Rme = 95.281\ lbf$
$Rmc = (1.273 \cdot 10^4)\ N$	$Rmc = (2.862 \cdot 10^3)\ lbf$
$Rbp = (1.358 \cdot 10^4)\ N$	$Rbp = (3.053 \cdot 10^3)\ lbf$
$Rbv = (1.454 \cdot 10^4)\ N$	$Rbv = (3.269 \cdot 10^3)\ lbf$
$Rhp = (7.834 \cdot 10^3)\ N$	$Rhp = (1.761 \cdot 10^3)\ lbf$
$Rhv = (1.45 \cdot 10^4)\ N$	$Rhv = (3.26 \cdot 10^3)\ lbf$
$Rmp = (1.216 \cdot 10^4)\ N$	$Rmp = (2.735 \cdot 10^3)\ lbf$
$Rmv = (1.195 \cdot 10^4)\ N$	$Rmv = (2.686 \cdot 10^3)\ lbf$

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