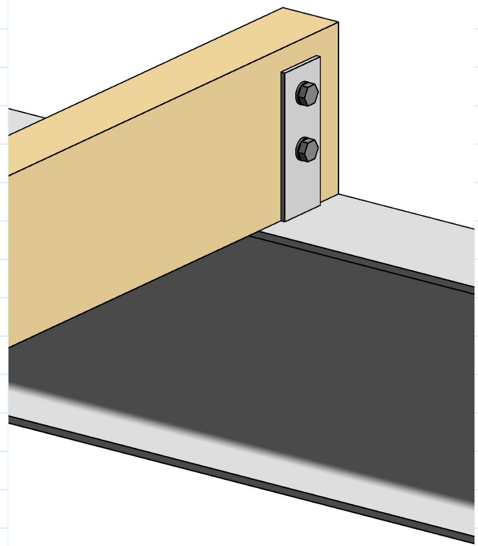
Wood Bearing Connection - 4x10 to W14x30:

$Dead := 0.511\ kip$ $Snow := 1.125\ kip$ $Wind := -0.675\ kip$

$$P_{asd} := \begin{bmatrix} Dead \\ Dead + Snow \\ Dead + 0.75 \cdot Wind + 0.75 \cdot Snow \\ 0.6 \cdot Dead + 0.6 \cdot Wind \end{bmatrix} = \begin{bmatrix} 511 \\ 1636 \\ 848.5 \\ -98.4 \end{bmatrix} lbf$$

$$P_u := \begin{bmatrix} 1.4 \cdot Dead \\ 1.2 \cdot Dead + 1.6 \cdot Snow \\ 1.2 \cdot Dead + 1.0 \cdot Wind + 0.5 \cdot Snow \\ 1.2 \cdot Dead + 0.5 \cdot Wind + 1.6 \cdot Snow \\ 0.9 \cdot Dead + 1.0 \cdot Wind \end{bmatrix} = \begin{bmatrix} 715.4 \\ 2413.2 \\ 500.7 \\ 2075.7 \\ -215.1 \end{bmatrix} lbf$$



Bearing Length Measured Parallel To Grain: $l_b := 8.74\ in$

Bearing Width: $Width := 3.5\ in$

$C_m := 1$ $C_i := 1$ $C_t := 1$ $K_f := 1.67$ $\phi := 0.90$

$F_{cp} := 750\ psi$

$$C_b := \begin{Vmatrix} \text{if } l_b \le 6\ in \\ \quad \Big\| \text{return } \dfrac{l_b + 0.375\ in}{l_b} \\ \text{else} \\ \quad \| \text{return } 1.0 \end{Vmatrix} = 1$$

NDS 3.10-2

$F`_{cp\_ASD} := F_{cp} \cdot C_m \cdot C_t \cdot C_i \cdot C_b = 750\ psi$

$F`_{cp\_LRFD} := \phi \cdot K_f \cdot F_{cp} \cdot C_m \cdot C_t \cdot C_i \cdot C_b = 1127.25\ psi$

$Capacity_{ASD} := F`_{cp\_ASD} \cdot Width \cdot l_b = 22.943\ kip$

$Capacity_{LRFD} := F`_{cp\_LRFD} \cdot Width \cdot l_b = 34.483\ kip$

```
Calculations for Wood Bearing Connection:
    Bearing Width = 3.500 in
    Bearing Length = 8.740 in
    Angle to Grain = 90 deg
    Fpc = 750.000 ksi, Fc = 2510.000 ksi
    Cm = 1.00, Ci = 1.00
    Ct = 1.00, Cb = 1.00
    Connection Code Check = 0.07
    P = 1.64 kips vs 22.94 kips
    For Dead + Snow
```

```
Calculations for Wood Bearing Connection:
    Bearing Width = 3.500 in
    Bearing Length = 8.740 in
    Angle to Grain = 90 deg
    Fpc = 750.000 ksi, Fc = 2510.000 ksi
    Cm = 1.00, Ci = 1.00
    Ct = 1.00, Cb = 1.00
    Connection Code Check = 0.07
    P = 2.41 kips vs 34.48 kips
    For 1.2 Dead + 1.6 Snow
```

Bolt Design for Uplift Connection: Fastener Diameter: $D := 0.5\ in$

Main Member Bearing Length: $l_m := 3.5\ in$ Side Member Bearing Length: $l_s := 0.25\ in$

Load angles: $\theta := 90\ deg$ G Values for main members: $G := 0.5$

Dowel Bearing Strength: $F_{yb} := 45000\ psi$

$$F_{em} := \left\| \begin{array}{l} F_{e\_par} \leftarrow 11200\ psi \cdot G \\ F_{e\_perp} \leftarrow \dfrac{6100\ psi \cdot G^{1.45}}{\sqrt{\dfrac{D}{in}}} \\ F_e \leftarrow \dfrac{F_{e\_par} \cdot F_{e\_perp}}{F_{e\_par} \cdot \sin(\theta)^2 + F_{e\_perp} \cdot \cos(\theta)^2} \end{array} \right. = 3157.558\ psi$$

$$F_{es} := 87000\ psi$$

$$K_\theta := 1 + 0.25 \cdot \left(\frac{\theta}{90\ deg} \right) = 1.25$$

$$I_m := \left\| \begin{array}{l} R_d \leftarrow 4 \cdot K_\theta \\ \text{return } \dfrac{D \cdot l_m \cdot F_{em}}{R_d} \end{array} \right. = 1105.145\ lbf \qquad I_s := \left\| \begin{array}{l} R_d \leftarrow 4 \cdot K_\theta \\ \text{return } \dfrac{2 \cdot D \cdot l_s \cdot F_{es}}{R_d} \end{array} \right. = 4350\ lbf$$

$$III_m := \left\| \begin{array}{l} R_d \leftarrow 3.2 \cdot K_\theta \\ R_e \leftarrow \dfrac{F_{em}}{F_{es}} \\ k_2 \leftarrow -1 + \sqrt{2 \cdot (1 + R_e) + \dfrac{2 \cdot F_{yb} \cdot (1 + 2 \cdot R_e) \cdot D^2}{3 \cdot F_{em} \cdot {l_m}^2}} \\ \text{return } \dfrac{k_2 \cdot D \cdot l_m \cdot F_{em}}{(1 + 2 \cdot R_e) \cdot R_d} \end{array} \right. = 657.047\ lbf$$

$$III_s := \left\| \begin{array}{l} R_d \leftarrow 3.2 \cdot K_\theta \\ R_e \leftarrow \dfrac{F_{em}}{F_{es}} \\ k_3 \leftarrow -1 + \sqrt{\dfrac{2 \cdot (1 + R_e)}{R_e} + \dfrac{2 \cdot F_{yb} \cdot (2 + R_e) \cdot D^2}{3 \cdot F_{em} \cdot {l_s}^2}} \\ \text{return } \dfrac{2 \cdot k_3 \cdot D \cdot l_s \cdot F_{em}}{(2 + R_e) \cdot R_d} \end{array} \right. = 1027.02\ lbf$$

$$IV := \left\| \begin{array}{l} R_d \leftarrow 3.2 \cdot K_\theta \\ R_e \leftarrow \dfrac{F_{em}}{F_{es}} \\ \text{return } \dfrac{2 \cdot D^2}{R_d} \cdot \sqrt{\dfrac{2 \cdot F_{em} \cdot F_{yb}}{3 \cdot (1 + R_e)}} \end{array} \right. = 1195.102\ lbf$$

$I_m = 1105.145\ lbf$

$I_s = 4350\ lbf$

$III_m = 657.047\ lbf$

$III_s = 1027.02\ lbf$

$IV = 1195.102\ lbf$

$Z := min\left(I_m, I_s, III_s, IV\right) = 1027.02\ lbf$

Number of Bolts: $N_{bolts} := 2$ Bolt Spacing: $s := 3\ in$ $End\_Distance := 2.75\ in$

$E_m := 2000\ ksi$ $E_s := 29000\ ksi$

$A_m := l_m \cdot s = 10.5\ in^2$ $A_s := l_s \cdot s = 0.75\ in^2$

Calculate the group factor per NDS 10.3-1

$$C_g := \left\| \begin{array}{l} \gamma \leftarrow 0\ \dfrac{lbf}{in} \\ \gamma \leftarrow 270000\ \dfrac{lbf}{in} \cdot \left(\dfrac{D}{in}\right)^{1.5} \\ u \leftarrow 1 + \dfrac{\gamma}{\dfrac{lbf}{in}} \cdot \dfrac{s}{2 \cdot in} \cdot \left(\dfrac{1}{\dfrac{E_m}{psi} \cdot \dfrac{A_m}{in^2}} + \dfrac{1}{\dfrac{E_s}{psi} \cdot \dfrac{A_s}{in^2}} \right) \\ m \leftarrow u - \sqrt{u^2 - 1} \\ R_{EA} \leftarrow min\left(\dfrac{E_s \cdot A_s}{E_m \cdot A_m}, \dfrac{E_m \cdot A_m}{E_s \cdot A_s} \right) \\ \text{return } \dfrac{m \cdot \left(1 - m^{2 \cdot N_{bolts}}\right)}{N_{bolts} \cdot \left(\left(1 + R_{EA} \cdot m^{N_{bolts}}\right) \cdot (1 + m) - 1 + m^{2 \cdot N_{bolts}}\right)} \cdot \left(\dfrac{1 + R_{EA}}{1 - m} \right) \end{array} \right. = 0.9998$$

Calculate the Geometry Factor per NDS 11.5.1

$$C_\Delta := \left\| \begin{array}{l} C_{end\_distance} \leftarrow 1.0 \\ C_{fastener\_spacing} \leftarrow 1.0 \\ \text{if } 2 \cdot D \le End\_Distance \le 4 \cdot D \\ \quad \left\| C_{end\_distance} \leftarrow \dfrac{End\_Distance}{4 \cdot D} \right. \\ \text{else if } End\_Distance < 2 \cdot D \\ \quad \left\| C_{end\_distance} \leftarrow 0.0 \right. \\ \text{else} \\ \quad \left\| C_{end\_distance} \leftarrow 1.0 \right. \\ \text{if } 3 \cdot D \le s \le 4 \cdot D \\ \quad \left\| C_{fastener\_spacing} \leftarrow \dfrac{s}{4 \cdot D} \right. \\ \text{else if } s < 3 \cdot D \\ \quad \left\| C_{fastener\_spacing} \leftarrow 0.0 \right. \\ \text{else} \\ \quad \left\| C_{fastener\_spacing} \leftarrow 1.0 \right. \\ \text{return } min\left(C_{end\_distance}, C_{fastener\_spacing}\right) \end{array} \right. = 1$$

Calculate the connection ASD Capacity: $C_D := \begin{bmatrix} 0.9 \\ 1.15 \\ 1.15 \\ 1.6 \end{bmatrix}$ $C_m = 1$ $C_g = 0.9998$ $C_\Delta = 1$

$P_{uplift\_ASD} := \left| P_{asd_3} \right| = 98.4\ lbf$

$Z` := Z \cdot C_{D_3} \cdot C_m \cdot C_t \cdot C_g \cdot C_\Delta = 1642.851\ lbf$ NDS Table 10.3.1

$P_{allowable} := N_{bolts} \cdot Z \cdot C_{D_3} \cdot C_m \cdot C_t \cdot C_g \cdot C_\Delta = 3.286\ kip$ $\dfrac{P_{uplift\_ASD}}{P_{allowable}} = 0.03$

```
Calculations for NDS Fastener Connection:
    Fastener Type = Bolt
    Total Number of Fasteners = 2
    Fastener Diameter = 0.500 in
    Cm = 1.00, Ct = 1.00
    Cg = 1.00, Ceg = 1.00
    Cdelta_main = 1.00, Cdelta_side = 1.00
    Single Fastener Z` = 1643 lbs
    Connection Code Check = 0.03
    P = -0.10 kips vs 3.29 kips
    For 0.6 Dead + 0.6 Wind
```

Calculate the connection LRFD Capacity: $K_f := 3.32$ $\phi := 0.65$ $\lambda := \begin{bmatrix} 0.6 \\ 0.8 \\ 0.8 \\ 0.8 \\ 1.0 \end{bmatrix}$

$P_{uplift\_LRFD} := \left| P_{u_4} \right| = 215.1\ lbf$

$Z` := Z \cdot C_m \cdot C_t \cdot C_g \cdot C_\Delta \cdot K_f \cdot \phi \cdot \lambda_4 = 2215.795\ lbf$ NDS Table 10.3.1

$P_{LRFD} := N_{bolts} \cdot Z \cdot C_m \cdot C_t \cdot C_g \cdot C_\Delta \cdot K_f \cdot \phi \cdot \lambda_4 = 4.432\ kip$ $\dfrac{P_{uplift\_LRFD}}{P_{LRFD}} = 0.049$

```
Calculations for NDS Fastener Connection:
    Fastener Type = Bolt
    Total Number of Fasteners = 2
    Fastener Diameter = 0.500 in
    Cm = 1.00, Ct = 1.00
    Cg = 1.00, Ceg = 1.00
    Cdelta_main = 1.00, Cdelta_side = 1.00
    Single Fastener Z` = 2216 lbs
    Connection Code Check = 0.05
    P = -0.22 kips vs 4.43 kips
    For 0.9 Dead + 1.0 Wind
```

AISC Fillet Weld Design:

Weld Material: $F_{EXX} := 70\ ksi$

Weld Length: $L_{weld} := 3\ in$

Weld Thickness: $T_{weld} := \frac{3}{16} \cdot in$

Angle between load and axial direction of weld: $\theta := 90\ deg$

Fillet Welds: $\phi := 0.75$ $\Omega := 2.0$

Number of welds: $N_{welds} := 2$

Shear - Weld per AISC 8-1:

$$V_{n\_weld} := 0.6 \cdot F_{EXX} \cdot \frac{\sqrt{2}}{2} \cdot T_{weld} \cdot \left(1 + \frac{\sin(\theta)^{1.5}}{2}\right) = 8.353\ \frac{kip}{in}$$

LRFD Weld Capacity:

$$\phi V_{n\_weld} := \phi \cdot V_{n\_weld} = 6.265\ \frac{kip}{in} \qquad \phi V_n := \phi V_{n\_weld} \cdot L_{weld} \cdot N_{welds} = 37.587\ kip$$

```
Calculations for AISC Line Weld Connection:
    Number of Welds = 2
    Fexx = 70 ksi
    L = 3.000 in
    Thickness of Weld = 0.188 in
    Connection Code Check = 0.01
    P = -0.22 kips vs 37.59 kips
    For 0.9 Dead + 1.0 Wind
```

ASD Weld Capacity:

$$V_{asd\_weld} := \frac{V_{n\_weld}}{\Omega} = 4.176\ \frac{kip}{in} \qquad V_{asd} := V_{asd\_weld} \cdot L_{weld} \cdot N_{welds} = 25.058\ kip$$

```
Calculations for AISC Line Weld Connection:
    Number of Welds = 2
    Fexx = 70 ksi
    L = 3.000 in
    Thickness of Weld = 0.188 in
    Connection Code Check = 0.00
    P = -0.10 kips vs 25.06 kips
    For 0.6 Dead + 0.6 Wind
```

AISC - Check the strap for tension:

Steel Yield: $F_y := 36\ ksi$ Steel Fracture: $F_u := 58\ ksi$ $E := 29000\ ksi$

Tension: $\phi_y := 0.9$ $\phi_f := 0.75$ $\Omega_y := 1.67$ $\Omega_f := 2.0$

Thickness of Plate: $t_{plate} := \frac{1}{4} \cdot in$

Length of Plate: $L_{plate} := 3\ in$

Gross Area of Connected Part: $A_g := t_{plate} \cdot L_{plate} = 0.75\ in^2$

Bolt hole size: $d_{hole} := \frac{1}{2} \cdot in + \frac{1}{16} \cdot in = 0.563\ in$

Net Area of Connected Part: $A_n := A_g - d_{hole} \cdot t_{plate} = 0.609\ in^2$

Shear Lag Factor: $U := 1.0$

Effective Area of Connected Part: $A_e := U \cdot A_n = 0.609\ in^2$

$R_{n\_yield} := F_y \cdot A_g = 27\ kip$ $R_{n\_fracture} := F_u \cdot A_e = 35.344\ kip$

LRFD: $\phi R_{n\_Tension} := min\left(\phi_y \cdot R_{n\_yield}, \phi_f \cdot R_{n\_fracture}\right) = 24.3\ kip$

```
Calculations for AISC Tension Part Connection:
    Number of Parts = 2
    Fy = 36 ksi
    Fu = 58 ksi
    Gross Area Agt = 0.75 in^2
    Net Area Ant = 0.609 in^2
    Connection Code Check = 0.01
    P = -0.22 kips vs 24.30 kips
    For 0.9 Dead + 1.0 Wind
```

ASD: $R_{Tension} := min\left(\frac{R_{n\_yield}}{\Omega_y}, \frac{R_{n\_fracture}}{\Omega_f}\right) = 16.168\ kip$

```
Calculations for AISC Tension Part Connection:
    Number of Parts = 2
    Fy = 36 ksi
    Fu = 58 ksi
    Gross Area Agt = 0.75 in^2
    Net Area Ant = 0.609 in^2
    Connection Code Check = 0.01
    P = -0.10 kips vs 16.17 kips
    For 0.6 Dead + 0.6 Wind
```

AISC Bolt Design - A307:

Bolt Nominal Tension Strength: $F_{nt} := 45\ ksi$

Bolt Nominal Shear Strength: $F_{nv} := 27\ ksi$

Number of Bolts: $n := 2$

Diameter: $d := \frac{1}{2} \cdot in$

Single (1) or Double (2) Loading: $l := 2$

Shear Strength Calculation:

Per J3-1: $\phi := 0.75$ $\Omega := 2.0$

$$A_b := \pi \cdot \left(\frac{d}{2}\right)^2 = 0.196\ in^2$$

$$R_n := F_{nv} \cdot A_b \cdot n \cdot l = 21.206\ kip$$

$$\phi R_{n\_bolt\_shear} := \phi \cdot R_n = 15.904\ kip \qquad R_{bolt\_shear} := \frac{R_n}{\Omega} = 10.603\ kip$$

Bearing Strength Calculation: $\phi := 0.75$ $\Omega := 2.0$

Number of Plates: $N_{plates} := 2$

Material thickness: $t_{plate} = 0.25\ in$

Steel Fracture Strength: $F_u = 58\ ksi$

If deformation at service loads **IS** important: $R_n := 2.4 \cdot d \cdot t_{plate} \cdot F_u = 17.4\ kip$ AISC J3-6a

$$\phi R_{n\_bearing} := \phi \cdot R_n = 13.05\ kip \qquad R_{bolt\_bearing} := \frac{R_n}{\Omega} = 8.7\ kip$$

Tear out Strength Calculation: $\phi := 0.75$ $\Omega := 2.0$

Material thickness: $t_{plate} = 0.25\ in$

Edge Distance: $l_c := 1.5\ in$

Steel Fracture Strength: $F_u = 58\ ksi$

If deformation at service loads **IS** important: $R_n := 1.2 \cdot l_c \cdot t_{plate} \cdot F_u = 26.1\ kip$ AISC J3-6c

$$\phi R_{n\_bolt\_tearout} := \phi \cdot R_n = 19.575\ kip \qquad R_{bolt\_tearout} := \frac{R_n}{\Omega} = 13.05\ kip$$

Bolt Design Summary - LRFD Design:

$\phi R_{n\_bolt\_shear} = 15.904\ \boldsymbol{kip}$

$\phi R_{n\_bearing} = 13.05\ \boldsymbol{kip}$

$\phi R_{n\_bolt\_tearout} = 19.575\ \boldsymbol{kip}$

$$\phi R_n := min\left(\begin{bmatrix} \phi R_{n\_bolt\_shear} \\ \phi R_{n\_bearing} \\ \phi R_{n\_bolt\_tearout} \end{bmatrix}\right) = 13.05\ \boldsymbol{kip}$$

```
Calculations for AISC Shear Bolt Connection:
    Number of Bolts = 2
    Fnv = 27 ksi
    Bolt Diameter = 0.500 in^2
    Connection Code Check = 0.02
    P = -0.22 kips vs 13.05 kips
    For 0.9 Dead + 1.0 Wind
```

Bolt Design Summary - ASD Design:

$R_{bolt\_shear} = 10.603\ \boldsymbol{kip}$

$R_{bolt\_bearing} = 8.7\ \boldsymbol{kip}$

$R_{bolt\_tearout} = 13.05\ \boldsymbol{kip}$

$$R_{bolt} := min\left(\begin{bmatrix} R_{bolt\_shear} \\ R_{bolt\_bearing} \\ R_{bolt\_tearout} \end{bmatrix}\right) = 8.7\ \boldsymbol{kip}$$

```
Calculations for AISC Shear Bolt Connection:
    Number of Bolts = 2
    Fnv = 27 ksi
    Bolt Diameter = 0.500 in^2
    Connection Code Check = 0.01
    P = -0.10 kips vs 8.70 kips
    For 0.6 Dead + 0.6 Wind
```