Bottom Flange Attachment Connections for Pinkwood PKI®20/23/35Plus/40/50 Joists Limit States Design (Canada)

During building construction instances arise in which items are suspended from the bottom flange of the PKI® Joists. Such items could include ductwork, suspended ceiling, hoods, vents, sprinklers, lighting…etc. When such items are suspended from the bottom flange the connections and the load limitations must be accounted for.

1) Withdrawal connections into the bottom flange of PKI®20/23/35Plus/40/50 Joists with wood screws and lag screws:

- **Maximum allowed bottom flange factored concentrated load is 720 pounds every 5 ft. (360 pounds force each side of flange), unless it is limited by the withdrawal connection capacity as indicated below.**
- Loads attached to the bottom of the flange shall be accounted for the joist design.
- Minimum fastener distances: edge, end, and spacing shall be as per CSAO86-19.
- Penetration into the web is permitted.
- Withdrawal factored resistance was determined using a specific gravity of 0.42 (CSAO86-19 Table A.11). See Appendix A for a design example.
- Lead holes: For Wood Screws: No. 6, No. 8, No. 10, & No. 12, lead holes are not required (CSAO86-19 Clause 12.11.2.1)
- Clearance holes and lead holes for ¼" Hex Lag Screw (CSAO86-19 Clause 12.6.2.5):
    - The clearance hole for the unthreaded portion of the shank shall have the same diameter, d_F = ¼", and the same depth as the penetration length of the unthreaded shank.
    - The lead hole for the threaded portion of the shank shall have a diameter of $0.7d_F$ (0.175"). The length of the head hole shall fit the threaded portion of the lag screw.

PKI® Joists Flange Sizes

Joist Series	Flange thickness [in]	Flange width [in]
PKI®20	1.5	2.5
PKI®23	1.5	2.5
PKI®35Plus	1.5	3.5
PKI®40	1.5	3.5
PKI®50	1.5	3.5

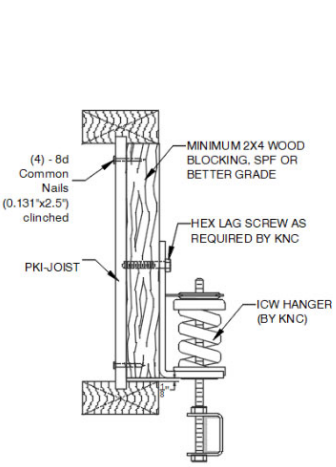
Common Screw Factored Withdrawal Resistance

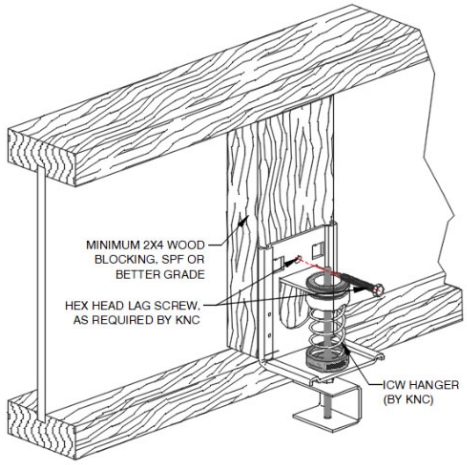
Fastener	Nominal Diameter [in]	W[1] [lb/in]	Wmax[2] [lb]
No. 6 Wood Screw	0.138	121	148
No. 8 Wood Screw	0.164	140	164
No. 10 Wood Screw	0.190	158	177
No. 12 Wood Screw	0.216	175	187
1/4" Hex Lag Screw	0.250	198	266

1) Factored withdrawal resistance as per CSAO86-19 based on the fastener nominal diameter. Capacity shown is in pounds per inch of thread penetration into the flange excluding the tip of the fastener.
2) Maximum factored withdrawal resistance is based on the threaded portion of the fastener engaging the full thickness of the flange. This may not occur with many fastener lengths and connections configurations. Capacity shown is in pounds force.

2) Suspended load detail for PKI®20/23/35Plus/40/50 Joists using ICW® Hangers by KNC:

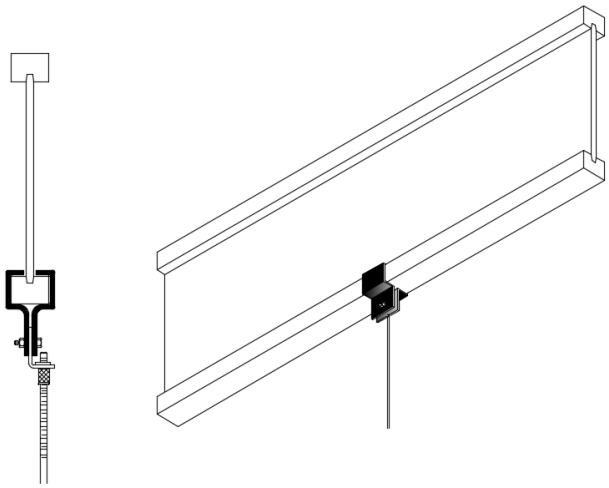
- **Maximum allowed bottom flange factored concentrated load is 300 pounds. Refer to the ICW hanger manufacturer for the hanger's resistance.**
- Loads attached to the bottom of the flange shall be accounted for the joist design.
- ICW hangers are typically space at 2 ft. on center (refer to the Kinetics Noise website: kineticsnoise.com/icw for more information regarding the ICW hangers and the maximum factored load allowed for this hanger).
- Install a 2x4 SPF (or better grade) wood blocking (grain oriented vertically) with 2 rows of 2- 8d Common Nails (0.131"x2-1/2"), clinched.
- ICW hangers shall not be installed on both sides of the web at the same location. There should be a min. distance of 2 ft. between any ICW hangers along the length of the joist.
- Minimum distances for the 8d Common Nails (0.131"x2-1/2") are as follows:
    - End distance = 2"
    - Edge distance = 1"
    - Distance between rows of nails = 1.5" (rows are parallel to the applied force direction)
    - Minimum spacing in a row = 3"





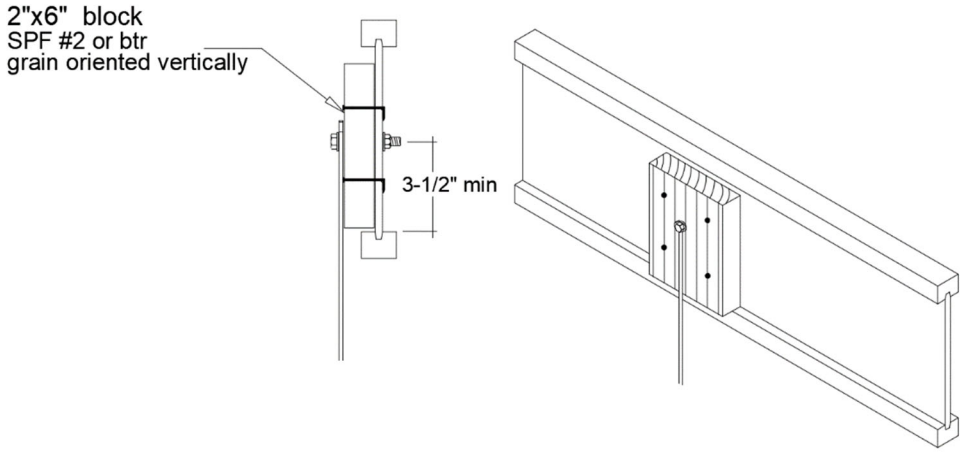
3) Load suspended directly from the bottom flange of PKI®20/23/35Plus/40/50 Joists with a bracket:

- **Maximum allowed bottom flange factored concentrated load is 720 pounds every 5 ft. unless it is limited by the bracket capacity. Refer to the bracket supplier for the bracket resistance.**
- Loads attached to the bottom of the flange shall be accounted for the joist design.
- Minimum bracket spacing along the bottom flange shall be 6 ft.
- Minimum bracket length = 2.5 inches.



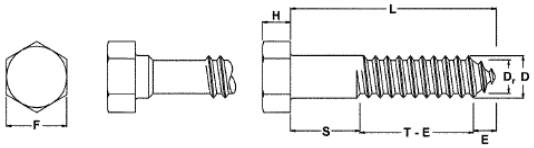
4) Load suspended from a 2x6 filler block for PKI®20/23/35Plus/40/50 Joists:

- **Maximum allowed bottom flange factored concentrated load is 360 pounds every 5 ft. unless it's limited by the suspended load connection capacity which needs to be provided by the professional of record.**
- Loads attached to the bottom of the flange shall be accounted for the joist design.
- Install a 2x6 SPF (or better grade) wood blocking (grain oriented vertically) with 2 rows of 2- 8d Common Nails (0.131"x2-1/2"), clinched.
- Minimum distances for the 8d Common Nails (0.131"x2-1/2") are as follows:
    - End distance = 2"
    - Edge distance = 1"
    - Minimum distance between rows of nails = 1.5" (rows are parallel to the applied force direction)
    - Minimum spacing in a row = 3"



1/4"x1-1/2" HEX LAG SCREW FACTORED WITHDRAWAL RESISTANCE THROUGH 1/4" METAL PLATE INTO BOTTOM FLANGE OF PINKWOOD PKI® 10/20/23/35Plus/40/50 JOISTS : CSAO86-19 Clause 12.6 - LSD DESIGN EXAMPLE

D = diameter, in.
D_r = root diameter, in.
S = unthreaded body length, in.
T = minimum thread length , in.



Reduced Body Diameter

Full-Body Diameter

E = length of tapered tip, in.
L = lag screw length, in.
N = number of threads/inch
F = width of head across flats, in.
H = height of head, in.

From 2018 NDS® Table L2, the 1/4"x1-1/2" Hex Lag Screw dimensions are as follows:

$D := 0.25 \cdot in$ $L := 1.5 \cdot in$ $T := 1.25 \cdot in$ $E := \frac{5}{32} \cdot in$ $S := 0.25 \cdot in$

The Factored Withdrawal Resistance, $W\left(\frac{lbf}{in}\right)$, is calculated as per CSAO86-19 Clause 12.6 as follows:

$d_F := D = 6.35\ mm$
$d_F = 0.25\ in$

d_F = nominal diameter of lag screw

$K_D := 1.0$ $K_T := 1.0$ $K_{SF} := 1.0$

K_D = 1.0 - Standard load duration factor

$G := 0.42$

G = mean relative density of flange (CSAO86-19:Table A.11)

$J_x := 1.0$
$t_{flange} := 38.1 \cdot mm$
$t_{flange} = 1.5\ in$
$n_F :=$ 1

n_F = number of fasteners in the connection

$\phi := 0.6$

$y_w := 59 \cdot \frac{N}{mm^{1.82}} \cdot {d_F}^{0.82} \cdot G^{1.77} \cdot J_x = 57.847\ \frac{N}{mm}$

y_w = specified withdrawal resistance per millimetre of threaded shank penetration into flange

$Y_w := y_w \cdot \left(K_D \cdot K_T \cdot K_{SF}\right) = 57.847\ \frac{N}{mm}$

$W := \phi \cdot Y_w \cdot n_F = 34.708\ \frac{N}{mm}$

$W = 198.188\ \frac{lbf}{in}$

lbf = pound force

W = Factored withdrawal resistance per inches of threaded shank penetration into flange, $\frac{lbf}{in}$

The Factored Withdrawal Resistance, P_{rw} (lbf), is calculated as per CSAO86-19 Clause 12.6 as follows:

$L_t := min\left(T - E, t_{flange} - E\right) = 27.781\ mm$
$L_t = 1.094\ in$

L_t = length of threaded shank penetration into flange.
For this example:
- the unthreaded length (S) has the same thickness as the metal side plate, so the shank does not penetrated the flange.
- the flange thickness (t_{flange}) minus the length of the taper tip (E) is greater than the length of thread engaged in the flange $T - E$, therefore, L_t = $T - E$. If $T - E >$ $t_{flange} - E$, L_t = $t_{flange} - E$.

$T - E = 1.094\ in$
$t_{flange} - E = 1.344\ in$
$P_{rw} := \phi \cdot Y_w \cdot L_t \cdot n_F = 964\ N$

$P_{rw} = 217\ lbf$

lbf = pound force

P_{rw} = Factored withdrawal resistance of the lag screw, which should be greater than or equal to the effect of the Factored Loads, lbf

Example:
- if the connection needs to support an Unfactored Live Load = 250 lbf, the Factored Live Load = 1.5(250 lbf)=500 lbf. The connection will require 3 lag screws since the Factored Withdrawal Resistance = 3(217 lbf)(1.0)=651 lbf >= Factored Load = 500 lbf, for a K_D=1.0.
- if the connection needs to support an Unfactored Dead Load = 150 lbf, the Factored Dead Load = 1.4(150 lbf)=210 lbf. The connection will require 2 lag screws since the Factored Withdrawal Resistance = 2(217 lbf)(0.65)=282 lbf >= Factored Load = 210 lbf, for a K_D=0.65.
- if the connection needs to support an Unfactored Dead Load = 75 lbf and an Unfactored Live Load of 200 lbf, the Total Factored Load = 1.25(75 lbf)+1.5(200 lbf)=394 lbf. The connection will require 2 lag screws since the Factored Withdrawal Resistance = 2(217 lbf)(1.0)=434 lbf >= Factored Loads = 395 lbf, for a K_D=1.0.

NOTE: Minimum end, edge, and spacing requirements shall be checked as per CSAO86-19